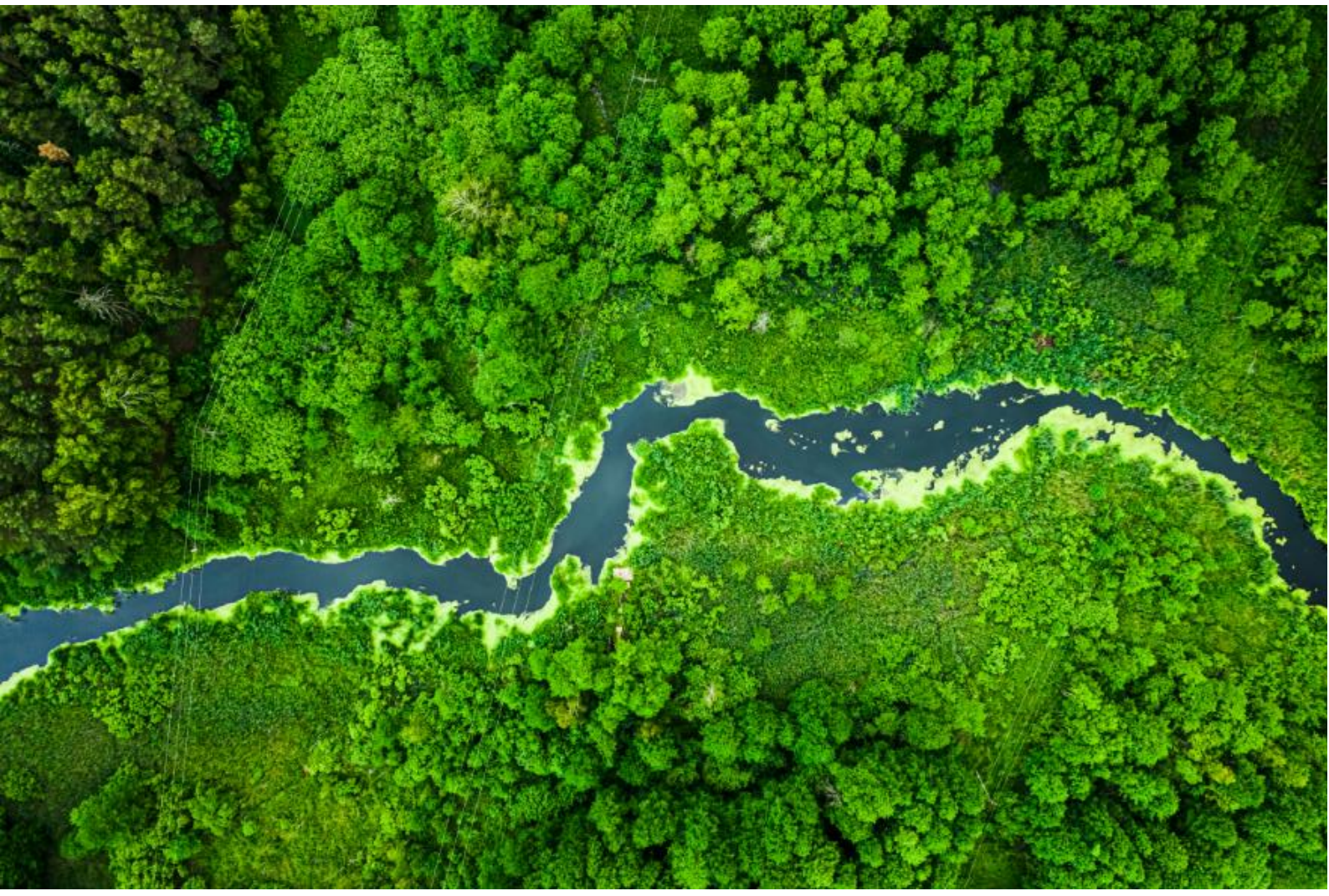
THE REPUBLIC OF POLAND

EIGHTH NATIONAL COMMUNICATION AND FIFTH BIENNIAL REPORT UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE



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EIGHTH NATIONAL COMMUNICATION AND FIFTH BIENNIAL REPORT
UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

prepared for the United Nations Framework Convention on Climate Change and the Kyoto Protocol

National Centre for Emissions Management
Institute of Environmental Protection
National Research Institute

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EXECUTIVE SUMMARY

S.1. Introduction

The present Eighth National Communication to the Conference of the Parties to the United Nations Convention on Climate Change is a continuation of the reports submitted by Poland to date to the Climate Convention Secretariat, including the Seventh National Communication submitted in 2017 and the Fourth Biennial Report submitted in 2019. The Eighth National Communication was prepared in accordance with Decisions 9/CP.16 and 6/CP.25 defining the due date for submission of reports and on the basis of the revised guidelines for its submission as laid down in the Annex to Decision 6/CP.25.

The Communication includes information on the period from 2016 to 2019 and on later years, if such data were available when the Communication was prepared. The Communication presents information on the national circumstances relevant to greenhouse gas emissions and removals and their inventory, describes the national policies and measures, as well as their effects and projections. Moreover, it presents the measures in the scope of adaptation to climate change, the development cooperation, technology transfer, research and observations, as well as education and the raising of the awareness of the Polish public.

S.2. Poland's circumstances relevant to greenhouse gas emissions and removals

The reconciliation of its economic growth with its care for the environment, including the reduction of the greenhouse emissions and other pollutants into the atmosphere, is the objective which Poland has successfully implemented, as evidenced by the significant reduction of its greenhouse gas emissions, along with the simultaneous GDP growth. It should be emphasised that the last two decades were the period of the continuous growth of the Polish economy, especially due to the new opportunities for cooperation and trade, access to technologies and sales markets, as well as the sources of financing related to Poland's accession to the European Union in 2004. The membership in the EU boosted the modernisation processes in the economy and contributed to the extensive expansion of infrastructure throughout the country. At the same time, the commitments made by Poland in the area of environmental protection are a large challenge, in particular for the energy sector. The dynamic economic growth clearly weakened in 2020, reflecting the global economic trends and actions taken in relation to the COVID-19 pandemic.

In 2019, in Poland primary energy was primarily produced from hard coal, lignite and natural gas. The energy production from renewable resources systematically grows in Poland, although the total primary energy production decreased in 2019. Until 2020, the energy efficiency also gradually improved in Poland and the greatest changes in the final energy consumption were found in transport and households, while the changes in the other sectors of the economy were slight. The change in the final energy consumption in the period from 2009 to 2019 resulted from many factors, including, among others, the activities in the particular sectors of the Polish economy, the lifestyles of society, energy conservation, structural changes or weather conditions. The resource productivity and the GDP can be seen to grow, while, at the same time, the national consumption of raw materials decreases (this is the so-called resource decoupling).

The number of cars grows in Poland, in particular passenger cars, with their average age exceeding 14 years. Despite the increasing railway passenger transport, still the road transport dominates freight transport. The air transport developed at the fastest pace, with the number of its

passengers tripling in the period from 2016 to 2019, while in 2020, due to the COVID-19 pandemic the air transport collapsed, with its operations falling by more than 83% compared with the previous years.

Industry is a particularly important pillar of the Polish economy, as it generates the largest part of the economic growth in Poland and its share in the generation of the GDP is higher than the average level in the EU. Despite the continued large share of energy-intensive branches of industry: the metallurgical, chemical and mineral industries, energy efficiency gradually improves and, as a result, the energy intensity of industrial output and greenhouse gas emissions decrease. An increasingly large number of companies use as far as possible renewable energy sources.

Households are one of the largest energy consumers in Poland, since they account for almost one fourth of the total final energy consumption, primarily for heating purposes. In the structure of energy consumption by Polish households, solid fuels, mainly hard coal and fuelwood, are most important. Due to Poland's climate conditions, which are characterised by transitionality and variability, the heating season needed to ensure the good functioning of the public in most regions of the country lasts approximately 7 months (from October to the end of April) and is often extended, to include September and May as well.

There were many positive changes in wastewater and waste management and, although the quantity of waste generated per capita in Poland has gradually grown for many years, this quantity continues to be lower than the average in the European Union and the Poles increasingly effectively collect waste selectively.

Far-reaching changes also came in the Polish agriculture sector which manages about 60% of the territory of the country. As a result of the structural changes, reducing the number of farms and, thus, at the same time, increasing their area, and access to the financial instruments used under the Common Agricultural Policy, along with the opportunities for exports to the EU market, the production significantly grew, in particular commercial production. Poland is one of the leading agricultural producers in the EU. In turn, forests, occupying 30% of the territory of the country, are an extremely important factor which mitigates the effects of climate change and plays important nature-related (protective), productive (economic) and social functions.

As regards the choice of the base year for the assessment of commitments arising under the UNFCCC, Poland adopted 1988 instead of 1990, as reflected in paragraph 5 of Decision 9/CP.2. The reason why Poland adopted the assumption concerning the change of the base year from 1990 to 1988 was the fact that 1990 was in Poland the first year following the fundamental political and economic changes, when the greenhouse gas emissions did not correspond to their normal levels, and, therefore, that year was not adequate as the base year.

S.3. Greenhouse gas inventory information

The unit responsible for preparing greenhouse gas inventories in Poland is the National Centre for Emissions Management (KOBiZE) established in 2009 and operating at the Institute of Environmental Protection – National Research Institute (IOŚ-PIB), supervised by the Minister of Climate and Environment. The KOBiZE IOŚ-PIB prepares annual inventories of greenhouse gases and substances defined in the Convention on Long-range Transboundary Air Pollution (UNECE CLRTAP) and submits them to the Minister. It also prepares datasets, including those on emissions, for the purposes of public statistics. The KOBiZE IOŚ-PIB also prepares projections of greenhouse emission

levels and submits them to the Minister responsible for climate and environment, who subjects them to internal and interministerial consultations, thus ensuring the consistency of the assumptions applied in the implemented and planned sectoral measures. After they are aligned and approved by the Government, these projections are forwarded to the EC and the UNFCCC Secretariat.

In 2020, the total national greenhouse gas emissions amounted to 376.04 million t CO_2 eq., excluding the LULUCF sector. Compared with 1988, the emissions in 2020 fell by 35.1%. Carbon dioxide dominated the national emissions, with its 80.7% share, the share of methane represented 11.8%, that of nitrous oxide was 6.1%, while F-gases accounted as a total for about 1.4%. The carbon dioxide emissions per capita in Poland fell from 12.5 t CO_2 in 1988 to 7.9 t CO_2 in 2020, while the emissions of all the GHGs decreased, respectively, from 15.3 t CO_2 eq. per capita to 9.8 t CO_2 eq. per capita.

The aggregated greenhouse emissions significantly fell between 1988 and 1990 as a result of transformations in the Polish economy, in particular in the heavy industry. Afterwards the national GHG emissions fell below 500 million t CO_2 eq. and varied about 400 million t CO_2 eq. The last increase in GHG emissions was noted in the period from 2016 to 2018. This was caused by economic prosperity and in particular the related higher fuel consumption in the road transport sector, experiencing dynamic carriage growth. Later, in 2019 the national GHG emissions fell by 5.1% compared with the previous year, mainly as an effect of lower fuel combustion in stationary sources, primarily that of coal (by about 8%) and that of lignite (by more than 15%). This resulted, among others, from the reduction of electricity generation, in particular from fuels, with the increased share of energy from RES and natural gas. Apart from the energy sector, the emissions also declined in agriculture, among others, as a result of lower consumption of mineral fertilisers, and in the sector of industrial processes, primarily as a result of a lower output in metallurgy. 2020, which was the first year of the COVID-19 pandemic in Poland, was another year with lower GHG emissions, as an effect of a further drop in the fuel combustion in stationary sources (that of coal by more than 6% and that of lignite by more than 8%) and in transport (that of petrol by almost 7% and that of diesel oil by almost 3%) compared with 2019.

Apart from the energy sector, the emissions also declined in the sector of industrial processes, mainly as a result of a lower output in metallurgy (with the basic oxygen steel production falling by 20%, that of pig iron by more than 18% and that of sinter by about 24%), as well as lower lime production (by more than 5% compared with 2019). Emissions also fell in the waste sector, where the quantity of waste disposed of at landfills decreased (by almost 5%) and so did the quantity of waste incinerated without heat recovery (by almost 22%).

The energy sector had the largest share in the sectoral structure of the total GHG emissions in Poland in 2020 (excluding the LULUCF), i.e. about 81.2%, while within this sector the fuel combustion processes had the largest share (75.5%). It was followed by agriculture with 9.1%, industrial processes with 6.7% and waste with 3.0%. The emissions in all the source categories fell compared with those in 1988, with the largest decreases in the sectors of waste and agriculture (respectively, by 48.2% and 31.6%).

In order to ensure a high quality of the national greenhouse gas inventories, Poland implements the National Programme for the Quality Assurance and Quality Control (QA/QC) of the National Greenhouse Gas Inventories. The KOBiZE IOŚ-PIB coordinates and implements QA/QC procedures and presents the in the annual National Inventory Reports (NIR). The QA/QC Programme sets out the tasks, the scope of responsibilities and the timetable for the implementation of the procedures and also contains a revised plan for improving the inventory QA/QC.

S.4. Policies and measures

In Poland, the Minister of Climate and Environment is responsible for the area of climate policy, including the implementation of the tasks under the UNFCCC, the Kyoto Protocol and the Paris Agreement, as well as for energy and forest policies. At the central level, in addition to the Minister of Climate and Environment, the Ministers responsible for the implementation of the sustainable development strategy, environmental policy and climate policy of the country into sectoral policies are also competent in the scope of the UNFCCC. The Minister of Climate and Environment involves the institutions subordinated to her, including the scientific research institutes (IOŚ-PIB, IBL and IMGW-PIB) in the implementation of the tasks under the UNFCCC, the Kyoto Protocol and the Paris Agreement. The system for financing environmental protection in Poland consists of the National Fund for Environmental Protection and Water Management (NFOŚiGW) and the Voivodeship Funds for Environmental Protection and Water Management (WFOŚiGW), as independent entities. The NFOŚiGW is a source of funding for environmental projects with a higher than regional character and also the operator of the resources which Poland receives from the EU Funds.

The Minister of Climate and Environment is also responsible for the monitoring and assessment of progress in the implementation of climate policy, including climate change mitigation policies and measures, and the GHG emission reduction targets. The climate change mitigation policies and measures and progress in the achievement of the GHG emission reduction targets are monitored pursuant to the 2009 national regulations, under which the system for inventorying, monitoring, reporting and projecting GHG emissions was established. The legal basis was also created for the management of the national GHG emission ceiling in a manner which would ensure that Poland could fulfil its international and EU commitments and enable the optimisation of the emission reduction costs. The main element of this system is the KOBiZE at the IOŚ-PIB which has been mandated by statute to carry a number of tasks.

As a Member State of the EU, Poland co-creates EU climate policy and is obliged to implement the EU regulations in this area. As a result of this, most actions which Poland carries out in the scope of climate change mitigation follow from the EU regulations. Part of them apply directly, while others, e.g. Directives, are implemented into the national legal order by means of Polish legal acts. Key national policies and measures contribute to GHG emission reductions and Poland's fulfilment of its commitments in the area of emission reductions. They also reflect the key directions of the development of EU climate policy. The Communication presents the main documents of a strategic character and the key legal regulations contributing to climate change mitigation, as well as policies and measures broken down into the particular sectors of the economy; as a total, 54 key policies and measures carried out by Poland to reduce GHG emissions and to fulfil its commitments in this area.

The policies and measures in the particular sectors of the economy are implemented on the basis of sectoral development strategies and legal regulations. The key instrument of a cross-sectoral character is the European Emission Allowance Trading System (EU ETS) implemented under Directive 2003/87/EC. The measures in the energy sector focus on the promotion of the development of RES, cogeneration and nuclear energy and the improvement of energy efficiency, in particular in buildings. Several systemic solutions are implemented in this scope (e.g. the auction-based support system for RES and the white certificate scheme) and a number of programmes are operated to provide grants and loans. In the transport sector, support for low- and zero-emission transport, collective transport (including urban transport), the use of biofuels and alternative fuels, and the improvement of road infrastructure are of key importance. In the sector of industrial processes,

in addition to the EU ETS system and the measures to improve energy efficiency in industry, the measures of essential importance are those intended to reduce the emissions of fluorinated greenhouse gases. The measures carried out in the agriculture sector primarily follow from the EU Common Agricultural Policy (CAP). They are measures to restore, preserve and enhance ecosystems related to agriculture and, at the same time, to implement the objectives of rural development (e.g. rational land management, the rationalisation of fertiliser use and the development of biogas use). The aim of the measures in the forestry sector is mainly to protect agricultural and forest land and to increase the forest cover in the country. In turn, in the waste sector, the measures focus on the development of wastewater and waste management. Depending on the availability of data, the estimated reduction effects were provide for part of policies and measures.

S.5. Projections and total effects of policies and measures

The national projections of greenhouse gas emissions and removals are presented in two variants, i.e. the scenario "*with existing measures*" (WEM), which includes the projected levels of greenhouse gas emissions and removals taking into account the adopted and already implemented policies and measures to reduce GHG emissions, and the so-called scenario "*with additional measures*" (WAM), which additionally includes planned measures.

In the scenario "*with existing measures*", the greenhouse gas emissions in Poland by 2040 will fall by 43% compared with 1988 and by 31% compared with 1990, with the largest reduction expected after 2030. In turn, for 2030 the expected greenhouse gas emission reduction levels will be 31% compared with 1988 and 16% compared with 1990.

The scenario "*with additional measures*" (WAM) projects that the greenhouse gas emissions in Poland by 2040 will fall by 53% compared with 1988 and by 43% compared with 1990. In turn, in 2030 the expected emission reductions will be 40% compared with 1988 and 27% compared with 1990. It should be added that the scenario "*with additional measures*" planned in the energy sector provides for the achievement of the reduction target for 2030 for the non-ETS sectors which has been specified for Poland in the EU climate and energy framework as −7% compared with 2005.

Since its submission in 2021 the sensitivity analysis has been expanded and includes two main basic projection scenarios: "*with existing measures*" (WEM) and "*with additional measures*" (WAM). The base year for that analysis was 2020, i.e. the last year of the current inventory of greenhouse gas emissions. The Communication addresses there variants of the analysis, i.e. the so-called sensitivity scenarios: (1) a gradual fall in the emissions of F-gases, (2) a 20% increase in the cattle population and (3) a 15% increase in the landfill of solid waste.

The STEAM-PL and MESSAGE models were applied to prepare a projection of the national energy demand. Its results were then used to estimate the greenhouse gas emissions from the energy sector. They are the same models and their results which were used to project activities for the energy sector in the Fourth Biennial Report (BR4).

S.6. Vulnerability assessment, climate change impacts and adaptation measures

Compared with the results presented in the Seventh National Communication, no major changes in the climate conditions were found, indicating fairly stable climate change trends in Poland. Over the last several dozen years warming has been clearly seen throughout Poland, although the rate of temperature changes has been regionally diversified. In the period from 1991 to 2020, the years

2019, 2020, 2018, 2015, 2014, 2008 and 2007 were the warmest. There has been a clearer increase in the frequency of high temperatures and in the number of extremely hot days, which is now even four times as high as before 1991. The average winters have become warmer, nevertheless there are from time to time long and intensive cold waves. Precipitation is characterised by strong variability between the years and seasons, as well as even greater regional diversification, while the annual precipitation totals slightly increase.

The climate change observed in Poland has not yet had a significant hazardous effect. However, as it progresses increased hazards for human safety and health, the environment and the economy, as a result, in particular, of the occurrence of extreme phenomena, can be expected. As the climate changes in Poland, the frequency and intensity of many extreme phenomena as heat waves, floods, droughts, strong storms or hurricanes grow, affecting human health and life, the economy and the natural environment. In recent years, the hazards resulting from strong winds and intensive rainfalls gained in large importance, often causing water rise, inundations or landslides. Analyses of the financial losses caused by the extreme phenomena showed that as a result of them Poland lost on average PLN 6 billion a year. Over less than two decades the extreme weather phenomena caused as a total about PLN 115 billion of direct losses in the period from 2001 to 2019. In the coming years the main climate change-related hazards in Poland will probably include droughts causing lower crop yields, forest fires and drinking water shortages, which, under the worst-case scenario, can affect as many as about 15 million Poles.

The national adaptation policy was formulated for the first time in a comprehensive form in 2013 in the Strategic Adaptation Plan for Sectors and Areas Vulnerable to Climate Change until 2030, while in 2021 work began to update this plan. In recent years, the Government launched many initiatives in the scope of strategic planning and programming in Poland and the comprehensive development management system. Work is underway to update the flood risk management plans, while the National Urban Policy 2030 adopted in 2022 is the document shaping the policy of cities on spatial management and such challenges as demographic problems, climate change, development problems and functional areas.

The adaptation problems are also addressed by the institutions responsible for the agriculture sector. As part of the future agricultural policy, different types of actions are planned to protect the environment and to tackle climate change.

The long-term forest policy measures were laid down in "*The comprehensive programme to prevent the forest dieback processes in Poland and to take mitigation measures until 2030*". Its aim is to avoid the emergence of natural phenomena (droughts and fires) or to minimise their adverse effects, to prevent the destructive impact of high waters, floods and inundations by developing small retention systems, and to strengthen the resilience of forest ecosystems threatened by progressing climate change. As part of forest policy, measures are also taken to combat droughts and fires.

The regional and local character of adaptation to climate change conditions the preventive initiatives which need to be undertaken in order to protect the local communities that are the most vulnerable to climate change and areas or sectors that are particularly vulnerable to extreme events.

The selected examples of measures in Poland demonstrate the complexity and diversity of the adaptation process which involves different entities, both Government bodies, EU funds, self-government authorities, nongovernmental organisations and residents (these are e.g. projects on blue-green infrastructure, sustainable rainwater management, local systems informing and warning about risks, especially flood risks, or renaturalisation of water ecosystems).

In recent years, many initiatives were launched in Poland to build the knowledge of climate change and to disseminate it among the public. Under the Project KLIMADA 2.0, i.e. the "*Knowledge base on climate change and adapting to climate change impacts, together with knowledge dissemination channels, to strengthen economic, environmental and societal resilience as well as to support the management of extraordinary risks associated with climate change*", a portal was launched to address climate change, also making available climate scenarios, the assessment of the climate change risks, the best adaptation practices, as well as the legal and economic aspects. In 2020, as part of the initiative "*Climate-friendly Cities*" of the Ministry of Climate and Environment, city workshops were held as a series of discussions with self-governments and nongovernmental organisations on the common vision of a climate friendly and neutral city and the tools to support the transition of cities. University-level schools, self-governments and nongovernmental organisations also play a large role in the dissemination of the knowledge of adaptation to climate change.

S.7. Financial, technological and capacity-building support

Fulfilling its international commitments and fully understanding the need to support sustainable development at the global level, Poland takes action to provide assistance to developing countries, in accordance with the principle of international solidarity. Poland is not one of the Parties listed in Annex II to the Climate Convention; therefore, it is not obliged to fulfil the commitments under Articles 4.3, 4.4 and 4.5 of the Convention to provide financial assistance to developing countries. However, since it acceded to the European Union in 2004, Poland has implemented a substantial number of assistance programmes and actions, but solely on a voluntary basis, making its contribution in accordance with the provisions of Article 9.2 of the Paris Agreement.

Poland carries out many assistance projects by making financial assistance available through bilateral and multilateral channels as part of official development assistance (ODA). As a total, in the period from 2016 to 2020 Poland provided more than PLN 289 million (USD 78 million) for the climate-related development assistance. Most of the resources were allocated to adaptation to climate change (82%), with part of them earmarked for climate change mitigation (6%). The total values of Poland's official development assistance in the period from 2016 to 2020 indicate a growing trend and the average rate of ODA as a percentage of the Gross National Income (ODA/GNI) in the period from 2016 to 2020 was about 0.14%. The multilateral cooperation in the period from 2016 to 2020 within the framework of which development projects and programmes were implemented represented about 75% of the official development assistance provided by Poland to developing countries. The most important channel, representing about 90% of the value of the assistance, which Poland uses to provide multilateral assistance is the European Union, by way of a contribution to the EU budget (a part of which is earmarked for external EU development assistance) and by way of contributions to the European Development Fund (EDF). In addition, the multilateral cooperation is implemented by way of contributions to the budgets of international organisations. In general, the support areas under Poland's development assistance covered a wide range of actions, including, among others, water supply, funding of fire and rescue services, disaster prevention, an exchange of experiences related to climate policy, raising of awareness, waste management/disposal, environmental policy and administrative management and solar energy production. This cooperation focused on partner countries in Eastern Europe and selected partner countries in Africa and Middle East.

Poland also allocated resources to promote technological development in developing countries. In the period from 2016 to 2020, the resources were provided for the transfer of technology

as part of the GreenEvo – Green Technology Accelerator Programme, designed to create favourable conditions for the dissemination of environmental protection technologies offered by Polish entrepreneurs in Poland and abroad. The actions taken as part of the Programme comprehensively stimulated the development and strengthened the position of advanced green technologies in the process of building the circular economy. Just as in the case of financial assistance, by way of its own contributions to the EU assistance budget, i.e. to the European Development Fund (EDF), Poland participated in EU projects and programmes intended to support the development and transfer of technology, e.g. Climate Technology Centre & Network and Switch to Green.

S.8. Research and systematic observations

The Ministry of Education and Science played the role of the leading centre for creating and coordinating science policy in Poland. The National Science Centre and the National Centre for Research and Development were responsible for creating programmes and funding research projects. The National Research Programme indicated the strategic directions of research and development work, including the issues of climate change and adaptation. The regulations adopted in 2018 significantly reorganised the system of higher education and science in Poland by introducing the guidelines defining the basis for the higher education and science system and setting out the scope of research activity.

In Poland, research in the field of climatology includes: physical climatology, climatology of areas exposed to large anthropogenic pressures, dynamic climatology, regional climatology, applied climatology and research on climate change and the factors which trigger and strengthen it. The Communication describes research projects on climate change. Poland carries out intensive research in the scope of climate change modelling and projection. Observations and measurements as part of the global system of weather and climate observations are carried out by the State Hydrological and Meteorological Service at the Institute of Meteorology and Water Management – State Research Institute (IMGW–PIB). The whole national network, consisting of about 1,000 points, implements a measurement and observation programme conforming to the WMO standards.

In the period from 2016 to 2020, the national gross R&D outlays in Poland grew by almost 45%: from PLN 17.9 billion to PLN 25.6 billion in current prices and almost tripled since 2010. In 2020, the national gross outlays on research and observations amounted to PLN 32.4 billion, so they grew by 7% compared with the previous year, while the R&D/GDP ratio was 1.39%. At present, the science budget consists, among others, of the statutory activities of research units, scientific foreign cooperation, the activity to disseminate science and EU funds.

S.9. Education, training and public awareness of global climate change

Poland effectively implements the recommendations of Article 6 of the UNFCCC in the scope of environmental education, access to information on the environment or training courses in these areas. These actions are implemented in Poland in the formal education system and to a large extent due to the activity of civic organisations and university-level schools, the well-developed infrastructure of non-formal education and the system of funds financing education projects.

Poland's response to its commitments under Article 6 of the UNFCCC was laid down in its National Environmental Policy 2030 (PEP2030). The aim of the PEP2030 is to develop the potential of the environment for citizens. In Poland, in accordance with the National Strategy for Environmental Education, the Ministries in the areas of the environment and education, with the participation of all

the Ministries within the range of their competence, are responsible, as the leading entities, for environmental education, including education in the area of climate change mitigation. This Strategy also emphasises the need to implement national education activities within the framework of both formal education and broad non-formal education contributing to raising the public awareness, including the understanding of the impact of the climate process on social and economic life. The Ministry of Climate and Environment supports environmental education and the raising of the environmental awareness of the public, with their components including: knowledge of the environment, practical competences and the environmentally friendly motivation to change attitudes and everyday behaviour. In the general education process, Polish schools are obliged, among others, to deliver environmental education at all the education stages, including the upbringing at kindergartens, The core curriculum emphasises the upbringing of pupils in harmony with nature and the development of attitudes conditioning their efficient and responsible functioning in the contemporary world.

In addition to the formal education pathway, environmental education is delivered as part of extracurricular education, provided by specialised centres, nongovernmental organisations, territorial self-governments, public environmental protection institutions and the mass media. In accordance with the recommendations of the COP25 decisions, the official participation of youth in the decision-making on climate was also strengthened in Poland by the actions of the Youth Climate Council as a body providing opinions to the Minister of Climate and Environment.

In Poland, there are numerous and diverse entities involved in environmental education in Poland which are supported a well-developed infrastructure (centres, didactic materials and differentiated methods of delivery). Diversified forms of forest education carried out on a wide scale by State Forests are particularly important. In addition to environmental education, actions are taken in Poland to shape sustainable consumption patterns. The awareness of business also grows, involving especially the efforts taken by large organisations associating employers and enterprises to develop the competences of their employees and to prepare the environmentally friendly development strategies of companies.

The Ministry of Foreign Affairs has a special role to play in the development of education which addresses climate issues at the global level, including Poland's responsibility for assistance in the process of adaptation to climate change in developing countries. Poland's representatives and numerous institutions, schools, nongovernmental organisations and self-governments take an active part in international cooperation at many levels. To a large extent, the international cooperation manifests its educational aspects and promotes the understanding of climate change, an exchange of experiences in the mitigation of the adverse effects of climate change and the development of the ways in which society and the economy can adapt to the changing environmental conditions.

CHAPTER 1. INTRODUCTION

The present Eighth National Communication and the Fifth Biennial Report to the Conference of the Parties to the United Nations Framework Convention on Climate Change was prepared in accordance with Decisions 9/CP.16 and 6/CP.25 which specify the due date for submission of the national communications and on the basis of Decision 6/CP.25 and the Annex thereto which present the revised "*Guidelines for the preparation of national communications by Parties included in Annex I to the Convention*" and define the content of the communications.

The Communication presents information on the period from 2016 to 2019 in the following areas:

- Poland's circumstances relevant to greenhouse gas emissions and removals;
- Greenhouse gas inventory information;
- Policies and measures;
- Projections and total effects of policies and measures;
- Vulnerability assessment, climate change impacts and adaptation measures;
- Development assistance and technology transfer under Articles 4.3, 4.4 and 4.5 of the UNFCCC;
- Research and systematic observations;
- Education, training and public awareness of global climate change.

Although this Communication presents information on the period from 2016 to 2019, it also provides information for later years if such data were available when the Communication was prepared. The legal and strategic documents describe the national circumstances in place in the period until 2022. The information contained in the Communication represents a continuation of the information provided in Poland's previous Communications to the UNFCCC, including the most recent ones, i.e. the Seventh National Communication (2017) and the Fourth Biennial Report (2019). This Communication also presents the data on 2015 in order to ensure the continuity of the reported data and to enable a comparison of Poland's measures with those in 2015, i.e. the last year covered by the scope of the Seventh National Communication.

This Communication also fulfils the recommendations of the Conference of the Parties for the preparation by developed countries, as set out in Decision 2/CP.17, of the Fifth Biennial Report, the due date and a substantial part of the scope of which coincide with those of the Eighth National Communication. In light of this, the present document also contains information required for biennial reports in the form of Annex 1. In order to avoid duplication of information in the Eighth National Communication and the Fifth Biennial Report, the latter was limited to tables in the Common Tabular Format (CTF).

Additional information required under Article 7(2) of the Kyoto Protocol is provided in the particular sections of the Communication. Table 1.1 presents a summary of additional information required under Article 7(2) of the Kyoto Protocol, with an indication of the relevant sections where this information is reported.

Table 1.1. Summary of additional information reported under Article 7(2) of the Kyoto Protocol

information reported under Article 7(2)	**Section of the Eighth National Communication**
National inventory system	Section 3.2
National registry	Section 3.3
Additionality related to the mechanisms under Articles 6, 12 and 17	Section 4.1
Policies and measures under Article 2	Sections 4.2 and 4.3
National and regional programmes and/or administrative procedures	Section 4.1
Information required under Article 10	
Article 10(a) (measures taken to improve national inventories)	Section 3.2
Article 10(b) (mitigation and adaptation measures)	Sections 6.7 and 6.8
Article 10(c) (measures related to technology transfer)	Section 7.3
Article 10(d) (measures related to systematic observations)	Chapter 8
Article 10(e) (measures related to international education, training and public awareness)	Chapter 9
Financial resources	Chapter 7

CHAPTER 2. POLAND'S CIRCUMSTANCES RELEVANT TO GREENHOUSE GAS EMISSIONS AND REMOVALS

2.1. Organisation of the state

The Republic of Poland is a constitutional republic with a parliamentary and cabinet system and a classical separation of powers into legislative, executive and judicial ones. The legislative power is exercised by a bicameral Parliament consisting of the Sejm (the Chamber of Deputies) and the Senate (the Chamber of Senators). The Sejm and the Senate sitting in a joint session constitute the National Assembly.

The executive power is exercised by the President and the Council of Ministers. The Government performs its duties through government administration authorities and units. At the national level they are: the Ministries, central offices and foreign services, and at the regional level – Voivodes (Voivodeship governors representing the Government in 16 Voivodeships), Voivodeship Offices (subordinated to Voivodes) and territorial units of integrated government administration. At the same time, under the principle of decentralisation of public power, some tasks intended to satisfy the needs of residents' communities are shifted to the competence of territorial self-government units.

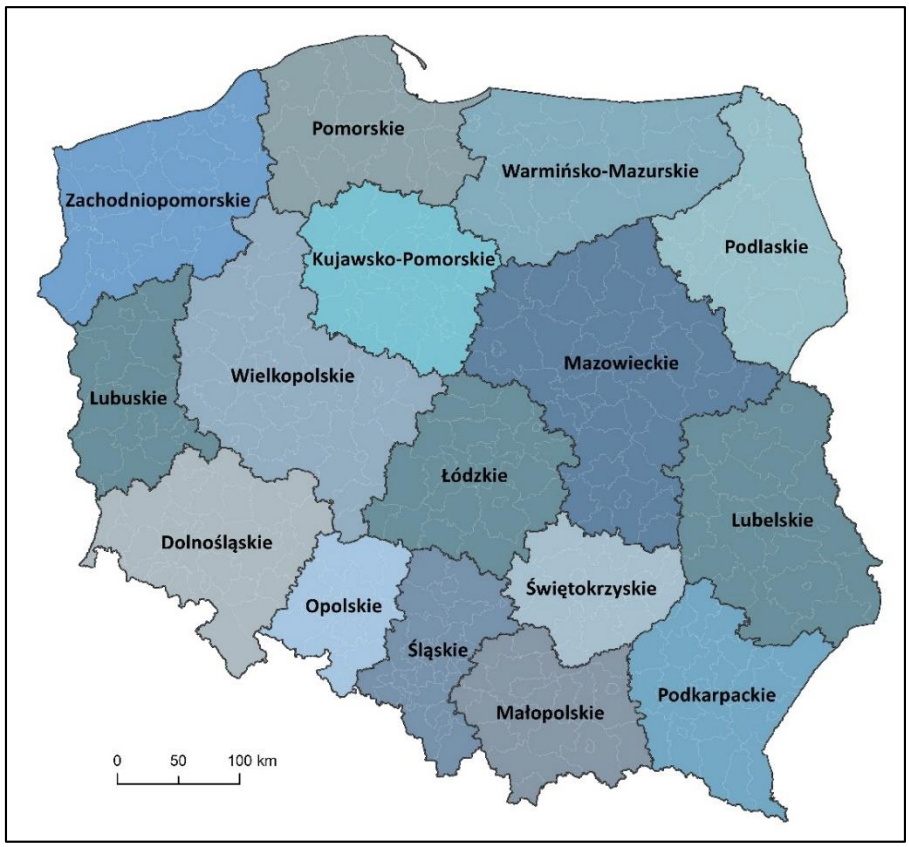


Fig. 2.1. Poland's administrative division
Source: https://www.geoportal.gov.pl/dane/panstwowy-rejestr-granic

Poland has a three-tiered territorial division. It consists of municipalities, counties and voivodeships. The basic self-government unit is a municipality, a higher unit is a county and the highest one is a voivodeship. As of 31 December 2020, in Poland there were 16 voivodeships, 314 counties, 66 cities with the rights of a county and 2,477 municipalities: 302 urban ones (including 66 municipalities also having the status the rights of a county), 1,533 rural ones and 642 urban-rural ones [Statistical Yearbook 2021, GUS 2022].

2.2. Population profile

As of 10 November 2022, Poland's population in 2021 was 37,907,000 persons. The population density in Poland varies spatially. The average density is 121 persons per 1 km^2, in the most urbanised region, i.e. Śląskie Voivodeship, it is 355 persons per 1 km^2, whereas in the most sparsely populated Voivodeships: Warmińsko-Mazurskie and Podlaskie, the density is 57 persons per 1 km^2. The number and share of urban residents in the total national population have slightly diminished since 2005, representing about 60%. In recent years, the working-age population declined, whereas the post-working age population grew.

Table 2.1. Population age structure in the period from 2005 to 2020 [thousand]

Population age	2005	2010	2015	2019	2020
Pre-working	7 864	7 243	6 902	6 949	6 954
Working	24 405	24 831	24 002	23 026	22 771
Post-working	5 888	6 456	7 533	8 408	8 540
Total	38 157	38 530	38 437	38 383	38 265

Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Statistical Yearbooks 2016-2021

2.3. Economic situation

Poland's economy systematically grew in recent years and its GDP gradually increased in the period from 2015 to 2019. After 2019 the GDP growth rate began to fall and its decrease reflected the trends in the response of the world economies to the crisis caused by the COVID-19 pandemic.

Table 2.2. GDP in Poland in the period from 2015 to 2020

Specification	2015	2016	2017	2018	2019	2020
GDP (million PLN, current prices)	1 798 471	1 853 205	1 982 794	2 126 506	2 288 492	2 337 672
GDP growth rate (Previous year = 100)	104.4	103.0	105.1	105.9	104.5	98.0

Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS

In recent years, the volume of Poland's foreign trade systematically grew, particularly in exports. In the period from 2015 to 2020, the export and import growth rates were varied. Despite an adverse impact of the COVID-19 pandemic on the condition of the world economies, in 2020 Poland reached an exceptionally high positive foreign trade balance of PLN 132.3 billion. In the period from 2016 to 2019, Poland's exports grew by more than 30% and imports increased by more than 29%.

Table 2.3. Foreign trade volume in the period from 2015 to 2021 [million PLN, current prices]

Specification	2015	2016	2017	2018	2019	2020	2021
Imports	815 939	876 040	976 041	1 078 191	1 132 652	1 106 497	1 430 968
Exports	853 380	931 575	1 032 157	1 121 690	1 217 371	1 238 754	1 519 546
Balance	37 441	55 535	56 116	43 499	84 719	132 257	88 578

Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from the GUS

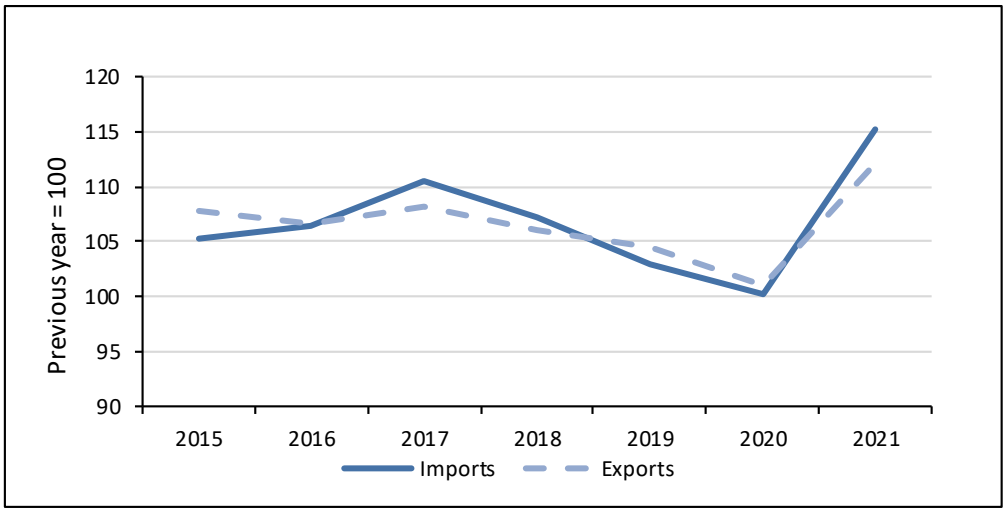


Fig. 2.2. Import and export growth rates in the period from 2015 to 2019 (current prices, the previous year = 100)
Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from the GUS

2.4. Geographical conditions

Poland is situated where Western Europe and Eastern Europe meet in the area of the North European Plain, between the South Baltic Coast and the ranges of the Sudety and Carpathian Mountains. Due to such a geographical situation, the country is characterised by large diversification in terms of climate, landscape and nature, with a specific feature of the transitionality between the conditions shaped by Atlantic influences from the west and the continental ones affecting them from the east, since in the extensive area of the North European Plain there are no longitudinal physico-geographical barriers. In addition, in Northern Poland the environment clearly demonstrates coastal, Baltic features, whereas in the South, within the mountain ranges and uplands, mountain and submontane features can be seen.

Fig. 2.3. Geographical situation of Poland
Source: https://www.openstreetmap.org

Poland's territory occupies a terrestrial area of 322,719 km^2 [Environmental Protection 2022, GUS 2022].

The diversification of Poland's landscape and ecosystems results from the belt-like system of geographical regions which extend latitudinally. A lowland landscape dominates, representing most of the territory of the country, along with the lake district landscape and the landscape of the Baltic coast. In the south, there are uplands and mountains ranges, including high mountains (up to 2,499 m a.s.l.). The areas rising above 500 m a.s.l. represent only 3% of the territory of the country. Each geographical region is characterised by the presence of specific ecosystems which, together with the plant and animal species living in them, make up the natural riches of Poland. Their specific character is shaped in a special way by: the geographical situation in the transitional climate zone with the influences of the oceanic air masses from the west and the continental ones from the east, the diversified relief of the terrain, the hydrographic system and the variability of the soil substrate.

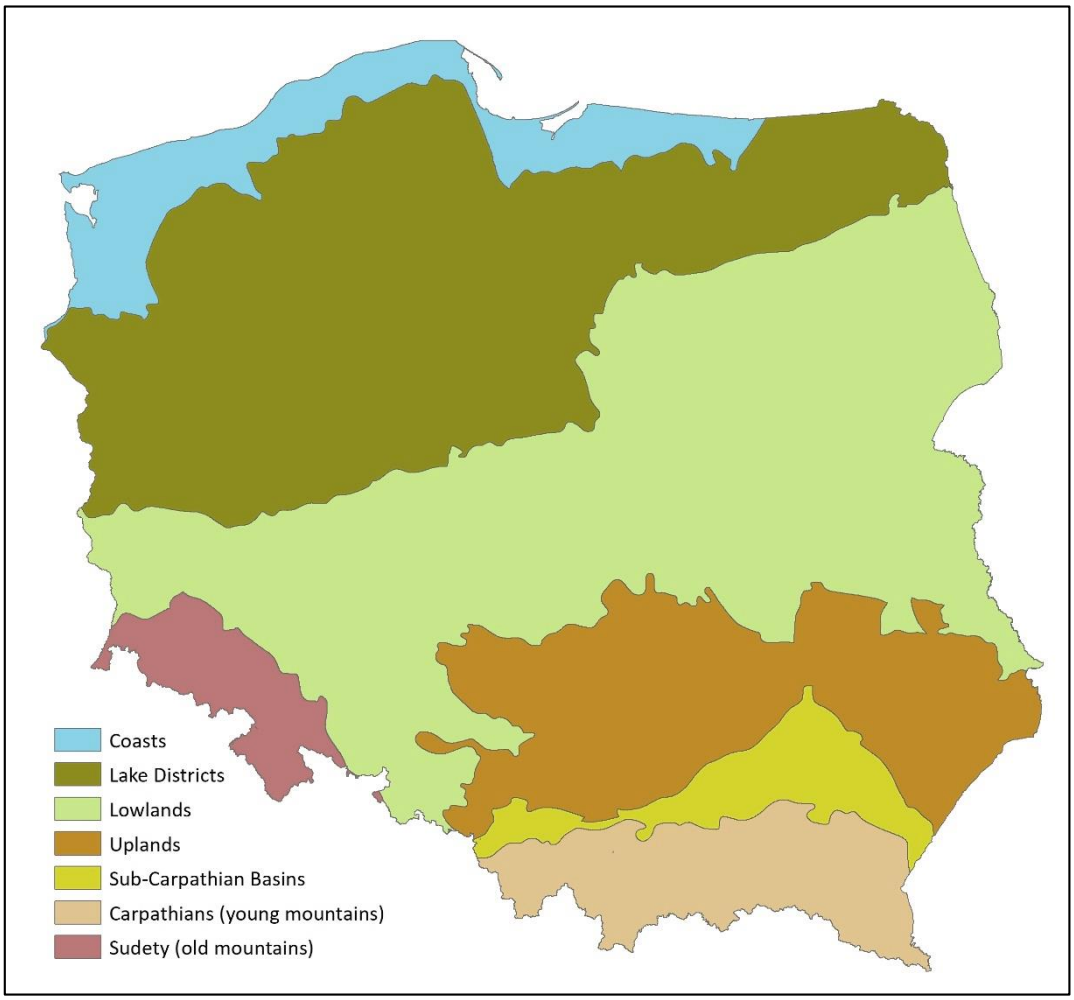


Fig. 2.4. Geographical regions of Poland
Source: https://geoserwis.gdos.gov.pl/mapy/

The most valuable ecosystems and habitats of a natural and semi-natural character are extensive wetlands, including peatlands, extensive meadows and pastures, in river valleys, mountain and xerothermic grasslands, as well as compact forest complexes. They constitute refuges of plants and animals, including many endemic species. In Poland, strict conservation covers 415 plant species, 232 fungal species and 589 animal species, including 50 mammal species and 427 bird species.

The natural values are subject to the legal protection by the state, covering different categories of protected areas. In 2020, there were: 23 national parks, including 10 designated as world biosphere reserves, 1,502 nature reserves, 126 landscape parks, 387 protected landscape areas, 181 documentation sites, 8,291 ecological sites and 327 nature and landscape complexes. Many of these areas have been incorporated into the European ecological network Natura 2000, which occupies about 20% of the terrestrial area of the county [Environmental Protection 2021, GUS 2022].

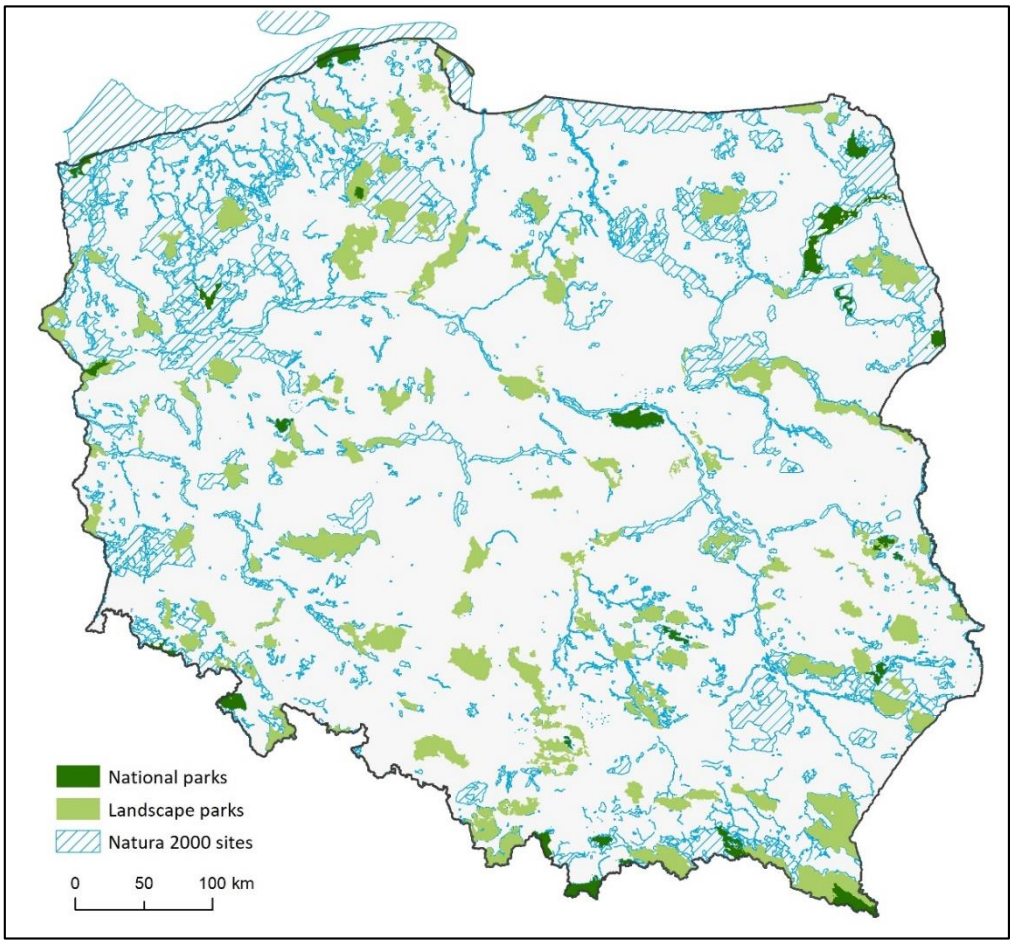


Fig. 2.5. Selected categories of protected areas
Source: https://geoserwis.gdos.gov.pl/mapy/

The land use in Poland is characterised by the dominating share of farmland (about 60% of the area of the country) and forests (more than 30%). As a result of the development of cities and settlements, as well as that of industrial, service and transport infrastructure, there is a systematic increase in built-up and urbanised land.

The extracted natural resources include energy raw materials, such as hard coal and lignite, as well as slight quantities of crude oil and natural gas. The extraction of metal ores is of large importance, particularly those of copper, zinc, lead and other minerals, including sulphur, rock salt, rock raw materials and aggregates, mainly sand and gravel. In Poland, thermal waters, curative waters and brines are also extracted.

The average water resources in Poland amount to about 60 billion m^3, while in dry seasons their quantity can fall even below 40 billion m^3. The quantity of these resources per capita is among the lowest in Europe and continues to decrease: in 2016, it was about 1,600 m^3/year, whereas in 2021 it was 1,400 m^3/year [Environmental Protection 2016, 2021, GUS 2022]. The situation is aggravated by

the large seasonal variability and substantial spatial differentiation of water resources. Along with the occurrence of extreme weather events, this causes droughts and sometimes floods.

In 2020, 79.6% of the water used for the purposes of the national economy and population was abstracted from surface water resources and 19.8% from groundwater resources, while about 0.5% came from the drainage of mines [Environmental Protection 2021, GUS 2022].

2.5. Climate

Poland lies in the temperate transitional climate zone where the conditions are shaped by the impacts of prevailing oceanic and continental air masses. As a result of the latitudinal arrangement of the geographical regions and the dominant share of lowland areas (the extensive North European Plain), the ranges of these impact are variable, therefore, a specific feature of Poland's climate is its transitionality. Poland's climate also demonstrates regional diversification, changing from the more continental one in the northeast to the mildest one in the west of the country. The regional diversification is, in addition, caused by the relief of the terrain, particularly in uplands and mountains, where a harsher submontane and mountain climate prevails, whereas on the coast the features of the climate are mitigated by the impact of the Baltic Sea.

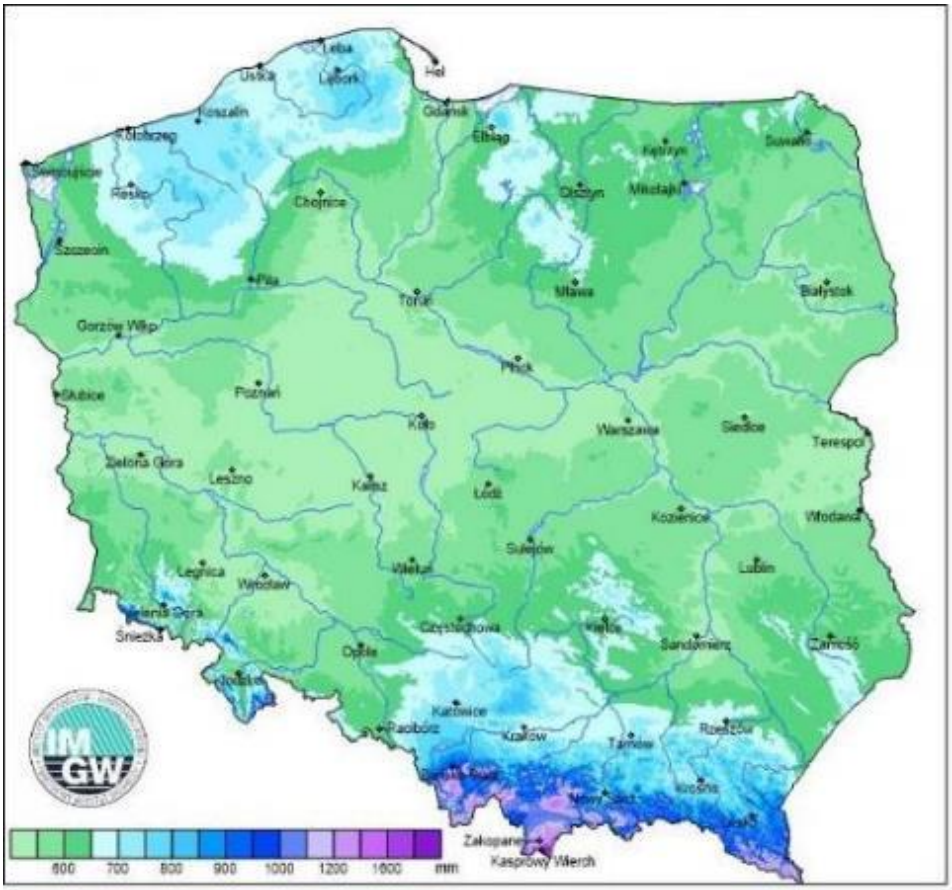


Fig. 2.6. Distribution of annual precipitation in the multiannual period from 1991 to 2020
Source: https://klimat.imgw.pl/pl/climate-maps/#Precipitation

The range of mean annual air temperatures, outside of the mountain areas, varies from about 8°C in North-eastern Poland to about 11°C in the southwest of the country. The span of the extreme values measured in the multiannual period from 1991 to 2020 falls between the lowest observed temperature of -35.4°C and the maximum one of 38.0°C, while the largest recorded amplitude was 70.9°C [Environmental Protection 2021, GUS 2022].

2.6. Energy sector

In 2019, the primary energy production decreased by 3.8% compared with the previous year and amounted to 2,601.8 PJ [Energy from renewable sources in 2020, GUS 2021]. In 2019, in Poland primary energy was primarily produced from hard coal, lignite and natural gas [Energy 2021, GUS 2021].

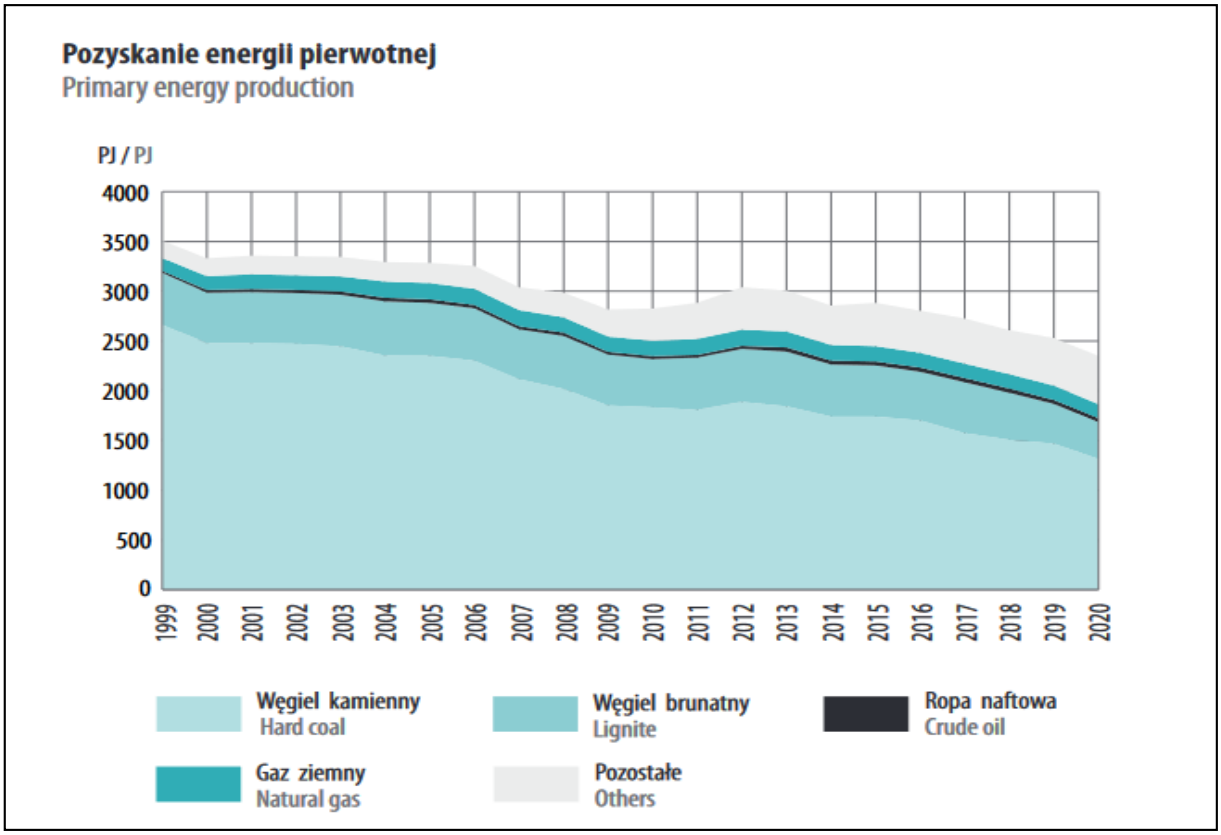


Fig. 2.7. Structure of primary energy production in Poland in the period from 1999 to 2020
Source: Energy 2021, GUS 2021

In Poland, the energy production from renewable resources systematically grows. In the period from 2016 to 2019, the total primary energy production fell by 6.7%, while at the same time the energy production from renewable sources grew by 33.8% [Energy from renewable sources in 2022, GUS 2021]. After 2019, there was a further increase in the share of energy from RES, despite a decrease in the total primary energy production in the country.

Table 2.4. Primary energy production, including renewable sources, in the period from 2016 to 2020

Specification	2016	2017	2018	2019	2020
	TJ				
Total primary energy production	2 788 454	2 686 474	2 705 541	2 601 790	2 427 363
Primary energy production from renewable sources	383 802	386 375	505 601	513 622	524 113
	%				
Share of energy from renewable sources in total primary energy	13.76	14.38	18.69	19.74	21.60

Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of data from GUS Energy from renewable sources in 2020, 2021

For many years solid biofuels dominated the national production and use of energy from renewable sources. In 2019, their share in the energy production from renewable sources was 73.41%, i.e. it had grown by 3.4 p.p. relative to 2016. Wind energy and liquid biofuels were also of large importance, although the shares of both of these carrier types in energy production fell.

In 2019, the largest increase in energy production relative to 2016 was achieved by solar energy (by 211.3%, 2,932 TJ), municipal waste (by 167.1%, 1,715 TJ) and heat pumps (by 162.6%, 4,112 TJ) [Energy from renewable sources in 2020, GUS 2021].

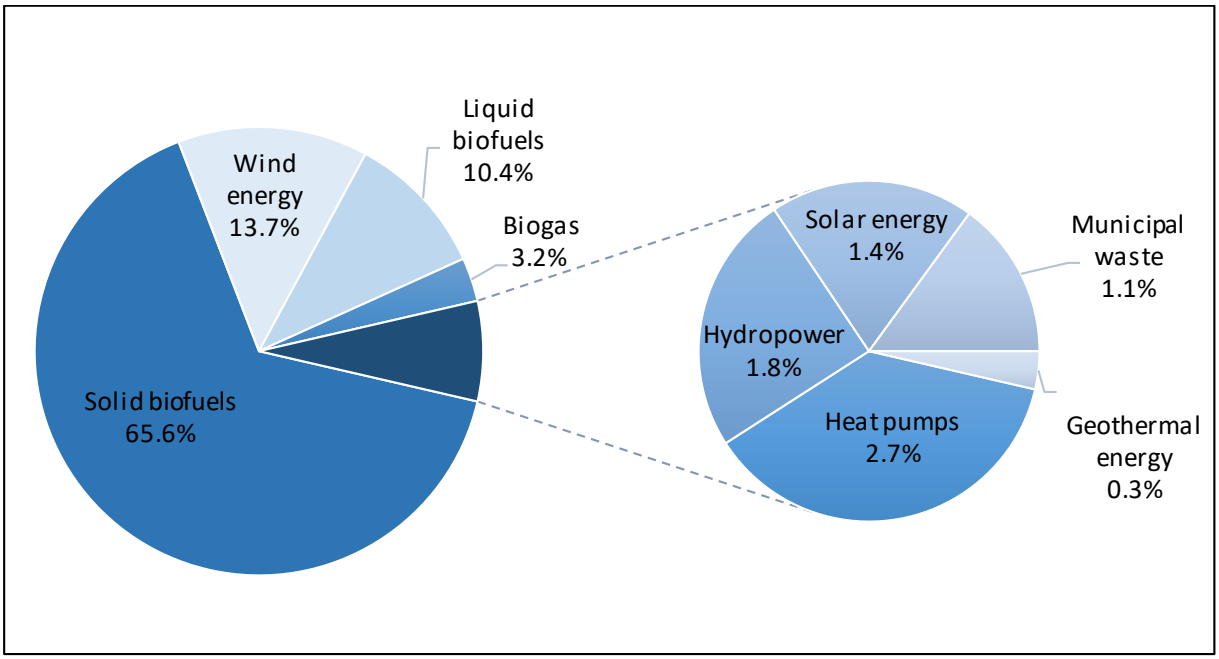


Fig. 2.8. Structure of energy production from renewable sources in Poland by carrier in 2019
Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Energy from renewable sources in 2020, 2021

In 2019, the volume of energy imports amounted to 2,683.6 PJ and exceeded the national energy production (2,645.6 PJ) [Fuel and energy management in the period from 2019 to 2020, GUS 2021]. Natural gas and crude oils are the most important energy carriers among Poland's imports, as they represented 65% of total energy imports in 2019 [Fuel and energy management in the period from 2019 to 2020, GUS 2021]. In 2019, Poland's energy import dependence rate was 46.8% [Energy 2021, GUS 2021]. The exports of energy carriers from Poland are lower than imports and systematically fall. In 2019, the exports amounted to 639.7 PJ, representing 23.8% of their volume in 2015. In 2019, the most important energy carriers exported by Poland included coke and semi-coke (27.0%) and hard coal (19.6%) [Fuel and energy management in the period from 2019 to 2020, GUS 2020]. Until 2018 the growth rate of the total final energy consumption in the Polish economy had gradually but slightly grew. The highest consumption level came in 2018 (105.87 Mtoe) and afterwards the energy demand began to fall.

Table 2.5. Total primary energy consumption and final energy consumption in the period 2015-2020

Specification	2015	2016	2017	2018	2019	2020
	Mtoe					
Total primary energy consumption	95.24	99.49	104.15	105.87	103.48	101.81
Total primary energy consumption with a climatic correction*	97.81	101.22	105.83	108.71	107.17	105.10
Final primary energy consumption	61.45	65.70	69.65	73.77	72.95	70.46
Final primary energy consumption with a climatic correction*	64.02	67.43	71.34	76.60	76.64	73.75

**A climatic correction defines the theoretical value of energy consumption for a given year under the assumption that it is characterised by the weather conditions described by a multiannual mean number of degree days.*

Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Energy efficiency in the period 2010-2020, 2022

In the period from the 2016 to 2019, the final primary energy consumption in Poland tended to grow, analogously to the growth rate of its total primary energy consumption. The highest level was reached in 2018 and afterwards the final consumption began to fall.

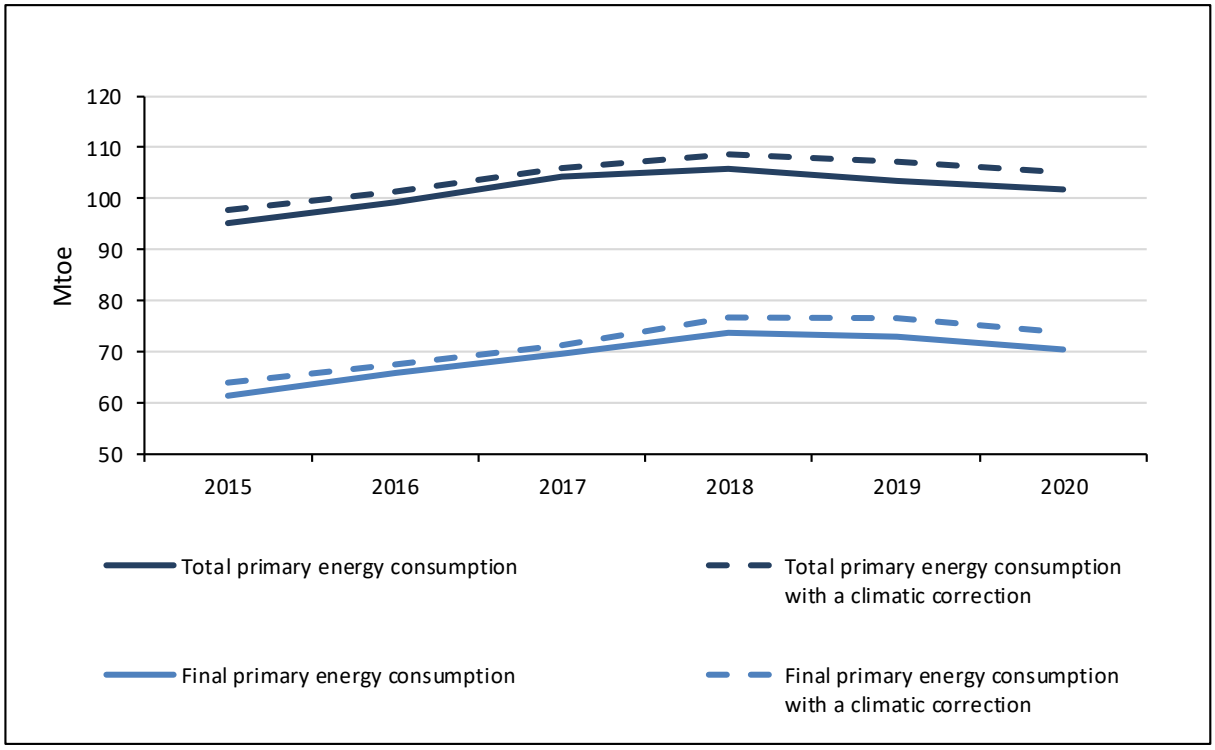


Fig. 2.9. Total primary energy consumption and final energy consumption in the period from 2015 to 2020
Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Energy efficiency in the period from 2010 to 2020, 2022

In 2019, the most important energy carriers in Poland included petroleum fuels and electricity with its share of 17.9 p.p. in the final consumption in the period from 2009 to 2019. At the same time, the share of coal fuels in that period decreased by 5.8 p.p. and the consumption of heat and natural gas also fell. In contrast, in that period the share of other carriers, including RES, grew to 9.9%.

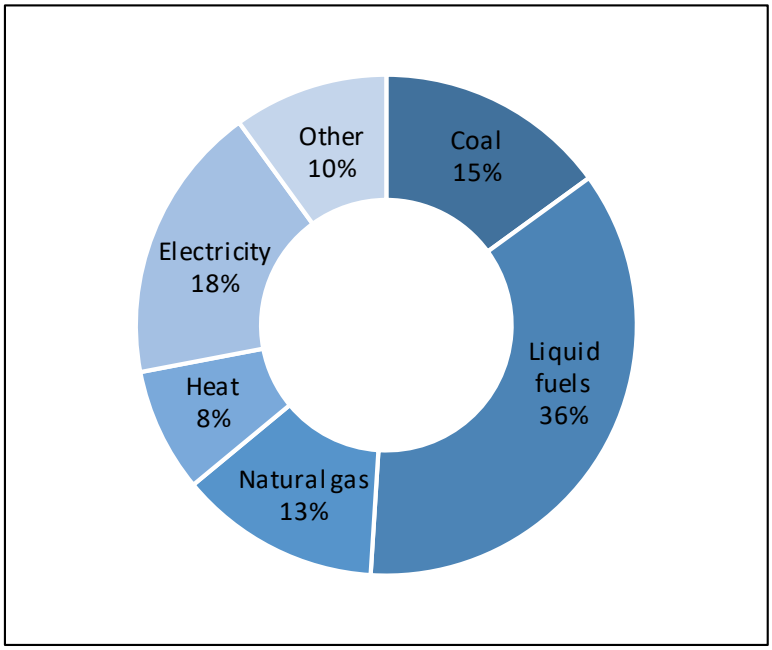


Fig. 2.10. Structure of the final energy consumption in Poland in 2019 by carrier
Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Energy efficiency in the period from 2009 to 2019, 2021

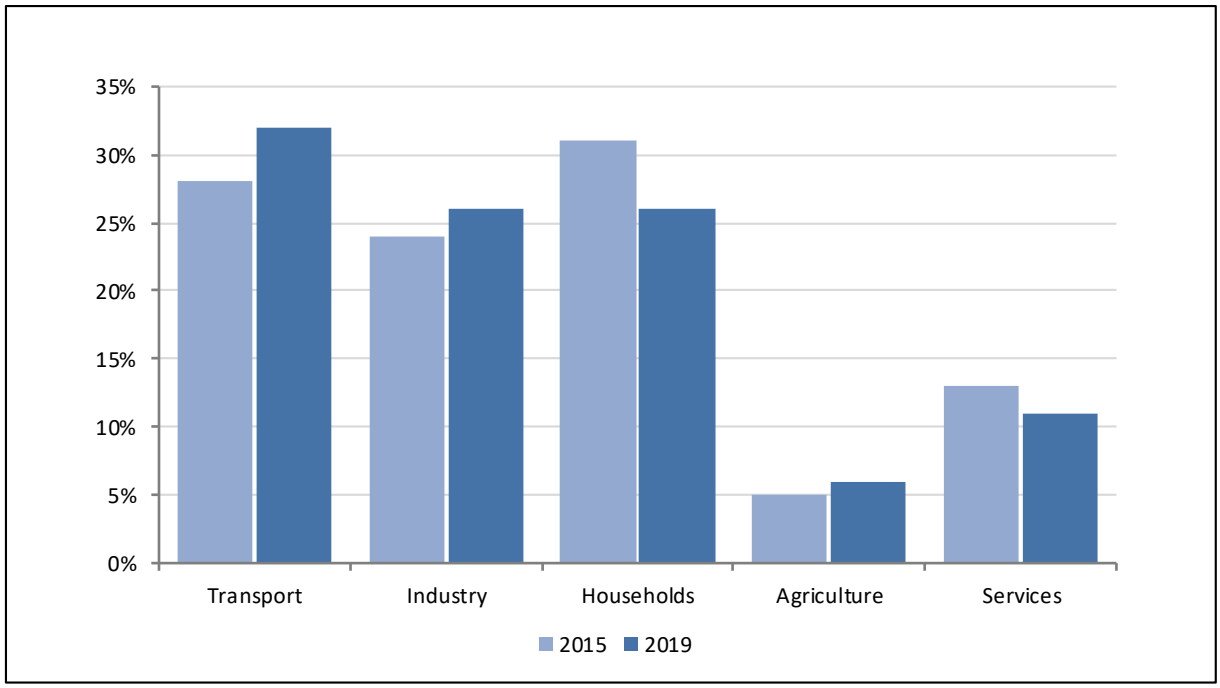


Fig. 2.11. Structure of the final energy consumption by sector in 2015 and 2019
Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from Energy efficiency in the period from 2009 to 2019, 2021

In the period from 2015 to 2019, the largest changes in the final energy consumption came in transport and households, whereas in the other sectors of the economy the changes were slight. The increase in the share of transport in the structure of the final energy consumption (with transport responsible for almost 32% of the final energy consumption in 2019) resulted from the dynamic development of road transport in Poland. In turn, the largest drop in the final energy consumption in that period was reached by households, with their share falling to about 26% (in 2015, their share was 31%). Industry still continued to be a significant energy consumer; nevertheless its share in the structure of the final energy consumption increased only by 2 p.p.in the period from 2015 to 2019.

Until 2020, the energy efficiency had gradually improved in Poland. In the period from 2016 to 2019, the primary and final energy intensity indicators of the GDP decreased by, respectively, 7.9 p.p. and 3.9 p.p. In that period, the ratio between the final energy intensity and the primary energy intensity showed a growing trend, reaching its highest level in 2019 (69.5%).

Table 2.6. Primary and final energy intensities of the GDP in the period from 2015 to 2020

Specification	2015	2016	2017	2018	2019	2020
Total primary energy consumption [Mtoe]	95.24	99.49	104.15	105.87	103.48	101.81
Final energy consumption [Mtoe]	61.45	65.70	69.65	73.77	72.95	70.46
Primary energy intensity of the GDP [kgoe/EUR10]	0.226	0.228	0.228	0.226	0.210	0.208
Final energy intensity of the GDP kgoe/EUR10]	0.147	0.152	0.154	0.154	0.146	0.144

Source: Energy efficiency in the period from 2010 to 2020, 2022

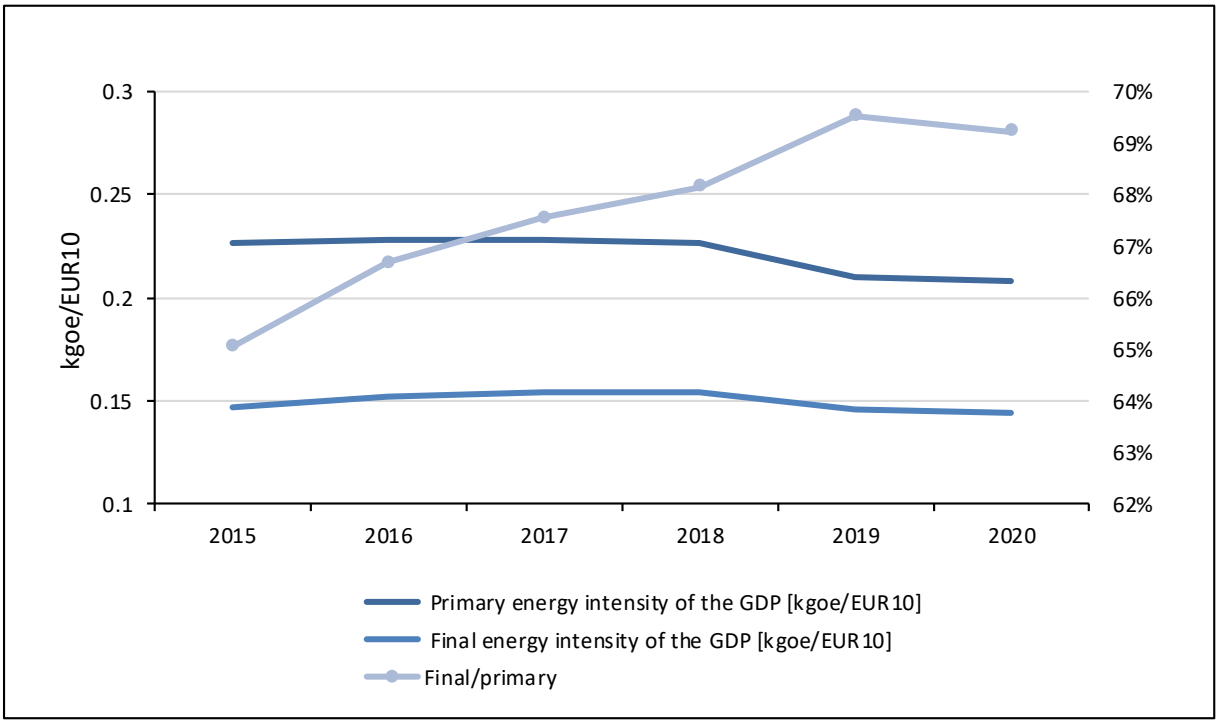


Fig. 2.12. Primary and final energy intensities of the GDP in the period from 2015 to 2020

Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Energy efficiency in the period from 2010 to 2020, 2022

In Poland, the dependence between the primary energy consumption and economic growth diminishes, as evidenced by the fact the growth rate of the national GDP in the period from 2016 to 2019 was higher than the increase in the total primary energy consumption, indicating the decreasing amount of energy used to generate a unit of the GDP.

Table 2.7. Primary energy productivity indicator in the period from 2016 to 2020

Specification	2016	2017	2018	2019	2020
GDP [PLN million]	1 863 487	1 989 835	2 121 555	2 293 199	2 338 996
Total primary energy consumption [ktoe]	99 490	104 150	105 870	103 480	101 810
Primary energy productivity indicator [PLN/ktoe]	18.7	19.1	20.0	22.2	23.0

Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Statistical Yearbooks 2016-2021 Energy efficiency in the period from 2010 to 2020, 2022

The energy savings achieved in the period from 2016 to 2019 in the Polish industry, transport and households are demonstrated by the values of the ODEX index (calculated from the baseline set at 100 for 2000), with its value decreasing in that period by 1.6 p.p. (falling from 67.3 to 65.7 points). The greatest improvement in that period was effected by households (by 3 p.p.), with their index value of 75.7 points in 2019. For the manufacturing and transport sectors, the value of the ODEX index fell to a lesser extent; therefore, the energy efficiency improved to a lesser extent, too. For the manufacturing industry the index decreased by 1.1 p.p. in the period from 2016 to 2019, while for transport it fell by 1.2 p.p. [Energy efficiency in the period from 2009 to 2019, GUS 2021].

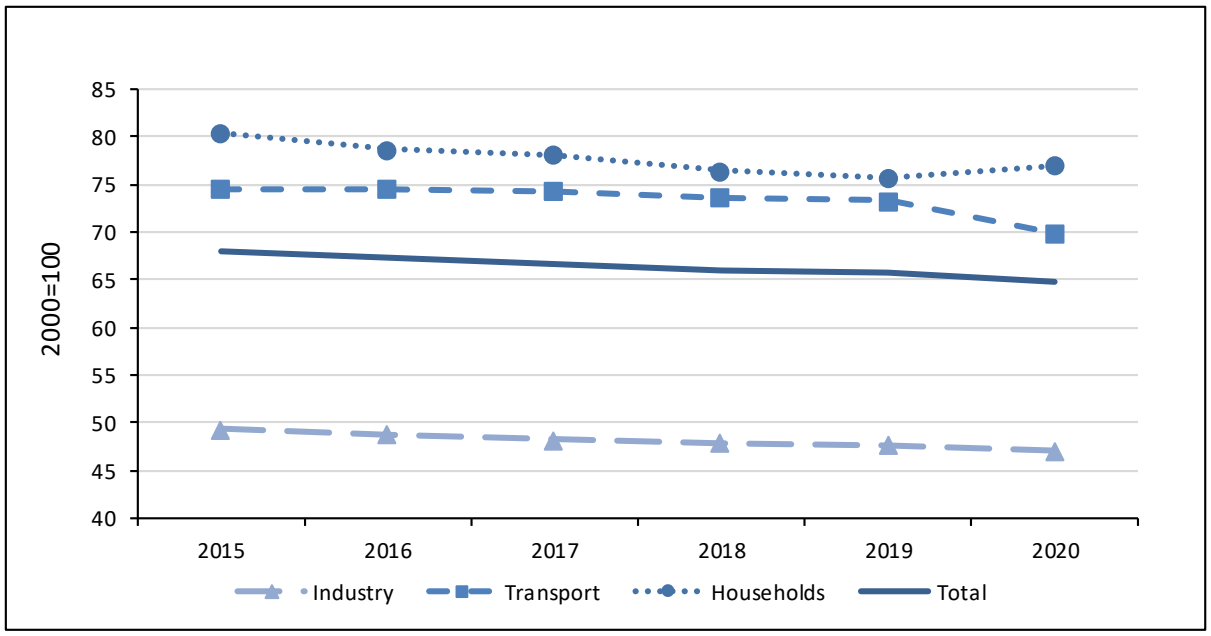


Fig. 2.13. ODEX index in the period from 2015 to 2020 (2000=100)

Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Energy efficiency in the period from 2009 to 2019 and from 2010 to 2020, 2021, 2022

The energy savings in the period from 2016 to 2019 were smaller than those in the previous years. This resulted from a slower pace of the improvement in energy efficiency. The savings achieved in 2019 in industry, transport and households amounted to 0.4 Mtoe [Energy efficiency in the period from 2009 to 2019, GUS 2021]. 2020 brought savings in energy consumption in transport and industry, whereas in the household sector the consumption was higher than in the previous year. The total savings achieved in 2020 in these three sectors amounted to 0.5 Mtoe [Energy efficiency in the period from 2010 to 2020, GUS 2022].

The decrease in the primary energy demand (by 9.5 Mtoe) resulted from higher electricity imports, the improved efficiency of thermal power plants and the increased use of energy from renewable sources. In the period from 2009 to 2019, the final balance of the increase in the primary energy consumption was 9.16 Mtoe.

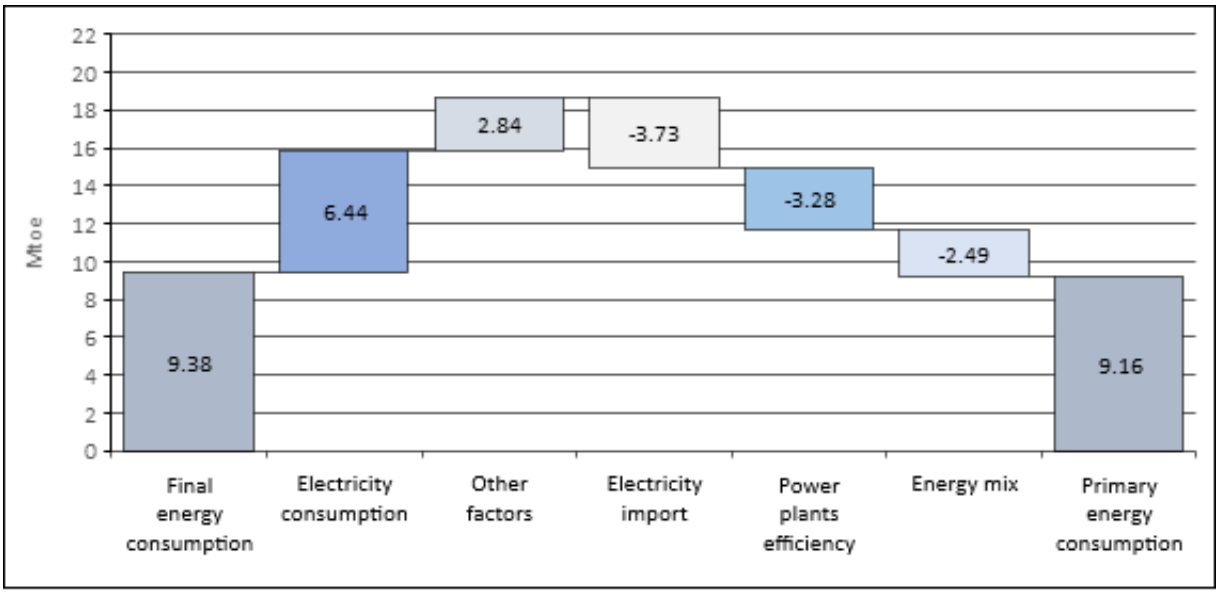


Fig. 2.14. Primary energy consumption balance in the period from 2009 to 2019

Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Energy efficiency in the period 2010-2020, 2021

The change in the final energy consumption in the period from 2009 to 2019 resulted from many factors, including, among others, the activities in the particular sectors of the Polish economy, the lifestyles of society, energy savings, structural changes or weather conditions. In the case of changes in the final energy consumption level, its largest increases were found in the sectors of transport (6.6 Mtoe), industry (4.5 Mtoe) and agriculture (0.3 Mtoe). The large transport activity in Poland in the period from 2009 to 2019 caused an increase in the energy consumption in this sector by 7.0 Mtoe. The energy savings (with the energy consumption falling by 2.6 Mtoe) and the structural changes introduced (causing the energy consumption to fall by 1.2 Mtoe) played a large part in the reduction of the final energy consumption in this sector. In the case of households, despite the final fall in their energy consumption in the period from 2009 to 2019, the factors contributing to an increase in the energy demand included, among others, a higher number of housing units and a change of the lifestyles of society (among others, larger housing units). In industry, in the period from 2009 to 2019, there was a further increase in the activity in this sector, causing higher energy consumption in that period (growing by 7.0 Mtoe). The final energy consumption in the Polish industry was reduced by the energy savings introduced in it. In contrast, the structural changes introduced in the Polish industry did not bring any large energy reduction (by 1.2 Mtoe) in the period from 2009 to 2019 because of the persisting low quality of transmission and distribution networks which required modernisation [Energy efficiency in the period from 2009 to 2019, GUS 2021].

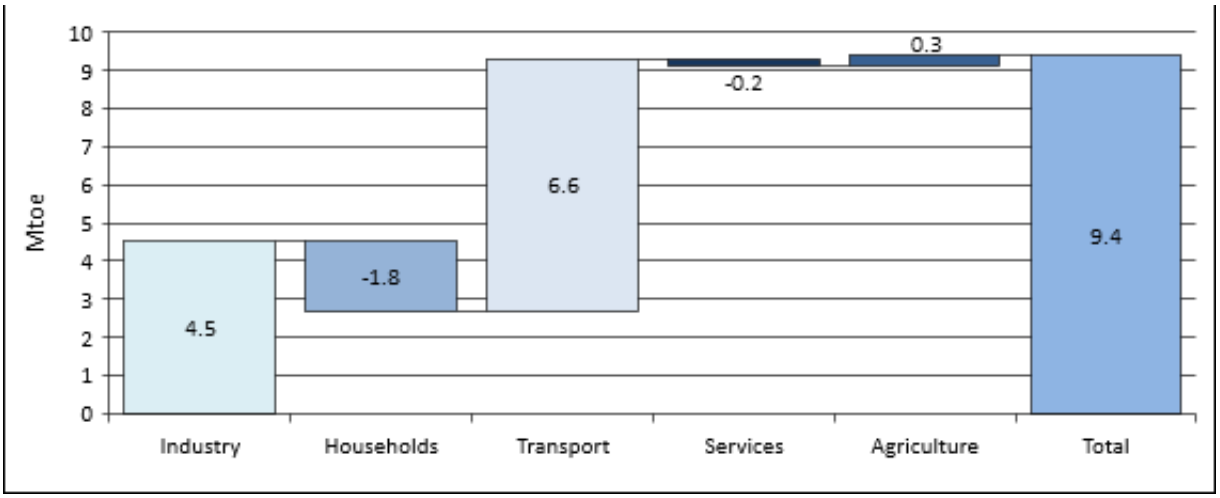


Fig. 2.15. Changes in the final energy consumption in selected sectors in the period from 2009 to 2019
Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Energy efficiency in the period from 2009 to 2019, 2021

2.7. Transport

The number of vehicles, including both passenger cars and trucks, systematically grows in Poland. In the period from 2016 to 2019, the number of motor vehicles rose by more than 3.4 million, with the greatest increase of their number found in the case of motorcycles and passenger cars. In 2019, almost 32 million vehicles were registered in Poland, with passenger cars representing 76.2% of them [The fleet of vehicles registered in Poland in the period from 1990 to 2021, PZPM and GUS 2022].

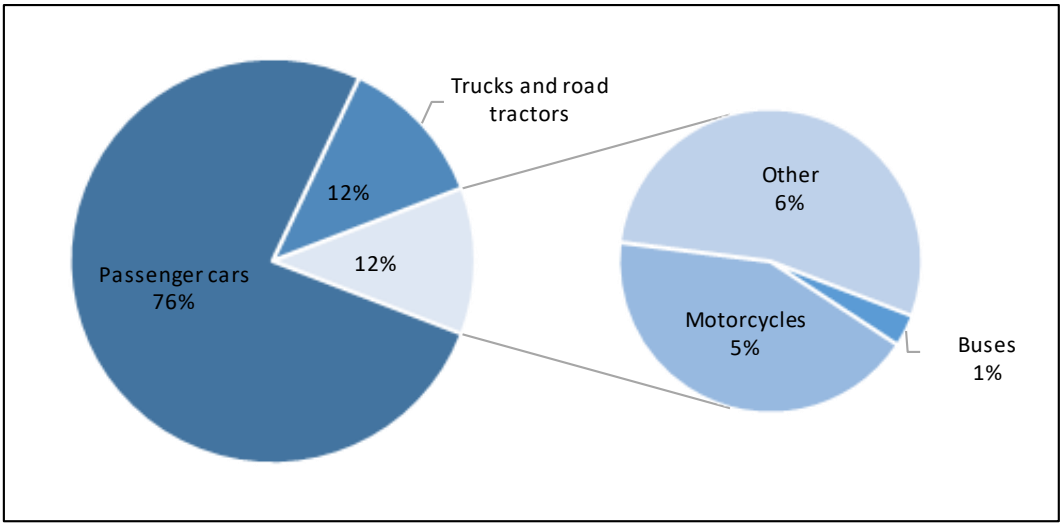


Fig. 2.16. The fleet of vehicles registered in Poland in 2019

Source: PZPM, GUS The fleet of vehicles registered in Poland in the period from 1990 to 2021, 2022

In 2019, passenger cars were dominated by models with petrol-powered engines (45%) and diesel oil-powered ones (40%), while the share of LPG-powered cars was 14%. In 2019, almost 90% of passenger cars in Poland was 6 and more years old, with the average car age of 14.1 years [PZPM calculations based on the data from the Central Register of Vehicles, "*PZPM Yearbook – Automotive Industry Report on 2020/2021*", Polish Automotive Industry Association 2020]. In turn, more than 50% of trucks were 16 and more years old [Road transport in Poland in 2018 and 2019, GUS 2021].

In 2019, in Poland 2,220.7 million t of freight was carried by all types of transport, i.e. 1.3% more than in the previous year and as much as 23.1% more than in 2015. Invariably for many years, the dominant mode of transport in Poland was road transport; in 2019 it accounted for 86.5% of the total transport in the country and after 2019 its position became even stronger. In the period from 2016 to 2019, the share of road transport in total transport grew at the expense of the railway, pipeline and inland waterway modes of transport. The largest increase in freight transport, i.e. almost doubling, was found in the period from 2016 to 2019 in air transport. 2020 brought another increase in the quantity of freight carried; nevertheless this increase only came in road transport, in which the quantity of freight carried rose by 21.4% relative to the previous year.

Table 2.8. Freight transport in Poland in the period from 2015 to 2020 by transport mode

Specification	2015	2016	2017	2018	2019	2020
	thousand t					
Total	1 803 818	1 836 652	2 053 244	2 191 889	2 220 678	2 613 817
Railway transport [a)]	224 320	222 523	239 501	249 260	233 744	218 381
Road transport	1 505 719	1 546 572	1 747 266	1 873 022	1 921 073	2 331 758
Pipeline transport	54 850	54 058	52 393	55 287	52 376	51 489
Maritime shipping	6 963	7 248	8 254	9 149	8 727	8 135
Inland waterway transport	11 928	6 210	5 777	5 107	4 681	2 991
Air transport [b)]	38	41	53	63	77	63

a) excluding manoeuvring transport;

b) Polish carriers

Source: Transport – the results of operations in 2016, 2017, 2018, 2019, 2020 (GUS 2017, 2018, 2019, 2020 and 2021); Freight and passenger transport in 2016 (GUS, 2017)

The most conspicuous change in the structure of passenger transport in recent years was the diminishing role of road transport in favour of other modes of transport. In the period from 2016

to 2019, the share of railway transport in passenger transport systematically increased so that in 2019 railways became the main mode of passenger transport (with its 48.8% share in passenger transport). Thus road transport ceased to be the dominant mode of passenger transport and the data after 2019 confirm this trend. Air transport was one of the most dynamically developing transport modes in Poland, with the number of passengers tripling in the period from 2016 to 2019.

In 2020, the COVID-19 pandemic significantly affected the transport in Poland, as a result of the restrictions limiting the movements in both Poland and abroad, as well as those on the international transport. In the case of air transport, as a result of the long-lasting suspension of domestic and international flights, the number of passengers fell compared with the previous year by 83.4%. After 2019 there were also large decreases in the other modes of passenger transport, e.g. by 51.2% in road transport and by 37.8% in railway transport.

Table 2.9. Passenger transport volume by transport mode in the period from 2015 to 2020

Specification	2015	2016	2017	2018	2019	2020
	thousand persons					
Total	703 742	693 908	696 178	660 421	687 680	373 810
Railway transport	277 321	291980	303 001	309 722	335 264	208 651
Road transport [a)]	416 774	390 493	378 610	336 511	327 494	159 700
Maritime shipping	597	632	1 459	1 535	1 677	1 148
Inland waterway transport [b)]	1 762	2 024	1 262	1 395	1 362	682
Air transport [c)]	7 288	8 779	11 846	11 258	21 883	3 629

a) Entities employing more than 9 persons, without transport by the city transport fleet
b) Including coastal transport, excluding the drivers of trucks transported by ferries
c) Polish carriers

Source: Transport – the results of operations 2016, 2019, 2020, GUS 2017, 2020, 2021); Freight and passenger transport 2016, 2018, GUS 2017, 2019

In 2019, almost all the energy used in transport, i.e. as much as 98.2%, was consumed by road transport. The remaining energy was consumed by railway transport – 1.6%, air transport – 0.2%, as well as inland waterway and coastal transport [Energy efficiency in the period from 2009 to 2019, GUS 2021]. In the period from 2009 to 2019, the fuel consumption grew by 42.9%, increasing annually by 3.6%. In the period from 2009 to 2019, the decrease in the energy consumption in railway transport stabilised at the level of 0.3% annually (3%); it is interesting to note it, comparing it with the decrease found in the period from 2005 to 2015 (a drop by 30%).

Table 2.10. Estimated consumption of liquid fuels in transport in 2019

Specification	Total		Including imports
	Thousand m^3	%	Thousand m^3
Total	32 478	100	10 312
Motor petrols	6 425	20	632
Diesel oil	20 952	64	5 596
Liquefied petroleum gas (LPG)	5 101	16	4 084

Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Road transport in Poland in 2019, 2021

2.8. Industry

Industry is a particularly important segment of the Polish economy. This sector has developed for many years and generates the largest part of the economic growth in Poland. The share of the industrial sector in the generation of the national GDP, which was 21.7% in 2019, is higher than the average level in the EU, which was 19.7% in 2019 [Statistical Yearbook 2020, GUS 2021]. In Poland, both the resource productivity and the GDP can be seen to grow, while, at the same time, the national consumption of raw materials decreases (this is the so-called resource decoupling).

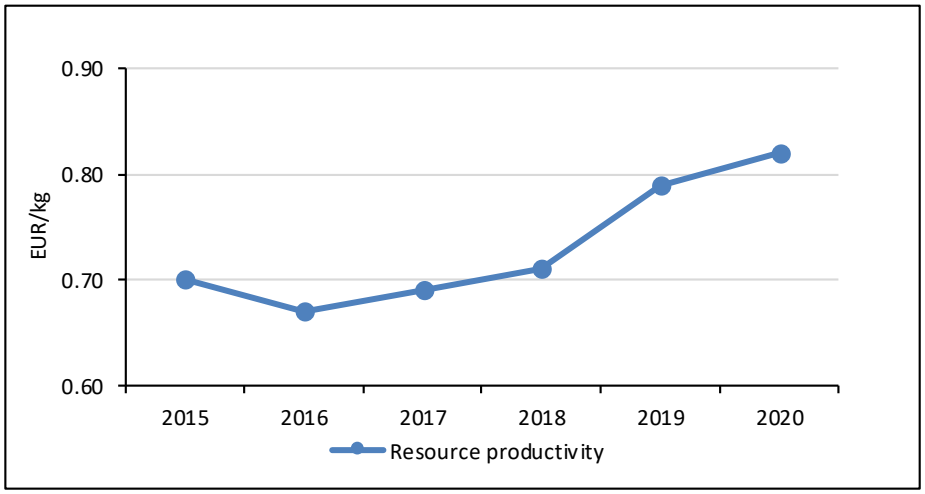


Fig. 2.17. The resource productivity in the period from 2015 to 2020
Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from Eurostat, 2022

In 2019, the sold production of industry was higher in current prices by 6.2% than in the previous year, while in the period from 2016 to 2019 it grew by 19.4%. In that period, the sold production per capita also increased. The trend of the growing share of the private sector also continued; for comparison in 2019 the sector produced 90.8% of the total sold production of industry, while in 205 its share was 82%. In 2020, there was a decrease in both the sold production of industry (by 2.2% in current prices compared with the previous year) and the sold production per capita (by 2.1%), nevertheless the trend of the growing share of the private sector in the production of industry continued.

Table 2.11. Sold production of industry in Poland in the period from 2015 to 2020

Specification	2015	2016	2017	2018	2019	2020
Total sold production [current prices, PLN million]	1 255 515.6	1 301 911.8	1 417 247.1	1 520 836.1	1 615 202.7	1 579 859.6
Sold production per capita [PLN]	32 649	33 880	36 886	39 592	42 077	41 191
Public sector [%]	9.9	9.0	9.4	10.0	9.2	8.8
Private sector [%]	90.1	91.0	90.6	90.0	90.8	91.2

Source: GUS Statistical Yearbook of Industry 2019, 2020 (2020, 2021)

The transformations of the ownership structure of industry and the sectoral structure of production were accompanied by organisational, technical and technological changes in the manufacturing processes, contributing to improvements in energy efficiency and, thereby, to a decrease in the energy intensity of industrial production and greenhouse gas emissions. In 2019, in most branches of industry, the sold production grew, with the largest increase (in current prices) found in the production of other transport equipment (by 27.1%), in waste management, raw materials recovery (by 20.6%), the manufacture of electrical equipment (by 15.2%), metal products (by 9.8%) and the manufacture of computers and electronic and optical products (by 5.5%). In contrast, the largest decrease in the sold production in 2019 could be seen in the manufacture of leather and leather products (by 6.9%), metals (by 5.6%) and hard coal and lignite mining (by 2.4%). There was

an increase in the production of the industrial branches and groups considered to be the drivers of technological progress. From 2016 there was a substantial increase in the final energy consumption in industry, reaching 18.2 Mtoe in 2019, while in 2020 the energy consumption fell by 6.1% relative to the previous year.

The energy consumption structure in the manufacturing industry is dominated by its three energy-intensive branches: the metallurgical, chemical and mineral industries, with their total share of 56.9% in the energy consumption in 2019 (54.5% in 2020). The largest part of the energy consumption in the manufacturing industry in 2019 was used for the manufacture of steel, cement and paper, representing 35.7% of the total energy consumption [Energy efficiency in period from 2009 to 2019, GUS 2021].

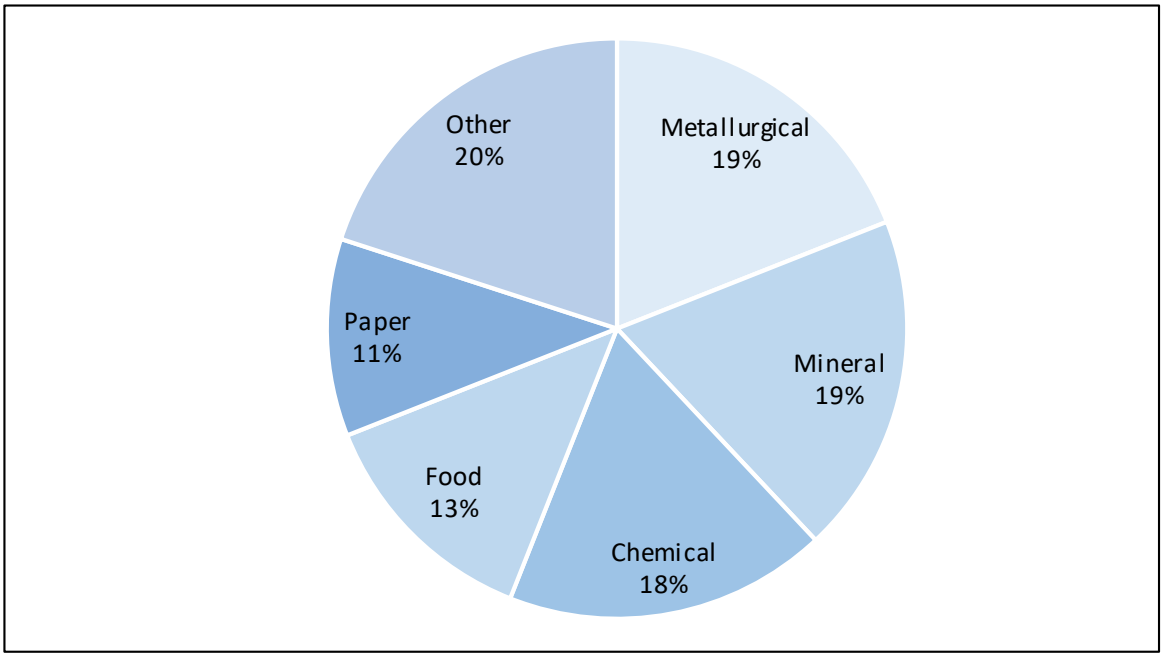


Fig. 2.18. Structure of the final energy consumption in the manufacturing industry in 2019
Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Energy efficiency in the period 2009-2019 (2021)

In the period from 2015 to 2019, the energy intensity fell at a rate of 2.4%/year, while the structural changes contributed to a decrease in the energy intensity by 1.8%/year. [Energy efficiency in period from 2009 to 2019, GUS 2021]. In the period from 2009 to 2019, the energy intensity of the manufacture of steel grew by 7% and that of the manufacture of paper increased by 5.8%, while the energy intensity of the manufacture of cement fell by 3.4%.

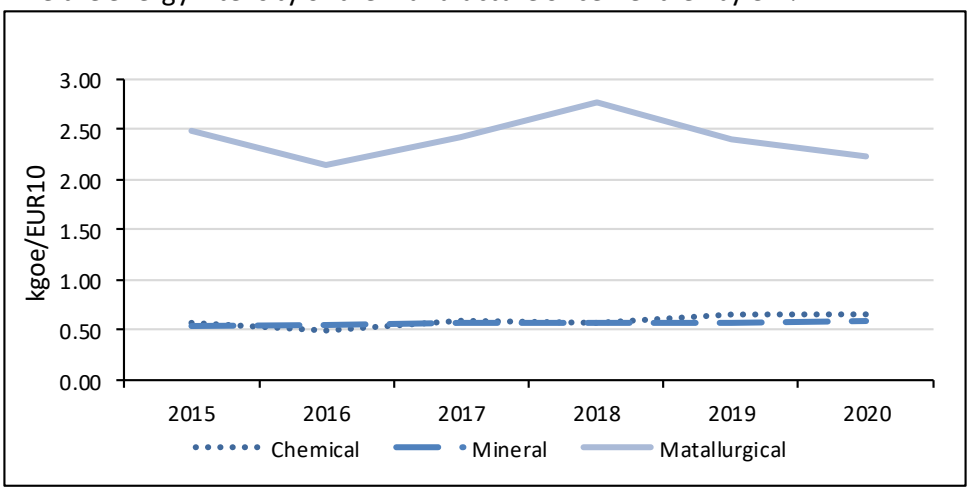


Fig. 2.19. Energy intensity indicators of selected sectors of industry in the period from 2015 to 2020
Source: Energy efficiency in the period from 2009 to 2019 and from 2010 to 2020, GUS 2021, 2022

2.9. Waste

In 2020, almost 123 million t of waste was generated in Poland, with nearly 90% of it generated by different economic activities (109.5 million t) and municipal waste representing 10.7% (13.1 million t). After 2000 the quantity of waste generated fell within the range from 110 to 130 million t [Environmental Protection 2021, GUS 2022]. The largest waste producers included mining and quarrying, manufacturing, and electricity, gas, steam and hot water generation and supply.

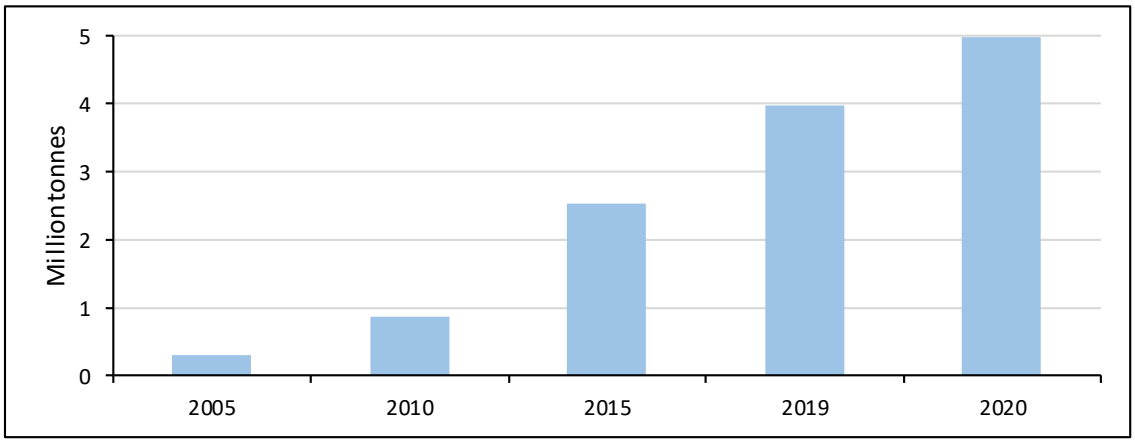


Fig. 2.20. Separately collected municipal waste in selected years
Source: Environmental Protection 2021, GUS 2022

In 2020, 342 kg of municipal waste was generated per capita in Poland. Although this quantity was almost 40% larger than in 2005, still the average quantity of municipal waste generated per capita in Poland, dependent, among others, on the consumption patterns, is significantly lower than the average in the European Union, which amounts to 505 kg [Eurostat 2022].

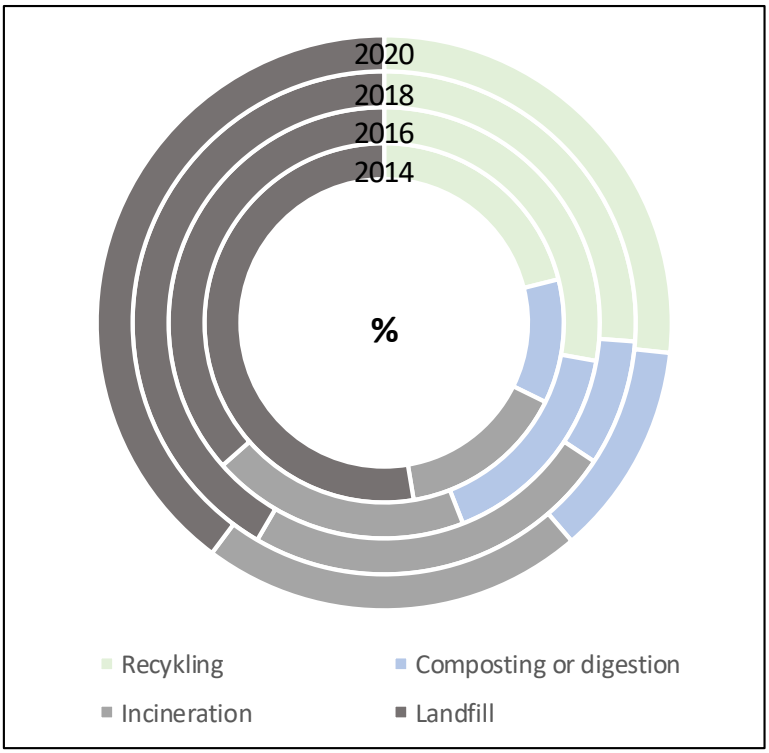


Fig. 2.21. Generated municipal waste by management mode in selected years
Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Environmental Protection 2015, 2017, 2019, 2021

The quantity of municipal waste is differentiated between rural and urban areas, as well as among the regions of Poland, since it is almost twice as high in the western part of the country than in its eastern part, while it is the highest in tourist destinations, where even more than 1,000 kg of municipal waste per capita is collected. The separate waste collection systematically increases; in 2005 it covered barely 3% of the municipal waste collected, whereas in 2020 it already captured as much as 38% of the total municipal waste generated.

In 2020, the largest quantity of wastewater was generated in the processes of electricity, gas, steam and hot water generation and supply (5,028 hm^3). A substantial quantity of this wastewater did not need to be treated, but it caused the temperature of surface waters to grow, since it was cooling water generated in production processes, mostly in thermal power plants. The largest quantity of industrial effluent requiring treatment was generated in manufacturing processes (50%) and mining and quarrying (34%).

The quantity of municipal waste requiring treatment slightly grew, amounting to a total of 1,344 hm^3 in 2020. The treatment with enhanced nutrient removal became the dominant wastewater treatment process, almost completely replacing solely mechanical treatment. Incidental increases in the quantities of wastewater which were not taken to wastewater treatment plants were most often caused by breakdowns and natural disasters (floods).

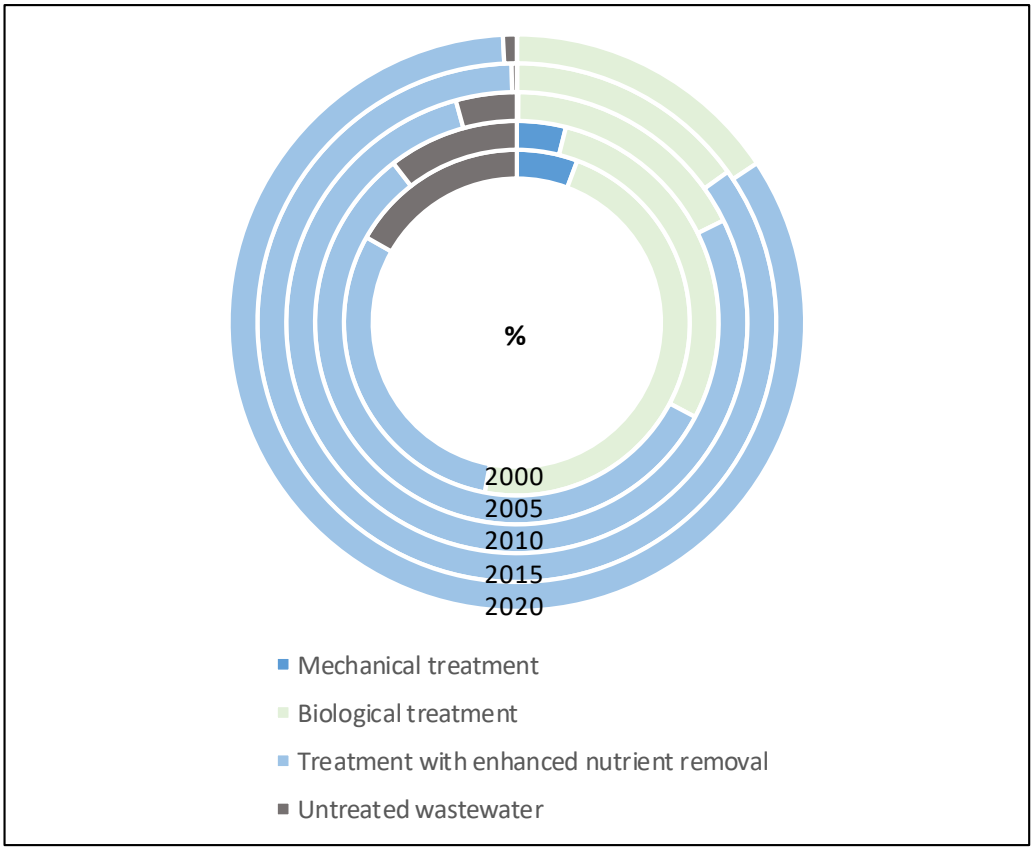


Fig. 2.22. Municipal waste requiring treatment which was discharged into the wastewater collection system
Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Environmental Protection 2021

2.10. Construction and housing

In Poland, the number of both single-family and multi-family residential buildings systematically grows. As of the end of 2019, the national housing stock consisted of 14.8 million housing units, while the average number of persons in a household was 2.6. [Housing in 2019, GUS 2020]. The largest number of housing units (34.3%) was built in the period from 1961 to 1980.

The housing conditions in Poland systematically improve, as standards become higher in both urban and rural areas. In 2019, compared with 2018, the greatest increase, by 2.3%, was noted in the supply of network gas to housing units. For housing units located in rural areas, this increase was 6.4%, whereas in urban areas it was 1.6%. The number of dwellings equipped with district heating (in both rural and urban areas) grew by 1.7% compared with 2018. The dwellings in rural areas are worse furnished than those in urban areas, but successive years levelled out these differences to an increasing extent. At the same time, Poland saw a tendency of the number of gas installations to fall in urban areas [Energy consumption in households in 2018, GUS 2019].

Households are one of the largest energy consumers in Poland, since they account for almost one fourth of the total final energy consumption (23.6%); in 2019, their consumption was 808.3 PJ. In the period from 2016 to 2019, there was a drop in energy consumption per user in urban households, whereas in rural areas such consumption grew. Due to the growing number of households in Poland, the amount of the energy which they consume increases; however, in the period from 2016 to 2019 there was a marked fall in energy consumption per user or housing unit in urban areas. This effect can be associated, among others, with the replacement of household furnishings and light sources with more energy efficient ones. In 2020, the energy consumption by households in Poland grew by 3%.

Table 2.12. Energy consumption and energy efficiency indicators for households in the period from 2015 to 2020

Specification	Unit of measure	2015	2016	2017	2018	2019	2020
Total electricity consumption by households	GWh	28 315	28 864	29 292	30 506	30 613	31 535
Urban areas		16 883	17 070	17 191	17 953	17 935	18 499
Rural areas		11 432	11 794	12 101	12 553	12 679	13 036
Electricity consumption in a year per user	kWh						
Urban areas		1 760	1 754	1 737	1 753	1 725	1 753
Urban areas		2 344	2 385	2 407	2 435	2 444	2 486
Consumption per housing unit	toe/ housing unit	1.336	1.385	1.374	1.544	1.401	1.388
Consumption per housing unit with a climatic correction		1.464	1.470	1.457	1.687	1.582	1.551
Total consumption per m^2	kgoe/m^2	18.1	18.8	18.6	20.8	18.8	18.6
Total consumption per m^2 with a climatic correction		19.9	19.9	19.7	22.7	21.3	20.8
Consumption for heating per m^2		11.9	12.5	12.2	14.1	12.3	12.3
Consumption for heating per m^2 with a climatic correction		13.7	13.6	13.3	16.1	15.0	14.5
Electricity consumption per housing unit	kWh/ housing unit	2001.7	2025.6	2020.8	2003.7	1984.3	1998.4

Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from Energy efficiency in the period from 2009 to 2019 and from 2010 to 2020, GUS 2021,2022; GUS Statistical Yearbook 2016, 2018, 2020, 2021

Households consume most energy to heat their rooms; in 2019, they used two thirds of their whole energy demand (534.6 PJ) for this purpose [Fuel and energy management 2018-2019, GUS 2020]. Due to Poland's climatic conditions, which are characterised by transitionality and variability, the heating season needed to ensure the good functioning of the public in most regions of the country is extended roughly from October to April inclusive and many times it begins as early as September and terminates in May.

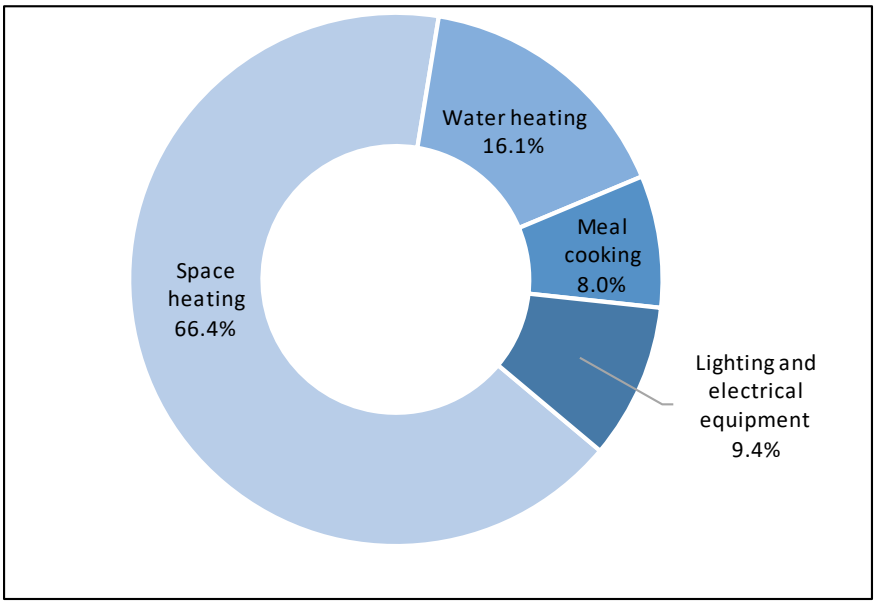


Fig. 2.23. Structure of energy consumption by households per use in 2019

Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Energy consumption by households in 2018, 2019

In the structure of energy consumption by households in Poland, solid fuels, mainly hard coal and fuelwood, are most important. They are most often used for space heating (by 45.4% of households in 2018). These fuels are also used to for water heating and less often for cooking meals. Hard coal and fuelwood are commonly used at the same time or alternately in the same boilers and ovens. As a rule, both fuels are burned alternately, depending on their current availability or prices; or wood is burned in warmer periods, while coal, as a fuel with a higher calorific value, is used in colder periods [Energy consumption by households in 2018, GUS 2019].

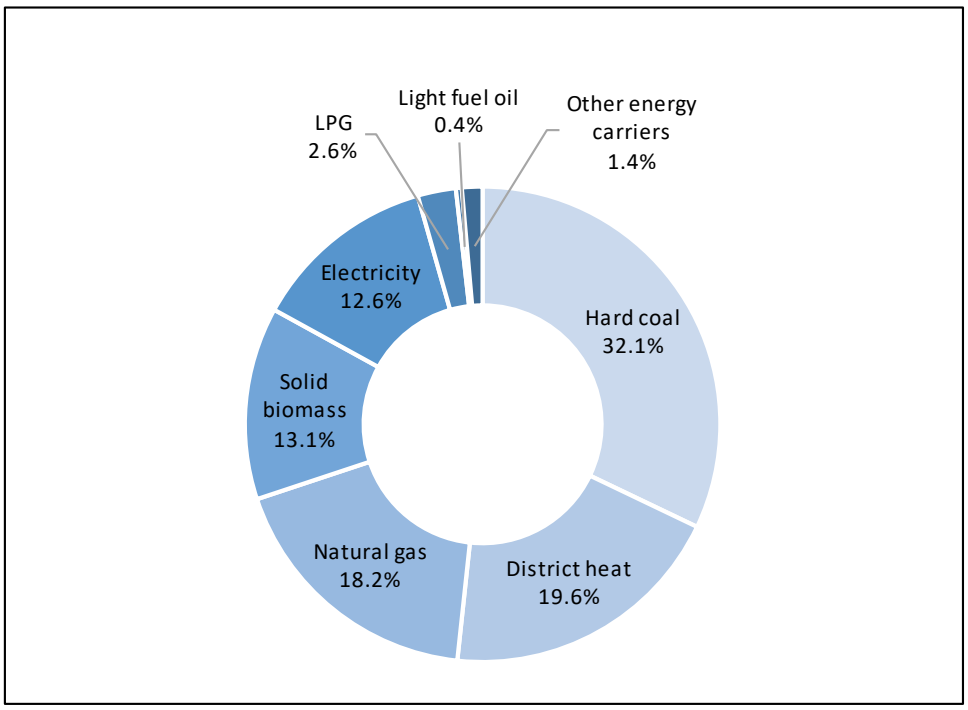


Fig. 2.24. Structure of energy consumption by households per inhabitant in 2017 by energy carrier

Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Energy consumption by households in 2018, 2019

District heat was used by 40.4% of all the housing units in 2018, primarily in large cities (multi-family buildings, blocks of flats), where it was the dominant heating medium (58.3%). In addition, more

than one third of households draw heated water from the network. Natural gas is used by more than half of households (55.7% in 2018), but more than half of users employ it exclusively to cook meals, while only 14.0% use it to heat their housing units. Households which are not connected to a natural gas network use it almost entirely to cook meals. Households commonly use electricity, mainly for heating and power supply. Given its high prices and the existence of cheaper substitutes, electricity is hardly (5.1%) used in Poland for heating purposes. It is also used to cook meals and – sporadically – to heat water [Energy consumption by households in 2018, GUS 2019]. In terms of the final consumption of the energy from RES in 2019, households were the largest consumers in the country of the energy produced by heat pumps and geothermal energy (respectively, 92.7% and 75.0% of the national consumption of the energy produced from these sources). Moreover, households accounted for about half of the national consumption of solar energy and the energy from solid biofuels (respectively, 49.6% and 55.9%) [Energy from renewable sources in 2020, GUS 2021].

2.11. Agriculture

The agriculture in Poland is characterised by large land resources and, at the same time, the dominant share of poor and acidified soils, particularly in the eastern and southern parts of the country. In the agriculture, the fragmentation of farms and traditional farming methods persist; however, the changes underway enable the development of an increasingly large part of the sector, particularly in the scope of commodity production. In the period from 2010 to 2020, the value of this production significantly increased, while the number of private farms decreased by more than 195,000, i.e. by about 13% [Statistical Yearbook 2021, GUS 2022].

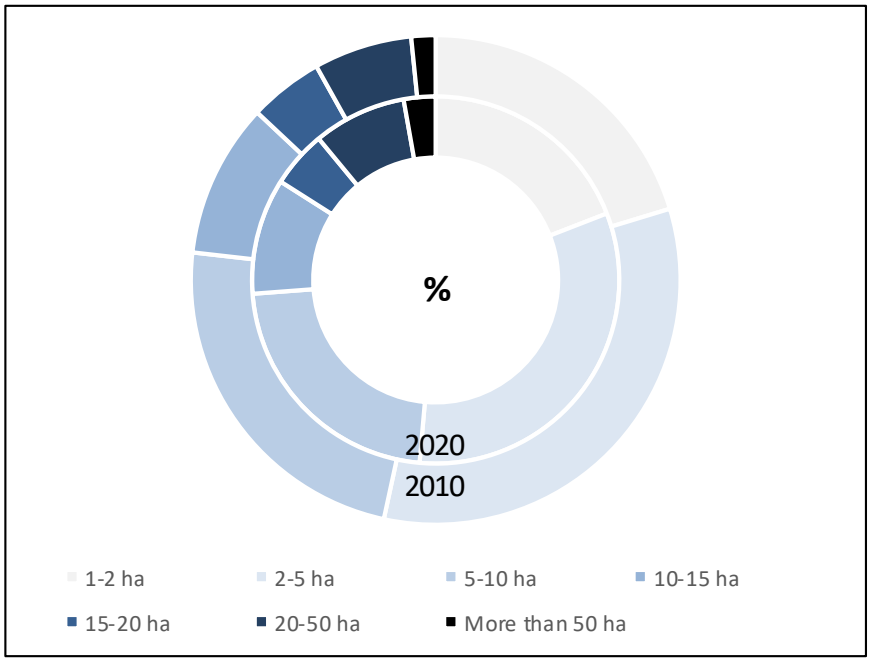


Fig. 2.25. Private farms by area-based group in 2010 and 2020 (as percentage of the total number of farms)
Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Statistical Yearbook 2021

The agriculture sector of agriculture in Poland has undergone transformations, which were particularly conspicuous in the period from 2010 to 2020. The main drivers of the transformations include: the introduction of the instruments of the Common Agricultural Policy of the EU, a change in the eating habits of society, the shift to other methods for animal farming, a search for new energy sources and the increasingly visible climate change [General Agricultural Census 2020, GUS 2021].

In Poland, as of 1 January 2021, the area of farmland was 18.7 million ha, representing 59.6% of the territory of the country, i.e. 0.49 ha of farmland per capita [Environmental Protection 2021, GUS 2022].

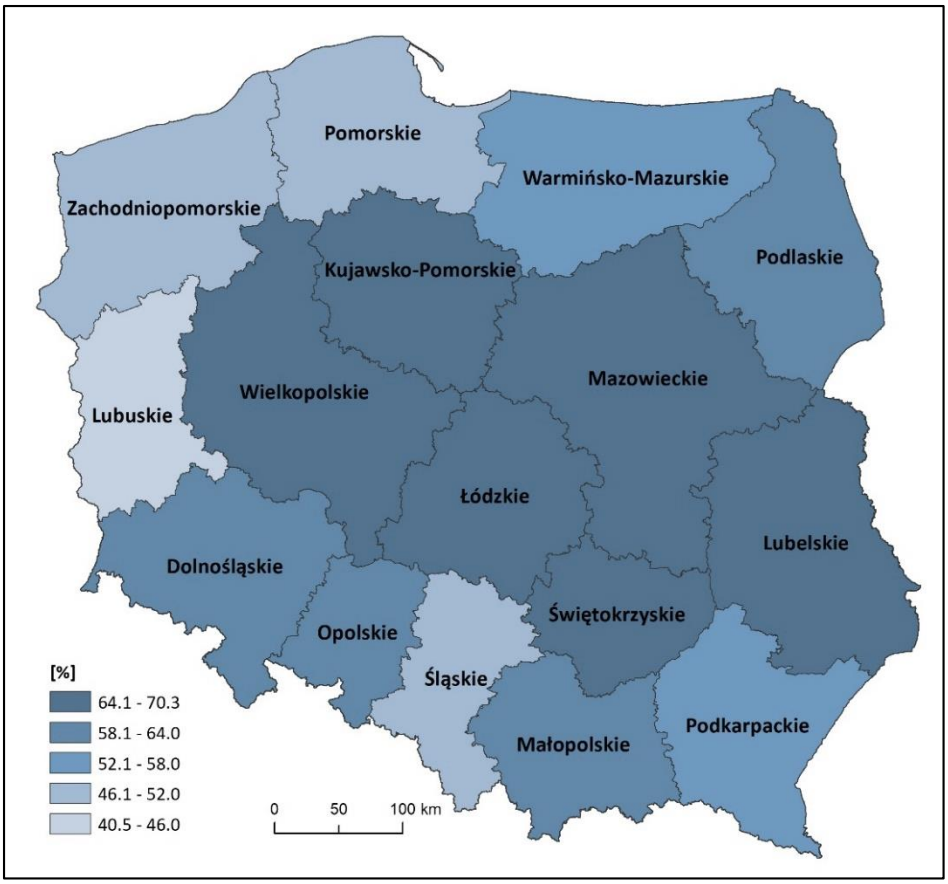


Fig. 2.26. Share of farmland in the area of Voivodeships

Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Environmental protection 2021

The levels of mineral fertilisation, the use of plant protection products and the degree of mechanisation gradually grow, as signs of modernisation and intensification of production, although they still continue to be modest when compared to the Western European countries.

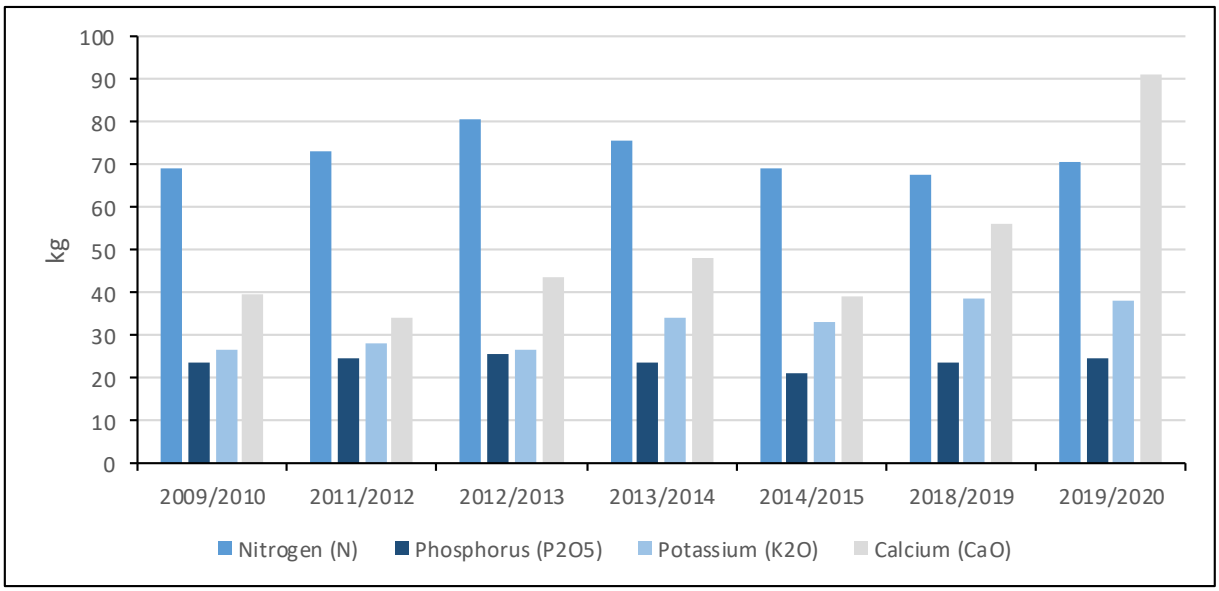


Fig. 2.27. Consumption of mineral or chemical and calcium fertilisers per ha of farmland in selected years (recalculated to pure components)

Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Statistical Yearbook 2014, 2016, 2021

As the area of the land used grows, farms can be seen to use more fertilisers, both mineral and calcium ones. In 2020, the consumption of mineral fertilisers belonging to area-based groups above 20 ha of farmland was higher than the national average, while the largest consumption occurred in farms with an area exceeding 100 ha, where it was 170.5 kg of NPK/ha of farmland as a total [General Agricultural Census 2020, GUS 2021].

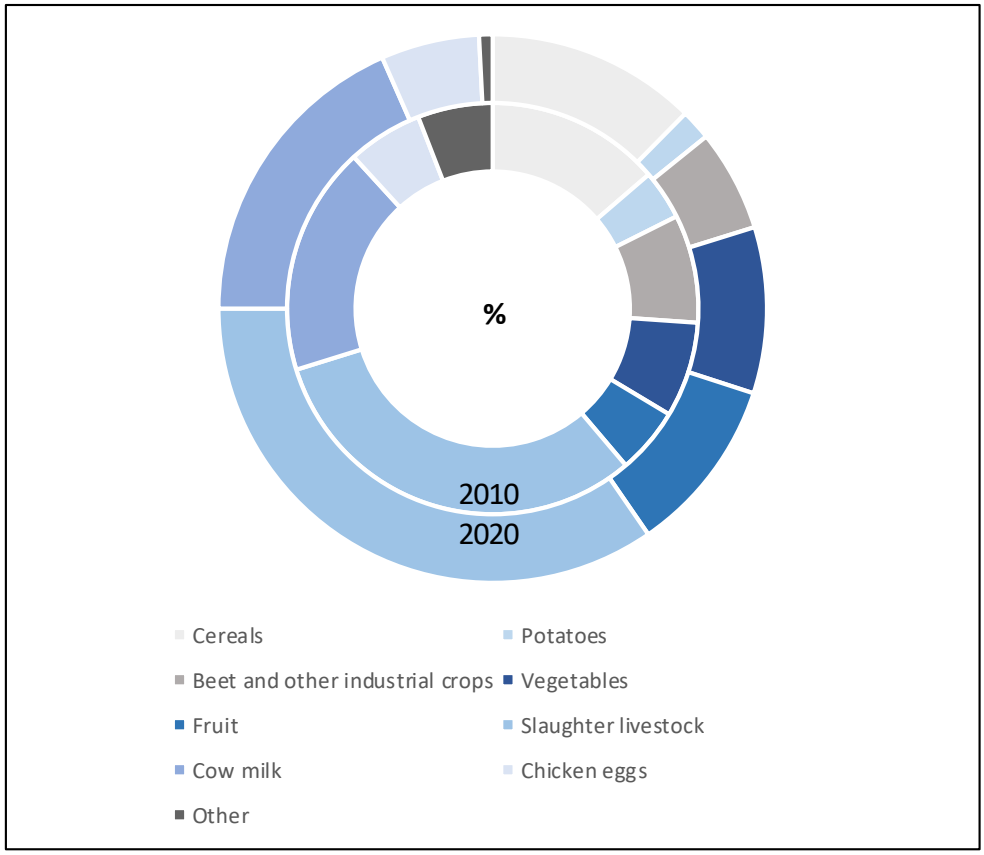


Fig. 2.28. Structure of the commercial agricultural production in 2010 and 2020 (as a percentage share in its total value)

Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Statistical Yearbook 2021

The intensification of agricultural production is demonstrated, among others, in an increase in productivity, in both plan and animal production. In the period from 2015 to 2020, there was an increase in yields per ha of the most popular ground vegetables from 25% to 43%, depending on the type. The average amount of milk produced also grew from 5,395 l to 5,798 l a year from one cow. The number of eggs also increased from 223 to 230 from one laying hen and the slaughter poultry production also grew from 2,680,800 t to 3,263,600 t [Statistical Yearbook 2021, GUS 2022]. Poland is the largest producer in the European Union, among others, of apples and poultry meat.

2.12. Forestry

As of 31 December 2021, the area of forests in Poland was 9,467,500 ha, representing the forest cover rate of 29.6% and 30.9% of Poland's terrestrial territory [Forestry Statistical Yearbook 2021, GUS 2022].

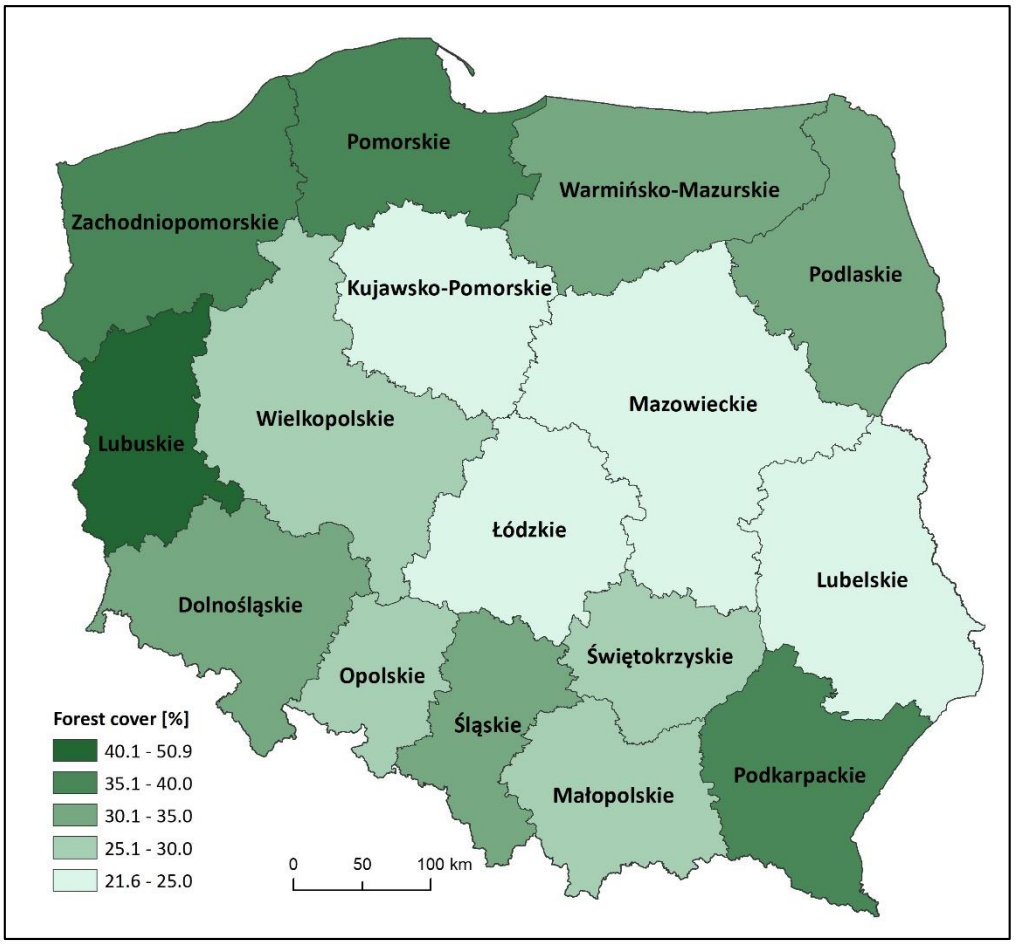


Fig. 2.29. Share of forest land in the area of Voivodeships
Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Environmental Protection 2021

The area of forests grows as a result of systematic tree plantings on non-forest land used before for agricultural purposes or uncultivated land and the classification of other land overgrown by forest vegetation as forests (the natural succession). The conversion of forestland for non-agricultural and non-forestry purposes is mostly related to the development of transport infrastructure, particularly roads. The average age of forest stands is 61 years [Statistical Yearbook of Forestry 2021, GUS 2022].

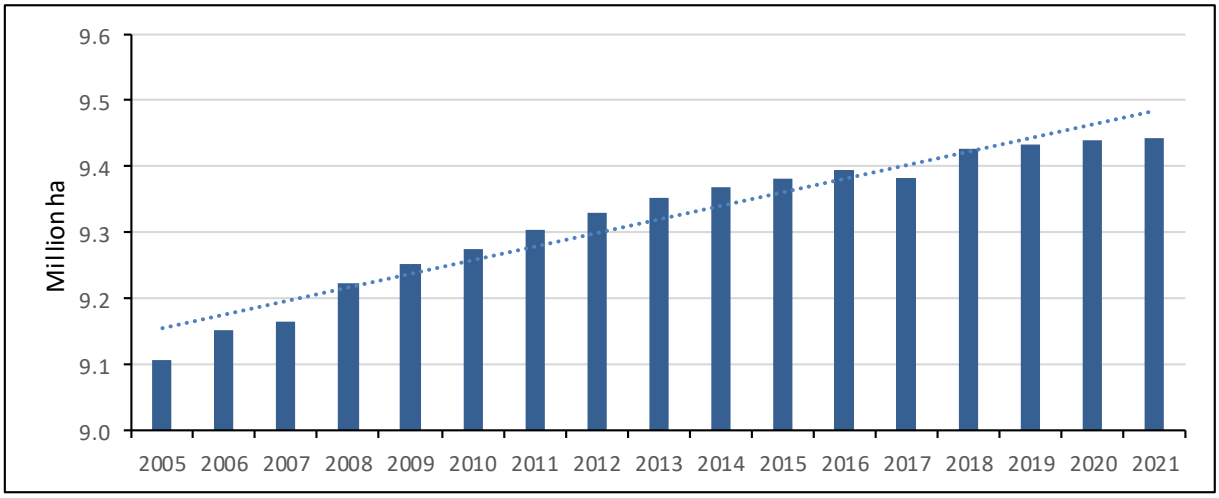


Fig. 2.30. Change in the area of forest land as of 1 January of a given year in the period from 2005 to 2021
Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of the data from GUS Environmental Protection 2021, NIR 2022

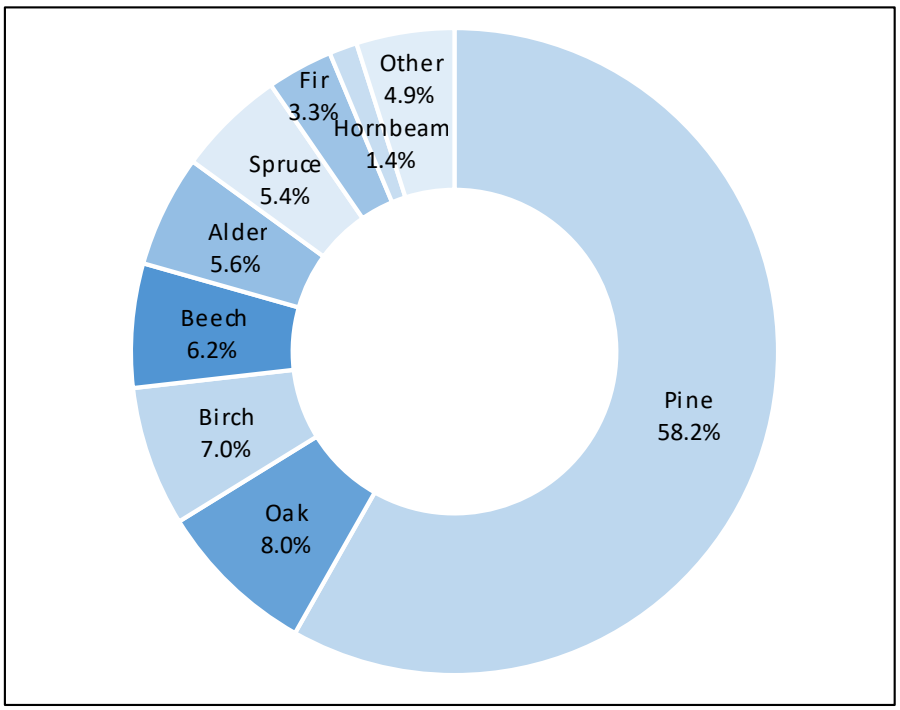


Fig. 2. 31. Structure of the forest land by dominant species
Source: Elaborated by KOBiZE IOŚ-PIB on the basis of the data from GUS Statistical Yearbook 2021

The most important functions of forests are nature-related (protective), productive (economic) and social ones. In light of their relatively large area on the scale of the country, forests play an important role in mitigating the effects of climate change.

2.13. Special circumstances of the fulfilment of its commitments by Poland

Pursuant to Article 4.6 of the United Nations Framework Convention on Climate Change, Poland has recognised the desirability of a flexible approach to the choice of the base year for the assessment of commitments arising under the Climate Convention and adopted 1988 instead of 1990, which is obligatory for the Member States of the Convention, as reflected in paragraph 5 of Decision 9/CP.2.

The reason why Poland has adopted the assumption concerning the change of the base year from 1990 to 1988 is the fact that 1990 was in Poland the first year following the fundamental political and economic changes, and, in consequence, also political ones which clearly undermined the stability of the Polish economy[1]. It was exactly 1990 that saw a temporary collapse of the economy. Therefore, the greenhouse gas emission levels in 1990 do not correspond to either the normal emission levels, or the actual economic potential of Poland. Thus, 1990 as the base year is not adequate for the assessment of the potential and condition of the Polish economy.

[1] A detailed justification of Poland's adoption of 1988 as the base year was given in the First National Communication to the Conference of the Parties to the Convention (1994)

CHAPTER 3. GREENHOUSE GAS INVENTORY INFORMATION

3.1. Information on GHG inventory

This report presents the results of the Poland's inventory of the greenhouse gas emissions and removals submitted in 2022, covering the years 1988–2020 and the following gases and groups of gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), nitrogen trifluoride (NF_3).

GHG emissions are reported according to classification and in the Common Reporting Format (CRF) tables in five main categories: 1. *Energy*, 2. *Industrial Processes and Product Use* (IPPU), 3. *Agriculture*, 4. *Land Use, Land Use Change and Forestr*y (LULUCF) and 5. *Waste* (covering also wastewater management).

According to the provisions of Article 4.6 of the UNFCCC and decision 9/CP.2 Poland uses 1988 as the base year for the estimation and reporting of GHG inventories for the main gases (CO_2, CH_4 and N_2O). Different base years have been established for other groups of gases: 1995 for HFCs, PFCs and sulphur hexafluoride (SF_6) and 2000 for the nitrogen trifluoride (NF_3).

The global warming potential (GWP) of the IPCC Fourth Assessment Report (AR4), in accordance with Decision 24/CP.19, was used to calculate the emissions of gases other than carbon dioxide.

3.1.1. GHG emission and removal trends by gases

In 2020 the total national emission of GHG amounted to 376.04 million t of CO_2 eq., excluding GHG emissions and removals from category 4 (*Land use, land use change and forestry* – LULUCF). Compared to 1988 the 2020 emissions have decreased by 35.1%.

Carbon dioxide is the main GHG in Poland with the share of 80.7% in national emissions in 2020. Methane and nitrous oxide contribute respectively with: 11.8% and 6.1% share. All F-gases are responsible for 1.4% of total GHG emissions while no NF_3 emissions were recorded in Poland. Percentage share of GHG in national total emissions (without LULUCF) in 2020 is presented at Fig. 3.1

Compared to 1988, the amount of carbon dioxide emissions (excluding CO_2 emissions and removals in the LULUCF sector) decreased by nearly 36%, methane – by almost 40%, and nitrous oxide – by over 31% (Fig. 3.2., Table 3.1). At the same time, the emission of carbon dioxide per capita in Poland decreased from 12.5 t CO_2 in 1988 to 7.9 t CO_2 in 2020, while the emission of all greenhouse gases fell from 15.3 t eq. CO_2 up to 9.8 t eq. CO_2/person.

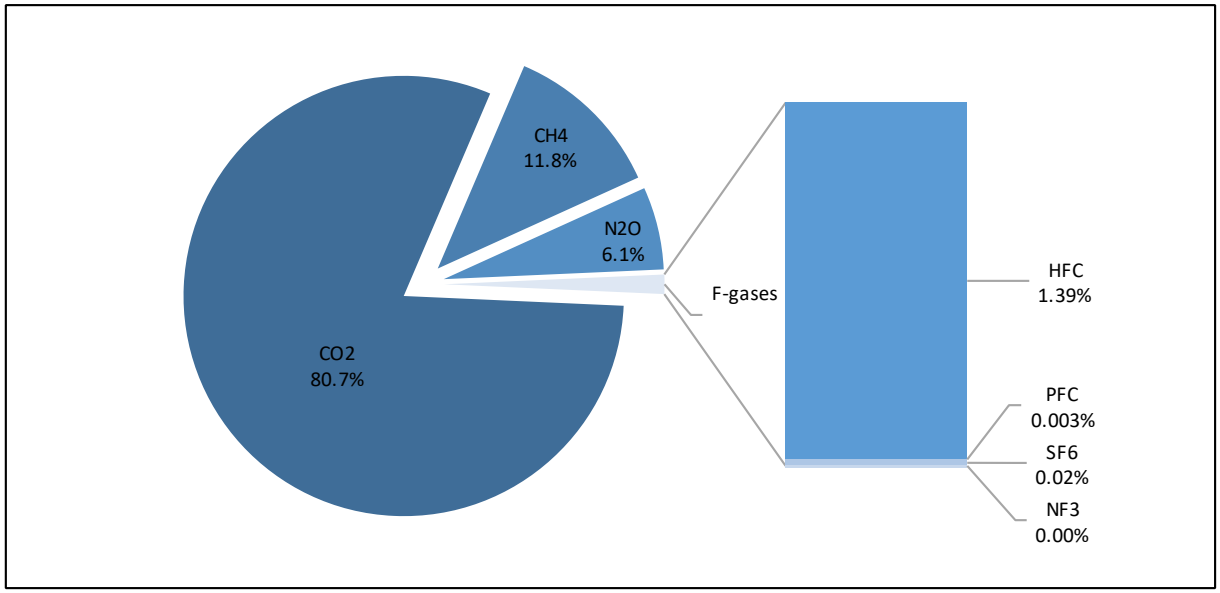


Fig. 3.1. Percentage share of greenhouse gases in national total emission in 2020 (without LULUCF)
Source: KOBiZE IOŚ-PIB

Table 3.1. GHG emissions in Poland in selected years since 1988 by gases

Gas	1988	1990	1995	2000	2005	2010	2015	2018	2020	change 2020 / 1988
	Mt CO_2 eq.									%
CO_2 (without net CO_2 from LULUCF)	472.05	376.81	362.89	317.72	323.41	334.92	313.46	337.05	303.52	-35.70
CO_2 (with net CO_2 from LULUCF)	453.59	347.22	344.28	282.33	274.77	301.26	283.36	298.99	283.43	-37.52
CH_4 (without CH_4 from LULUCF)	73.52	67.61	57.75	52.35	52.84	50.26	48.56	47.19	44.36	-39.67
CH_4 (with CH_4 from LULUCF)	73.57	67.66	57.79	52.39	52.87	50.27	48.59	47.21	44.38	-39.68
N_2O (without N_2O from LULUCF)	33.51	31.31	26.34	25.34	24.95	22.07	21.46	23.18	22.84	-31.85
N_2O (with N_2O from LULUCF)	35.50	33.19	27.94	26.68	26.03	23.09	23.45	25.15	24.79	-30.18
HFCs			0.17	1.07	3.80	5.60	5.58	5.59	5.22	–
PFCs	0.15	0.14	0.17	0.18	0.19	0.02	0.01	0.01	0.01	-93.06
Unspecified mix of HFC and PFC	NA. NO	NA. NO	NA. NO	NA. NO	NA. NO	NA. NO	NA. NO	NA. NO	NA. NO	NA. NO
SF_6	NA. NO	NA. NO	0.03	0.02	0.03	0.04	0.08	0.11	0.09	–
NF_3	NA. NO	NA. NO	NA. NO	NA. NO	NA. NO	NA. NO	NA. NO	NA. NO	NA. NO	NA. NO
Total (without LULUCF)	**579.22**	**475.87**	**447.35**	**396.68**	**405.20**	**412.90**	**389.15**	**413.13**	**376.04**	**-35.08**
Total (with LULUCF)	562.81	448.22	430.38	362.66	357.68	380.28	361.07	377.05	357.91	-36.41

Source: KOBiZE IOŚ-PIB

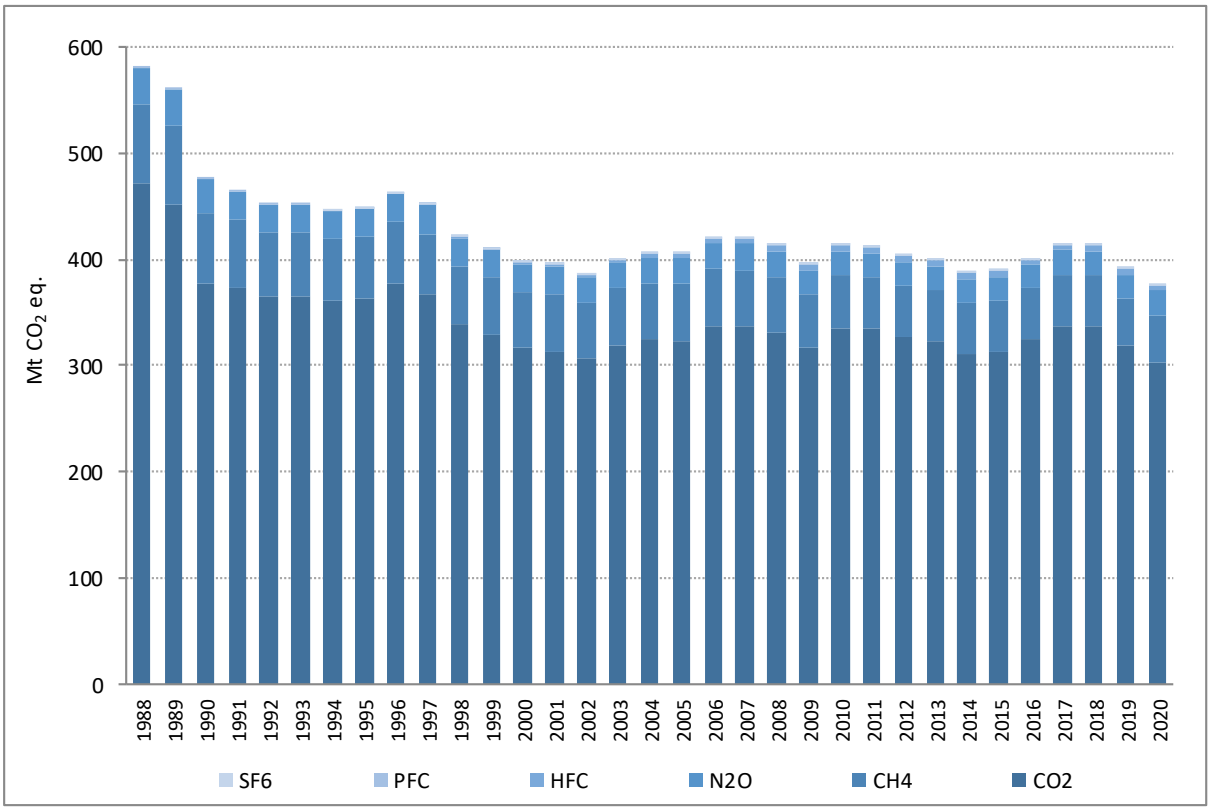


Fig. 3.2. GHG emissions in 1988-2020 by gases (without LULUCF)
Source: KOBiZE IOŚ-PIB

The GHG emission trend for period between 1988 and 1990 indicates significant decrease triggered by substantial economic changes, especially in heavy industry. This was the time when political transformation from centrally planned to free market economy began. This drop in emissions continued up to 1992 and then emissions started to rise with a peak in 1996 as a result of development in heavy industry and other sectors and dynamic economic growth. Slow decline in emissions (up to 2002) characterized the succeeding years, when still energy efficiency policies and measures were implemented, and then slight increase up to 2007 caused by animated economic development. In 2008-2011 stabilisation in emissions has been noted with distinct decrease in 2009 related to world economic slow-down. In 2012–2014 GHG emissions in Poland slowly decreased then starting to rise in the next years (Fig. 3.2 and 3.4). The main cause of significant increase of GHG emissions in 2016–2018, besides economic animation, was substantial rise of fuels use in road transport resulting, inter alia, from increase in transport work related to the dynamic economic development.

On the other hand, 2019 saw a decrease in domestic GHG emissions by 5.5% compared to the previous year, what was caused by lower consumption of fuels burned in stationary sources, mainly hard coal (by approx. 8%) and lignite (by over 15%). This resulted, inter alia, from limiting the production of electricity, especially from solid fuels (hard coal by 6.5% and lignite by 14.5%), with an increase in the share of energy from RES and natural gas. At the same time, electricity imports increased (by over 29%). In addition to the energy sector, emissions in the agricultural sector have also decreased, due to the lower consumption of mineral fertilizers. The nearly 16% decrease in the consumption of nitrogen fertilizers was mainly caused by the occurrence of droughts covering a large area of Poland, as well as the introduced regulations regarding their application[2]. On the other hand,

[2] Regulation of the Council of Ministers of June 5, 2018 on the adoption of the "*Action Program to reduce water pollution with nitrates from agricultural sources and to prevent further contamination*"

in the waste sector, the amount of municipal waste utilized by landfilling decreased, as well as the amount of industrial waste and thermal treatment of sewage sludge.

The year 2020, which was the first year of the COVID-19 pandemic in Poland, is another year with a decrease in GHG emissions caused by lower consumption of fuels burned in stationary sources (hard coal by over 6% and lignite by over 8%) and in transport (gasoline by nearly 7% and diesel by nearly 3%). In addition to the energy sector, emissions from the industrial process sector have also decreased. This is mainly the result of a decrease in production in the metal industry (reduction in the production of converter steel by 20%, pig iron by over 18% and sinter by about 24%). In 2020, lime production was also lower by more than 5% compared to 2019. A decrease in emissions was also recorded in the waste sector, where the amount of municipal waste disposed of through landfilling (by nearly 5%) and municipal waste thermally disposed of without energy recovery (by almost 22%).

3.1.2. GHG emission and removal trends by sectors

The largest share in the total greenhouse gas emissions (expressed in CO_2 equivalent) in Poland in 2020 (without LULUCF) was from sector 1. *Energy* (approx. 81.2%), and within this sector – *Fuel combustion* (75.5%). Agriculture was responsible for 9.1%, Industrial processes for 6.7% and Waste for 3.0% (Fig. 3.3).

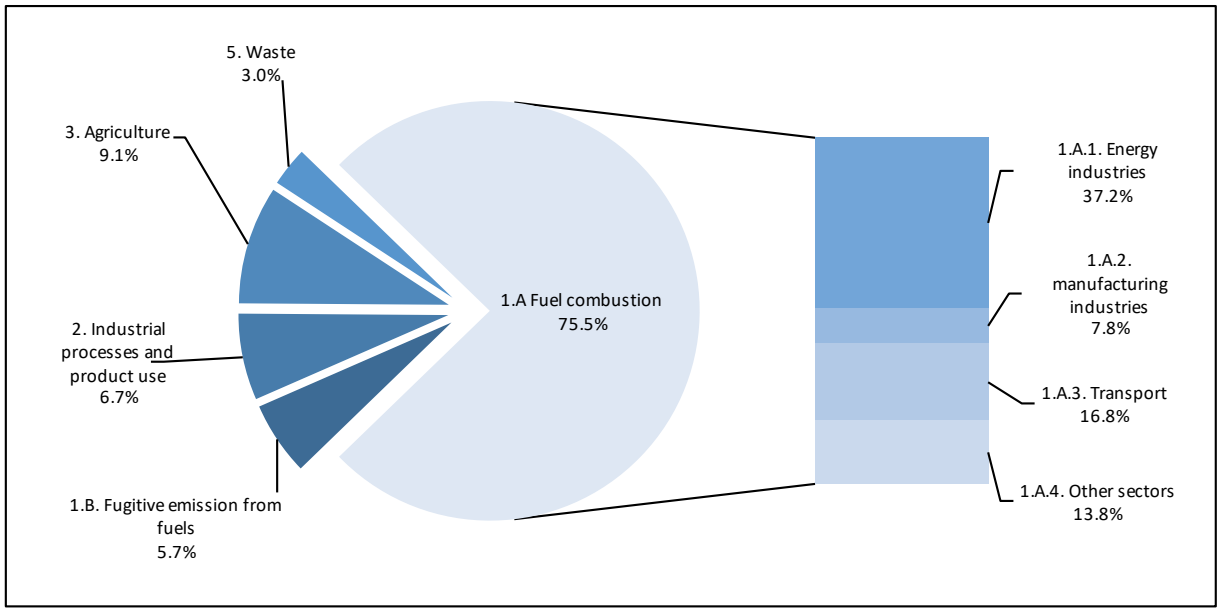


Fig. 3.3. GHG emissions in Poland by sector in 2020 (without LULUCF)
Source: KOBiZE IOŚ-PIB

In all categories emission reduction has been since 1988. The highest drop in emissions has occurred in two categories: 5. *Waste*, 1. *Energy* and 3. *Agriculture* (by 48.2%, 35.9% and 31.6% respectively). In sector 5, it was caused by the development of waste disposal technology (as a result of which, in 2020, 32% of the weight of waste in relation to the base year was utilized by landfilling), and the development of recycling and thermal waste disposal. The decline in emissions in sector 1 was caused by the transformation in the energy and industry sectors, which impact on reducing the amount of coal combusted (in total in the energy and manufacturing industries by more than 53% as relates to hard coal and by almost 36% in the case of lignite). The consumption of coal in households also decreased (by approx. 60%). There was also a significant reduction in coal production (by almost 72% compared to 1988), which resulted in a decrease in fugitive emissions. On the other hand, in agriculture, such a significant decrease in emissions was caused by structural and economic changes after 1989, including a decrease in animal and plant production (e.g. there was a decrease in the cattle

population in 1988-2020 from over 10 million to approx. 6 million, sheep from over 4 million to approx. 288 thousand). The emissions and removals of greenhouse gas in sector 4. *Land use, land use change and forestry* for 2020 was estimated at nearly -18 million t of CO_2 eq., of which the net absorption of CO_2 (mainly from forest land) was -21 million t CO_2. In the case of sector 4, 2020 is the second consecutive year in which the level of carbon accumulation in Polish forests did not reach the level recorded in the years preceding the collapse of this accumulation trend in 2019. The trend of changes in greenhouse gas emissions in Poland by sectors is presented in Table 3.2.

Table 3.2. GHG emissions in Poland in selected years since 1988 by sectors

Sector	1988	1990	1995	2000	2005	2010	2015	2018	2020	change 2020 / 1988
	Mt CO_2 eq.									%
1. Energy	476.16	382.40	367.99	321.79	331.77	342.05	319.25	340.99	305.34	-35.88
2. Industrial processes and product use	31.04	22.55	22.88	23.08	24.73	23.47	24.87	26.04	25.07	-19.22
3. Agriculture	50.19	49.42	36.91	33.49	31.94	32.01	32.00	34.03	34.31	-31.63
4. Land use. land use change and forestry (LULUCF)	-16.41	-27.65	-16.96	-34.02	-47.52	-32.62	-28.08	-36.07	-18.13	10.46
5. Waste	21.84	21.50	19.56	18.32	16.77	15.38	13.03	12.06	11.31	-48.19
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (without LULUCF)	**579.22**	**475.87**	**447.35**	**396.68**	**405.20**	**412.90**	**389.15**	**413.13**	**376.04**	**-35.08**
Total (with LULUCF)	562.81	448.22	430.38	362.66	357.68	380.28	361.07	377.05	357.91	-36.41

Source: KOBiZE IOŚ-PIB

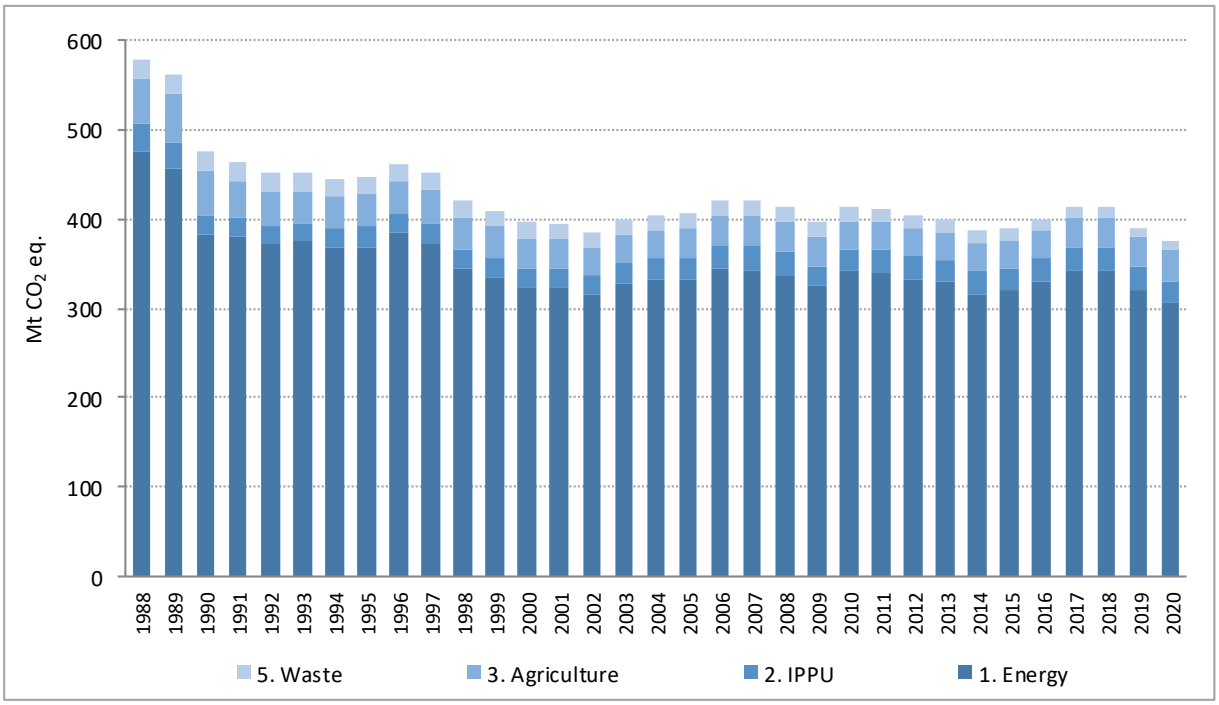


Fig. 3.4 Trend of aggregated GHG emissions (without LULUCF) for 1988–2020 according to source categories
Source KOBiZE IOŚ-PIB

Carbon dioxide emissions

In 2020, the CO_2 emissions (without LULUCF) were estimated to be 303.52 million t. It is 35.7% less compared to the emissions in the base year (1988) (Table 3.1) and 4.7% less than in 2019. The main CO_2 emission source is *Fuel Combustion* (1.A) subcategory. This sector contributed to the total CO_2 emission (without LULUCF) with 91.6% share in 2020. The shares of the main subcategories in 1.A were as follows: *Energy industries* - 45.8%, *Manufacturing Industries and Construction* – 9.5%, *Transport* – 20.6% and *Other Sectors* – 15.7%. Sector 2. *Industrial Processes* contributed to the total CO_2 emission with 6.3% share in 2020. *Mineral industry* (especially *Cement Production*) (Fig. 3.5) is the main emission source in this sector. The CO_2 emission/removal in LULUCF sector in 2020, was calculated to be approximately – 20.1 million t what means that removals prevail emissions significantly in this sector.

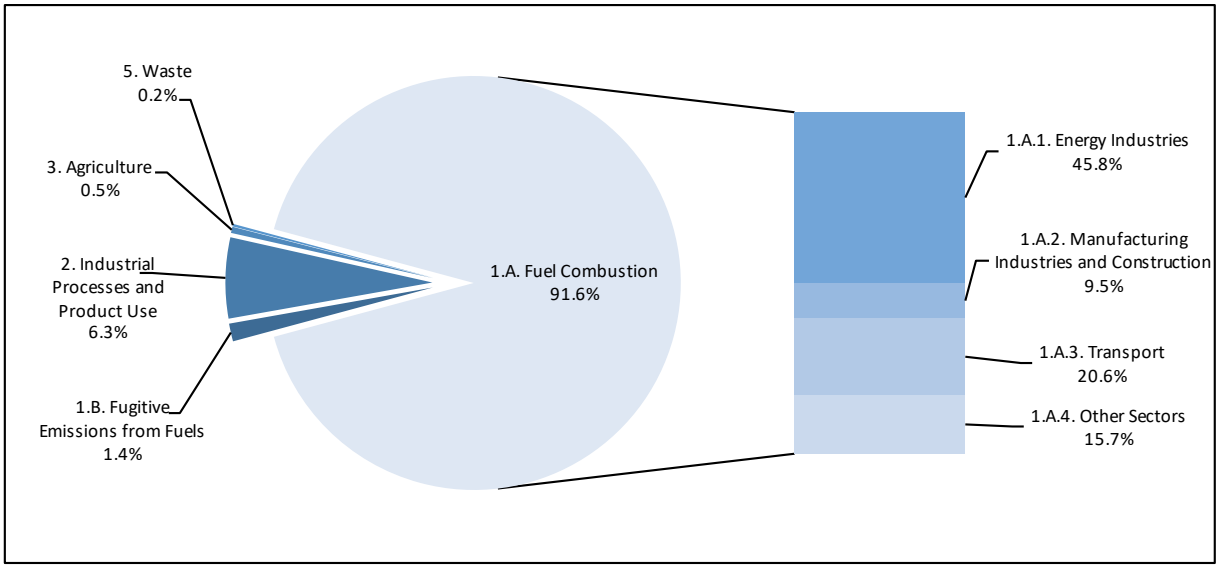


Fig. 3.5. Carbon dioxide emission (without LULUCF) in 2020 by sector
Source: KOBiZE IOŚ-PIB

Methane emissions

The CH_4 emission (without LULUCF) amounted to 1 774.23 kt in 2020 i.e. 44.36 million t of CO_2 equivalents. The emission in 2020 compared to the base year (1988) was lower by 39.7% (Table 3.1) and by 0.4% lower than in 2019. Three of main CH_4 emission sources include the following categories: *Fugitive Emissions from Fuels, Agriculture* and *Waste*. They contributed with 38.7%, 31.9% and 22.0% shares to the national methane emission in 2020, respectively (fig. 2.4). The emission from the first mentioned sector was covered by emission from coal and lignite mines (app. 32.6% of total CH_4 emission) and *Oil and Natural Gas* systems (about 6.0% of total emission). The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 29.1% of total methane emission in 2020. Emissions from *Solid waste disposals* contributed to 17.0% and from *Wastewater treatment and discharge* to 4.6% of the national methane emissions (Fig. 3.6).

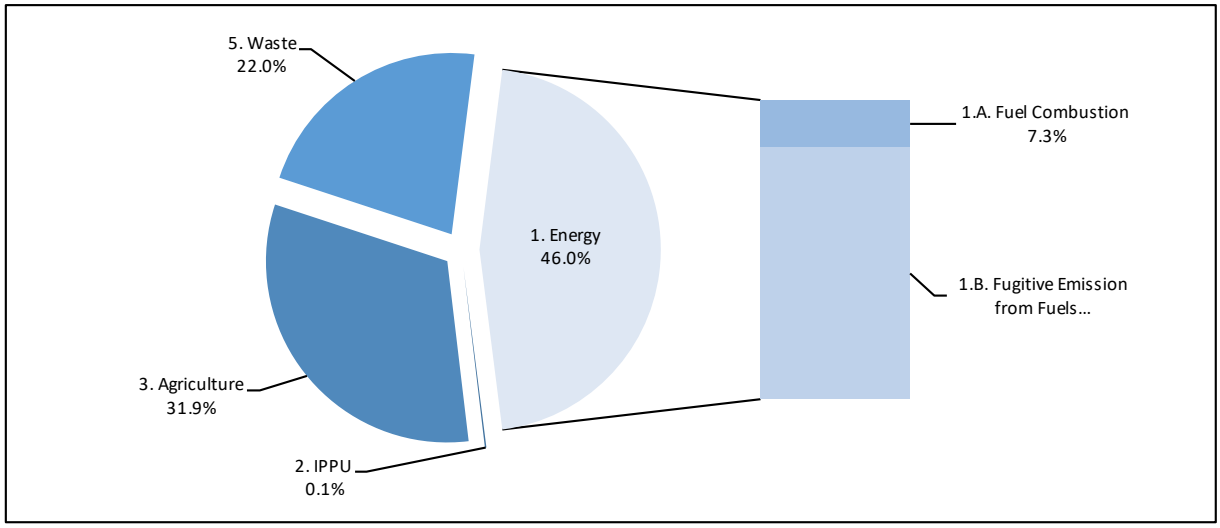


Fig. 3.6. Methane emission (without LULUCF) in 2020 by sector
Source: KOBiZE IOŚ-PIB

Nitrous oxide emissions

The nitrous oxide emissions (without LULUCF) in 2020 were 76.64 kt i.e. 22.84 million t of CO_2 equivalents. N_2O emissions were 31.8% lower than in the base year of 1988 and 3.8% lower than in 2019. The main N_2O emission source in Poland is sector 3. *Agriculture* (81.8% of total nitrous oxide emissions in 2020). The highest shares in total N_2O emissions in 2020 in this sector are: *Agricultural Soils* – 68.9% and *Manure Management* – 12.9%. The other significant sources of N_2O emissions included: *Fuel Combustion* (in the 1. Energy sector) – 11.5%, *Chemical Industry* (in the 2. IPPU sector) with share 1.8% and *Domestic wastewater treatment* (in the 5. *Waste* sector) with share of 3.4% in total N_2O emissions. N_2O emissions by major categories are shown in Fig. 3.7.

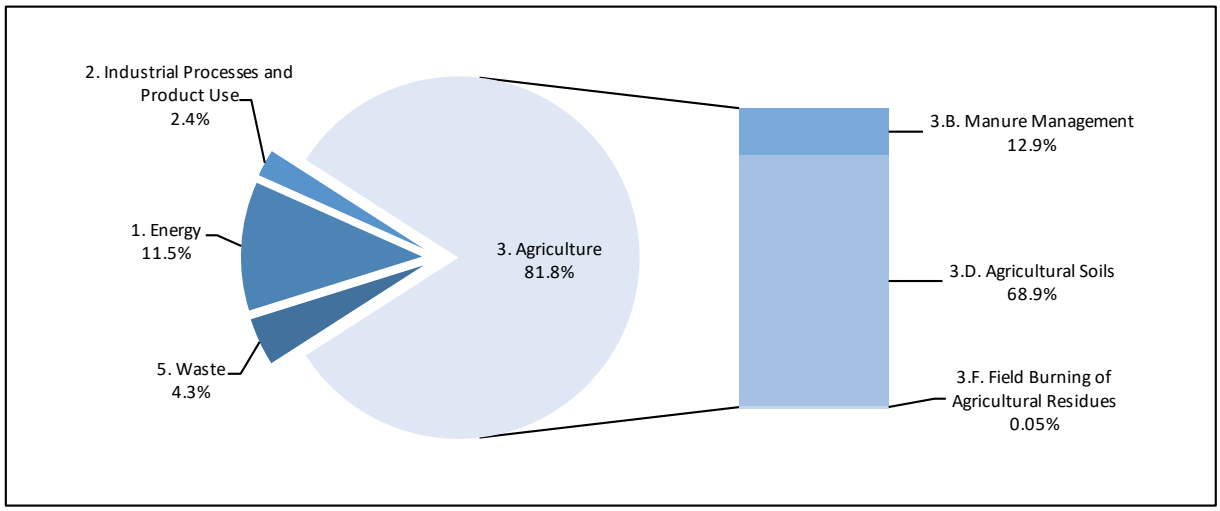


Fig. 3.7. Nitrous oxide emission (without LULUCF) in 2020 by sector
Source: KOBiZE IOŚ-PIB

Emissions of fluorinated gases

The total emission of industrial gases (HFCs, PFCs, SF_6 and NF_3) in 2020 was 5 320.72 kt CO_2 equivalent what accounts for 1.4% of total GHG emissions share in 2020 (Fig. 3.1). Industrial gases emissions were by 1326.2% higher comparing to the base year. This significant growth in HFCs emission is mainly due to the increase in emission from refrigeration and air conditioning equipment. Shares of HFCs, PFCs and SF_6 in total 2020 GHG emissions was respectively as follows: 1.39%, 0.003% and 0.02%. NF_3 emissions did not occur.

3.2. National inventory arrangements

The unit responsible for carrying out the inventory of greenhouse gases is the National Center for Emissions Management (KOBiZE) operating at the Institute of Environmental Protection – National Research Institute (IOŚ-PIB), established under the Act of 17 July 2009 on the system to manage the emissions of greenhouse gases and other substances[3], further called USZE. According to Article 11 of above mentioned Act, the National Centre prepares and submits to the Minister of Climate and Environment annual greenhouse gas inventories carried out in accordance with the UNFCCC guidelines and annual inventories of the substances listed in the Convention on Long-range Transboundary Air Pollution (UNECE CLRTAP). GHG emission inventories are elaborated in accordance with the mandatory guidelines. The tasks of KOBiZE IOŚ-PIB also include the preparation of other information, including information on emissions, for the purposes of public statistics.

Work for the inventory of greenhouse gas emissions, including the emission calculation, choices and development of methodology, activity data related to emission sources as well as establishing the emission factors are performed by the Emission Inventory and Reporting Unit in the National Centre for Emissions Management. The inventory team collaborates with a number of individual experts as well as institutions when compiling inventories. Among the latter are: Statistics Poland (GUS), Agency of Energy Market (ARE), Office for Forest Planning and Management (BULGiL). Those institutions are mainly involved in providing activity data for inventory estimates for given sectors.

The experts of the National Centre have the access to the emission data submitted by the individual entities participating in the European Union Emission Trading System (EU-ETS). Such verified data are used within the GHG inventory in some sectors (like industrial processes). Additionally the inventory team has the access to the emission data which are submitted by individual entities to the National Database on Emissions – the biggest database with individual emission reports available in Poland, where in 2021 almost 50 thousand enterprises reported data on GHG and air pollution emissions emitted by 125 thousand installations.

The Minister of Climate and Environment supervises the activity and performance of the National Centre for Emissions Management (Fig. 3.8). The GHG inventory becomes a process of approval by the Council of Ministers before official submission. The Minister of Climate and Environment is responsible for acceptance the results of the national GHG inventory.

Apart from the emission inventory, KOBiZE IOŚ-PIB elaborates GHG emission projections. he projections are submitted to the minister responsible for climate and environment, who submits them to internal and inter-ministerial consultations. The consultations ensure that the assumptions used in the projections are consistent with the ongoing and planned sectoral activities carried out by the relevant ministers. Projected emissions, after agreement and approval by the government, are submitted to the European Commission and the UNFCCC.

[3] Journal of Laws 2022, Item 673

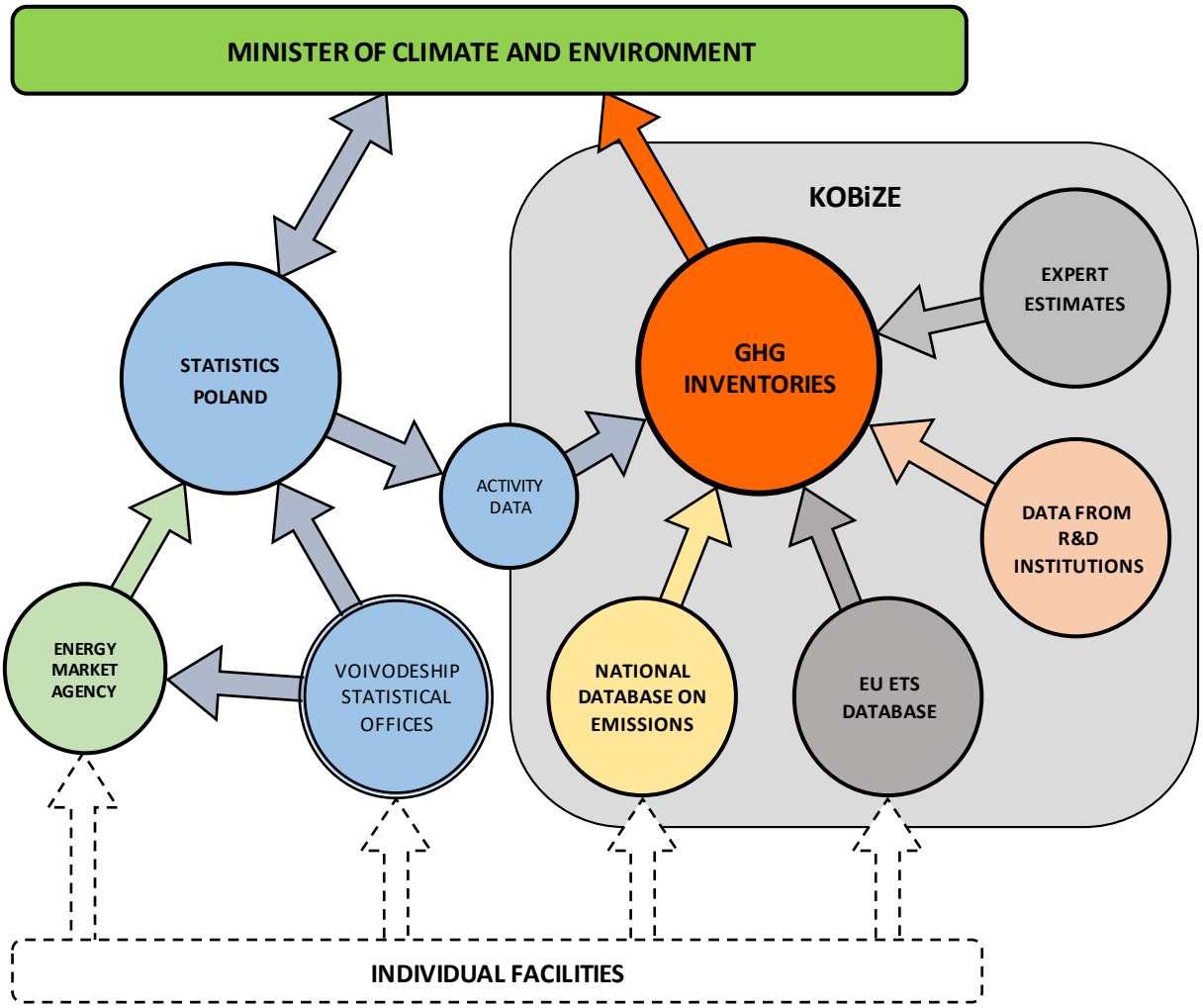


Fig. 3.8. National GHG emissions inventory system scheme
Source: KOBiZE IOŚ-PIB

In order to further ensure the high quality of the National Greenhouse Gas Inventory, *the National Quality Assurance / Quality Control and Verification Programme of the Polish Greenhouse Gas Inventory* has been developed. The QA/QC program defines the tasks, responsibilities as well as the timeline for the performance of QA/QC procedures and is presented in the annual National Inventory Reports (NIR). Elements of the national quality assurance and control system include:

- Inventory agency responsible for coordinating QA/QC activities,
- QA/QC plan,
- General QC procedures (*Tier 1* method),
- Source category-specific QC procedures (*Tier 2*),
- QA review procedures,
- Reporting, documentation and archiving procedures.

An additional element of the system is the inventory improvement plan, which is constantly updated. It mainly covers methodological aspects, both in terms of greenhouse gas emissions and air pollutants, resulting from the process of international inventory reviews, internal and inter-ministerial consultations. Priority is given to the main emission sources for which national methodologies and emission factors are developed where possible. The unit responsible for the coordination and implementation of QA/QC procedures in the national inventory is KOBiZE IOŚ-PIB.

3.3. National Registry

The Polish Registry was launched in July 2006 and, since 2008, has been linked to the International Transaction Log (ITL). According to national regulations, the Registry is managed by the National Centre for Emissions Management at the Institute of Environmental Protection – National Research Institute in Warsaw. The Registry database collects information on entities covered by the system, installations, verified emission data, national holding accounts, installation accounts, aircraft operator accounts and trading accounts.

The amended EU regulations, in particular, the EU Directive 2009/29/EC, which was adopted in 2009, paved the way for centralizing the EU Emissions Trading Scheme (EU ETS) in one EU Registry, and to include the aviation sector into the trade system. Consequently, in June 2012, national registries of the European Union countries were consolidated. As a result of the merger, both the physical location of the Polish Registry and the relevant software were changed, and all technical procedures applied were updated. The software and infrastructure for the common Registry is provided and technically operated by the European Commission. The Registry is connected via network with the International Transaction Log (ITL) managed by the Secretariat of the United Nations Framework Convention on Climate Change and with the European Union Transaction Log (EUTL) serving as an additional transaction log.

Currently, national registries of 27 Member States of the European Union as well as Iceland, Liechtenstein, Norway and Northern Ireland are merged into one consolidated registry.

In accordance with art. 25 of the Directive 2003/87/EC[4], since 2020 the EU ETS Scheme was connected to the Swiss registry, enabling the exchange of units and allocations for aircraft operators performing flights within the European Economic Area and Switzerland.

Participants in the emissions trading system as well as the administrators have access to the Registry via a secure website[5].

The consolidated Registry has been established based on the following assumptions:

1) In countries (also in Poland), there are still organizations functioning as administrators of national registries, responsible for fulfilling all obligations of the parties with respect to the common Registry;
2) Each international unit issued in the Polish part of the EU Registry is marked with a unique serial number containing the identifier of origin;
3) Within the EU Registry, Poland, as a Party to the Kyoto Protocol, has its own national accounts. Each of these accounts was assigned a unique number, consisting of the country code ("PL"), and a unique number in this part of the EU Registry;
4) Transactions performed using Kyoto units are transferred and verified by the International Transaction Log (ITL), which is responsible for verifying transactions' correctness and validity;
5) Reconciliations of data between the different parts of the registry and the International Transaction Log have been still continuing to ensure consistency of data and enable the ITL's automatic controls;

[4] Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC ((EU Journal of Laws 275 of 25.10.2003)

[5] https://ets-registry.webgate.ec.europa.eu/euregistry/PL/index.xhtml

6) All parts of the EU Registry are kept on the consolidated IT platform, sharing the same infrastructure technology, which ensures the security, uniqueness, and possibility of unambiguous identification of a given part of the Registry.

The implementation of the above is based on the following guidelines:

- with respect to data exchange, each part of the EU Registry, administered by a Party to the Kyoto Protocol, has a direct, separate and secure communication link via a unified communications channel (VPN);
- ITL is responsible for authenticating national registries and ultimately registers all transactions made with the use of Kyoto units, as well as verifies other administrative processes in such a way that the completed operations cannot be challenged and rejected;
- with respect to data storage, the consolidated platform guarantees their confidentiality and protection against unauthorized access;
- the data storage architecture provides for the distinction and unambiguous identification of data relating to the Polish part of the EU Registry in relation to data associated with the remaining parts of the consolidated registry;
- each part of the EU Registry conducts a separate URL, with separate rules for authorization and configuration.

The National Centre for Emissions Management provides the required information[6] at the address: http://www.kobize.pl/en/article/rejestr-uprawnien/id/348/reports-public. The site is fully controlled by the Polish administrator. The following data were posted on the website and have been subject to update:

- account information (in accordance with paragraph 45 of part E of the Annex to Decision 13/CMP.1);
- information on projects as defined in Article 6. (in accordance with paragraph 46 of Part E of Annex 13 to CMP.1);
- information on units and their transfers (in accordance with paragraph 47 of Part E of Annex 13 to CMP.1) prepared on the basis of the SEF report;
- the list of entities authorized by the country (in accordance with paragraph 48 of part E of the Annex to Decision 13/CMP.1).

It should be noted that some of the data required under the above mentioned Decision has not been made public (e.g. balance of individual accounts, personal data of account representatives, etc.) due to security requirements[7].

Current information and changes in the National Registry are presented annually in the National Inventory Report (NIR), submitted to the UNFCCC Secretariat before April 15.

[6] in accordance with Part E of Annex I to Decision 13/CMP.1; http://www.kobize.pl/pl/article/rejestr-uprawnien/id/348/raporty-publiczne

[7] in accordance with Art. 80 of the Commission Delegated Regulation No 2019/1122 of 12 March 2019, supplementing Directive 2003/87/EC of the European Parliament and of the Council as regards the functioning of the Union Registry (EU Journal of Laws 177 of 02.07.2019, p.3)

CHAPTER 4. POLICIES AND MEASURES

4.1. Climate policy-making process

4.1.1. Climate policy of the European Union

As a Member State of the EU, Poland co-creates EU climate policy and is obliged to implement the EU regulations in this area. As a result of this, most actions which Poland carries out in the scope of climate change mitigation result from the EU regulations. Part of the EU regulations apply directly, while others, e.g. Directives, are implemented into the national legal order by means of national regulations which translate into specific measures described in Section 4.2.

The further part of this Section outlines the key directions of the development of EU climate policy which, as explained above, are reflected in Poland's climate policy.

2020 climate and energy package

In 2009, the EU adopted the climate and energy package (hereinafter referred to as the 2020 CEP) to further tackle climate change, including further greenhouse gas emission reductions. The package provided that by 2020 the EU would:

- reduce the greenhouse gas emissions by 20% compared with 1990 levels;
- increase the share of renewable energy in the final energy consumption to 20%;
- improve energy efficiency by 20% relative to 2020 projections (a non-obligatory target);
- increase the share of biofuels in the total consumption of transport fuels to at least 10%.

The 2020 CEP included the following main legal acts:

- Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community (OJ L 140, 05.06.2009, p. 63);
- Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020 (the so-called ESD Decision) (OJ L 140, 05.06.2009, p. 136);
- Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006 (OJ L 140, 05.06.2009, p. 114);
- Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (OJ L 140, 05.06.2009, p. 16);
- Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC (OJ L 315, 14.11.2012, p. 1);
- Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC (OJ L 140, 05.06.2009, p. 88).

The greenhouse gas emission reduction target at the EU level (14% compared with 2005 levels) was divided between the two main areas of the economies of the EU and its Member States in the following way:

- the target for the area covered by the EU ETS (including domestic and international aviation): a 21% reduction of the greenhouse gas emissions compared with 2005 levels;

- the target for the area not covered by the EU ETS (the so-called non-ETS, i.e. the sectors subject to the ESD Decision): a 10% reduction of the greenhouse gas emissions compared with 2005 levels. The EU target was divided among all the EU Member States. As part of this division, Poland was allowed to increase its greenhouse gas emissions by +14% above 2005 levels.

Section 4.1.2 provides detailed information on the reduction targets.

EU climate policy until 2030 and beyond

2030 climate and energy package

In 2018, the EU adopted another climate and energy package (hereinafter referred to as the 2030 CEP), among others, to achieve the greenhouse gas emission reduction target for 2030. The package provided that by 2030 the EU would:

- reduce the greenhouse gas emissions by 40% compared with 1990 levels;
- increase the share of renewable energy in the final energy consumption to 32%;
- improve energy efficiency by 32.5% relative to 2030 projections;
- increase the share of biofuels in the total consumption of transport fuels to at least 14%.

The 2030 CEP included the following main legal acts concerning the reform of the EU ETS system, the non-ETS area, the promotion of RES or energy efficiency, representing to a large extent amendments to the regulations setting out the targets and manner of their implementation by 2020, i.e.:

- Directive (EU) 2018/410 of the European Parliament and of the Council of 14 March 2018 amending Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments, and Decision (EU) 2015/1814 (OJ L 76, 19.3.2018, p. 3);
- Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No 525/2013 (the so-called ESR Regulation) (OJ L 156, 19.6.2018, p. 26);
- Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework, and amending Regulation (EU) No 525/2013 and Decision No 529/2013/EU (the so-called LULUCFR Regulation – LULUCFR) (OJ L 156, 19.6.2018, p. 1);
- Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (OJ L 328, 21.12.2018, p. 82);
- Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 amending Directive 2012/27/EU on energy efficiency (OJ L 328, 21.12.2018, p. 210).

The achievement of the EU target for 2030 was divided between the three main areas of the economies of the EU and its Member States in the following way:

- the target for the EU ETS area (including domestic and international aviation): a 40% reduction of the greenhouse gas emissions compared with 2005 levels;
- the target for the area not covered by the EU ETS (the so-called non-ETS, i.e. the sectors subject to the ESR Regulation): a 30% reduction of the GHG emissions compared with 2005 levels. The EU target was divided among all the EU Member States. As part of this division, Poland's target is to reduce its GHG emissions by 7% compared with 2005 levels by 2030;
- the LULUCF area: the Member States were expected to ensure that their emissions would not exceed their removals in this area.

Section 4.1.2 provides detailed information on the reduction targets.

Moreover, Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action[8] imposed on the Member States the obligation to prepare national energy and climate plans (NECPs) and set out other rules on the reporting of the achievement of the targets for 2030.

The European Green Deal, the "Fit for 55" Package, the REPowerEU Plan and European Climate Law

However, in 2019, in its Communication of 11 December 2019 on the European Green Deal[9], the EC presented its new strategy aimed at transforming the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy, which would reach net zero emissions of greenhouse gases in 2050 and within the framework of which economic growth would be decoupled from the use of natural resources. The strategy also provided for the need to achieve a more ambitious greenhouse gas emission reduction target by 2030 (a reduction by at least 55% compared with 1990 levels). The aim of the European Green Deal was also to protect, conserve and enhance the EU's natural capital, and protect the health and well-being of citizens from environment-related risks and impacts. At the same time, the Commission emphasised that the transition had to be just and inclusive so that no one was left behind.

Subsequently, in order to implement the objectives set out in the European Green Deal, on 14 July 2021 the EC published the "*Fit for 55*" Package[10], containing legislative proposals intended to ensure that the EU would meet the raised greenhouse gas emission reduction target for 2030, i.e. a reduction by at least 55% compared with 1990 levels. The Package included the following key elements[11]:

- a revision of the EU ETS system to ensure greenhouse gas emission reductions in this area by 61% compared with 2005 levels by raising the ambition of the existing EU ETS system, making indispensable adjustments to the Market Stability Reserve (MSR), expanding the EU ETS to include the maritime sector, implementing the CORSIA scheme for aviation and also establishing a new ETS covering the emissions from fuels used in the municipal and household sector and road transport – with amendments to Directive 2003/87/EC, the so-called EU ETS Directive, proposed in (COM(2021) 551, (COM(2021) 552, (COM(2021) 571 and (COM(2021) 567;
- raising the emission reduction targets of the Member States to ensure a greenhouse gas emission reduction in the area not covered by the EU ETS system by 43% compared with 2005 levels – the proposal for an amendment to Regulation (EU) 2018/842 of the European Parliament and of the Council (ESR) in (COM(2021) 555;
- increasing the ambition on the removals of greenhouse gases as a result of land use, land use change and forestry, with the overall EU net greenhouse gases removal target of 310 million t of CO_2 eq. in 2030 distributed among the Member States in the form of annual national targets for the period from 2026 to 2030 – the proposal for an amendment to Regulation (EU) 2018/841 of the European Parliament and of the Council (LULUCFR) in (COM(2021) 554;

[8] Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council (OJ L 328, 21.12.2018)

[9] Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions The European Green Deal, COM(2019) 640

[10] Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions "*Fit for 55*": delivering the EU's 2030 Climate Target on the way to climate neutrality, COM(2021) 550

[11] More information on the "*Fit for 55*" Package can be found at the address: https://ec.europa.eu/clima/eu-action/european-green-deal/delivering-european-green-deal_en

- the adoption of new, more ambitious CO_2 emission targets for the whole EU fleet for new passenger cars and light commercial vehicles from 2030 – the proposal for an amendment to Regulation (EU) 2019/631 of the European Parliament and of the Council in (COM(2021) 556;
- the proposal for a Regulation establishing a carbon border adjustment mechanism (CBAM) in (COM(2021) 564;
- the proposal for an amendment to Directive 2018/2001 on renewable energy source to meet ambitious objectives of the new climate target for 2030 (increasing the share of RES for 2030 to 40%) in (COM(2021) 557;
- the proposal for an amendment to Directive 2012/27/EU on energy efficiency (raising the target of the improvement of energy efficiency for 2030 to 36-39%, i.e. 9% above the proposals of the Member States contained in the NECPs) in (COM(2021) 558.

At present, discussions are underway at EU level on the final contents of the abovementioned regulations and, thus, on the final scope of the rules applicable to the achievement of the targets for 2030. The expected end date of the legislative process is the end of 2022.

In addition, in May 2022 the European Commission published the REPowerEU Plan[12], which aims to indicate solutions enabling a reduction of the dependence of fossil fuel imports from Russia. This plan proposed a further raising of the EU targets for 2030 as regards the share of RES (from 40% to 45%) and an improvement in energy efficiency (from 9% to 13% above the proposals contained in the NECPs).

Moreover, another outcome of the European Green Deal strategy was Regulation 2021/1119, the so-called European Climate Law[13], adopted on 21 June 2021, constituting the first EU regulation directly referring to the greenhouse gas emission reductions until 2050 and specifying the reduction targets which the EU was expected to achieve. More information on the emission reduction targets is given in Section 4.1.2.

Other EU policies and measures

Important EU regulations which are not mentioned in the enumeration above and corresponding with EU climate and energy policy are listed below. To a large extent, they determine the scope of policies and measures implemented by Poland in the area of climate change mitigation.

- Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency (OJ L 156, 19.6.2018, p. 75);
- Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting CO_2 emission performance standards for new passenger cars and for new light commercial vehicles, and repealing Regulations (EC) No 443/2009 and (EU) No 510/2011 (OJ L 111, 25.4.2019, p. 13);
- Regulation (EU) 2019/1242 of the European Parliament and of the Council of 20 June 2019 setting CO_2 emission performance standards setting CO_2 emission performance standards for new heavy-duty vehicles and amending Regulations (EC) No 595/2009 and (EU) 2018/956 of the European Parliament and of the Council and Council Directive 96/53/EC (OJ L 198, 25.7.2019, p. 202);
- Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products (OJ L 285, 31.10.2009, p. 10);

[12] Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions REPowerEU Plan, COM(2022) 230

[13] Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ("*European Climate Law*") (OJ L 243, 09.07.2021)

- Regulation No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006 (OJ L 150, 20.5.2014, 195);
- Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure (OJ L 307, 28.10.2014, p. 1);
- Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC (OJ L 140, 5.6.2009, p. 88);
- Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport (OJ L 123, 17.5.2003, p. 42, as amended);
- Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste (OJ L 182, 16.7.1999, p. 1, as amended);
- Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (OJ L 312, 22.11.2008, p. 3, as amended).

4.1.2. Greenhouse gas emission reduction targets

This Section addresses the greenhouse gas reduction targets which Poland has undertaken to achieve. They apply to the period until 2050.

Greenhouse gas reduction targets by 2020

EU reduction effort

Under the UNFCCC, the EU and its Member States committed to achieving a joint quantified economy-wide greenhouse gas emission reduction target of 20% below the 1990 level by 2020 ("*the Cancun pledge*"). It is therefore a joint pledge with no separate targets for Member States under the Convention. The UK remains part of the joint EU 2020 target together with the 27 EU Member States. More information on the EU reduction commitments under the UNFCCC is given in Table 4.1.

The EU has jointly committed to its UNFCCC target and implemented it internally through EU legislation in the 2020 EU Climate and Energy Package. In this package, the EU introduced a clear approach to achieving the 20% reduction in total GHG emissions from 1990 levels, by dividing the effort between the sectors covered by the EU Emissions Trading System (EU ETS) and the sectors under the Effort Sharing Decision (ESD). Binding national targets were set for Member States under the Effort Sharing Decision. The achievement of EU internal compliance under the 2020 Climate and Energy Package including the national targets under the ESD is not subject to the UNFCCC assessment of the EU's joint commitment under the Convention.

The EU has substantially overachieved its reduction target under the Convention, which means that also its Member States and the United Kingdom have fulfilled their emission reduction obligations. As stated in the 2022 EU GHG inventory submission to the UNFCCC, the total GHG emissions, excluding LULUCF and including international aviation, decreased by 34% in the EU-27 + UK compared to the base year 1990 or 1.94 billion t of CO_2 eq.

Table 4.1. EU reduction commitments for 2020 under the UNFCCC

Target year	2020
GHG emission reduction target	-20% in 2020 compared with 1990 levels
Base year	1990
Gases affected by the commitment	CO_2, CH_4, N_2O, F-gases: HFC, PFC, SF_6
Sectors covered by the commitment	All the sectors excluding LULUCF and a part of the aviation sector (the international aviation only to the extent to which it is covered by the EU ETS)
Global warming potentials	AR4
Use of international credits	Subject to limits
Additional commitments	A conditional pledge to raise this target to 30%, if the other Parties to the Convention make adequate commitments

Source: Elaborated by the KOBiZE IOŚ-PIB

In turn, under the Kyoto Protocol, in the second commitment period set out in the Doha Amendment to the Kyoto Protocol, in the period from 2013 to 2020, the European Union, its Member States, Great Britain and Iceland concluded the agreement to jointly fulfil the reduction target relative to the base year. The joint reduction target was expressed as the commitment to reach mean annual emissions at the level of 80% of the sum total of the emissions of all the countries in the base years. After their review, the data on GHG emissions submitted to the UNFCCC Secretariat in 2022 (the 2022 EU NIR) will provide the basis for the evaluation of the fulfilment of this target. The data suggest that the target has been achieved with a surplus.

Poland's contribution to the EU reduction effort by 2020

The EU Member States have not their individual reduction targets under either the UNFCCC or the Kyoto Protocol, but participate in the efforts to achieve the joint EU reduction target (20% compared with 1990).

The joint fulfilment of its reduction commitments by the EU for the period from 2013 to 2020 was based on the internal EU legislation, i.e. the climate and energy package, which divided the emission sources into two main areas: the EU ETS and the so-called non-ETS (ESD). The greenhouse gas emissions from the part of sources which were covered by the EU ETs (the energy sector, district heating and industrial plants) were reported and accounted for directly by the installation operators. The emissions primarily included CO_2 but also N_2O, mainly from the nitric acid production.

In turn, the emissions from the other, non-EU ETS sectors were reported and accounted for by the particular EU Member States individually. Pursuant to Decision No 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020 (the so-called ESD Decision), Poland was obliged to limit the growth of its GHG emissions to 14% compared with 2005 levels.

Pursuant to the ESD Decision, the annual emission limits expressed in the form of annual emission allocations (AEAs) were set for the Member States for the period from 2013 to 2020 in Commission Decision 2013/162/EU of 26 March 2013[14] (Annex II). In 2017 the annual emission

[14] Commission Decision of 26 March 2013 on determining Member States' annual emission allocations for the period from 2013 to 2020 pursuant to Decision 406/2009/EC of the European Parliament and of the Council (OJ L 90, 28.3.2013, p. 106)

allocations were adjusted by Commission Decision (EU) 2017/1471[15] in order to apply the 2006 IPPC Guidelines for National Greenhouse Gas Inventories in effect from 2015. Subsequently, these AEAs were adjusted as a result of a change in the scope of the ETS after 2012 and indicated in Commission Implementing Decision 2013/634/EU of 31 October 2013[16]. The final AEAs for Poland are presented in Table 4.2.

Table 4.2. National annual emission allocations (AEAs) for Poland for the period from 2013 to 2020

2013	2014	2015	2016	2017	2018	2019	2020
193 642 822	194 885 546	196 128 269	197 370 991	199 974 468	201 710 045	203 445 622	205 181 199

Source: Elaborated by the KOBiZE IOŚ-PIB

The total emissions from the non-EU ETS sectors in the period from 2013 to 2020 in Poland did not exceed the total allocations set out for Poland in that period. It should be noted that pursuant to the ESD Decision the Member States can carry forward and use or bank the surplus AEA units from previous years. Throughout the period Poland achieved a surplus amounting to 545,461 t of CO_2 eq. In light of this, it can be said that Poland fulfilled the obligations imposed on it under EU law.

In turn, under the Kyoto Protocol, in the second commitment period set out in the Doha Amendment to the Kyoto Protocol, in the period from 2013 to 2020, the European Union, its Member States and Iceland concluded the agreement to jointly fulfil the reduction target relative to the base year. Poland indicated 1988 as the base year for the emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). In turn, 1995 was indicated as the base year for SF_6 and the group of fluorinated gases HFCs and PFCs, while 2000 was selected for NF_3.

It should be noted that in its implementation of the target under the Kyoto Protocol in both the first and the second commitment periods, Poland did not use the flexible mechanisms of the Kyoto Protocol to fulfil its commitments. The emission reductions were achieved only as a result of the domestic actions taken in Poland.

Greenhouse gas emission reduction targets for 2030

EU reduction effort

Submitting its nationally determined contribution (NDC) under the Paris Agreement, the European Union, along with its Member States, originally (in the NDC submitted to the Secretariat in 2015) committed to reducing the greenhouse gas emissions by 40% by 2030 relative to 1990 levels. This target is expected to be achieved using the three main pillars established in EU legislation:

- the EU emission allowance trading system: a 43% reduction of the greenhouse gas emissions compared with 2005 levels by 2030 (Directive (EU) 2018/410);
- the sectors not covered by the EU ETS (the so-called non-ETS, i.e. the sectors subject to the ESR Regulation): a 30% reduction of the emissions compared with 2005 levels by 2030 (Regulation (EU) 2018/842);
- the LULUCF area, where the objective is for the Member States to ensure that their emissions do not exceed their removals in this area (Regulation (EU) 2018/841).

Subsequently, in accordance with the decision of the European Council of December 2020, the EU increased its greenhouse gas emission reduction target declared in the NDC to at least -55% by

[15] Commission Decision (EU) 2017/1471 of 10 August 2017 amending Decision 2013/162/EU to revise Member States' annual emission allocations for the period from 2017 to 2020 (OJ L 209, 12.8.2017, p. 53)

[16] Commission Implementing Decision 2013/634/EU of 31 October 2013 on the adjustments to Member States' annual emission allocations for the period from 2013 to 2020 pursuant to Decision No 406/2009/EC of the European Parliament and of the Council (OJ L 292, 1.11.2013, p. 19)

2030 compared with 1990 levels, immediately making the relevant submission to the UNFCCC Secretariat. This target was also defined in EU legal regulations, i.e. in the European Climate Law. It will be implemented by the amended legal acts concerning the EU ETS system, the non-EU ETS sectors and the LULUCF sector. At present, work is underway on the final content of these regulations (see Section 4.1.1).

Poland's contribution to the EU reduction target by 2030

Poland acceded to the Paris Agreement as a Member State of the EU and, therefore, it did not submit its individual NDC to the UNFCCC. However, just as in the case of the implementation of the target for 2020, it participates in the joint EU efforts to achieve the declared emission reductions.

As a result of this, under the EU regulations, Poland was originally obliged to achieve a 7% reduction by 2030 compared with 2005 levels in the area of the sectors not covered by the EU ETS system. However, given the increased ambition of the EU target for 2030 as proposed in the amendment to Regulation (EU) 2018/842, the target for Poland would be raised to -17.7% compared with 2005 levels. No final decisions in this matter have been taken yet at the EU level.

Greenhouse gas emission reduction targets for 2050

In 2021, the European Climate Law was adopted. In it, the EU committed to reaching climate neutrality by 2050, with a view to reaching the long-term temperature target specified in Article 2(1)(a) of the Paris Agreement. At present, the detailed rules for the implementation of this target have not been defined; still, due to its adoption, the political EU climate declarations have been transformed into a legal obligation.

Table 4.3. Comparison of the greenhouse gas emission reduction targets of Poland and the EU

	International commitments (UNFCCC)			EU legislation				
	Kyoto Protocol (KP)		Paris Agreement	Climate and energy package 2020		Climate and energy package 2030		
				EU ETS	ESD (non-ETS)	EU ETS	ESR (non-ETS)	LULUCF
	Poland	European Union						
Commitment period or target year	First commitment period (2008–2012) CP1	Second commitment period (2013–2020) CP2	2030	2013–2020		2021–2030		
Emission reduction target	-6%	-20%	Originally: at least -40%	Total EU emission reduction: -20%		Total EU emission reduction Originally: at least -40%, Updated: at least -55%		

	International commitments (UNFCCC)			EU legislation				
	Kyoto Protocol (KP)		Paris Agreement	Climate and energy package 2020		Climate and energy package 2030		
				EU ETS	ESD (non-ETS)	EU ETS	ESR (non-ETS)	LULUCF
	Poland	European Union						
			Updated: at least -55%	Total EU emission reduction by 21% compared with 2005	Emissions increased by 14% compared with 2005, in accordance with the annual emission allocations	Originally: -43% Updated: -61% (with the target accounted for at the EU level for the whole EU ETS)	Originally: -30% Updated: -40% (distributed individually among the particular Member States)	Originally: the rule of maintaining a positive difference between removals and emissions from the LULUCF sector *(no debit rule)* Updated: the *no debit rule* in the period from 2021 to 2025 and the EU-wide net removal target for 2030 (-310 Mt CO_2), including the mechanism of the breakdown into the national targets in the period from 2026 to 2030
Other commitments	–	–	–	Increasing the use of RES to 20% of the final energy consumption and improving energy efficiency by 20% (EU)		The EU renewable energy target for 2030 – originally: at least 32% of the final energy consumption, updated: 40% The energy efficiency target - originally: at least 32.5% to be achieved jointly by the EU by 2030, updated: 36-39%		
Base year	1988 for CO_2, CH_4, N_2O 1995 for HFCs, PFCs, SF_6	1990 or another year selected by the country; 1995 or 2000 for NF_3 (Poland: 1988 for CO_2, CH_4, N2O; 1995 for HFCs, PFCs, SF_6; 2000 for NF_3)	1990	2005 (1990 for total EU emissions)		2005 (1990 for total EU emissions)		Originally: subject to the accounting rules; updated: in the period from 2021 to 2025: in accordance with the accounting rules; in the period from 2026 to 2030: the average from the period from 2016 to 2018

	International commitments (UNFCCC)			EU legislation				
	Kyoto Protocol (KP)		Paris Agreement	Climate and energy package 2020		Climate and energy package 2030		
				EU ETS	ESD (non-ETS)	EU ETS	ESR (non-ETS)	LULUCF
	Poland	European Union						
Aviation and shipping	Domestic aviation included, international aviation excluded	Domestic aviation included, international aviation excluded	Aviation within the scope of the EU ETS included (practically all aviation included)	Domestic and international aviation within the scope of the EU ETS	Generally, aviation excluded, certain air operations included (below the EU ETS threshold)	Outgoing flights from the EU and maritime shipping to and from the EU included	Excluded	Not applicable
Use of international credits	Use of the KP mechanisms in accordance with the KP	Use of the KP mechanisms in accordance with the KP	Excluded	Subject to quantitative and qualitative limits	Subject to quantitative and qualitative limits	Excluded		
Carry-over of units from preceding periods	Not applicable	Subject to the KP rules, including the Doha Amendment	Not applicable	EU ETS allowances can be banked into subsequent ETS trading periods since the second trading period	No carry-over from the previous period allowed	Not applicable		
Gases affected	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6		CO_2, N_2O, CF_4, C_2F_6	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6	CO_2, CH_4, N_2O
Sectors affected	In accordance with Annex A of the KP (energy, industrial processes and product use, agriculture, waste), LULUCF in accordance with the accounting rules for CP1	In accordance with Annex A of the KP (energy, industrial processes and product use, agriculture, waste), LULUCF in accordance with the accounting rules for CP2	Energy, industrial processes and product use, agriculture, waste, LULUCF	Electricity and heat production and industry, including: cement, chemical, coke, refinery and other industries, aviation (in accordance with Annex I to the ETS Directive)	Transport (excluding domestic aviation), the municipal and household sector, other industry, agriculture and waste	Electricity and heat production and industry, including: cement, chemical, coke, refinery and other industries, aviation (in accordance with Annex I to the ETS Directive); after the update of the target, also maritime shipping to/from the EU	Transport (excluding domestic aviation), the municipal and household sector, other industry, agriculture and waste	Land use, land-use change and forestry
GWP applied	IPCC SAR	IPCC AR4	IPCC AR5	IPCC AR4		IPCC AR5		

Source: elaborated by the KOBiZE IOŚ-PIB

4.1.3. Key national strategic documents

The table below lists the key national strategic documents of a cross-sectoral character which affect climate change mitigation and greenhouse gas emission reductions.

Table 4.4. Key national strategic documents

Title	Description
Implemented	
National Recovery and Resilience Plan (KPO), approved by the EC on 1 June 2022 and accepted by the European Council on 17 June 2022	The KPO is a comprehensive programme of reforms and strategic projects which aims to strengthen the economic and social resilience and to build the potential of the Polish economy for the future. It covers the reforms and investments which began after 01.02.2020 and will be completed by 31.08.2026. It is funded from the EU resources, i.e. the Recovery and Resilience Facility (RRF) and offers support in the form of grants and preferential loans. Poland is expected to receive a total of EUR 35.4 billion (about PLN 158.5 billion). A substantial part of this amount will be allocated to climate objectives (the green transition). The financial resources under the KPO will be allocated to specific investments corresponding with the areas of crucial importance for the EU: infrastructure, transport, energy and environment, innovation, digitisation, society and territorial cohesion. The KPO provides, among others, for measures to support the development of RES, including off-shore wind farms and energy storage systems, the promotion of the development of hydrogen production and use, and measures to improve energy efficiency and to modernise buildings.
National Procurement Policy for 2022-2025, adopted by the Council of Ministers on 11 January 2022	The National Procurement Policy is a document which defines the most important actions of the Government related to public procurement. Its role is to exert a positive effect on the public procurement market and establish the standards which would help implement public procurement. This procurement is expected to become a tool to support economic growth, including primarily the potential of the sector of small and medium-sized enterprises, the growth of innovation and the implementation of social, health and environmental policies. The National Procurement Policy has the character of a medium-term strategy and is adopted once every four years. The development of the potential of small and medium-sized enterprises by opening more widely the public procurement market to them is one of the most important objectives set out in the National Procurement Policy. It is expected to strengthen the competitiveness of the Polish economy, among others, by implementing sustainable and innovative procurement (e.g. of high-quality food, energy efficient equipment and devices produced by environmentally friendly methods). The intention of the National Procurement Policy is to link public procurement to the national strategic goals so that it would serve not only to purchase services, supplies or construction works, but also to implement the national economic and social policies.
Programme of European Funds for Infrastructure, Climate and Environment for 2021-2027 (FEnIKS), adopted by the Council of Ministers on 4 January 2022 and approved by the European Commission on 6 October 2022	FEnIKS is an instrument for implementing the resources from the EU Cohesion Policy. It is a continuation of the two previous Programmes Infrastructure and Environment 2007-2013 and 2014-2020. The main goal of the Programme is to improve the conditions for the development of the country by building technical and social infrastructure in accordance with the assumptions of sustainable development, among others, through: – reducing the emission intensity of the economy by way of a transition towards an environmentally friendly and circular economy; – building an efficient and resilient transport system with as low an adverse impact on the natural environment as possible; – completing the implementation of the sections of the TEN-T core network by 2030; – improving the transport safety;

Title	Description
	– ensuring equal access to healthcare and improving the resilience of the healthcare system; – strengthening the role of culture in social and economic development. The budget of the Programme is more than EUR 24 billion.
National Health Programme for 2021-2025, adopted by the Council of Ministers on 30 March 2021	The National Health Program includes, among others, under operational objective no. 4 – Environmental health and infectious diseases, a task concerning educational activities regarding the impact of the living environment on health.
National Energy and Climate Plan for 2021-2030 (NECP), adopted by the Council of Ministers on 18 December 2019	The NECP was prepared to meet the obligation under Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action. The NECP presents the assumptions and objectives as well as policies and measures designed to implement the five dimensions of the Energy Union, i.e. energy security; the internal energy market; energy efficiency; decarbonisation; and research, innovation and competitiveness. The NECP provides for the implementation of the EU climate policy targets set out for Poland (a 7% GHG emission reduction relative to 2005 levels in the non-ETS sectors). Moreover, it specifies the target for the RES share in the final gross energy consumption at the level of 21-23% in 2030 and the target for energy efficiency improvement of 23% by 2030 relative to the 2007 PRIMES projection. It also addresses the issue of the share of coal in Poland's energy mix and indicates that its share in electricity production is to be reduced to 56-60%. The final version of the NECP was submitted to the European Commission in December 2019. At present, work is underway to update the NECP. The draft document is expected to be sent to the EC by 30.06.2023 and the final document to be submitted by 30.06.2024.
2030 National Environmental Policy, adopted by the Council of Ministers on 16 July 2019	The 2030 National Environmental Policy specifies further and operationalises the provisions of the Strategy for Responsible Development until 2020 (with an Outlook until 2030). Its aim is to ensure Poland's environmental safety and a high quality of life for all its citizens. It strengthens the Government's actions to build an innovative economy while complying with the principles of sustainable development. Its specific objectives are set out in response to the most important challenges in the field of the environment, in a manner enabling the issues of environmental protection to be coupled with the economic and social needs related to health, economy and climate. The implementation of the environmental objectives is to be supported by horizontal objectives related to environmental education and to the effective functioning of environmental protection instruments. The 2030 National Environmental Policy will provide the basis for investing EU funds under the financial perspective 2021–2027. The Strategy also supports the implementation of Poland's international objectives and commitments, including those at the EU and UN levels, particularly, in the context of EU 2030 climate and energy policy objectives and the Sustainable Development Goals set out in the 2030 Agenda.
National Air Pollution Control Programme (NAPCP), adopted by the Council of Ministers on 29 April 2019	Directive (EU) 2016/2284 of 14 December 2016 (the so-called NEC Directive[17]) set out the Member States' obligations to reduce the emissions of the anthropogenic air pollutants: sulphur dioxide (SO_2), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC), ammonia (NH_3) and fine particulate matter ($PM_{2.5}$), as well the requirements for the preparation,

[17] Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC (OJ L 344, 17.12.2016, p. 1)

Title	Description
	adoption and implementation of national air pollution control programmes (NAPCPs). Poland's commitments to reduce its emissions cover two periods: from 2020 to 2029 and from 2030. The reduction commitments were defined with respect to the emissions in the reference year 2005. The elaboration of this document meets the requirements of the Directive mentioned above. The NAPCP indicates the measures and scenarios for Poland's achievement of the emission targets laid down in the NEC Directive. At present, work is underway to update the NAPCP, including consultations on the draft of this document.
Strategy for Responsible Development until 2020 (with an Outlook until 2030), adopted by the Council of Ministers on 14 February 2017	The Strategy is a key document in the area of medium- and long-term economic policy. Its main objective is to create conditions for increasing the incomes of Polish citizens, while, at the same time, increasing cohesion in the social, economic, environmental and territorial dimensions. The Strategy has the following specific objectives: I. Sustainable economic growth increasingly driven by knowledge, data and organisational excellence (Areas of: Re-industrialisation, Development of innovative enterprises, Small and medium-sized enterprises, Capital for growth, Expansion abroad). II. Socially sensitive and territorially sustainable development (Areas of: Social cohesion, Territorially sustainable development) III. Effective state and institutions contributing to growth as well as social and economic inclusion (Areas of: Law serving citizens and the economy, Pro-growth institutions and strategic growth management, E-state, Public finance. Effective use of EU resources, as well as areas contributing to the achievement of the objectives of the Strategy: Human and social capital, Digitisation, Transport, Energy, Environment, National security). The specific objectives which it sets out include, among others, support for measures to reduce the emissions of greenhouse gases and air pollutants as well measures related to energy efficiency.
Strategic Adaptation Plan for Sectors and Areas Vulnerable to Climate Change until 2020 with an Outlook until 2030 (SPA 2020), adopted by the Council of Ministers on 29 October 2013	The main aim of the SPA2020 is to ensure the sustainable development and efficient functioning of the economy and society in the conditions of climate change. The documents sets out the priority directions of adaptation measures which need to be taken until 2020 in the areas which are the most vulnerable to climate change, such as: water management, agriculture, biodiversity, health, energy, construction and spatial development, urbanised areas, transport, mountain areas and coastal zones. These measures (taken by public and private entities) will be carried out by the implementation of policies, investments in infrastructure and the development of technology. They include both technical projects and amendments to legal regulations.

Source: Elaborated by the KOBiZE IOŚ-PIB

4.1.4. Key national legal regulations

The table below lists the key national legal regulations of a cross-sectoral character which affect climate change mitigation and greenhouse gas emission reductions.

Table 4.5. Key national legal acts

Title	Description
Implemented	
Act of 12 June 2015 on the Greenhouse Gas Emission Allowance Trading Scheme (Official Journal of the Laws of 2022, Item 1092, as amended)	The Act now in effect which transposed Directive 2003/87/EC and the changes made by amendments to the Directive into the national regulations. The Act establishes the rules for the operation of the EU ETS system.
Act of 17 July 2009 on the System to Manage the Emissions of Greenhouse	The Act lays down the tasks of the National Centre for Emissions Management; the operating rules for the National System of Emissions Management, the rules for the management of the emissions of greenhouse

Title	Description
Gases and Other Substances (Official Journal of the Laws of 2022, Item 673)	gases and other substances; the operating rules for the National Registry of Kyoto units; the rules for trading and management of Kyoto units; the operating rules for the National Green Investment Scheme and the climate account; the conditions and principles of the execution of Joint Implementation projects in the territory of the Republic of Poland; the conditions and principles of the execution of Joint Implementation and Clean Development Mechanism projects outside the territory of Poland.
Act of 27 April 2001 - Environmental Protection Law (Official Journal of the Laws of 2021, Item 1973, as amended)	The Act lays down the principles of environmental protection and the conditions for the use of environmental resources, taking into account the requirements of sustainable development, in particular, the principles of establishing the conditions for the protection of environmental resources, the conditions for releasing substances and energies into the environment, as well as the obligations of administrative authorities, liabilities and penalties.
Act of 20 July 1991 on the Inspectorate for Environmental Protection (Official Journal of the Laws of 2021, Item 1070, as amended)	The Act establishes the State Environmental Monitoring System and the rights and obligations of the State with regard to the monitoring of the state of the environment and the enforcement of the provisions of environmental law pertaining to all the elements of the environment (among others, air, water, nature, noise, electromagnetic fields and waste).

Source: Elaborated by the KOBiZE IOŚ-PIB

4.1.5. National authorities and institutions involved in the implementation of climate policy and the financial mechanisms supporting the measures to reduce emissions

Authorities and institutions

In Poland, the Minister of Climate and Environment is responsible for the area of climate policy, including the implementation of the tasks under the United Nations Framework Convention on Climate Change done in New York on 9 May 1992[18] (UNFCCC), the Kyoto Protocol[19] to the United Nations Framework Convention on Climate Change (KP), done in Kyoto on 11 December 1997, and the Paris Agreement[20] to the United Nations Framework Convention on Climate Change (PA), done in New York on 19 May and adopted in Paris on 12 December 2015 (previously this post was held by the Minister of Environment). In this area, the tasks of the Minister of Climate and Environment include, the implementation and monitoring of progress in the implementation of climate policy, the preparation and coordination of draft national strategies, the monitoring of the activities of the government administration bodies and inter-institutional working teams in the field of climate policy, the submission of the required reports on climate issues and the supervision over Poland's achievement of GHG emission reductions targets, including progress in their achievement, and the supervision over the operation of the emission allowance trading system in Poland. The Minister of Climate and Environment is also responsible for energy and forest policies.

At the national level, in addition to the Minister of Climate and Environment, the following Ministers, who are responsible for the introduction of the sustainable development strategy, environmental policy and the national climate policy into sectoral policies, are competent in the scope of the UNFCCC:

- Minister of Economic Development and Technology – responsible for the implementation of the national socio-economic development strategy, the innovativeness of the economy, construction, spatial planning and development and housing;

[18] Official Journal of the Laws of 1996, Item 238, as amended
[19] Official Journal of the Laws of 2005, Item 1684
[20] Official Journal of the Laws of 2016, Item 1631

- Minister of Development Funds and Regional Policy – responsible for the implementation of the economic and national development strategies and the programming and spending of resources from the European Funds;
- Minister of Agriculture and Rural Development – responsible for the implementation of the government policy in the area of agriculture and rural development;
- Minister of Infrastructure – responsible for the transport sector, maritime economy, inland navigation, and water and wastewater management;
- Minister of State Assets – responsible for the issues related to the mining and extraction of coal and other energy raw materials.

The Minister of Climate and Environment uses the subordinated institutions, including research and development institutes, to carry out the tasks under the UNFCCC, the Kyoto Protocol and the Paris Agreement. They include primarily:

- the Institute of Environmental Protection – National Research Institute (IOŚ-PIB); its structure includes the National Centre for Emissions Management, which plays the role of the national administrator of the greenhouse gas emission allowance trading system (EU ETS), carries out analyses relating to climate policy and prepares, among others, reports on the emissions of greenhouse gases and air pollutants, as well as draft national and biennial communications to the UNFCCC;
- the Forest Research Institute (IBL) – carrying out research on the issues related to carbon dioxide removals in the scope of land use, land use change and forestry (LULUCF);
- the Institute of Meteorology and Water Management – National Research Institute (IMGW-PIB) – carrying out systematic climate change observations.

Moreover, the National Fund for Environmental Protection and Water Management (NFOŚiGW), along with the Voivodeship Funds for Environmental Protection and Water Management (WFOŚiGW), as independent entities, constitute the system for funding environmental protection in Poland. The NFOŚiGW is the source of funding for environmentally friendly projects with a higher than regional character, among others, measures to reduce emissions and supporting the implementation of climate policy, particularly in the scope of the improvement of energy efficiency, the development of renewable energy sources and the modernisation of energy generation processes. The NFOŚiGW manages domestic resources and is also the operator of the resources which Poland receives from different EU funds. More detailed information on the programmes implemented by the NFOŚiGW is given in Section 4.2.

Key financial mechanisms

In addition to the support provided by the NFOŚiGW as part of the programmes for the protection of the climate and environment, since 2016 the Polish Government has issued green bonds. The main aim of the issue of these bonds is to finance projects which have a beneficial effect on the environment. The proceeds from the issue of the bonds can finance projects in the scope of sustainable agriculture, clean transport, renewable energy sources, afforestation of land, the functioning of national parks and the remediation of degraded areas.

Moreover, as part of the Operational Programme Infrastructure and Environment (POiŚ), under both financial perspectives 2007-2013 and 2014-2020, projects were carried out to reduce greenhouse gas emissions, to improve energy efficiency, to support renewable energy sources or to adapt to the adverse effects of climate change and to develop low-emission transport and road infrastructure in cities. The main source of funding for 2014-2020 was the EU Cohesion Fund and, in addition, the European Regional Development Fund. The total value of the resources involved was about EUR 27.4 billion. The support for the protection of the climate and GHG emission reductions

with EU resources is continued by the Programme of European Funds for Infrastructure, Climate and Environment for 2021-2027 (FEnIKS)[21] and the National Recovery and Resilience Plan (KPO)[22]. The FEnIKS resources (as a total, about EUR 24 billion) will support such areas as, among others, RES, energy efficiency, efficient district heating systems, zero emission transport or adaptation to climate change. As part of the KPO (as a total, about EUR 35.4 billion, with 42.7% for the green transition), support will be provided in such areas as, among others, air quality improvements, RES, zero emission public transport, development of hydrogen technologies or district heating.

In addition, the Just Transition Fund[23] (JTF), a new financial instrument of the Cohesion Policy is intended to support areas facing severe socioeconomic challenges caused by the transition towards climate neutrality. This Fund will facilitate the implementation of the European Green Deal, the purpose of which is to ensure that the EU reaches climate neutrality by 2050. The JTF provides support to all the EU Member States. The award criteria are based on industrial emissions in regions with the high intensity of carbon oxide emissions, the employment in industry, hard coal and lignite extraction, the production of peat and bituminous shale, and on the economic development level. The co-financing rate is determined depending on the category of the region where these projects are carried out and varies between 50% and 85%, depending on the degree of development of a given region. The total budget of the Fund for the period from 2021 to 2027 is EUR 17.5 billion. Poland is expected to receive more than EUR 4.4 billion from the JTF. The Fund aims to mitigate the adverse social, economic and environmental effects of the energy transition. The condition for seeking JTF resources is the preparation of regional just transition plans. These plans are expected to indicate the directions of the allocation of these resources, how the regions understand their energy transition and how its adverse effects should be eliminated. The regions are in the process of preparing their plans. The JTF resources are expected to go to all the coal regions in Poland, i.e. in addition to Śląskie, Dolnośląskie and Wielkopolskie Voivodeships, also to Lubelskie, Łódzkie and Małopolskie Voivodeships.

Moreover, support for climate change mitigation measures is provided from the resources of the Modernisation Fund which is supplied by the monetisation of 2% of the emission allowance pool for the period from 2021 to 2030 as part of the EU ETS. It is an instrument supporting the modernisation of the energy system and energy efficiency improvements. The Fund is dedicated to 10 EU Member States, with about 43% of its resources, i.e. about 119 million EUAs, going to Poland (the final amount of resources depends on the EUA price). As part of the first three tranches of the MF resources, Poland has received more than PLN 12 billion. These resources were used in many NFOŚiGW programmes, among others, those involving the development of electricity infrastructure for the purposes of the development of charging stations for electric vehicles, the renovation of buildings, support for RES, energy efficiency improvements in the energy-intensive industry, support for the development of cogeneration and the use of alternative fuels for energy generation purposes. As part of the fourth tranche of the resources, Poland was granted consent to implement subsequent programmes to be supported from the MF in an amount of almost PLN 2.7 billion.

Poland also uses non-returnable financial assistance in the form of two instruments called: the EEA Financial Mechanism and the Norwegian Financial Mechanism[24]. The donors are three EFTA

[21] More information can be found on the website https://www.pois.gov.pl/strony/o-programie/fundusze-europejskie-na-infrastrukture-klimat-srodowisko/zalozenia-programu/

[22] More information can be found on the website: https://www.pois.gov.pl/strony/o-programie/fundusze-europejskie-na-infrastrukture-klimat-srodowisko/zalozenia-programu/

[23] More information can be found on the website: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/finance-and-green-deal/just-transition-mechanism/just-transition-funding-sources_en

[24] More information can be found on the website: https://www.eog.gov.pl/

countries: Norway, Iceland and Liechtenstein. The same rules and procedures apply to both and they are subject to one system for their management and implementation in Poland. On 20 December 2017, Poland signed intergovernmental Memoranda of Understanding on the 3rd edition of the Norway and EEA Grants (2014-2021), receiving under them about EUR 809 million (including EUR 140 million for the environment, energy and climate change), which made it the largest beneficiary, just as in the previous editions. The Ministry of Development Funds and Regional Policy (MFiPR) is responsible for the coordination of the implementation of the Norway and EEA Grants in Poland. It plays the role of the so-called National Contact Point (NCP) for the Norway and EEA Grants. As the NCP, the MFiPR is engaged in continuous cooperation with the Financial Mechanism Bureau in Brussels. The individual programmes of the 3rd edition of the Norway and EEA Grants will be implemented until 2024. An exception is the Bilateral Cooperation Fund, which will be implemented until 30 April 2025.

In Poland, work is also underway to establish a new fund, i.e. the Energy Transition Fund (ETF). It will manage part of the proceeds from the sales of the emission allowances (EUAs) allocated to Poland. The value of the present pool of resources expected to be allocated to the ETF is about PLN 90 billion (with the final amount depending on the EUA price). These resources will be spent on investments to modernise the energy sector. The NFOŚiGW will play the main role in managing the ETF resources. It will be responsible for preparing and implementing the priority programmes to be funded from these resources. Moreover, the Council of the Energy Transition Fund, an authority operating with the Minister responsible for energy, will play an important role. The Minister responsible for energy will exercise a supervisory function. The ETF will be used primarily to finance investments for the purposes of modernisation, diversification or sustainable transition of the energy sector; in particular, in the areas of: the use of nuclear energy, RES; heat and cold generation and polygeneration, the construction, expansion and modernisation of heating or cooling network systems and the infrastructure designed to supply district heat or cold and the development of systems to monitor and manage heating or cooling systems; gas-fired generation units; underground energy storage systems; systems for storing electricity, heat, cold, hydrogen and biomethane; the development of networks and installations to store waste heat; heat pumps; hydrogen production and the conversion of electricity to hydrogen using electrolytic methods, as well as the transport, storage and use of hydrogen and biomethane; innovative technologies; energy generation and use efficiency improvements; carbon dioxide capture, transport, processing and storage; coal degassing; the production of alternative fuels; installations for waste or RDF incineration operating under the high-efficiency cogeneration to generate energy in order to supply public heating networks; enhancing the operational flexibility and diminishing the technological minimum levels of existing power units / conventional units; the conversion of existing power units / conventional units into multi-fuel units; support for just transition to enable the employees in the energy sector and associated sectors to change a job. In contrast, projects involving the energy generation using solid fossil fuels will be excluded from the funding from the ETF resources, with the exception of fuels in the area of the use of nuclear energy in electricity generation, district heating and industry.

Moreover, the resources for climate change mitigation will be also provided by the Social Climate Fund (SCF), newly established at EU level. It will support vulnerable households, micro enterprises and transport users to enable the introduction of the emission allowance trading system for the emissions from the municipal and household sector and the road transport sector. In order to be supported, each EU Member State will have to prepare and submit to the EC a special document (a social climate plan) containing a set of measures and investments designed to address the impact of carbon dioxide emission prices on vulnerable citizens. The Fund will support increased energy

efficiency of buildings, renovation of buildings, decarbonisation of heating and cooling of buildings, and zero- and low-emission mobility and transport. The Fund will be part of the EU budget and its resources are expected to amount to EUR 59 billion as a maximum. It is to be established for the period from 2027 to 2032, coinciding with the entry into force of the ETS system for the sectors of buildings and road transport.

4.1.6. Monitoring and assessment of progress in the implementation of climate policy, including its reduction targets and the provisions of the Kyoto Protocol

Monitoring and assessment of progress at the EU level

Progress in the implementation of climate policy, including its targets to reduce GHG emissions at the EU level, is monitored under Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council (the so-called Governance Regulation)[25]. It replaced the previous regulation, i.e. Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC (the so-called MMR)[26]. Regulation (EU) 2018/1999 continues the approach applied in the MMR, enabling the achievement of the emission reduction target to be monitored at the levels of Member States and the EU as a whole. In addition, it imposed on the Member States the obligation to prepare (in 10-year cycles) the national energy and climate plans (NECPs). These plans define, among others, the manner of the implementation (i.e. the planned policies and measures) of the GHG emission reduction target in the non-ETS area and also define the national contributions to the implementation of the EU targets in the scope of the development of RES and energy efficiency improvements.

Moreover, under Regulation (EU) 2018/1999 the EU Member States are obliged to report the following to the EC:

- historical GHG emissions;
- GHG emission projections;
- policies and measures undertaken to reduce GHG emissions;
- a long-term strategy (for low-emission development);
- assistance provided to developing countries;
- use of resources from the sales of emission allowances in the EU ETS system;
- adaptation to climate change.

The EU also introduced a number of regulations on the monitoring, reporting and verification of emissions by aircraft operators and stationary installations covered by the EU ETS system. The EU Member States implemented these provisions into their legislation.

Monitoring and assessment of progress at Poland's level

The Minister of Climate and Environment, who is competent in the area of climate policy, is responsible for the monitoring and assessment of progress in the implementation of climate policy,

[25] OJ L 328, 21.12.2018, p. 1
[26] OJ L 165, 18.6.2013, p. 13

including climate change mitigation policies and measures and GHG emission reduction targets. In Poland, the monitoring of climate change mitigation policies and measures and progress in reaching the greenhouse gas emission reduction targets is based on the provisions of the Act of 17 July 2009 on the System to Manage the Emissions of Greenhouse Gases and Other Substances (USZE)[27].

This Act established a system for inventorying, monitoring, reporting and projecting GHG emissions. It also created the legal basis for the management of the national GHG emission ceiling in a manner which would ensure that Poland could fulfil its international and EU commitments and enable the optimisation of the emission reduction costs. The main element of this system established pursuant to the USZE Act is the National Centre for Emissions Management (KOBiZE) at the Institute of Environmental Protection – National Research Institute (IOŚ-PIB) which has been mandated by statute to carry out many tasks in the area of climate policy for the Minister of Climate and Environment. The scope of the tasks of the KOBiZE related to the monitoring of the national progress in climate change mitigation as set out by the Act includes, among others:

- the execution of the work related to the operation of the National System of Emissions Management, including the management of the National Database on the Emissions of Greenhouse Gases and Other Substances;
- the development of the methodology for determining the emission levels from particular types of installations or activities and the methodology for determining the emission factors;
- the preparation of inventories and projections of emission levels;
- the preparation of analyses and reports on climate change mitigation policies and measures;
- the administration of the Polish part of the Union Registry and the management of the National Registry of Kyoto Units;
- the execution of the tasks of the National Administrator of the Greenhouse Gas Emission Allowance System (EU ETS);
- the management of the national GHG emission allocation in the non-ETS area.

In relation to its tasks as specified above, the KOBiZE prepares the annual national inventory of GHG emissions, estimates projections of GHG emissions, monitors the policies and measures implemented in the area of climate change mitigation and also elaborates draft national communications (NCs), biennial reports (BRs) and cyclical reports on climate change mitigation policies and measures required by EU law. The KOBiZE analyses emission levels and trends relative to the levels of the national emission allocations in the non-ETS areas, expressed in units of annual emission allocations (AEAs). Just as the other EU Member States, Poland implements its individual targets only in the non-ETS area. They were defined in the ESD Decision (for the period from 2013 to 2020) and in the ESR Regulation (for the period from 2021 to 2030). More information on the reduction targets is given in Section 4.1.2.

An element of the monitoring system is also the national inventory system described in Section 3.2. Information on the implementation of climate policy is available to the public, among others, under the provisions of the USZE Act, through the publication of diverse items of information, reports and results of analyses by the KOBiZE IOŚ-PIB on its website.

Under the provisions of the USZE Act, the national system to manage the national allocation of GHG emissions was established. It supports the Minister of Climate and Environment in optimising the manner of accounting for emission levels within the annual emission allocations (AEAs) awarded to Poland.

[27] Official Journal of the Laws of 2022, Item 916

Taking action to prevent the risk of failing to meet the emission reduction target

The system in place in Poland for the adoption of policies, strategies and other planning and development documents by the Council of Ministers ensures that the implemented sectoral policies are consistent with one another and that they meet the targets which Poland has adopted under national, EU and international agreements. When draft government policies are elaborated each of them undergoes the process of inter-ministerial consultations which enable consideration of the comments and suggestions of the Ministers responsible for different areas of the government administration. Such a system eliminates the risk that a given sectoral policy may fail to take into account the need to fulfil the commitments for which another Minister in the Polish Government is responsible.

In addition, with respect to the emission reduction target in the non-ETS area, the Polish law implementing the EU regulations provides for a corrective mechanism which is triggered in the case where the adopted policies are insufficient to meet the target. The corrective mechanism consists in the preparation and implementation of additional reduction measures in the case where the emission allocation for a given year is not complied with, despite the application of available flexible mechanisms. The Polish Government submits its plan of adjustment measures to the European Commission.

Information on the possible use of the mechanisms under Articles 6, 12 and 17 of the Kyoto Protocol

In the Polish legal order, there are three mechanisms under the Kyoto Protocol (KP): Joint Implementation, the Clean Development Mechanism and emissions trading.

Joint Implementation (JI) under Article 6 of the KP

The procedure applied to date in Poland to approve Joint Implementation projects was consistent with the international guidelines. It was laid down in the USZE Act. Its provisions regulate the issues concerning JI projects, providing a legal basis for their approval and implementation. Poland carried out Joint Implementation projects under the Track I procedure. As part of this procedure in Poland, 38 Joint Implementation projects were approved, generating 21.1 million t of verified emission reductions units by 2012. In light of the international circumstances, no project was approved in Poland after 2012.

Clean Development Mechanism under Article 12 of the KP

The principles and procedures for the implementation of projects under the Clean Development Mechanism (CDM) by Poland were set out in the USZE Act. The participation in the CDM project requires the consent of the Minister of Climate and Environment issued in the form of an administrative decision. The consent is granted at the request of an entity interested in participating in the project. Poland has implemented no such projects, even though the CDM procedure has been established.

International emissions trading under Article 17 of the KP

Under the provisions of Decision 11/CMP.1, which defines the rules and guidelines for emissions trading under the Kyoto Protocol (FCCC/KP/CMP/2005/8/Add.3), each country must meet certain conditions in order to participate in emissions trading (Article 17 of the Kyoto Protocol). On 29

April, 2008, Poland became a country which met these requirements with no objection from the Compliance Committee Enforcement Branch.[28]

National Green Investment Scheme (GIS)

The National Green Investment Scheme (GIS) was derived from the emissions trading mechanism. The GIS mechanism consists in the sales of a surplus of Assigned Amount Units (AAUs) to countries or entities authorised by these countries which use them to meet their reduction targets under the Kyoto Protocol. The idea and purpose of the Scheme are to generate and strengthen the environmental effect of the sales of a surplus of Assigned Amount Units.

The legal framework for the National Green Investment Scheme in Poland was laid down in the USZE Act. The Act regulates the functioning of the National Green Investment Scheme, including its organisation and project selection. Additional regulations[29] define the types of projects and programmes to be implemented under the GIS. These include projects to avoid or reduce greenhouse gas emissions, or involving carbon sinks or sequestration, actions on adaptation to climate change and other projects related to air protection. Poland signed and implemented 11 contracts to sell AAUs with a total value of more than EUR 196 million which was allocated to the co-financing of tasks, programmes and projects covered by the National Green Investment Scheme.

Information on the possible use of the activities under Articles 3.3 and 3.4 of the Kyoto Protocol

The Act of 28 September 1991 on Forests[30] sets out the principles of the preservation, conservation and augmentation of forest resources and the principles of forest management in relation to other elements of the environment and the national economy. On the basis of this Act, the National Forest Policy adopted on 22 April 1997 set out further measures and indicated the linkages to forestry in cross-sectoral and international systems. The aim of the Forest Policy is to lay down out a comprehensive set of measures to shape man's attitude to forest, with a view to preserving in the changing the natural and socio-economic realities the conditions for the sustained multi-functionality of forests, their versatile usefulness and conservation, and their role in the development of the natural environment in line with the present and future expectations of society. The sustainability of forests, along with their multi-functionality, will be achieved through: the augmentation of the national forest resources, the improvement of the condition of the forest resources and their comprehensive conservation, the reorientation of forest management from the domination of the raw materials based model to the model of environmentally friendly and economically sustainable multi-functional forest management. The augmentation of the forest resources will be accomplished through: increasing the national forest cover to 30% in 2020 and 33% by 2050, the recovery and rehabilitation of forest ecosystems, mainly through the reconstruction on the appropriate sites of single-species forest stands into mixed ones and the regeneration of devastated and neglected forest stands.

The Act of 3 February 1995 on the Protection of Agricultural Land and Forest Land[31] regulates the principles of the protection of agricultural land and forest land, their remediation and the increase of their utility value and also defines the possible conversion of agricultural land and forest land to other uses. In order to protect agricultural land and forest land, legal restrictions were imposed on the possibilities of their conversion. Primarily, land classified as uncultivated sites in the land register can

[28] More information can be found on the UNFCCC website: http://unfccc.int/kyoto_protocol/compliance/ items/2875.php
[29] Regulation of the Council of Ministers of 27 June 2019 on the types of programmes and projects intended to be implemented under the National Green Investment Scheme (Official Journal of the Laws of 2019, Item 1209)
[30] Official Journal of the Laws of 2022, Item 672
[31] Official Journal of the Laws of 2021, Item 1326, as amended

be used for non-agricultural and non-forestry purposes and, in their absence, so can other land with the lowest productive value. When building facilities related to industrial activities and also other built structures, solutions limiting the effects of the adverse impact on land need to be applied.

In turn, the Act of 16 April 2004 on Nature Conservation[32] sets out the scope of conservation to ensure the maintenance or restoration of a favourable status of sites protected in the Natura 2000 network. Sustainable forest management directly enhances biodiversity conservation and sustainable use of natural resources.

4.2. Policies and measures and their effects

4.2.1. Introduction to policies and measures

Section 4.2 of the Communication presents the most important national policies and measures which contribute to the reduction of greenhouse gas emissions and Poland's fulfilment of its commitments to reduce emissions. Explanations are given below regarding the approach to the presentation of policies and measures compared with the previous reports. In turn, successive Sections 4.2.2-4.2.9 present policies and measures in a breakdown into sectors; specifically, first the cross-sectoral policies and measures, then the policies and measures in the energy sector in a breakdown into energy supply and consumption, followed by the sectors of transport, industrial processes, agriculture, forestry and waste.

Changes in the approach to the presentation of policies and measures with respect to NC7 and BR4

In this Communication, certain changes have been made to the approach to the presentation of policies and measures compared with the National Communication NC7 and the Biennial Report BR4. The modifications which have been made result from amendments to regulations and the use of a verified, different approach to analyses of policies and measures, which has brought further improvements in the scope, comprehensiveness and reliability of information reported on policies and measures.

In this Communication, some policies and measures have been replaced by other measures, among others, as a result of a more detailed approach to the presentation of policies and measures in the particular sectors and an update of sectoral plans, programmes and strategies. The documents which have been adopted often represent a continuation of an earlier policy or its extension with new objectives and tasks. Certain policies and measures have been regrouped and aggregated in a different manner in order to improve the transparency of the information reported. Moreover, the names of some measures have been changed. Several new measures, not included in the National Communication NC7 and the Biennial Report BR4, have also been added and one of the measures presented in the previous reports has been deleted. The tables below show the changes in the presentation of policies and measures with respect to the National Communication NC7 and the Biennial Report BR4.

Table 4.6. Measures replaced by other measures

Measures in NC7/BR3	Measures in BR4	Measures in NC8/BR5
Enhancing the use of renewable energy sources, including biofuels	Measure 3: Development of RES	Measure 7: Scheme of certificates of origin for RES (the green certificate scheme) Measure 8: Auction-based support scheme for RES

[32] Official Journal of the Laws of 2022, Item 916

Measures in NC7/BR3	Measures in BR4	Measures in NC8/BR5
		Measure 9: Feed-in tariff and feed-in premium schemes for RES Measure 10: Obligation to purchase electricity generated at RES installations with total installed power capacity of less than 500 kW
Support for the use of methane from hard coal mines to produce electricity and heat	Measure 6: Support for and development of the use of coalbed methane	Measure 18: Research projects on methane removal using the technology of underground directional boreholes (DD-MET Project)
	Measure 4: Development of high-efficiency cogeneration	Measure 5: Preferences for electricity generators using high-efficiency cogeneration Measure 6: Cogeneration premium
National Energy Efficiency Action Plan for Poland 2014	Measure 8: Improvement of energy efficiency	Measure 22: White certificate scheme
Urban-Building Code		Measure 23: Energy audits
		Measure 25: Thermal Modernisation and Renovation Fund
		Measure 27: Improvement of the operation of the energy efficiency system of buildings
	Measure 9: Improvement of air quality	Measure 24: Clean Air Priority Programme
National Waste Management Plan	Measure 21: Modern principles of waste management	Measure 53: Rational waste management
	Measure 22: Modern wastewater management	Measure 54: Development of water and wastewater management
Package for road transport	Measure 10: Road transport package	Measure 29: Development of road infrastructure Measure 32: Development of electromobility Measure 33: Development of vehicles using alternative fuels Measure 34: Promotion of biofuels Measure 35: Shaping of environment-friendly attitudes of drivers Measure 36: Requirements for improving the emission factors of vehicles
	Measure 11: Urban transport package	Measure 30: Development of collective transport
		Measure 31: Development of zero-emission urban transport
Package for domestic air transport	Measure 13: Air transport package	Measure 40: Innovative measures for air transport
Package for international air transport		
Rationalization of the use of fertilizers, including nitrogen fertilizers	Measure 19: Agri-environmental measures	Measure 43: Agri-environmental measures
Afforestation of agricultural land and afforestation of non-agricultural land		
Sustainable management of agricultural land		
Support for adaptation and reduction measures in agricultural holdings	Measure 18: Support for adaptation and mitigation measures in agricultural holdings	Measure 44: Supporting adaptation and mitigation measures in agricultural holdings

Measures in NC7/BR3	Measures in BR4	Measures in NC8/BR5
Improvement of monogastric livestock systems, reduction of methane emissions from livestock manure		
Elimination of gaseous pollutants emitted from livestock buildings		
Counteracting changes in land use	Measure 17: Rational management of agricultural and forest land	Measure 51: Rational management of farmland and forest land - the protection of farmland and forestland
Restoring the forest production potential destroyed by disasters and implementing preventive measures		
Rationalization of forest management, incentives and actions supporting afforestation and the protection of ecological stability of forests	Measure 23: Forest land development and improvement of the viability of forests	Measure 52: Forest area development and improvement of the viability of forests

Source: Elaborated by the KOBiZE IOŚ-PIB

Table 4.7. Measures with a changed title

Measures in NC7/BR3	Measures in BR4	Measures in NC8/BR5
Implementation of the Greenhouse Gas Emissions Trading Scheme (EU ETS)	Measure 1: Greenhouse gas emissions trading scheme (EU ETS)	Measure 1: Greenhouse gas emission allowance trading system (EU ETS)
Effort Sharing Decision (ESD)	Measure 2: Emission reductions in non-ETS sectors	Measure 2: Emission reductions in non-ETS sectors
Nuclear Power Programme for Poland	Measure 5: Implementation of nuclear energy	Measure 4: Implementation of nuclear energy
Package for rail transport	Measure 12: Rail transport package	Measure 37: Measures for efficient railway transport
Package for inland waterway transport	Measure 14: Inland navigation package	Measure 39: Measures for the development of inland waterway transport
Package for maritime shipping	Measure 15: Maritime shipping package	Measure 38: Measures for the environmentally friendly development of maritime shipping

Source: Elaborated by the KOBiZE IOŚ-PIB

Table 4.8. New measures in NC8/BR5

Measures in NC8/BR5
Measure 3: Our Climate Campaign
Measure 12: Support for the development of offshore wind power – individual support and an auction-based scheme
Measure 13: My Power Priority Programme
Measure 14: Energy Plus Priority Programme
Measure 15: Polish Geothermal Energy Plus Priority Programme
Measure 16: District Heating Priority Programme
Measure 17: Agroenergy Programme
Measure 19: Other programmes supporting the development of RES and cogeneration
Measure 20: New Energy Programme
Measure 21: My Heat Priority Programme
Measure 26: Thermal modernisation relief

Measures in NC8/BR5
Measure 28: Warm Flat Priority Programme
Measure 42: Proposed adoption of more stringent requirements for the limitation of the use of fluorinated greenhouse gases
Measure 45: Organic farming
Measure 46: Rationalisation of fertiliser use
Measure 47: Research and scientific and educational projects in the scope of rational and low-emission agricultural production
Measure 49: Reduction of food losses
Measure 50: Eco-schemes

Source: Elaborated by the KOBiZE IOŚ-PIB

Table 4.9. Measures not included in NC8/BR5

Measure in NC7/BR3	Measure in BR4	Clarification
National Green Investment Scheme (GIS)	The measure was not included. BR4 had provided the clarification as cited on the right and this approach was upheld in NC8/BR5.	The GIS is implemented by national policies/measures dedicated to particular sectors; therefore, it has been decided that a separate GIS-related measure would not be formulated in the set of policies so as to avoid double accounting of the reduction effects. In order to ensure greater transparency in the evaluation of the reduction effects of the presented set of policies, it has been recognised that its effects are taken into account in the evaluation of the measures related to energy production and consumption.

Source: Elaborated by the KOBiZE IOŚ-PIB

4.2.2. Cross-sectoral policies and measures

Measure 1: Greenhouse gas emission allowance trading system (EU ETS)

Greenhouse gases affected: CO_2, N_2O, PFCs

Status: implemented

In both Poland and other Member States of the European Union, the greenhouse gas emissions trading system (EU ETS) operates in accordance with the rules set out by Directive 2003/87/EC[33] and its successive amendments. Directive 2003/87/EC was transposed into the national legal order in 2004 by the Act on the Greenhouse Gas Emission Allowance Trading Scheme, which has been amended many times ever since in response to changes in the operating rules of the EU ETS system at the level of EU legislation.

The aim of the system is to reduce greenhouse gas (GHG) emissions in an economically viable manner. It is expected to reduce the GHG emissions from installations which it covers by 21% by 2020 and by 43% by 2030 (compared with 2005 levels). At present, work is underway on another amendment to the EU regulations on the EU ETS system (under the so-called "*Fit for 55*" Package), which for EU ETS will set out for 2030 a more ambitious GHG emission reduction target of 61%[34] compared with 2005 levels.

[33] Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC (OJ L 275, 25.10.2003, as amended)

[34] The proposal of the Council of the European Union and the EC provides for the reduction target of 61%, while the EP proposes an even higher target of 63% (as of 30 June 2022)

The EU ETS system covers energy and industrial installations and aircraft operators, with the system covering only flights within the EU and other European countries from the EEA area which have acceded to the system, i.e. Iceland, Liechtenstein, Norway and Switzerland. All the installations and aircraft operators covered by the system must annually account for their greenhouse gas emissions by surrendering an appropriate number of their emission allowances (EUAs, EUAAs).

The number of installations covered by the EU ETS slightly varies as a result of the inclusion of new installations which meet the criteria for the participation in the EU ETS system and the exclusion of installations from the EU ETS system in the case of the cessation of their activities or a drop in the threshold values of the production capacity of installations which qualify them for their participation in the system, or in consequence of a merger or demerger of installations. The number of installations covered by the EU ETS and the total CO_2 eq. emissions in the EU ETS in the period from 2008 to 2021 in Poland are shown in Table 4.10 below.

Table 4.10. Basic data on the EU ETS system in Poland

Year	Number of installations	GHG emissions from installations	Number of aircraft operators	GHG emissions from aviation	Total GHG emissions	Change in CO_2 eq. emissions relative to the previous year
	[installation]	[t CO_2 eq.]	[operator]	[t CO_2 eq.]	[[t CO_2 eq.]	[%]
2008	832	204 107 419	0	0	204 107 419	-2.63
2009	828	191 174 249	0	0	191 174 249	-6.34
2010	810	199 726 907	0	0	199 726 907	4.47
2011	811	203 026 525	0	0	203 026 525	1.65
2012	764	196 636 280	12	641 424	197 277 704	-2.83
2013	783	205 735 395	7	616 587	206 351 982	4.60
2014	767	197 129 387	7	629 899	197 759 286	-4.16
2015	738	198 700 536	6	591 020	199 291 556	0.77
2016	727	198 051 726	5	749 946	198 801 672	-0.25
2017	710	202 166 696	6	943 715	203 110 411	2.17
2018	699	199 974 539	7	1 142 534	201 117 073	-0.98
2019	688	183 690 533	7	1 097 467	184 788 000	-8.12
2020	642	171 729 419	7	421 061	172 150 480	-6.84
2021	602	191 467 852	7	487 570	191 955 422	11.50

Source: Elaborated by the KOBiZE IOŚ-PIB

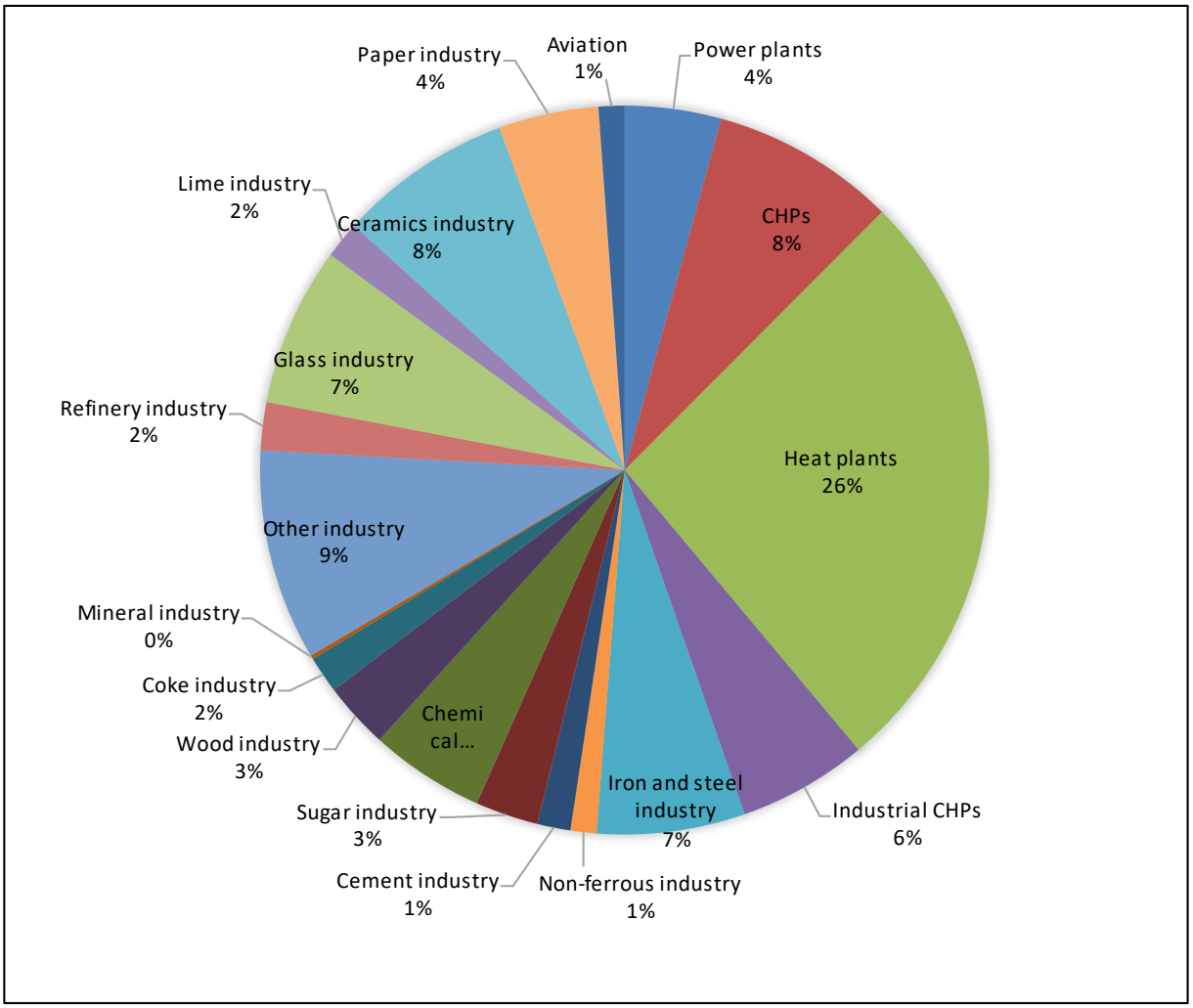


Fig. 4.1. The shares of installations in the EU ETS in Poland by sector in 2021
Source: Elaborated by the KOBiZE IOŚ-PIB

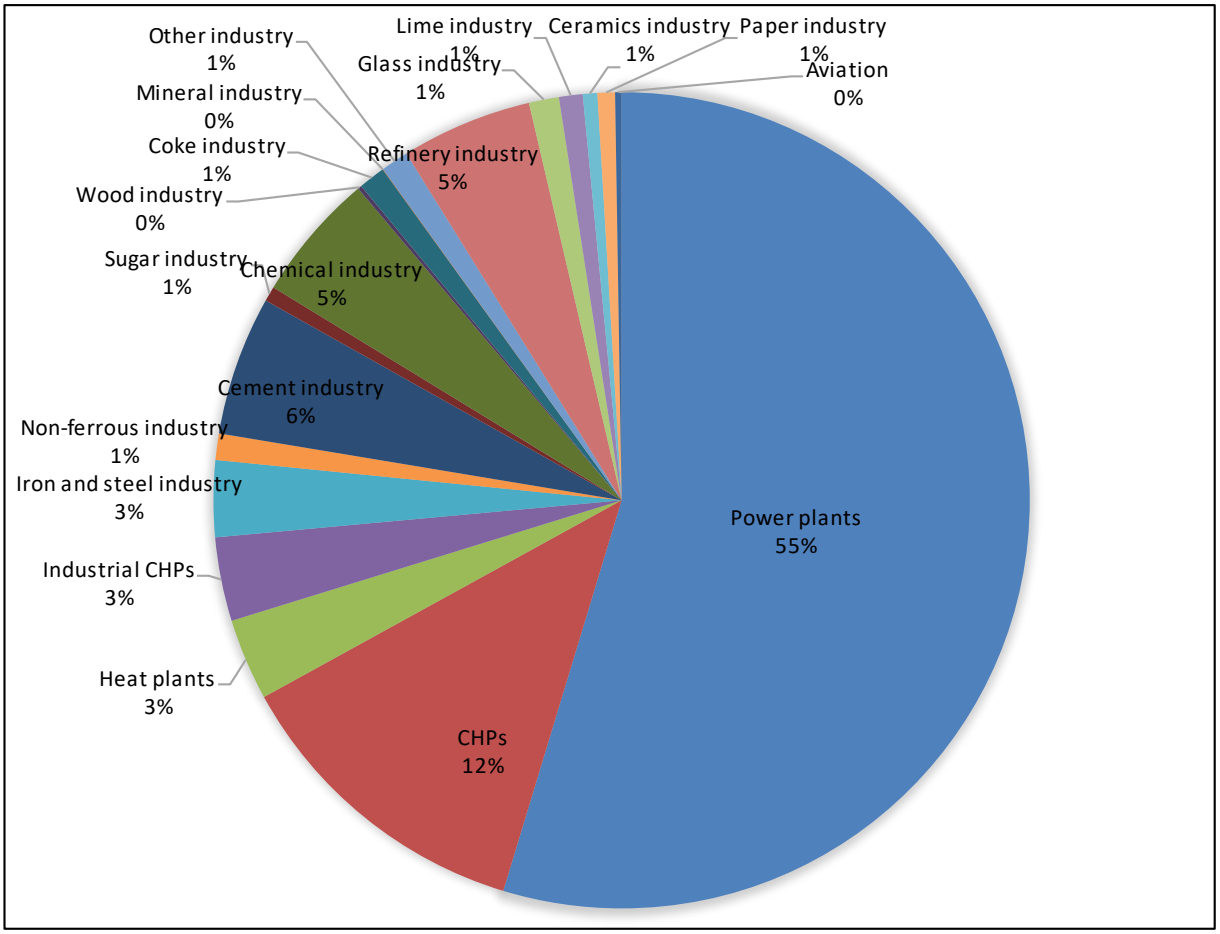


Fig. 4.2. The shares of the particular sectors in Poland's emissions in the EU ETS sectors in 2021
Source: Elaborated by the KOBiZE, IOŚ-PIB

In the third trading period, i.e. from 2013 to 2020, the number of emission allowances was annually reduced, starting in 2013, by 1.74% (the linear reduction factor – LRF). From 2013 the basic method for the allocation of emission allowances was the sale of allowances at auctions. Free allocation of emission allowances was limited to production other than electricity generation and based on product benchmarks (the point of departure for establishing the rules for the adoption of the ex-ante emission factors for the particular sectors or subsectors were the average parameters of 10% of the most efficient installations in terms of emissions in a given sector or subsector), the historical outputs of a given product at an installation, the application of the carbon leakage exposure factor (CLEF) and a correction of the allocation in the case where a uniform cross-sectoral correction was determined.

An exception to the above rule was the allocation of emission allowances under Article 10c of Directive 2003/87/EC, the so-called derogation. A Member State which met specific criteria (i.e. the dependence of the electricity generation on one type of fossil fuel to an extent exceeding 30% and the GDP per capita level of less than 50% of the average GDP in the EU) could seek to use this possibility. Poland met these requirements and, in consequence, it was decided that the possibility of the free allocation of allowances to electricity generators would be used. The total number of emission allowances which Poland could allocate under this derogation to energy generators was about 404.65 million EUAs in the period from 2013 to 2019, of which 264.8 million EUAs were actually allocated,

while the remainder, i.e. 139.8 million EUAs were sold at auctions[35]. The award of the derogation required the adoption of the national investment plan (KPI), including investment projects with their value balancing the value of the free allocation. These were mostly investment projects to build new power generation units and modernise old ones. Moreover, the aim of the KPI was to limit energy price rises which could emerge in the absence of the derogation. The emission allowances allocated to electricity generators came from the pool of emission allowances which a given Member State could sell at auctions (each Member State has a specific pool of emission allowances which it sells).

Emission allowances are sold on the primary market (at auctions) on the European Energy Exchange (EEX) platform and on the secondary trading market (the most allowances are sold at the EEX and ICE Futures Europe exchanges). It should be borne in mind that since 2019 the pool of allowances to be sold at auctions has been additionally reduced by the application of the MSR mechanism (the so-called Market Stability Reserve) which consists in:

- adding allowances deducted from the auction pool to the reserve pool (until 2023 24% of the allowance surplus on the market and later 12%) if the allowance surplus on the market exceeds 833 million allowances, or
- adding allowances from the reserve to the auction pool (100 million EUAs) if the allowance surplus on the market is less than 400 million EUAs in a given year.

The fourth trading period covers the period from 2021 to 2030 and the rules which originally governed it were set out in the amendment to the ETS Directive adopted in 2018.[36] For the purposes of the allocation of allowances, the period from 2021 to 2030 was divided into two sub-periods: from 2021 to 2025 and from 2026 to 2030, for which the allowances are allocated on the basis of the different values of the benchmark. This follows from the introduction of the rule that the emission factors will be adapted to technological progress – their values are calculated on the basis of data collected over 5 years from applications for the allocation and published in an Implementing Regulation of the Commission. Rules were also changed with regard to sectors vulnerable to carbon leakage by changing the list of the sectors, to be valid for 10 years, and preferential rules for district heating networks were added by keeping the exposure factor at the level of 30% throughout the 10-year period. The total number of emission allowances will be reduced, starting in 2021, by 2.2% per year (the linear reduction factor – LRF). More flexible rules for the free allocation were also developed to apply so-called "*dynamic allocation*", in order to better adapt the allocation levels to the real production levels. Dynamic allocation consists in adapting the allowance allocation to an increase or decrease in production. The ceiling for allocation changes has been set out as the moving average from the two years preceding the year for which allowances are be to allocated and is now at least ±15% in the first year of the change, with successive threshold changes by at least ± 5%.

Moreover, work is now underway to amend the EU regulations on the fourth trading period of the EU ETS system (the EC proposal was published as part of the "*Fit for 55*" Package), intended to enable the achievement of a higher EU emission reduction target for 2030, i.e. a GHG reduction of at least 55% compared with 1990 levels (including the contribution from the EU ETS system, amounting to 61% compared with 2005 levels). Among others, the following changes are now discussed:

- increasing the LRF factor – from the present 2.2% to 4.2% with the reduction target in the EU ETS raised from 43% to 61% (as proposed by the EC and the Council of the EU) or adopting

[35] According to the Annex to the Report from the Commission on the functioning of the European Carbon Market of 26 October 2021

[36] Directive (EU) 2018/410 of the European Parliament and of the Council of 14 March 2018 amending Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments, and Decision (EU) 2015/1814 (OJ L 76, 19.3.2018)

a progressive approach as proposed by the EP – from 4.4% in 2024 to 4.6% in 2029 (with the reduction target in the EU w EU ETS raised to 63%);
- so-called rebasing, i.e. as a one-off reduction of the number of EUAs available by 117 million in 2024 (as proposed by the EC and the Council of the EU) or phased in over two years – 70 million in 2024 and 70 million in 2026 (as proposed by the EP);
- the introduction of the border tax, called the Carbon Border Adjustment Mechanism (CBAM) on commodities imported from countries which fail to apply appropriate climate change mitigation measures;
- in light of the introduction of the CBAM, it is envisaged that the free allocation of EUAs in the sectors subject to the CBAM will be gradually withdrawn – in the period from 2026 to 2035 (as proposed by the EC and the Council of the EU) or slightly sooner, in the period from 2027 to 2032 as proposed by the EP;
- strengthening the MSR mechanism – by increasing the "*intake rate*" (the proportion of allowances transferred to the MSR) from 12% to 24% after 2023;
- the incorporation of maritime shipping in the EU ETS system;
- the introduction from 2026 of a new, separate EU ETS system covering the suppliers of fuels to the municipal and household sector and the road transport sector (so-called BRT ETS).

Measure 2: Emission reductions in non-ETS sectors (a group of measures)

Greenhouse gases affected: CO_2, N_2O, CH_4, PFCs, HFCs, SF_6

Status: implemented

The non-ETS area includes the sectors of the economy which are outside the emission allowance trading system, i.e. transport, agriculture, waste, the municipal and household sector, and the industrial sector outside the EU ETS. The EU regulations set out the emission reduction targets in this area for the particular Member States. Decision No 406/2009/EC9[37] (the so-called Effort Sharing Decision, ESD) set out percentage-based greenhouse gas emission targets for the period from 2013 to 2020, which were subsequently broken down by Commission Decision 2013/162/EU into annual emission allocations, expressed in units of annual emission allocations (AEAs). In turn, Regulation (EU) 2018/842[38] (the so-called Effort Sharing Regulation, ESR) extended the requirements for emission reductions in the non-ETS sectors to the period from 2021 to 2030. As an EU Member State, Poland is obliged to achieve the reduction targets which have been determined for it.

The EU reduction targets for the non-ETS sectors as compared with 2005 levels were -10% by 2020 and - 30% by 2030. As part of the achievement of these EU targets, Poland's emission reduction targets compared with 2005 levels were: +14% by 2020 and subsequently -7% by 2030. Moreover, work is now underway on the EU regulations intended to ensure the achievement of the reduction target for 2030 at the level of at least -55% compared with 1990 levels, with the non-ETS area contributing at the level of -40% compared with 2005 levels. The new reduction target proposed for Poland for 2030 is expected to be -17.7% (compared with 2005 levels).

The GHG emissions from the non-ETS area in each Member State are reported annually, the reports are subjected to the EU verification process and, subsequently, each country accounts for its

[37] Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020 (OJ L 40, 5.6.2009, as amended.)

[38] Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No 525/2013 (OJ L 156, 19.6.2018)

emissions against its annual emission allocation (AEA). In accounting for the emissions in the non-ETS area in the period from 2013 to 2020, the flexible mechanisms laid down in Decision No 406/2009/EC (ESD) can be used. They include:

- the banking, borrowing and transfer of AEA units – the ESD lays down the rules under which the Member States may bank the unused part of their AEAs to successive years of the period, borrow part of their AEA units from the future years or buy AEA units from other Member States;
- using certain specific types[39] of CERs and ERUs.

To date, Poland has banked its AEA units, i.e. it has carried over the unused number of its AEA units to successive years of the period.

With regard to the target for 2030, no decision has been issued yet to set out the annual emission allocations of the Member States for the period from 2021 to 2030. In contrast, it is already known that in accounting for emissions it will be possible to apply mechanisms that are similar to those in the period from 2013 to 2020, i.e.:

- the banking, borrowing and transfer of AEA units – just as in the period from 2013 to 2020, the Member States may bank the unused part of their AEAs to successive years of the period, borrow part of their AEA units from the future years or buy AEA units from other Member States;
- the LULUCF flexibility – the possibility of using a certain pool of units originating from removals in the LULUCF sector to account for the emissions from the non-ETS sectors;
- compliance – an additional pool of AEA units – compliance for Poland will involve a certain additional pool of AEA units (7,456,340 t CO_2 eq.) which would increase on a one-off basis the annual emission allocation, to be added in the first year of the period;
- the safety reserve – an additional pool of AEA units (105 million t CO_2 eq.) for eligible Member States, which may be awarded to them at the end of the period after specific conditions are satisfied.

On 14 July 2021, the European Commission proposed an amendment to the ESR Regulation as part of the published "*Fit for 55*" Package. The Commission proposal preserves the existing architecture and scope of the ESR Regulation. In addition to setting out more ambitious targets for the EU and its Member States, the proposal provides for limited changes to the manner in which the Member States can use the existing flexibilities to achieve their reduction targets. The proposed updated targets will additionally reduce the GHG emission levels per capita in the Member States in 2030 compared with the targets now in effect.

A new instrument for emission reductions in the non-ETS area is the introduction of a separate emission allowance trading system for the buildings sector and the road transport sector, the so-called BRT ETS (the Emission Trading System for the Buildings and Road Transport Sectors), also proposed as part of the "*Fit for 55*" Package. By assumption, the ESR and the BRT ETS are expected to apply in parallel, still they will be addressed to different addressee groups. The ESR concerns the Member States, that is why it applies to the government administration, while the BRT ETS system will cover all

[39] The types of units allowed for use in non-ETS are listed in Article 5 of Decision No 2009/406/EC:

- certified emission reduction units (CERs) and emission reduction units (ERUs), set out in Directive 2003/87/EC, issued for emission reductions by 31 December 2012 and eligible for use in the Community scheme in the period from 2008 to 2012;
- certified emission reduction units (CERs) and emission reduction units (ERUs) issued for emission reductions from 1 January 2013 as part of projects which were registered before 2013 and eligible for use in the Community scheme in the period from 2008 to 2012;
- certified emission reduction units (CERs) issued for emission reductions achieved in projects which were implemented in least developed countries and eligible for use in the Community scheme in the period from 2008 to 2012, until the ratification of a relevant agreement with the Community by these countries or until 2020, whichever is sooner;
- temporary CER units (tCERs) or long-term CER units (lCERs) from afforestation and reforestation projects – under the condition laid down in Decision No 2009/406/EC (Article 5(1)(d)

the entities in the municipal and housing sector and the road transport sector which place on the market fuels intended to be burned for heating or transport purposes. In addition, it should be emphasised that the final content of the BRT ETS is not known yet, as it is the subject matter of EU negotiations.

The new BRT ETS system, along with carbon dioxide emission allowance prices resulting from it, will be a key instrument contributing to GHG emission reductions in the municipal and housing sector and the road transport sector. This instrument will be complemented by the introduction of new, more stringent CO_2 emission standards for passenger cars and light-duty delivery vehicles for the purposes of assisting in the quick dissemination of decarbonisation technologies. The regulations indicated here, which guide the policies and measures in the non-ETS area, are expected to help the Member States meet their national targets as set out in the ESR.

The EU regulations on the non-ETS area only set out the national reduction targets and the rules of accounting for them. It is only the implementation of policies and measures in specific sectors included in the non-ETS area that will translate into the achievement of the set reduction target. Specific sectoral policies and measures are described in the successive parts of Section 4.2, while the issue of the achievement of the target for the non-ETS area is addressed in Section 4.1.2.

Measure 3: Our Climate Campaign

Greenhouse gases affected: CO_2

Status: implemented

It is an information and education campaign carried out by the Ministry of Climate and Environment with the main aim of raising the environmental awareness of the public about the individual actions which can be taken for the purposes of climate change mitigation.

The campaign uses many channels, including, among others, the traditional media (television, the printed press, the radio) and the Internet (banners, social media: Facebook, Instagram, Twitter, YouTube, VOD podcasts and services). An important feature of the campaign is entering into cooperation with bloggers and influencers who address on a daily basis the issues of climate change mitigation and environmental protection.

The spots which can be seen on TV show how little it takes for people to adopt eco-habits in their everyday life. The graphic theme of the campaign uses energising colours, while the whole is modern and appeals to addresses of different age. Its leitmotif "*People Create the Climate*" even more strongly stresses the role of the individual's involvement in climate change mitigation actions.

The activities planned during the campaign, i.e. until the end of October 2022, will make it possible to initiate a discussion about climate change and ensure that Poland's residents become actively involved in climate change mitigation actions.

4.2.3. Policies and measures in the energy supply sector

This Section presents documents of a strategic character, legal regulations, policies and measures associated with the energy supply sector which contribute to greenhouse gas emission reductions.

The measures in the area of energy supply focus on the development of the production of energy in RES, cogeneration and nuclear energy. Several systemic solutions are implemented in this scope (support schemes) and there are a number of programmes which award grants and loans.

Key strategies, plans and programmes

The table below lists the key strategies, plans and programmes associated with the energy supply sector which affect its functioning and condition environmental protection and climate change mitigation.

Table 4.11. Key strategies, plans and programmes in the energy supply sector

Title	Description
Implemented	
Polish Hydrogen Strategy until 2030 with an Outlook until 2040, adopted by the Council of Ministers on 2 November 2021	The document sets out the objectives and measures associated with the development of the national competences and technologies to enable the building of a low-emission hydrogen economy. They apply to the three sectors where hydrogen is to be used: the energy, transport and industry sectors, as well as to its production, distribution, required legal changes and financing. The Strategy indicates 6 objectives which need to be achieved: Objective 1 – implementation of hydrogen technologies in the energy sector; Objective 2 – use of hydrogen as an alternative fuel for transport; Objective 3 – supporting the decarbonisation of industry; Objective 4 – hydrogen production in new installations; Objective 5 – efficient and safe hydrogen distribution; Objective 6 – creating a stable regulatory environment. The Strategy provides for a total of 40 measures to achieve the objectives which have been set out in order to use the Polish technological, scientific and research potential in the scope of advanced hydrogen technologies and to ensure the emergence of the Polish branch of the hydrogen economy. It identifies the current status of the hydrogen market, presents the basic technological and business obstacles and sets out the directions in which the market should develop so that in the next decade it can operate on a scale allowing it to compete with conventional fuels.
Energy Policy of Poland until 2040, adopted by the Council of Ministers on 2 February 2021	The PEP2040 is one of the nine integrated sectoral strategies under the Strategy for Responsible Development (SOR2020). The PEP2040 is consistent with the National Energy and Climate Plan for 2021-2030 (NECP). It also sets out the directions of actions to be taken in the periods until 2030 and 2040 in the energy sector. The PEP2040 is based on 3 pillars: - just transition; - zero-emission energy generation system; - good air quality. The PEP2040 sets out 8 specific objectives: - the optimum use of own energy resources; - the expansion of the electricity generation and grid infrastructure; - the diversification of supplies and the expansion of the grid infrastructure for natural gas, crude oil and liquid fuels; - the development of energy markets; - the implementation of nuclear energy; - the development of renewable energy sources; - the development of district heating and cogeneration; - the improvement of energy efficiency. The implementation of the objectives and measures indicated in the PEP2040 will deliver the low-emission energy transition, with an active role of the end-users and the involvement of the national industry, bringing momentum to the further development of the economy, while ensuring energy security, in an innovative way, which is acceptable to society and respects the environment and climate. The document provides that in 2040 more than half the installed capacity will be provided by zero-emission sources. The integration of offshore wind energy generation into the Polish power grid and the commissioning of a nuclear power plant will play a special role In this process. These will be two new strategic areas and, at the same time, branches of industry

Title	Description
	which will be developed in Poland. In parallel to the large-scale energy sector, dispersed and citizen-operated energy generation will develop on the basis of local capital. The planned energy transition also requires the enhanced application of RES technologies in heat production and the development of the market of alternative fuels in transport. The PEP2040 also provides for the cessation of hard coal mining at particular mines by 2049. This was confirmed by the social contract signed on 28 May 2021. At the end of March 2022, the Council of Ministers adopted the assumptions for an update of the Energy Policy of Poland until 2040, mostly intended to strengthen energy security and independence, especially in the scope of making the national economy quickly independent from imported fossil fuels (coal, crude oil and natural gas) and their derivatives (LPG, diesel oil, petrol and kerosene) from Russia and other countries covered by economic sanctions. The aim of the update is to neutralise or reduce the risks related to possible emergency situations in Poland and abroad, thus contributing to the implementation of the main goal of energy policy, i.e. energy security, while ensuring the competitiveness of the economy, reducing the impact of the energy sector on the environment and protecting users from excessive energy price increases and the aggravation of energy poverty.
Polish Nuclear Energy Programme (PPEJ)	The PPEJ was adopted in 2014 and was the first comprehensive document on nuclear energy in Poland. It sets out the scope and structure of measures which need to be taken to implement nuclear energy in Poland and to ensure the safe and effective operation of nuclear power facilities, their decommissioning after the end of their service life and the safe handling of spent nuclear fuel and radioactive waste. In 2020, an amendment to PPEJ was adopted. Its aim is to commission in Poland nuclear energy units with the total net capacity of 6-9 GW. Their commissioning will make it possible to significantly reduce the emissions of greenhouse gases and air pollutants in the energy sector and ensure energy security, lower energy costs for the economy and the development of the national industry. The present time schedule provides for the commissioning of two three-unit power plants successively in the periods from 2033 to 2037 and from 2039 to 2043.
Planned	
Draft Heating Strategy	The Heating Strategy is expected to achieve the objectives set out by the Energy Policy of Poland until 2040 and the National Energy and Climate Plan for 2021-2030. The Polish heating sector consists of two main subsectors: - public supply heating – the area regulated by the President of the Energy Regulatory Office, consisting of enterprises which produce and supply heat to meet the needs of other entities; - non-public heat supply – the other part of the sector where the individual heat sources at households are the largest group. The Strategy presents the present situation of the sector and sets out its objectives consistent with the strategic documents and then the methods for their implementation. The solutions proposed in the draft Strategy include: - the transition of the fuel mix towards renewable energy sources supported by natural gas; - a change in the regulatory environment of the public supply heating – primarily, the cost-based adjustment of tariffs; - the introduction of a system of guarantees of origin for public supply heat; - a wide scale of the use of heat from municipal waste and waste heat; - the activation of territorial self-government units in the scope of heat generation with support from the central administration. On 30 May 2022, the draft Strategy was submitted for consultations.

Source: Elaborated by the KOBiZE IOŚ-PIB

Key legal acts

The table below lists the key legal acts associated with the energy supply sector which affect its functioning and condition environmental protection and climate change mitigation.

Table 4.12. Key legal acts in the energy supply sector

Title	Description
Implemented	
Act of 17 December 2020 on the Promotion of Electricity Generation at Offshore Wind Farms (Official Journal of the Laws of 2022, Item 1050)	The Act responds to the need to quickly increase the share of renewable energy sources in the national energy mix by introducing a support scheme and administrative and legal improvements to enable the more effective management of the investment process to build offshore wind farms.
Act of 14 December 2018 on the Promotion of Electricity from High-Efficiency Cogeneration (Official Journal of the Laws of 2022, Item 553)	The Act defines the rules for the award of support for electricity generated from high-efficiency cogeneration at cogeneration units and the issue of guarantees of origin for electricity from high-efficiency cogeneration. The Act introduces an auction-based system of support for high-efficiency cogeneration.
Act of 20 May 2016 on Investments in Wind Power Plants (Official Journal of the Laws of 2019, Item 654)	The Act lays down the conditions and procedures for the location and construction of wind power plants and the conditions for the location of wind power plants in the vicinity of existing or planned housing.
Act of 20 February 2015 on Renewable Energy Sources (Official Journal of the Laws of 2022, 1378, as amended)	The Act lays down the rules and conditions for carrying out operations in the scope of the production of electricity from renewable energy sources, agricultural biogas in RES installations and bioliquids. Moreover, it sets out mechanisms and instruments to support the production of electricity from renewable energy sources, agricultural biogas and heat in RES installations. It also regulates the rules for issuing guarantees of origin for electricity generated from RES, the principles of the implementation of the national action plan for energy from RES and the conditions and procedures for certifying the installers of micro installations, small installations and RES installations with total installed thermal capacity not exceeding 600 kW. It lays down the principles of international cooperation on RES and joint investment projects. The Act contains a number of solutions designed to create a stable environment for enhancing generation in the sector of renewable energy sources. They include: the auction system, transitional solutions for the system of green certificates, net-metering for prosumers and energy clusters.
The Act of 29 November 2000 - Atomic Law (Official Journal of the Laws of 2021, Item 1941, as amended)	The Act lays down the rules for carrying out operations in the scope of the peaceful use of nuclear energy related to the real and possible exposure to ionising radiation from artificial radioactive sources, nuclear materials, equipment generating ionising radiation, radioactive waste and spent nuclear fuel, the duties of the head of the organisational unit carrying out these operations, the authorities competent in the matters of nuclear safety and radiological protection, the rules for the civil liability for nuclear damage, the rules for the fulfilment of international commitments on nuclear safety, including those within the European Union, the protection against ionising radiation, the securing of nuclear materials and the control of nuclear technologies. In addition, the Act lays down the rules for monitoring radioactive contamination and regulates measures taken in response to radiation events and in the case of long-term exposure in the aftermath of radiation events or operations carried out in the past.
Act of 10 April 1997 - Energy Law (Official Journal of the Laws of 2022, Item 1385, as amended)	The Act lays down the rules for shaping the national energy policy, the rules and conditions for the supply and use of fuels and energies, including heat, and the operations of energy enterprises, and also specifies the authorities competent for fuel and energy management. Its aim is to create the conditions for the sustainable development of the country, to ensure energy security, the economical and rational use of fuels and energies and the development of competition, to prevent the adverse impacts of natural monopolies, to take into account the requirements of environmental

Title	Description
	protection and the commitments under international agreements and to balance the interests of energy enterprises and energy and fuel users.
Regulation of the Minister of the Economy of 21 November 2005 on the technical conditions to be met by terminals and stations of liquid fuels, long-distance pipelines for transfer of crude oil and its products, and their location (Official Journal of the Laws of 2014, Item 1853, as amended)	The Regulation regulates the issues of the hermetic storage and distribution of liquid fuels with a view to limiting their losses, which partly constitute greenhouse gas emissions.
Planned	
Draft Act Amending the Act on Investments in Wind Power Plants	The draft Act provides, among others, for enabling local communities to decide on the location of new investments in onshore wind power plans, unblocking the possibilities of the development of housing in the vicinity of these power plants, ensuring the maximum safety of the operation of the new wind infrastructure for the residents who decide to allow the local sites to be used for this infrastructure and the reduction of the environmental impacts of new power plants by investors using the state-of-the-art technologies. In July 2022, the draft Act was submitted for consultations.

Draft Act Amending the Act on Renewable Energy Sources to Transpose Directive (EU) 2018/2001 of 11 December 2018 on the promotion of the use of energy from renewable sources	Changes are planned in many areas associated with renewable energy sources for the common purpose of increasing the share of renewable sources in the national gross energy consumption and the broadly conceived development of the energy sector consistent with the ambitions to reduce the emission intensity of the economy and to fulfil the international commitments.
	The aim of the draft Act is, in particular, to transpose Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (OJ L 328, 21.12.2018, p. 82, as amended), the so-called RED II.
	The regulations expected to be laid down in the amendment apply to the following areas:
	- Biomethane;
	- Energy clusters;
	- Transposition of RED II in the following areas:
	  - Heating and cooling (Articles 23-24 of RED II)
	  - Guarantees of origin (Article 19 of RED II)
	  - National Contact Point (Article 16 of RED II)
	  - Administrative procedures (Articles 15-16 of RED II)
	  - Peer-to-peer trading of energy (Article 21 of RED II)
	  - The other provisions of RED II requiring implementation
	- Modernisation of installations of renewable energy sources (hereinafter referred to as RES);
	- Operational support for RES installations for which the 15-year support scheme expires;
	- Hybrid RES installations;
	- Offshore wind energy generation (supplementary provisions);
	- The other regulations.
	In February 2022, the draft Act was submitted for consultations.

Source: Elaborated by the KOBiZE IOŚ-PIB

Policies and measures

Measure 4: Implementation of nuclear energy

Greenhouse gases affected: CO_2

Status: implemented

The Polish Nuclear Energy Programme (PPEJ) was adopted in 2014 and was the first comprehensive document on nuclear energy in Poland.

The PPEJ sets out the scope and structure of measures which need to be taken to implement nuclear energy in Poland and to ensure the safe and effective operation of nuclear power facilities, their decommissioning after the end of their service life and the safe handling of spent nuclear fuel and radioactive waste.

The original document provided that two nuclear power plants with the total capacity of up to 6 GW would be commissioned and that the operation of the first unit of a nuclear power plant would begin at the end of 2024.

In 2020, an amendment to the Programme was adopted, modifying both the planned capacity of the nuclear power plants and the dates when the units would be commissioned. According to them, nuclear energy units with the total net capacity of 6-9 GW are expected to be commissioned in Poland. Their commissioning will make it possible to significantly reduce the GHG emissions in the energy sector and ensure energy security, low energy costs for the economy and the development of the national industry. The present schedule provides for the commissioning of two three-unit power plants successively in the periods from 2033 to 2037 and from 2039 to 2043. The choice of technology was limited to the pressurised water reactor (PWR) type.

The reduction effect of this measure was estimated under the assumption that none of the nuclear units would be commissioned by 2030.

Measure 5: Preferences for electricity generators using high-efficiency cogeneration

Greenhouse gases affected: CO_2

Status: implemented

Polish regulations provide for the preferential treatment of electricity generators using high-efficiency cogeneration. Among others:

- the electricity grid operator is obliged to give to all entities priority in the provision of the services of transmission or distribution of electricity produced using high-efficiency cogeneration;
- the electricity grid operator is obliged to take electricity produced using high-efficiency cogeneration at plants located in Poland and directly connected to the grid of that operator;
- there is the obligation to connect to the existing district heating network, or to equip with an individual renewable heat source, a source of heat from cogeneration or a source of waste heat from new plants located in an area where there are the technical conditions for heat supply from an energy efficient heating or cooling system which are not connected to a district heating network or equipped with an individual heat source and in which the expected peak thermal capacity of the installation and the equipment designed to heat this facility is 50 kW or more.

Measure 6: Cogeneration premium

Greenhouse gases affected: CO_2

Status: implemented

The new scheme of support for high-efficiency cogeneration was introduced in 2019. It consists of a system of premiums to the electricity generated at CHPs, awarded under different rules, depending, among others, on the size and type of CHP installations:

- A cogeneration premium for new and substantially modernised cogeneration units with installed electrical capacity of 1-50 MW which win auctions announced, implemented and resolved by the President of the Energy Regulatory Office (URE). Auctions are held at least once a year. The maximum support period is 15 years (from the first day following the date of the resolution of an auction, the generation, feeding into the grid and sales of electricity), but not longer than until 31.12.2048. The maximum amount of electricity from high-efficiency cogeneration the sales of which may be subject to a cogeneration premium was 6 TWh in 2019, 24 TWh in 2020 and 18 TWh in 2021, while the maximum budget for these premiums was, respectively, about PLN 1 billion, about PLN 4 billion and about PLN 2 billion. The values for subsequent years are successively announced in the year when auctions are held.

- In 2022, the maximum amount of electricity from high-efficiency cogeneration the sales of which may be subject to a cogeneration premium was set at 18 TWh, while the maximum budget for these premiums was more than PLN 4.2 billion.

- A guaranteed premium for:
  - existing and modernised cogeneration units with installed electrical capacity of 1-50 MW, and
  - new, substantially modernised, existing or modernised small cogeneration units (with installed electrical capacity of less than 1 MW).

  The value of the premium is set by the Minister responsible for energy in a relevant Regulation. The maximum support period is 15 years (from the first generation of electricity), but not longer than until 31.12.2035 (existing CHP plants) or 31.12.2048 (new and substantially modernised CHP plants). Support for modernised units is awarded for a period of 5-7 years, but not longer than until 2036. The unit rate of the premium depends on the type of installation and fuel, and is, as a maximum, about PLN 290/MWh.

- An individual cogeneration premium for new and substantially modernised cogeneration units with installed electrical capacity of 50 MW and more which win calls for applications announced and implemented by the President of the URE. The maximum amount of electricity from high-efficiency cogeneration the sales of which might be subject to an individual cogeneration premium was 36 TWh in both 2019 and 2020, while the maximum total value of premiums awarded was about PLN 4 billion in each of those periods. The unit rate of the premium depends on the type of installation and fuel, and is, as a maximum, more than PLN 475/MWh.

- A guaranteed individual premium for existing and modernised cogeneration units with installed electrical capacity of 50 MW and more. The value of the premium is determined on a case by case basis by a decision of the President of the URE.

Before they obtain the support, all the cogeneration units need to be authorised by a decision of the President of the URE to participate in the relevant scheme (the procedure in this matter will be held at the entrepreneur's request). In particular, a CHP unit which seeks support must meet the condition of a unit CO_2 emission factor at a level not exceeding 450 kg per 1 MWh of energy generated. This new scheme of support for high-efficiency cogeneration is funded by the cogeneration fee which has been shifted onto end-users.

The Act was amended in 2021 in order to improve the process of admitting generators to an auction or a call for applications and to make it more transparent and consistent with the other regulations, to increase the number of investors' bids for a cogeneration premiums and an individual cogeneration premium, thus contributing to the implementation of the objectives of the Act.

At the same time, the amendment makes it possible to optimise the investors' costs of preparing investments, to enhance the transparency of regulations and reduce the risks which may result in failure to meet the assumptions on the objectives and effects of the Polish heating sector and the transformation of systems into efficient heating systems.

The reduction effect of this measure was estimated on the basis of the projected amount of energy generated from high-efficiency cogeneration as presented in the Impact Assessment for the Act on the Promotion of Electricity from High-Efficiency Cogeneration and the CO_2 emission factor for the electricity generation in Poland in 2020.

Measure 7: Scheme of certificates of origin for RES (the green certificate scheme)

Greenhouse gases affected: CO_2

Status: implemented

In 2005, a scheme of support for RES was introduced. It used formal certificates of origin for energy from RES and the property rights to them as tradable instruments. The obligation to register all transactions on green certificates at the Polish Power Exchange (TGE) in Warsaw was introduced.

The most important elements of the green certificate scheme include:

- a statutory obligation to surrender for redemption certificates of origin for electricity from RES, with their number corresponding to a predetermined percentage share of that energy in the total supply to the end-users;
- the award of one certificate of origin for 1 MWh of electricity from RES, irrespective of technology;
- the need to pay a substitution fee in case of failure to surrender certificates of origin, with their number corresponding to a predetermined share; the rate of the substitution fee was set on the basis of the difference in energy prices between the green energy segment and the open market and the reasonable revenues for the cheapest RES technologies.

At present, the scheme covers only the existing RES installations. In principle, since 2016 new installations have been able to participate in the auction-based scheme. On a voluntary basis, the existing installations can shift from the green certificate scheme to the auction-based scheme.

Measure 8: Auction-based support scheme for RES

Greenhouse gases affected: CO_2

Status: implemented

The auction-based support model, adopted under the RES Act in 2015, ensures that investors can use stable support for RES generators and also avoid the adverse consequences related to the previous support system, which was based on the system of certificates of origin, i.e. the so-called green certificates.

Such an approach ensures fair competition between technologies and equal chances of individual generators by introducing the so-called "*technology baskets*" at auctions and creates a separate auction basket for electricity from agricultural biogas. The system covers new RES generators and already existing RES generators which have decided to shift from the green certificate scheme to the auction system.

The auction system consists in that the Government orders a specific amount of renewable energy and its generators take part in an auction. The auction is won by those participants who offer

the lowest electricity sale price until the amount or value of the electricity to be sold at a given auction is exhausted. The support period is 15 years, counting from the date of the first electricity sales following the date when a given auction is won by the RES generator concerned.

The first auction took place in December 2016. Auctions are organised by the President of the Energy Regulatory Office (URE) at least once a year, with a breakdown into technology baskets, separately for new and existing installations, and with a breakdown based on the capacity of installations, i.e. below and above 1 MW. Every year, the Council of Ministers defines and announces the total amount and value of energy from renewable sources to be offered for sale at auctions. In turn, the Minister responsible for energy sets the reference prices of electricity from renewable energy sources. The reference prices are diversified, depending on the type and capacity of RES installations.

The generators and the support scheme dedicated to the RES sector can be financed due to the RES fee. The RES fee is a variable fee depending on the electricity consumption by a given end-user, thus ensuring a fair and proportional value of this fee. It is incurred by all electricity users.

The reduction effect of this measure was estimated on the basis of the amount of energy generated by RES sources covered by the support scheme as resulting from the outcomes of auctions and the CO_2 emission factor for the electricity generation in Poland in 2020.

Measure 9: Feed-in tariff and feed-in premium schemes for RES

Greenhouse gases affected: CO_2

Status: implemented

The support scheme in the form of feed-in tariff (FIT) and feed-in premium (FIP) has its legal basis in the RES Act. It is addressed to RES generators with the lowest capacity and serves to manage the energy which has not been used by a small generator.

The FIT scheme can be used by generators of electricity from RES operating small or micro installations which sell or will sell unused electricity to a designated energy trading company. In turn, the FIP scheme is intended for generators of electricity from RES with total installed electrical capacity of not more than 1 MW which sell or will sell unused electricity to an entity of their choice (other than an energy trading company)

The constant purchase price in the FIT/FIP schemes represents 90% of the reference price, established for a given calendar year by a Regulation of the Minister responsible for energy, which is in effect as of the day when a FIT/FIP declaration is submitted. The constant purchase price is subject to annual valorisation.

The FIT/FIP schemes are dedicated only to RES installations using agricultural biogas, biogas extracted from waste landfills, biogas extracted from wastewater treatment plants, a different biogas or hydropower.

The following installations may join the FIT/FIP schemes:

- those planned to be commissioned where no electricity has been generated to date;
- those implemented after 1 July 2016 which have not used the auction-based support scheme referred to in Article 73 of the RES Act;
- those that have been commissioned and generate electricity which use the scheme of certificates of origin referred to in Article 44(1) of the RES Act;
- those that had won auctions resolved before the entry into force of the amendment to the RES Act of 7 June 2018 (Item 1276, as amended) – on the principles set out in Article 9 of the amending Act.

Measure 10: Obligation to purchase electricity generated at RES installations with total installed power capacity of less than 500 kW

Greenhouse gases affected: CO_2

Status: implemented

Since 1 January 2018 the purchase obligation has been limited to electricity generated at RES installations with total installed power capacity of less than 500 kW. The obligated sellers are obliged to buy the whole electricity generated at these installations at a price equivalent to the average sales price of electricity on the competitive market in the previous quarter of the year as announced by the President of the URE under Article 23(2)(18a) of the Act on Energy Law.

Measure 11: Reduction of methane emissions from fuel production and distribution processes

Greenhouse gases affected: CH_4

Status: implemented

The reduction of methane emissions from fuel production and distribution processes is required pursuant to the Regulation of the Minister of the Economy of 21 November 2005 on the technical conditions to be met by terminals and stations of liquid fuels, long-distance pipelines for transfer of crude oil and its products, and their location.

This measure consists in the introduction of more stringent technical requirements for the operation of storage systems. This Regulation introduced a limit for the level of annual losses of oil products in the storage, filling and emptying processes. The new maximum release level is 0.01% of their capacity.

Measure 12: Support for the development of offshore wind power – individual support and an auction-based scheme

Greenhouse gases affected: CO_2

Status: implemented

The Act on the Promotion of Electricity Generation at Offshore Wind Farms introduces a support scheme for offshore wind farms located on the Baltic Sea, consisting in the covering of the negative balance. The generator can exercise this right for a period of 25 years, counted from the first electricity generation at an offshore wind farm and feeding into the grid under a licence granted for electricity generation. The right to cover the negative balance can be exercised for electricity in an amount not exceeding the product of 100,000 hours and the installed electrical capacity of an offshore wind farm or its part resulting from the generation licence (however, not higher than the capacity specified in the decision awarding support or a bid submitted at auction).

The right to cover the negative balance can be obtained in two ways. Firstly, this right can be granted by way of an individual decision issued by the President of the Energy Regulatory Office (URE). The total capacity of an offshore wind farm for which the President of the URE can issue the decision to grant support may not exceed 5.9 GW. This pool had been completely exhausted by June 2021. In the case of an individual decision issued by the President of the Energy Regulatory Office, the negative balance is accounted for on the basis of the price specified in a Regulation of the Minister responsible for energy.

Secondly, the right to cover the can be obtained at auctions held by the President of the URE. The maximum price which can be specified in bids submitted by generators will be defined by a Regulation of the Minister responsible for energy. In principle, auctions are expected to be held in 2025 and 2027. Pursuant to the Act, the maximum capacity of an offshore wind farm for which support can be granted is required to be 2.5 GW at each auction. The Government has the right to hold more auctions in successive years.

The reduction effect of this measure was estimated on the basis of the amount of energy generated by offshore wind farms as specified in the Regulation Impact Assessment for the Act on the Promotion of Electricity Generation at Offshore Wind Farms and the CO_2 emission factor for the electricity generation in Poland in 2020.

Measure 13: My Power Priority Programme

Greenhouse gases affected: CO_2

Status: implemented

The My Power Priority Programme, coordinated by the NFOŚiGW, implements the Strategy for Responsible Development. The aim of the Programme is to increase electricity production at micro photovoltaic installations in Poland. This is an instrument dedicated to supporting the development of prosumer energy generation, specifically the segment of micro photovoltaic installations.

It provides for co-financing (in the form of a grant of up to PLN 5,000) of the purchase and assembly of a photovoltaic installation with 2 to 10 kW capacity, meeting the needs of existing residential buildings. Co-financing can be obtained when an installation has already been built and connected to the electricity grid (among others, a bi-directional meter is required).

The beneficiaries of the Programme can be physical persons who generate electricity to meet their own needs and who have signed a comprehensive contract regulating the issues related to the transfer of the electricity generated at their micro installation to the grid.

In 2021, the support level was reduced to PLN 3,000 PLN, while in the fourth edition in 2022, support covered not only household-based micro photovoltaic installations, but also power and heat storage systems which enhance the self-consumption of electricity generated from own PV panels. The third and fourth editions of the My Power Priority Programme are financed from the Operational Programme Infrastructure and Environment 2014-2020 (POIiŚ) as part of Measure 11.1 with the resources of the REACT-EU instrument (additional resources allocated to the Member States' cohesion policy programmes to mitigate the impacts of the crisis caused by the COVID-19 pandemic).

The reduction effect of this measure was determined on the basis of data from the NFOŚiGW.

Measure 14: Energy Plus Priority Programme

Greenhouse gases affected: CO_2

Status implemented

The aim of the Programme is to diminish the adverse impact of enterprises on the environment, including an improvement in air quality, by supporting investment projects. Under the Programme, the following types of projects are eligible to be supported:

- those that reduce the consumption of primary raw materials;
- those that limit or avoid harmful emissions into the atmosphere;
- new sources of heat and electricity;

- modernisation / expansion of district heating networks;
- the use of geothermal resources for energy generation purposes.

The beneficiaries of the Programme are entrepreneurs within the meaning of the Act of 6 March 2018 on Entrepreneurs Law (Official Journal of the Laws of 2021, Item 162, as amended), who carry out economic activity.

Support is provided in the form of grants and loans (PLN 1-300 million for a period of 15 years). Co-financing in the form of loans can be provided to cover up to 85% of eligible costs, while co-financing in the form of grants can be awarded to cover up to 50% of eligible costs.

The reduction effect of this measure was determined on the basis of data from the NFOŚiGW.

Measure 15: Polish Geothermal Energy Plus Priority Programme

Greenhouse gases affected: CO_2

Status: implemented

The aim of the Programme is to enhance the use of geothermal resources in Poland. In light of this, support is only provided to local projects in areas with favourable conditions for the development of geothermal energy. The types of projects which can be supported include:

- the construction of a new heating plant/heat and power generating plant/geothermal power plant or the expansion or modernisation of an existing heating plant/heat and power generating plant/geothermal power plant, based on a geothermal source;
- the modernisation or expansion of existing energy generating plants with a heating plant/heat and power generating plant/geothermal power plant, based on a geothermal source;
- the execution or reconstruction of a geothermal borehole, excluding the execution of the first exploratory borehole.

In addition, the Programme provides for "*optional projects*", consisting, among others, in the construction, expansion and modernisation of installations and equipment to reduce the consumption of primary raw materials; projects to reduce the emissions of air pollutants; projects to improve air quality, etc.

The beneficiaries of the Programme are entrepreneurs within the meaning of the Act of 6 March 2018 on Entrepreneurs Law. Support is provided in the form of grants and loans.

The reduction effect of this measure was determined on the basis of data from the NFOŚiGW.

Measure 16: District Heating Priority Programme

Greenhouse gases affected: CO_2

Status: implemented

The aim of the Programme is to diminish the adverse impact of district heating enterprises on the environment, particularly the enterprises which operate locally, including an improvement in air quality, by supporting investment projects. The types of projects which can be co-financed include:

- the construction, expansion or modernisation of the existing production installations or industrial equipment to diminish the consumption of primary raw materials (within their own production lines), among others, by replacing them with secondary materials and waste, or to reduce the quantities of waste generated;
- projects to diminish harmful emissions into the atmosphere from installations described in Directive (EU) 2015/2193 of the European Parliament and of the Council of 25 November 2015 on the limitation of emissions of certain pollutants into the air from medium combustion plants (OJ L 313, 28.11.2015, p. 1, as amended);

- projects to improve air quality by reducing the levels of emissions from combustion plants with a total rated thermal input of 50 MW and more at least to the national emission standards for installations with such a rated thermal input or to the levels resulting from the best available techniques (BAT) conclusions for large combustion plants, if these are adopted for these plants, including: the modernisation of equipment or the fitting of the combustion installations with equipment or installations to reduce the emissions of gas and dust emissions. A combustion plant is understood to mean stationary technical apparatus with a thermal capacity in fuel of more than 1 MW;
- projects to improve air quality by reducing the levels of emissions into the atmosphere from industrial operations (not related directly to combustion plants);
- projects consistent with the Notice of the Minister of Energy of 23 November 2016 on a Detailed List of Projects to Improve Energy Efficiency, intended to improve energy efficiency and the technological changes for the same purpose at the existing plants, installations and technical equipment;
- projects implemented at an existing enterprise/facility to build or reconstruct generating units, including their connection to the distribution/transmission network, where energy is produced from:
  (a) energy from renewable energy sources,
  (b) waste heat, or
  (c) heat from cogeneration.
- the modernisation or expansion of a district heating network;
- the use of geothermal resources for energy generation purposes.

The beneficiaries of the Programme can be capital companies engaged in heat production to meet municipal and household needs if the share of a company of a territorial self-government unit, including that of a union of territorial self-government units, in their share capital, is not less than 70%. At the same time, the total thermal ordered capacity of the district heating network in which the operations in question are carried out may not be more than 50 MW. Support is given in the form of a grant or loan. The funding comes from EU sources as part of the KPO.

The reduction effect of this measure was determined on the basis of data from the NFOŚiGW.

Measure 17: Agroenergy Programme

Greenhouse gases affected: CO_2

Status: implemented

The aim of the Programme is to provide comprehensive support to limit the adverse impact of agricultural activities on the environment.

Support is provided to projects consisting in the purchase and assembly of:

- photovoltaic installations with installed electrical capacity higher than 10 kW and not higher than 50 kW;
- wind installations with installed electrical capacity higher than 10 kW and not higher than 50 kW;
- heat pumps with capacity higher than 10 kW and not higher than 50 kW, for which an application can be submitted on the condition that an energy audit is carried out earlier and that it recommends the proposed scope of the project;
- hybrid installations, i.e. photovoltaics combined with a heat pump or a wind farm combined with a heat pump, integrated into one coupled system, for which an application can be submitted on the condition that an energy audit is carried out earlier and that it recommends the use of a heat pump to meet the applicant's own energy needs.

The beneficiaries of support under the Programme can be:

- natural persons who are the owners or leaseholders of agricultural properties with a total area of agricultural land falling in the range from 1 ha to 300 ha and who personally managed a farm at least one year before the submission of the application;
- legal persons who are the owners or leaseholders of agricultural properties with a total area of agricultural land falling in the range from 1 ha to 300 ha and who carried out agricultural activity or economic activity in the scope of agricultural services at least one year before the submission of the application for co-financing.

Support is given in the form of a grant.

In May 2021, the Programme was updated to meet the need for changes to allow for wider access and to enhance the attractiveness of the Programme. An analysis of the first call for applications identified the need to simplify the process of submitting the applications for co-financing. The definition of the beneficiaries was also extended to include legal persons carrying out agricultural activity or economic activity in the scope of agricultural services. The Programme was divided into two parts:

- Part 1) Micro installations, heat pumps and the accompanying energy storage systems;
- Part 2) Agricultural biogas plants and small hydropower plants.

Given the expected large number of applications, the WFOŚiGW were entrusted with the implementation of Part 1 of the Programme. The call for applications was launched on 1 October 2021.

In Part 1, the applicants can seek co-financing for:

- photovoltaic installations with installed electrical capacity higher than 10 kW and not higher than 50 kW;
- wind installations with installed electrical capacity higher than 10 kW and not higher than 50 kW;
- heat pumps with capacity higher than 10 kW and not higher than 50 kW, for which an application can be submitted on the condition that an energy audit is carried out earlier and that it recommends the proposed scope of the project;
- hybrid installations, i.e. photovoltaics combined with a heat pump or a wind farm combined with a heat pump, integrated into one coupled system, for which an application can be submitted on the condition that an energy audit is carried out earlier and that it recommends the use of a heat pump to meet the applicant's own energy needs on the site where the agricultural activity is carried out.

The accompanying energy storage systems can also be co-financed.

Part 2) Agricultural biogas plants and small hydropower plants is implemented by the NFOŚiGW. As part of it, the applicants can seek co-financing for the purchase and assembly of an agricultural biogas plant with capacity not exceeding 500 kW, along with the accompanying installation for the production of agricultural biogas, or the purchase and assembly of a hydropower plant with capacity not exceeding 500 kW. The accompanying energy storage systems can also be co-financed.

The reduction effect of this measure was determined on the basis of data from the NFOŚiGW.

Measure 18: Research projects on methane removal using the technology of underground directional boreholes (DD-MET Project)

Greenhouse gases affected: CH_4

Status: implemented

The aim of the DD-MET Project is to develop an advanced methane removal strategy using the technology of underground directional boreholes to prevent the main risk areas and to eliminate greenhouse gas emissions. It has been implemented since 1 July 2019 and its completion is planned

for December 2023. The Project is coordinated by the Oil and Gas Institute and, among others, PGG S.A. participates in it.

As part of the Project, a cost-effective and environment-friendly technology will be developed for methane drainage during the extraction from coal beds using the technology of underground directional boreholes in mines, replacing very expensive methane drainage galleries built under coal beds and also other auxiliary methane drainage methods. The assumptions of the Project will be validated in the field conditions and, as a result, the best practices will be developed, addressing the technical, technological, environmental and economic aspects which should be considered when decisions are taken to implement the proposed methane drainage technology.

Measure 19: Other NFOŚiGW programmes supporting the development of RES and cogeneration (a group of measures)

Greenhouse gases affected: CO_2

Status: implemented

The group of measures provides co-financing for projects to build or modernise heating and electricity systems to enable the connection of RES and to build or modernise RES units and units generating heat and electricity in high-efficiency cogeneration.

The group of measures includes programmes under POIiŚ 2014-2020, involving projects in the scope of the low-emission and resource-efficient economy, encompassing the generation and distribution of energy originating from renewable sources, the connection of RES sources to the distribution/transmission networks, as well as those in the scope of the high-efficiency cogeneration of heat and electricity and the distribution of heat and cold.

The group of measures includes the programmes presented below.

Table 4.13. Other NFOŚiGW programmes supporting the development of RES and cogeneration

Programme	Short description
Promoting the production and distribution of energy derived from renewable sources Sub-measure: Support for investments related to the energy generation from renewable sources including the connection of these sources to the distribution / transmission network	**Aim and scope:** The aim of the measure is to support for the implementation of investment projects to build or reconstruct generating units resulting in enhanced energy generation from renewable energy sources, including the connection of these sources to the distribution/transmission network. An element of the project is the connection to the electricity grid or the heating network belonging to the project beneficiary (energy generator). The support is provided for the construction or reconstruction of energy generating units using wind energy (of more than 5 MWe), biomass (of more than 5 MWth/MWe), biogas (of more than 1 MWe), water (of more than 5 MWe), solar radiation energy (of more than 2 MWe/MWth) and geothermal energy (of more than 2 MWth). Support for RES units using water-based electricity will be available on the existing dams, enabling the construction of hydro-power plants on them, while preserving the morphological continuity of a watercourse by ensuring full passability of the structure for movements of water fauna. In addition, in the case of support for projects involving RES units using only water energy, they are subject to the conditions applicable to projects which may affect the status of waters. **Beneficiaries:** Entrepreneurs – generators of energy from renewable energy sources. Support is provided for projects in the area of renewable energy sources under the National Renewable Energy Action Plan. **Form of support:** Grant or repayable aid **Source of financing:** POIiŚ 2014-2020
Promoting the production and distribution of energy	**Aim and scope:** The aim of the measure is to support projects to build or reconstruct an electricity grid resulting in enhanced capacity of the electricity infrastructure, enabling the connection of new capacity for generating energy from renewable sources to the electricity

Programme	Short description
derived from renewable sources Sub-measure: Promotion of projects related to construction and reconstruction of networks enabling the connection of RES units	grid of the Transmission System Operator (TSO) or the electricity grids of the Distribution System Operators (DSO) with 110 kV voltage. The support available for the connection of renewable energy sources to the National Power System (KSE) can cover the part of the connection belonging to the TSO or the DSO, as well as the construction or reconstruction of infrastructure so as to enable the connection of the capacity of renewable energy sources notified to the Operator which apply for the issue of the conditions for the connection to the electricity grid. Support is given to projects consisting in the construction or reconstruction of an electricity grid with voltage of at least 110 kV and enabling the connection of units generating energy from renewable sources to the National Power System (KSE) and a 110 kV distribution network. **Beneficiaries:** Transmission System Operator and Distribution System Operators. **Form of support:** Grant **Source of financing:** POIiŚ 2014-2020
Effective distribution of heat and cold	**Aim and scope:** The aim of the measure is to Improve air quality by limiting the emissions of pollutants which are particularly harmful for the quality of human life, i.e. reducing so-called "*low emissions*" in the areas where the PM10 limit values are exceeded. The investments are expected to contribute to reducing the consumption of non-renewable primary energy, reducing carbon dioxide emissions and diminishing particulate matter emissions into the atmosphere. As part of this measure, support is given to improving the effectiveness of heat transmission and distribution to the existing users, in particular, through the modernisation and reconstruction of district heating networks and the liquidation of collective and individual sources of so-called "*low emissions*", including those in residential buildings, through their connection to effective heating and cooling systems. Support is provided to the following types of projects: – the reconstruction of the existing heating systems and cooling networks to reduce transmission and distribution losses; – the construction of connections to the existing buildings and the installation of individual substations resulting in the liquidation of collective substations; – the construction of new sections of a heating network, including the heating connections and substations to liquidate the existing local heat sources using a solid fuel; – the connection of buildings to a heating network to liquidate the individual and collective sources of low emissions. **Beneficiaries:** Entrepreneurs, territorial self-government units and the organisational units operating on their behalf, housing cooperatives and entities providing public services as part of the fulfilment of the own responsibilities of the territorial self-government units which are not entrepreneurs. **Form of support:** Grant **Source of financing:** POIiŚ 2014-2020
Promoting the use of high-efficiency cogeneration of heat and electricity based on demand for useful heat	**Aim and scope:** The aim of the measure is to attain savings in primary energy consumption. Support is given for the construction of new capacity or the enhancement of the capacity (as a result of expansion or reconstruction) of the existing electricity and heat generators using high-efficiency cogeneration technology in cogeneration units. Priority is given to projects with the highest potential for carbon dioxide emission reduction per unit of co-financing and also enabling the greatest reduction of particulate matter emissions into the air. Support is provided to the following types of projects: – installations with capacity of more than 20 MW: the construction and reconstruction of high-efficiency cogeneration units and the reconstruction of the existing units into high-efficiency ones using biomass as a fuel; – installations with capacity of up to 20 MW: the construction of new, economically viable high-efficiency cogeneration units with as low as possible emissions of CO_2 and other air pollutants or the reconstruction of the existing installations into ones using high-efficiency cogeneration units resulting in CO_2 reductions by at least 30% compared with the heat stream in the existing installation;

Programme	Short description
	– the implementation of comprehensive projects to build new high-efficiency cogeneration units or to reconstruct existing ones, along with heating or cooling networks, to enable the use of heat/cold arising at a given installation. **Beneficiaries:** Entrepreneurs, territorial self-government units and the organisational units operating on their behalf, entities providing public services as part of the fulfilment of the own responsibilities of the territorial self-government units which are not entrepreneurs, housing cooperatives and energy service providers within the meaning of Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC (OJ L 315, 14.11.2012,p. 1, as amended) acting in favour of territorial self-government units. **Form of support:** Grant **Source of financing:** POIiŚ 2014-2020

Source: Elaborated by the KOBiZE IOŚ-PIB

The measures in this group are expected to be completed in 2023, given the need to account for all the projects which have been started.

The reduction effect of this measure was determined on the basis of data from the NFOŚiGW.

Measure 20: New Energy Programme

Greenhouse gases affected: CO_2

Status: implemented

The aim of the Programme which was launched in 2021 is to diminish the adverse impact of enterprises on the environment, including an improvement in air quality, by supporting investment projects. The following types of projects are eligible to be supported:

- those that reduce the consumption of primary raw materials;
- those that limit or avoid harmful emissions into the atmosphere;
- new sources of heat and electricity;
- modernisation / expansion of district heating networks;
- the use of geothermal resources for energy generation purposes.

The beneficiaries are entrepreneurs within the meaning of the Act of 6 March 2018 on Entrepreneurs Law. Support is provided in the form of grants and loans in an amount from PLN 1 to 300 million for a period of 15 years. Co-financing in the form of a loan can be provided to cover up to 85% of eligible costs, while co-financing in the form of a grant can be awarded to cover up to 50% of eligible costs.

Measure 21: My Heat Priority Programme

Greenhouse gases affected: CO_2

Status: implemented

The aim of the Programme is to support the development of individual heating and the development of prosumer energy generation in the areas of air source heat pumps, ground source heat pumps and water source heat pumps in new single-family residential buildings.

Co-financing is provided for investments in the purchase and assembly of new heat pumps (air source heat pumps and ground source heat pumps) used for the purposes of heating or heating of domestic hot water in new single-family residential buildings.

Investments in the following can be co-financed:

- the purchase/assembly of ground source heat pumps – ground-to-water and water-to-water heat pumps with accessories, an accumulation/buffer tank and a hot water tank with accessories;
- the purchase/assembly of an air-to-air heat pump (in a central system serving the whole building) with accessories;
- the purchase/assembly of an air-to-water heat pump with accessories, an accumulation/buffer tank and a hot water tank with accessories.

In a single-family residential building, there may not be (in the period of sustainability of an investment, too) a solid fuel-fired heat source. A new single-family residential building is understood to mean a building in respect of which as of the date of the submission of an application for co-financing:

- no notification of the completion of the construction of a single-family residential building has been submitted or no application for the issue of a use permit has been submitted in accordance with the provisions of the Act of 7 July 1994 on Construction Law (Official Journal of the Laws of 2021, Item 2351, as amended) has been submitted, or
- a notification of the completion of the construction of a single-family residential building was submitted not earlier than 01.01.2021 or an application for the issue of a use permit was submitted not earlier than 01.01.2021.

The beneficiary is a natural person who is the owner or co-owner of a new single-family residential building.

Support is given in the form of a grant to cover up to 30% or up to 45% of eligible costs, but not more than PLN 21,000 per one co-financed investment. The rate of co-financing will depend on the type of the heat pump installed and whether the applicant holds the large family card.

The call for applications for a grant will be held continuously until 31.12.2026, but only until the allocation funds are exhausted.

The reduction effect of this measure was estimated on the basis of data from the NFOŚiGW.

4.2.4. Policies and measures in the energy consumption sector

This Section presents documents of a strategic character, legal regulations and policies and measures associated with the energy consumption sector which contribute to greenhouse gas emission reductions.

The aim of the measures addressing energy consumption is to reduce energy use on the users' premises, mainly by improving the energy efficiency of industrial and energy generation processes and carrying out thermal modernisation of buildings. There are systemic solutions in place (the white certificate scheme) and a number of support programmes providing grants and loans.

Key strategies, plans and programmes

The table below lists the key strategies, plans and programmes associated with the energy consumption sector which affect its functioning and condition environmental protection and climate change mitigation.

Table 4.14. Key strategies, plans and programmes in the energy consumption sector

Title	Description
Implemented	
Long-term Renovation Strategy (DSRB), adopted by the Council of Ministers on 9 February 2022	The DSRB presents a comprehensive diagnosis of the situation and the challenge of improving the energy efficiency of the construction sector. It also presents the paths for achieving the large-scale and deep renovation of the construction

Title	Description
	resources in Poland, broken down for 2030, 2040 and 2050. In accordance with the assumptions of the DSRB, in the long-term, Polish buildings should be modernised in a manner consistent with the transition towards a climate-neutral economy, while, at the same time, responding to the urgent need to replace the most emission intensive heat sources in order to improve air quality, ensuring, in addition, the economic viability of renovation and the equitable sharing of the costs of investments in the modernisation of buildings.
National Housing Programme, adopted by the Council of Ministers on 27 September 2016	The aims of the National Housing Programme (NPM) include, among others, an improvement in the living conditions of the population and the technical condition of the housing resources and an enhancement of energy efficiency. The measures provide in particular for financial support for renovation and thermal modernisation projects, from both national and EU resources, the implementation of instruments supporting the processes to revitalise degraded areas and a review of the regulations on the technical parameters affecting the energy efficiency in residential buildings.
National Plan to Increase the Number of Nearly Zero-Energy Buildings, adopted by the Council of Ministers on 22 June 2015	The Plan contains a definition of nearly zero-energy buildings, reflecting the existing conditions and the feasible and economically viable measures to improve the energy performance of buildings. It also specifies the measures taken by the government administration to promote low-energy buildings, also in the scope of their design, construction and reconstruction in a way which ensures their energy efficiency, and to increase the supplies of energy from renewable sources in new and existing buildings.

Source: Elaborated by the KOBiZE IOŚ-PIB

Key legal acts

The table below lists the key legal acts associated with the energy consumption sector which affect its functioning and condition environmental protection and climate change mitigation.

Table 4.15. Key legal acts in energy consumption sector

Title	Description
Implemented	
Act of 20 May 2016 on Energy Efficiency (Official Journal of the Laws of 2021, Item 2166)	The Act defines the rules for the development of the national energy efficiency action plan and establishes the rules, among others, for the fulfilment of the obligation to save energy and to carry out the energy audit of an enterprise. It also identifies the energy efficiency tasks of public sector entities. It introduces changes to the white certificate scheme, using energy efficiency certificates which confirm the implementation of measures which have brought specific energy savings. It also specifies the energy efficiency targets to be achieved by public sector authorities and entities by 2030. In addition to the energy efficiency certificates, additional alternative measures were introduced for the purposes of meeting the savings target and a central register of final energy savings was established to gather data, among others, on the implemented energy efficiency projects using alternative measures.
Act of 29 August 2014 on the Energy Performance of Buildings (Official Journal of the Laws of 2021, Item 497, as amended)	The Act lays down the rules for drawing up the energy performance certificates for buildings, the rules for inspections of the heating and air-conditioning systems in buildings and the rules for keeping the central register of energy performance certificates for buildings. It also sets out the manner of preparing the national action plan to enhance the number of low-energy buildings. The Act improved the system for the assessment and improvement of the energy efficiency of buildings, which had until then been regulated by the Act on Construction Law and the implementing acts for this Act. Following the amendment in 2014, the energy performance of a building became an integral part of the architectural and construction design indispensable for obtaining a

Title	Description
	construction permit. Under the Act on the Energy Performance of Buildings, the central register of the energy performance of buildings was established.
Act of 21 November 2008 on Support for Thermal Modernisation and Renovation and on the Central Emission Register of Buildings (Official Journal of the Laws of 2022, Item 438, as amended)	The Act lays down the rules for using the resources of the Thermal Modernisation and Renovation Fund to cover part of the costs of thermal modernisation, renovation and low-emission projects. In accordance with the provisions of the Act, the BGK forwards: - information on the amounts of premiums awarded and paid out - to the Minister responsible for economic development; - information on the planned changes in the demand for fuels and the planned decrease in the demand for energy as projected as a result of the thermal modernisation projects (on the basis of information acquired from energy audits) - to the Minister responsible for climate. On 1 July 2021, under the amendment to the Act, the Central Emission Register of Buildings (CEEB) was established to gather uniform, standardised and consistent data on buildings, housing units, heat sources used in them, including supplies from a heating network, electricity sources used in them, as well as fuel combustion. The supervision over the CEEB was entrusted to the Central Office of Construction Supervision.
Regulation of the Minister of Infrastructure of 12 April 2002 on the technical conditions to be met by buildings and their situation (Official Journal of the Laws of 2022, Item 1225)	The Regulation regulates the issues of the technical equipment of the building, energy savings and thermal insulation for buildings designed, built and reconstructed or when the manner of their use is changed.

Source: Elaborated by the KOBiZE IOŚ-PIB

Policies and measures

Measure 22: White certificate scheme

Greenhouse gases affected: CO_2

Status: implemented

The scheme imposing the obligation related to energy efficiency was introduced by the statutory imposition of the obligation on the obligated parties on 1 January 2013. At present, this scheme operates pursuant to the Act on Energy Efficiency of 20 May 2016 and also implements the provisions of Directive 2012/27/EU on energy efficiency and Directive (EU) 2018/2002 which amended it.

The white certificate scheme, introduced under the Act mentioned, is the basic mechanism for supporting measures to improve the energy efficiency of the economy, to increase energy savings by end-users and to diminish the losses of electricity, heat, natural gas or liquid fuels in transmission or distribution. The scheme covers energy enterprises. The main aim of the white certificate scheme is to ensure the fulfilment of the target in the area of energy efficiency. In accordance with the provisions of the Act, the final energy savings achieved by meeting the obligation referred to in Article 10(1) and by using the alternative measures referred to Article 10(3) from 1 January 2021 to 31 December 2030 should amount at least to 5,558,000 t of oil equivalent (toe).

As part of the white certificate scheme, applicants can seek to obtain energy efficiency certificates for the implementation, among others, of the following projects: the insulation of industrial installations, the reconstruction or renovation of a building, including technical installations and

equipment, the modernisation or replacement of lighting and equipment used in industrial processes, heating networks, household appliances, vehicles, energy recovery or loss reduction.

The scheme covers energy companies which are obliged by statute to:

- implement a project or projects to improve energy efficiency on the end-users' premises which result in final energy savings every year at a rate of 1.5%, confirmed by an energy efficiency audit, or
- acquire and surrender for redemption to the President of the Energy Regulatory Office (URE) energy efficiency certificates which can be obtained for a measure which produces annual final energy savings of not less than 10 toe.

Information on the energy savings achieved as part of the white certificate scheme is included, among others, in annual reports prepared in accordance with the requirements of Directive 2012/27/EU by the Ministry of Climate and Environment and submitted to the European Commission.

The reduction effect of this measure was estimated on the basis of final energy savings planned in the Act on Energy Efficiency to be achieved as part of the white certificate scheme, using the CO_2 emission factor for the electricity production in Poland in 2020.

Measure 23: Energy audits and energy management systems

Greenhouse gases affected: CO_2

Status: implemented

The 2016 Act on Energy Efficiency imposed on large entrepreneurs the obligation to carry out an energy audit every 4 years. The introduction of this obligation also implemented the provisions of Directive 2012/27/EU.

The energy audit of an enterprise is mandatory and covers the consumption of all forms of energy, but it is not related to the white certificate scheme. Its aim is to determine potential energy savings and to carry out detailed and confirmed calculations for the proposed projects to improve energy efficiency. There is the requirement to perform a detailed review of energy consumption representing at least 90% of total energy consumption related to the activity carried out by a given company. The energy audit of an enterprise should be performed by an entity independent of the enterprise audited which has knowledge and professional experience in carrying out audits of this type.

An entrepreneur notifies the President of the URE of the energy audit performed within 30 days of the date when it is carried out. With the notification, the entrepreneur encloses information on savings which can be achieved as indicated by the energy audit of the enterprise.

Measure 24: Clean Air Priority Programme

Greenhouse gases affected: CO_2

Status: implemented

The Clean Air Priority Programme, coordinated by the NFOŚiGW and implemented together with 16 WFOŚiGW, implements one of the tasks laid down in a strategic project as part of the Strategy for Responsible Development, with the same name of "*Clean Air*". Its aims include improving energy efficiency and reducing the emissions of particulate matter and other pollutants into the atmosphere from single-family residential buildings.

Financial support covers the replacement of solid fuel-fired furnaces, thermal modernisation of residential buildings, including, among others, the costs of preparing sectoral design documentation

(the modernisation of the internal installation and exchange of heat sources, the roof modification for the purposes of thermal modernisation) and the purchase costs of equipment, installations and construction materials as part of the thermal modernisation of a building.

The beneficiaries of the Programme are the owners or co-owners of single-family buildings. Grants and loans are awarded via the WFOŚiGW. Since its launch in September 2018, the Programme has been modified several times. A number of changes were introduced, with the most important ones including the simplification of the rules for the award of grants, the reduction of the time for consideration of applications from 90 to 30 days, the simplification of the grant application, the introduction of the possibility of submitting an application online, the integration with the My Power Programme, the Stop Smog Programme and the thermal modernisation relief, the linking of the grant level to the environmental effect, preferences for zero-carbon investment projects, grants for those who have already replaced their heat sources and the possibility of financing started and completed projects. As a new element, banks also joined the Clean Air Priority Programme. At present, eight financing institutions manage credit paths. Due to the guarantees of Bank Gospodarstwa Krajowego, banks will be able to propose better conditions for financing environmentally friendly investments, among others, resigning from the borrowers' obligation to present additional securities.

Since 25 January 2022, the third version of the Programme has applied, with a higher grant for thermal modernisation and furnace replacement, i.e. up to PLN 69,000 for a monthly income not exceeding PLN 900 or PLN 1,260 PLN per person. In addition, important changes included: the admission of dual-fuel boilers gasifying wood and burning wood pellets as consistent with the objectives of the Clean Air Priority Programme and the specification of the requirements for the flues in the case of solid fuel-fired boilers. Another edition of the Programme called Clean Air Plus, since 15.07.2022 enabled the payment of PLN 40,000 before renovation to the owners of single-family buildings who wish to replace their furnace (a so-called smoker) or thermally modernise their houses. The contractor will receive the remainder of the support after the works are completed.

It is planned that the Clean Air Priority Programme will be co-financed from EU resources, i.e. as part of the KPO and the Programme of European Funds for Infrastructure, Climate and Environment for 2021-2027.

The reduction effect of the Programme was given on the basis of data from NFOŚiGW.

Measure 25: Thermal Modernisation and Renovation Fund

Greenhouse gases affected: CO_2

Status: implemented

The Thermal Modernisation and Renovation Fund (FTiR) operates pursuant to the Act on Support for Thermal Modernisation and Renovation and is one of the instruments of the implementation of the National Housing Programme adopted in 2016 and the National Action Plan on Energy Efficiency for the period from 2021 to 2030.

The aim of the FTiR is to give financial assistance (in the form of thermal modernisation, renovation and compensation premiums) to investors who can be the owners of housing stock (single- and multi-family buildings), municipalities, housing cooperatives, the owners of company apartments and private owners.

The financial support covers projects to improve the technical condition of existing residential buildings and the payment of compensations to the owners of residential buildings for

the implementation of measures significantly contributing to reducing energy consumption in the buildings for heating and preparing domestic hot water, reducing primary energy losses in local district heating networks or replacing heat sources by more efficient and environmentally friendly ones.

The key measures covered by the financial support include those:

- reducing the demand for the energy delivered for the purposes of heating and preparing domestic hot water and heating residential buildings, collective dwelling buildings and buildings owned by territorial self-government units which are used for the execution of their public tasks;
- reducing the supply costs of the heat delivered to buildings – as a result of the implementation of a technical connection to a centralised heat source in relation to the liquidation of a local heat source;
- reducing primary energy losses in local district heating networks and their local heat sources;
- the complete or partial replacement of energy sources by renewable sources or the use of high-efficiency cogeneration.

The financial support under the FTiR can also be combined with the Stop Smog Programme. The legal framework for the operation of this Programme was established by the Act on Support for Thermal Modernisation and Renovation, which entered into force on 11 February 2019. The Stop Smog Programme is intended for energy poor persons who live in single-family buildings. The Programme is addressed to all the municipalities which can demonstrate bad air quality in their areas, i.e. where the concentrations of air pollutants exceed the EU standards. The Programme includes the implementation in the households mentioned above of projects consisting in:

- the replacement of heating equipment or systems by ones meeting low-emission standards;
- the liquidation of heating equipment or systems and the connection to a district heating, electricity or gas network;
- the comprehensive thermal modernisation of a building.

Projects are implemented in favour of the final beneficiary by a municipality and financed with public resources up to 100% of their value. The municipality ensures 30% of the own contribution (in the case of municipalities with more than 100,000 inhabitants the contribution must be higher). The other part of the Programme (70%) is financed from the state budget via the Thermal Modernisation and Renovation Fund. The Programme has now been planned for implementation in the period from 2019 to 2024 and its total budget (the contributions from the state budget and municipalities) is PLN 1.2 billion.

The operating rules of the Stop Smog Programme continued to be improved. An amendment to the Act on Support for Thermal Modernisation and Renovation in effect since 1 January 2021 introduced improvements to the Stop Smog Programme facilitating access to its resources, including, among others:

- the lifting of the obligation of municipal self-governments to prepare municipal low-emission programmes;
- the reduction of the minimum number of single-family buildings enabling the submission of applications to the Programme (from 2% to 1% or 20 buildings),
- an expansion of the catalogue of eligible costs;
- the decrease of the required household heat demand reduction from 50% to 30%,
- the reduction of the period for the measures/obligations of the municipality and the beneficiary after the expiry of an agreement from 10 to 5 years.

It is planned that the operations of the Thermal Modernisation and Renovation Fund will be co-financed from EU resources as part of the KPO.

The reduction effect of this measure was estimated on the basis of final energy savings confirmed and planned in the NECP, using the CO_2 emission factor for the electricity production in Poland in 2020.

Measure 26: Thermal modernisation relief

Greenhouse gases affected: CO_2

Status: implemented

The thermal modernisation relief consists in the possibility of detracting the costs of the implementation of a thermal modernisation project in a single-family residential building from the tax calculation base (in the case of a flat-rate tax, the revenues). It has been in effect since 1 January 2019. The taxpayer who is the owner or co-owner of a single-family residential building has the right to the relief provided that the thermal modernisation project in that building is completed within 3 subsequent years, counting from the end of the tax year when the first expenditure is incurred. The expenditure may not exceed PLN 53,000.

The following is considered to be a thermal modernisation project:

- an improvement which brings about a reduction in the demand for energy supplied for the purposes of heating and preparing hot domestic water and heating to residential buildings;
- an improvement which brings about a reduction in the primary energy loses in local district heating networks and the local heat sources supplying them if the residential buildings to which heat is supplied from these networks meet the requirements for energy savings set in the provisions of construction law or if measures have been taken to reduce the consumption of energy supplied to these buildings;
- the implementation of a technical connection to a centralised heat source, in relation to the liquidation of a local heat source, which brings about a reduction in the supply costs of the heat delivered to residential buildings;
- the complete or partial replacement of energy sources by renewable sources or the use of high-efficiency cogeneration.

The documented expenditures should be detracted on an ongoing basis, separately for each year, in the annual PIT tax declaration, without the need to confirm the energy savings with an energy audit.

The reduction effect of this measure was estimated on the basis of the final energy savings planned in the NECP, using the CO_2 emission factor for electricity the electricity production in Poland in 2020.

Measure 27: Improvement of the operation of the energy efficiency system of buildings (a group of measures)

Greenhouse gases affected: CO_2

Status: implemented

The improvement of the operation of the system for the energy efficiency of buildings involves a group of measures to improve the operation of the system and registers of the energy efficiency of buildings, changes in the technical construction requirements and regulations in the area of energy efficiency intended to reduce energy demand and to reduce carbon dioxide emissions from the municipal and household sector, as well as financial programmes supporting improvements in the energy efficiency of buildings.

The group of measures implements the obligations related to the Long-term Renovation Strategy and the application of energy efficiency measures at public bodies under Directive 2012/27/EU. It also contributes to the achievement of the national energy efficiency target of primary energy savings by 2030 at the level of 23% for the period 2021 to 2030 as pledged in the NECP for 2021-2030 (the reduction of the primary energy consumption by 27.3 Mtoe by 2030).

The reduction effect of this group of measures was estimated on the basis of data from NFOŚiGW and the data on the planned final energy savings contained in the Central Register of Final Energy Savings, using the CO_2 emission factor for the electricity production in Poland in 2020.

The development of the renovation of buildings

The Long-term Renovation Strategy (DSRB) adopted in 2022 includes recommendations for the shaping of public policy in the area of support for the renovation of buildings and considers three scenarios (including the recommended one) for the thermal modernisation of the building stock by 2050.

In Poland, there are 14.2 million buildings and almost 40% of them are single-family residential buildings. A large part of the buildings are characterized by low energy efficiency and will require thermal modernisation consistent with the assumptions of the DSRB in the successive years. It is estimated that by 2050 a total of 7.5 million thermal modernisation investment projects, including 4.7 million deep thermal modernisation projects, will be carried out, with some of them phased in. The Strategy provides for the average annual rate of thermal modernisation of about 3.8% under the assumption that by 2050 65% of buildings will reach the PEF factor not exceeding 50 kWh/m^2/year.

System for the energy efficiency of buildings

The system for the energy efficiency of buildings operates pursuant to the Act on the Energy Performance of Buildings, under which the Central Register of the Energy Performance of Buildings has been established and which implements in this scope the requirements of Directive 2010/31/EU on the energy performance of buildings. This system includes, among others, the requirements for the energy certification of buildings and the regular inspection of heating and air-conditioning systems, contributing to improving the energy performance of buildings by reducing demand for energy used for the purposes of heating, cooling, preparing domestic hot water and lighting.

The requirements for the energy certification of buildings and the regular inspection of heating and air-conditioning systems contribute to improving the energy performance of buildings by reducing demand for energy used for the purposes of heating, cooling, preparing domestic hot water and lighting, as well as ensuring the appropriate energy standard of buildings constructed and reconstructed. The energy performance certificate of a building is a document which determines the level of demand for energy needed to meet the different needs associated with the use of a building or a housing unit, such as heating, hot water, ventilation and air-conditioning. The certificate assesses the energy needs related to the purpose and standard of the building and its technical systems, i.e. on the basis of its constant, objective properties rather than on the basis of the results of energy consumption measurements which can change depending on the manner of use and users' behaviour.

Pursuant to the amendment to the Act of 21 November 2008 on Support for Thermal Modernisation and Renovation and on the Central Emission Register of Buildings, on 1 July 2021 the Central Emission Register of Buildings (CEEB) was established to gather uniform, standardised and consistent data on buildings and housing units, heat sources, including supplies from a heating network, and electricity sources used in them, as well as fuel combustion. The Register is a tool for the

central and self-government administration authorities for the implementation of low-emission policy. The data gathered in the CEEB will come from several sources, among others, including the already existing databases, such as the Central Register of the Energy Performance of Buildings.

Technical construction regulations and requirements for design standards

The amendment to the technical construction regulations made in 2015 was intended to align the standards of Polish construction law (i.e. the Regulation of the Minister of Infrastructure on the technical conditions to be met by buildings and their situation and the Regulation of the Minister of Infrastructure and Development on the methodology for determining the energy performance of a building or part of a building and energy performance certificates) with EU law (Directive 2010/31/EU on the energy performance of buildings) and provided, among others, for a reduction in the permissible indicator of demand for non-renewable primary energy.

Before 9 March 2015 the issues related to the requirements for the energy efficiency of buildings and the improvement of the energy standard of buildings had been regulated by the provisions of the Act on Construction Law and the implementing regulations for this Act. In turn, since 9 March 2015 an amended system has been in place for the assessment and improvement of the energy efficiency of buildings, operating pursuant to the Act on the Energy Performance of Buildings and the implementing regulations for this Act. The designed energy performance of a building has become an integral part of the technical design which is indispensable for the issue of a construction permit.

In addition, since 31 December 2020 an amendment to the Regulation on the technical conditions to be met by buildings and their situation has been in effect, among others, strengthening the requirements for better insulation, which are expected to result in lower energy demand. Its provisions also introduced more stringent heat transfer coefficients for the building envelope, including walls, roofs and windows. The current requirements have been formulated so as to ensure that the permissible level of energy performance results in the lowest costs in the course of the estimated lifecycle of a building. At the same time, these requirements have been set at a level ensuring that the buildings erected or expanded on their basis are nearly zero-energy buildings.

Central Register of Final Energy Savings

Pursuant to an amendment to the Act of 20 May 2016 on Energy Efficiency, the Central Register of Final Energy Savings was established. It is managed by the Institute of Environmental Protection – National Research Institute. The Register gathers data, among others, on the implemented energy efficiency projects. The Register is expected to eliminate gaps in the system for monitoring and reporting energy savings arising as a result of the implementation of EU and national programmes.

Financial support from the NFOŚiGW and POIiŚ for reducing energy consumption in the construction sector and supporting energy efficiency in buildings

The programmes implemented by the National Fund for Environmental Protection and Water Management (NFOŚiGW) and the Voivodeship Funds for Environmental Protection and Water Management (WFOŚiGW) and with the resources of the Operational Programme Infrastructure and Environment (POIiŚ) and their continuation, i.e. the resources from the European Funds for Infrastructure, Climate and Environment for 2021-2027 (FEnIKS), are very important financial instruments supporting the implementation of energy efficient investment projects in Poland. Of these, the key programmes are presented below.

Table 4.16. Key NFOŚiGW and POIiŚ programmes on the energy efficiency of buildings

Title	Short description
Priority Programme Energy-efficient Construction Sector Part 1) Reducing energy consumption in the construction sector Part 2) PUSZCZYK – Low-carbon public building	**Aim and scope:** The support focuses on limiting the emissions of air pollutants and achieving electricity savings by co-financing projects related, among others, to the thermal insulation of buildings, the replacement of windows and external doors, the modification of heating systems and the replacement of internal and external lighting systems by energy-efficient ones, as well as Increased generation of energy from renewable sources. The modernisation includes, among others, hospices, hospital-based outpatient clinics, laboratories, historic sites, church sites, student dormitories and other sites used for the purposes of culture, religious worship education, care, upbringing and science. **Beneficiaries:** Entities carrying out medical activity by providing medical services, entities managing museums entered into the State Register of Museums, entities managing student dormitories, in accordance with the Act of 20 July 2018 on the Law of Higher Education and Science[40], entities which are the owners of historic buildings entered into the Register of Monuments or the provincial or municipal lists of monuments. **For of support:** Grant or loan **Source of financing:** NFOŚiGW
Operational Programme Infrastructure and Environment 2014-2020 Measure 1.3.1 – Promoting energy efficiency in public buildings	**Aim and scope:** The support focuses on the deep and comprehensive energy modernisation of public buildings. The scope of a project must be based on an ex-ante energy audit and lead to a reduction in final energy consumption by at least 25%. The types of projects include, among others: the thermal insulation of the building envelope, including the external walls, floors and roofs, the replacement of external doors, the replacement of lighting by energy-efficient one, the modification of heating systems (or the connection of a more energy and environmentally efficient heat source), the installation/modification of cooling systems, also those using RES, the construction and modification of ventilation and air-conditioning systems, the application of weather-compensated automatic control and energy management systems in buildings, etc. **Beneficiaries:** State budget-supported units, universities, government administration and its supervised or subordinated bodies and organisational units, energy service providers within the meaning of Directive 2012/27/EU acting in favour of state budget-supported units, universities and public authorities. **Form of support:** Non-returnable aid **Source of financing**: POIiŚ 2014-2020
Operational Programme Infrastructure and Environment 2014-2020 Measure 1.3.2 – Promoting energy efficiency in the housing sector	**Aim and scope:** The support focuses on the deep and comprehensive energy modernisation of multi-family residential buildings. The scope of a project must be based on an ex-ante energy audit and lead to a reduction in final energy consumption by at least 25%. The types of projects include, among others: the thermal insulation of the building envelope, including the external walls, floors and roofs, the replacement of windows and external doors, the replacement of lighting by energy-efficient one, etc. **Beneficiaries:** Housing cooperatives and associations, and energy service providers acting in favour of housing cooperatives and associations **Form of support:** Repayable aid **Source of financing**: POIiŚ 2014-2020
Operational Programme Infrastructure and Environment 2014-2020 Measure 1.7.1 - Promoting energy efficiency in residential buildings in Śląskie Voivodship	**Aim:** Support for investment projects involving deep, comprehensive energy modernisation of multi-family residential buildings in Śląskie Voivodship. **Beneficiaries:** The group of beneficiaries includes housing cooperatives and associations in Śląskie Voivodship, territorial self-government units and their unions, the organisational units of self-government units and enterprises carrying out the own tasks of the territorial self-government units, commercial-law companies in Śląskie Voivodship, where the State Treasury holds shares, involved in housing operations, providers of energy services to housing cooperatives and associations and territorial self-government units in Śląskie Voivodship. **Form of support:** Non-returnable aid, depending on the type of beneficiary / Repayable aid (with the possible award of an investment bonus) **Source of financing**: POIiŚ 2014-2020

[40] The Act of 20 July 2018 on the Law of Higher Education and Science (Official Journal of the Laws of 2022, Item 574, as amended)

Title	Short description
Good air quality Improving air quality by replacing heat sources in multi-family buildings – a pilot project in Zachodniopomorskie Voivodeship	**Aim:** Improving air quality and reducing greenhouse gas emissions by replacing heat sources and improving energy efficiency in multi-family buildings with 3 to 20 housing units – a pilot project in Zachodniopomorskie Voivodeship. The project includes the disassembly of an inefficient solid fuel-fired heat source and the purchase and assembly of an air-to-water heat pump of a higher energy efficiency class for heating purposes. In addition, the following can be carried out: - the disassembly and the purchase and assembly of a new district heating and/or hot domestic water system; - the purchase and assembly of a mechanical ventilation system with heat recovery ; - the purchase and assembly of windows and doors separating the housing unit from the unheated space (also including disassembly); - the design documentation. **Beneficiaries:** A natural person who is the owner/co-owner of a housing unit, with an individual mortgage register, separated in a multi-family building with 3 to 20 housing units. The beneficiary's annual income may not exceed PLN 100,000. **Form of support:** Grant **Source of financing:** NFOŚiGW
Good air quality Improving air quality in the most polluted municipalities – a pilot project in the Municipality of Pszczyna	**Aim and scope:** Improving air quality and reducing greenhouse gas emissions by replacing heat sources and improving energy efficiency in multi-family buildings with 3 to 20 housing units – a pilot project in the Municipality of Pszczyna. The project includes the disassembly of an inefficient solid fuel-fired heat source and the purchase of and assembly of an air-to-water heat pump of a higher energy efficiency class for heating purposes. In addition, the following can be carried out: - the disassembly and the purchase and assembly of a new district heating and/or hot domestic water system; - the purchase and assembly of a mechanical ventilation system with heat recovery; - the purchase and assembly of windows and doors separating the housing unit from the unheated space (also including disassembly); - the design documentation. **Beneficiaries:** A natural person who is the owner/co-owner of a housing unit, with an individual mortgage register, separated in a multi-family building with 3 to 20 housing units. **Form of support:** Grant **Source of financing:** NFOŚiGW
Improving air quality by replacing heat sources in multi-family buildings – a pilot project in Dolnośląskie Voivodeship	**Aim and scope:** Improving air quality and reducing greenhouse gas emissions by replacing heat sources and improving energy efficiency in multi-family buildings with 3 to 20 housing units – a pilot project in Dolnośląskie Voivodeship. The project includes the disassembly of an inefficient solid fuel-fired heat source and the purchase and assembly of an air-to-water heat pump of a higher energy efficiency class for heating purposes. In addition, the following can be carried out: - the disassembly and the purchase and assembly of a new district heating or hot domestic water system; - the purchase and assembly of a mechanical ventilation system with heat recovery; - the purchase and assembly of windows and doors separating the housing unit from the unheated space (also including disassembly); - the design documentation. **Beneficiaries:** A natural person who is the owner/co-owner of a housing unit, with an individual mortgage register, separated in a multi-family building with 3 to 20 housing units. **Form of support:** Grant **Source of financing:** NFOŚiGW
Priority Programme Renovation with guaranteed savings EPC (Energy Performance Contract) Plus	**Aim and scope:** Improving air quality and reducing greenhouse gas emissions through optimised investments in the energy efficiency of multi-family residential buildings and public buildings carried out under the Energy Performance Contract (EPC) to improve energy efficiency. **Beneficiaries:** Housing cooperatives and associations, territorial self-government units, commercial-law companies in which territorial self-government units hold 100% of shares or

Title	Short description
	stock and which are intended to carry out the own tasks of territorial self-government units as indicated by statute. **Form of support**: Grant **Sources of financing**: NFOŚiGW, Modernisation Fund

Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of information from the NFOŚiGW

Measure 28: Warm Flat Priority Programme

Greenhouse Gases Affected: CO_2

Status: implemented

The aim of the Programme is to improve air quality and reduce dust and greenhouse gas emissions by replacing inefficient heat sources and improving energy efficiency in at least 80,000 housing units in multi-family buildings.

The Warm Flat Priority Programme supports the use of: a gas-fired condensing boiler, a higher-standard wood pellet boiler, an electrical heating system, air-to-water or air-to-air heat pumps, or the connection of a housing unit to the joint efficient heat source. In addition, it supports the implementation of a district heating and/or hot domestic water system, the replacement of windows and doors and the implementation of a mechanical ventilation system with heat recovery. An eligible cost under the Programme is also the preparation of the design documentation of a project.

The implementation of the Programme addresses, on a supplementary basis, the target group of the beneficiaries of the Clean Air Priority Programme, i.e. the owners of single and multi-family buildings. The particular municipalities distribute the grants under the Programme. Depending on the applicant's income, the maximum share of the grant in eligible costs represents 30%, 60% or even 90% of the eligible costs of the projects funded. The average value of a grant per housing unit depends on the applicant's income and can vary between PLN 15,000 and even PLN 37,500.

4.2.5. Policies and measures in the transport sector

This Section presents documents of a strategic character, legal regulations, policies and measures associated with the transport sector which contribute to greenhouse gas emission reductions.

The measures in the transport sector focus primarily on the promotion of low- and zero-emission transport, collective transport, the use of biofuels, infrastructure improvements and the implementation of solutions diminishing the environmental impact of the sector in the scope of road, railway and air transport, maritime shipping and inland waterway navigation.

Key strategies, plans and programmes

The table below lists the key strategies, plans and programmes associated with the transport sector which affect its functioning and condition environmental protection and climate change mitigation.

Table 4.17. Key strategies, plans and programmes in the transport sector

Title	Description
Implemented	
Road transport	
National Urban Policy 2030, adopted by the Council of Ministers on 14 June 2022	The strategic objective of the National Urban Policy 2030 (KPM 2030) is to build the conditions for strengthening the capacity of cities and functional urban areas to pursue sustainable development, to improve the quality of their residents' life and to build the resilience to the observed climate change. Its priorities include the development of public transport and its integration, while at the same time imposing constraints on the adverse environmental impacts of road transport. In parallel, an emphasis is placed on the opening of public spaces to the promotion of cycling, walking and micromobility. Measures of key importance for cities are those designed to optimise traffic streams, including their speed, parking policy or support for services in the scope of urban logistics. Some of the main benefits from the promotion of measures in this scope include decreased energy consumption and reduced exhaust emissions. The KPM 2030 assumes that road investment projects should be implemented in accordance with established rules and focus on completing the construction of the basic transport system of the city and its functional area, that the existing system should be modernised to improve it in order to ensure its consistency with the priorities of the urban transport policy, that solutions should be adopted to change the manner in which the street space is shaped in urban agglomerations, that investments should be made in the public transport system and that the transport system should be widely integrated. The National Urban Policy 2030 replaced the National Urban Policy 2023 which was adopted in October 2015.
National Road Safety Programme 2021–2030, adopted by the National Road Safety Council in December 2021	This is a programme of measures to be undertaken by the government administration with a view to implementing, in the field of road safety, the main goal and specific objectives of diminishing the number of road accidents causing fatalities or serious injuries. The Programme is a diagnosis and assessment of road safety in Poland, and takes into account the Polish and European conditions of road safety programming.
Programme to Strengthen the National Road Network until 2030 (PWKSD), adopted by the Council of Ministers on 4 October 2022	The Programme to Strengthen the National Road Network until 2030 is the first medium-term document of this type concerning the comprehensive maintenance of the national road network. The Programme provides PLN 58.3 billion to be spent on the implementation of all the works set out in it. The Programme ensures a stable source of financing for the comprehensive maintenance of the growing road network in the multiannual timeframe. The main objectives of the PWKSD include increasing the coherence of the national road network adapted to the traffic of vehicles with a single axle load of up to 11.5 t, ensuring the required technical condition of the existing infrastructure and intensifying the measures to reduce the adverse impact of the road infrastructure on the environment. The Programme to be implemented in the period from 2023 to 2030 provides for the implementation of the structural maintenance (comprehensive expansions and reconstructions), the current maintenance (routinely carried out renovation, repair, maintenance and cleaning works) and, on a pilot basis, new maintenance solutions to reduce the adverse environmental impact in the entire national road network (including motorways and expressways) managed by the General Director for National Roads and Motorways.
Sustainable Transport Development Strategy until 2030, adopted by the Council of Ministers on 24 September 2019	The main aim of the Sustainable Transport Development Strategy (SRT2030) is to enhance the transport accessibility and, at the same time, to improve the safety of traffic users and the efficiency of the transport sector by creating a coherent, sustainable, innovative and user-friendly transport system at the national, European and global levels. The directions of interventions set out in the SRT2030 include: building an integrated and mutually linked transport network serving a competitive economy, improving the manner of organisation and management of the transport system, changes in individual and collective mobility, improving the safety of traffic participants and goods transported, limiting the negative impact of transport on the environment and improving the effectiveness of the use of public resources for transport projects.

Title	Description
Programme for the Construction of National Roads 2014–2023 (with an Outlook until 2025), adopted by the Council of Ministers on 8 September 2015 and updated on 24 September 2019	The Programme for the Construction of National Roads sets out the objectives and investment priorities in the scope of the infrastructure of national roads which are to be implemented by 2025 by carrying out strictly defined tasks (investment projects). The Programme contains the plans to build motorways and expressways, based for the most part on the implementation of projects which are elements of the Trans-European Transport Network TEN-T. The Programme specifies the ways of improving the effectiveness of road transport and the directions of measures and investment priorities for the development of the network of national roads in Poland. It also diagnoses the condition of the present road sector. All the investment tasks under this Programme are financed from the National Road Fund.
Clean Transport Package, adopted by the Council of Ministers on 16 March 2017, including: the Electromobility Development Plan for Poland - Energy for the Future and the National Framework for Alternative Fuels Infrastructure Development Policy	The Clean Transport Package consists of two documents: the Electromobility Development Plan for Poland and the National Framework for Alternative Fuels Infrastructure Development Policy. The main objective of the package is to create the conditions for the development of electromobility, the development of the electromobility industry and the stabilisation of the power grid by integrating vehicles with the grid. The Electromobility Development Plan for Poland specifies the areas and stages of the development of electromobility, also proposing intervention tools. The Plan provides for intervention stages, i.e. the promotion of electric vehicles as a mean of transport in cities, the development of the market of the vehicles, the financing of the electromobility industry, the regulations for the development of electromobility and a smart grid integrated with the market of the vehicles. The aims of the Plan include the development of the electromobility industry In Poland, the creation of the conditions for its development and the stabilisation of the power grid. The document "*The National Framework for Alternative Fuels Infrastructure Development Policy*" contains an analysis of the current status of the development of alternative fuels in Poland, a diagnosis of bottlenecks hampering the further dissemination of these fuels and a specification of the objectives of the development of the infrastructure. It also proposes instruments to support the construction of the infrastructure and the development of the market of the vehicles. The objective set out for 2025 is the development of the recharging infrastructure and the limitation of the emissions of harmful compounds by the transport sector. It is assumed that transport should be electrified primarily in agglomerations and densely populated areas. Since 2020, the body responsible for the financing of measures to develop e-mobility and alternative fuels has been the National Fund for Environmental Protection and Water Management (NFOŚiGW), which has taken over the tasks of the liquidated Low-Emission Transport Fund. This solution is expected to simplify the development of low-emission transport, reduce the administrative burden related to it and accelerate its funding from the public resources.
Railway transport	
Government Programme for the Construction or Modernisation of Railway Stops for 2020-2025 (the Railway Stop Programme), adopted by the Council of Ministers on 19 May 2021	The Programme provides for the modernisation of existing railway stops and the construction of new ones at localities through which railway lines go, but at which there is no adequate infrastructure for passengers. As a result of the construction of new stops, travellers who have not used railways to date will gain access to this transport mode and can use it instead of private vehicles.
Investment Programme for the Central Transport Hub (CPK Programme), adopted by the Council of Ministers on 28 October 2020	The CPK Programme includes new railway lines creating the core of the modernised national railway transport system as an attractive alternative to road transport. It provides for the construction of about 1,800 km of new lines with high parameters. The CPK Programme implements the provisions of the Sustainable Transport Development Strategy until 2030, indicating the construction of the national railway transport system based on the CPK hub as part of the Strategic Project: the Construction of the Central Transport Hub. The lines in question are also indicated in the maps of the railway network in Poland in 2030.

Title	Description
Programme for Complementing the Local and Regional Railway Infrastructure (Railways Plus Programme) until 2028, adopted by the Council of Ministers on 3 December 2019	The aim of the Programme is to complement the railway network with railway connections between localities with more than 10,000 residents which have no access to passenger connections with voivodeship capitals or those that have access to railways but their existing connections need to be improved. The Programme provides for the implementation of linear investment projects, i.e. the modernisation of existing railway lines or the construction of new ones, and point investments, such as the construction of new railway stops, passing places or sidings.
National Implementation Plan for the Technical Specifications for Interoperability Relating to Control-Command and Signalling, adopted by the Minister of Infrastructure in June 2017	The most important element of the Plan is the establishment of the deadlines for the implementation of the European Rail Traffic Management System on individual railway lines in Poland. The cost-benefit analysis of the implementation of the system is also part of the Plan. The information provided in the Plan will allow railway carriers to appropriately plan rolling stock investments with a view to equipping rail vehicles with on-board equipment of the system.
Railway Station Investment Programme 2016 – 2023	The Railway Station Investment Programme is one of the undertakings envisaged as part of the Strategy for Responsible Development. It is expected to enable the implementation of 189 railway station-based investment projects with the total value of PLN 1.74 billion. As a result of the activities launched at railway stations, the quality of service offered to passengers will improve and the railways will be integrated with other modes of transport. The final effect of the implementation of the Programme will be standardised, high-quality railway stations, adapted to the needs of passengers and the transport system, and, at the same time, corresponding to the local conditions. The railway stations will meet the real needs of local communities, playing functions related to the changing of the means of transport so as to encourage passengers to use railways.
National Railway Programme until 2023, adopted by the Council of Ministers on 15 September 2015	The National Railway Programme (KPK) is a multiannual programme. It defines the amount and sources of financing (including EU resources and national funds) for investment projects on railway lines. The document implements strategies adopted by the Council of Ministers with a view to improving the technical condition and current parameters of railway infrastructure. The KPK replaced the Multiannual Railway Investment Programme which was in effect in the period from 2011 to 2015. The overarching objective of the Programme is to strengthen the role of railway transport in the integrated transport system of the country by creating a coherent and a modern railway network. Among others, this includes the mitigation of negative impacts on the environment. The aim of the projects launched is to improve the technical parameters, to enable the transport network to raise the quality of public transport services and to take into account the needs of persons with limited mobility.
Air transport	
Programme for the Development of a Network of Aerodromes and Aerial Ground Equipment, adopted by the Council of Ministers on 8 May 2007	This Programme is a basic government document which sets out the directions of the development of aerodrome and navigation infrastructures in Poland. By assumption, it is a directional document indicating, on the basis of projections of air traffic development in Poland, the need for the development of aerodromes assigned to the TEN-T network and the infrastructure related to communication, navigation and control of air traffic until 2020. Given that this document has been partly implemented and become outdated in certain areas, work is now underway to replace it with a new document of a strategic character which would address broadly understood air transport.
Maritime shipping	
Programme for the Development of Polish Seaports until 2030, adopted by the Council of Ministers on 17 September 2019	The main aim of the Programme is to permanently strengthen the position of Polish seaports as the leaders among the seaports in the Baltic Sea Basin, playing the role of the key hubs of the global supply chains delivering to Central and Eastern Europe, and to enhance their contribution to the socio-economic development of the country. The Programme contributes to raising the incomes of Poland's citizens by improving the operating conditions of the seaports, along with, among others, an increase in the

Title	Description
	cargo volumes handled, greater transport accessibility of the port-based centres and improved conditions for the operation of services involving goods and passenger transports – among others, as a result of the construction, modernisation and mutual integration of the linear infrastructure providing access to ports from the land and the sea, in accordance with the principle of intermodality. The Programme gives direction to the development of Polish seaports to ensure that in 2030 the volumes transhipped in them exceed 150 million t. The effects of the implementation of the Programme will include, among others: the higher transhipment capacity of the seaports and the increased gross tonnage (GT) of the vessels served in the seaports. The value of the tasks included in the proposed Programme is almost PLN 40 billion.
Maritime Policy of the Republic of Poland, adopted by the Council of Ministers on 17 March 2015	The Maritime Policy of the Republic of Poland (PMRP) sets out the directions of the sustainable socio-economic development and the rational use of Poland's situation on the seacoast. The PMRP is based on the constitutional principle of sustainable development. It specifies the basic objectives focusing on the comprehensive use of Poland's maritime potential, including the development of the maritime economy, related to the use of the sea, the methods and legal and economic instruments for achieving these objectives under the current political and socio-economic conditions. The PMRP addresses the areas of the political, socio-economic, scientific and cultural life of the country. The most important directions of Poland's sea-related development until 2030 include: strengthening the position of the Polish seaports, increasing the competitiveness of the maritime shipping and the employment in the maritime economy, as well as ensuring safety on the sea. The Maritime Policy of the Republic of Poland is implemented through the participation in the measures to protect the marine environment at the EU and IMO levels and within the HELCOM, in order to fulfil the legal commitments to protecting the marine environment of the Baltic Sea, including the reduction of greenhouse gas emissions from ships, sampling procedures, checking the sulphur content in navigation fuels and increasing the use of alternative fuels.
Inland waterway navigation	
Assumptions for the development plans for inland waterways in Poland for 2016–2020, with an outlook until 2030, adopted by the Council of Ministers on 14 June 2016	The document sets out the directional objectives of the national inland waterway policy. It is the basis for the development of plans for modernisation or construction of missing sections of the most important waterways in Poland. The document presents an analysis of the current status of the most important national inland waterways and focuses on measures to restore their transport and economic functions, i.e. to ensure shipping parameters consistent with at least IV class of navigability and to meet the inland waterway infrastructure requirements for the TEN-T network. The projects to be implemented will be financed by the Cohesion Fund, the European Regional Development Fund, the Connecting Europe Facility (CEF), the European Fund for Strategic Investments and special purpose funds, e.g. from the resources of the National Fund for Environmental Protection and Water Management or from the resources of the Inland Navigation Fund, from the resources of the state budget, territorial self-governments, investors from the interested sectors and from the resources earmarked for the implementation of tasks included in the Strategy for Responsible Development.
Planned	
Draft Government Programme for the Construction of National Roads until 2030 (with an Outlook until 2033) (RPBDK)	Work is underway on the Programme, which will present a list of investments on national roads which the Government plans to carry out in the early 2030s. The new RPBDK sets out the objectives of transport policy in the scope of the construction of the TEN-T road network in Poland and the complementary road connections. The Draft Government Programme for the Construction of National Roads until 2030 (with an Outlook until 2033) was submitted for consideration by the Standing Committee of the Council of Ministers in November 2022.

Title	Description
National Navigation Programme until 2030 (KPŻ2030)	The KPŻ2030 will be the first planning document dedicated to the inland navigation sector in Poland. The aim of the measures indicated in the Programme is the development of the inland navigation sector at the national and local levels. The implementation of the KPŻ2030 will contribute to improving the navigation conditions at the sections of waterways used for transport in the hinterland of the seaports located at the mouths of the Vistula and Odra Rivers. It will strengthen the role of inland waterways in the national transport system and enable the adaptation of the navigation to the challenges related to the sustainable development of the transport sector. The document will contribute, among others, to improving the state of the environment by reducing the emission factors of inland navigation vessels and developing traffic management systems. The planned investment measures provide for the modernisation of the hydro-engineering infrastructure and, as a result of this, for the elimination of the greatest bottlenecks at the waterway sections covered by the scope of the Programme. Since February 2022 the document has been subjected to the strategic environmental impact assessment procedure, as part of which a draft environmental impact prognosis has been prepared and public consultations have been held.
Draft Policy for the Development of Civil Aviation in Poland until 2030 (with an Outlook until 2040)	The Policy for the Development of Civil Aviation in Poland until 2030 (with an Outlook until 2040) will define the main assumptions on the objectives, directions and ways of the creation and implementation of the Government policy in accordance with the principles governing public policies as laid down by the Act on the Principles of Pursuing Development Policy. The Aviation Policy will complement the development directions set out in the higher-level programming documents, i.e. the Strategy for Responsible Development until 2020 (with an Outlook until 2030) and the Sustainable Transport Development Strategy until 2030, while maintaining consistency and complementarity with respect to the abovementioned strategies. It also complements the abovementioned documents by indicating new measures, in accordance with the results of the projections cited, the analyses and studies carried out, as well as opinions. The Policy will set out the directions in which the aviation market should develop in Poland. One of the most important directions of interventions laid down in the Draft Policy is environmental protection in air transport. The reduction of the adverse impact of air transport on the environment should be one of the priorities for airports and air carriers in Poland. It is assumed that the measures taken by the air transport sector should significantly contribute to reducing global pollutant emissions. The Draft Policy was prepared in 2021 and is now subjected to the 2nd round of interministerial consultations.

Source: Elaborated by the KOBiZE IOŚ-PIB

Key legal acts

The table below lists the key legal acts associated with the transport sector which affect its functioning and condition environmental protection and climate change mitigation.

Table 4.18. Key legal acts in the transport sector

Title	Description
Implemented	
Act of 30 March 2021 Amending the Act on Railway Transport (Official Journal of the Laws, Item 780)	The aim of the Act is to halt the degradation of the railway infrastructure, including as part of transport corridors. The aim of the provisions of the Act is to create a mechanism of incentives for Voivodeship self-governments to ensure local connections deeper into the neighbouring Voivodeships. The mechanism consists in enabling the resources of the Railway Fund to be allocated for financing or co-financing by the Voivodeship of tasks in the scope of the purchase, modernisation and repairs of the railway stock intended for passenger transports carried out under a contract to provide public services. The purpose is to enable

Title	Description
	Voivodeship self-governments to carry out railway transports farther than the nearest railway station beyond the boundary of the Voivodeship.
Act of 11 January 2018 on Electromobility and Alternative Fuels (Official Journal of the Laws of 2022, Item 1083, as amended)	The Act was drawn up on the basis of the Electromobility Development Plan for Poland and the National Framework for Alternative Fuel Infrastructure Development Policy. It was the first regulation to comprehensively lay down the rules for the functioning of the alternative fuel market in transport. The Act sets out the rules for the development and functioning of the infrastructure for the use of alternative fuels in transport, including the technical requirements for this infrastructure, the obligations of public entities in relation to the development of the alternative fuel infrastructure, the information obligations related to alternative fuels, the operating conditions for clean transport zones, the national framework for alternative fuel infrastructure development and the manner of its implementation. The amendment to the Act on Electromobility and Alternative Fuels adopted in 2021 enabled, among others, the general setting up of clean transport zones - by alleviating the conditions and adopting more flexible rules for their setting up and operation. They may be set up in all municipalities and their operating rules will be defined by the municipal authorities. In addition, the amendment introduced obligations to maintain the minimum share of low- and zero-emission road vehicles in the public procurement contracts awarded for transport-related supplies and services. It also made it easier to build charging points in multi-family buildings and introduced definitions needed for establishing the hydrogen refuelling infrastructure.
Act of 16 December 2010 on Collective Public Transport (Official Journal of the Laws 2022, Item 1343)	The Act sets out the rules for the organisation and operation of regular passenger carriage in the collective public transport carried out in the territory of Poland and in the transboundary zone, in road transport, railway and other rail transport, cable and funicular transport, maritime shipping and inland navigation. It also lays down the rules for financing regular passenger carriage in the collective public transport with respect to carriage with the character of a service in the general public interest.
Act of 25 August 2006 on Biocomponents and Liquid Biofuels (Official Journal of the Laws of 2022, Item 403)	The Act lays down the rules for carrying out economic activity in the scope of the production of biocomponents, the import or intra-Community purchase of biocomponents, the farmers' production of liquid biofuels for their own use, the performance of economic activity in the scope of the placing on the market of biocomponents and liquid biofuels, the determination and implementation of the National Indicative Target, the confirmation of compliance with the sustainability criteria, the performance of economic activity in the scope of the award of authorisation for the use of a recognised certification system and the performance of economic activity in the scope of the issue of certificates. Moreover, it regulates the rules for carrying out inspections, preparing reports and the procedure for submitting reports. It implements the requirements of Directive 2009/28/EC for achieving the target of a 10% share of renewable energy in transport in 2020 and introducing sustainability criteria for biocomponents and liquid biofuels. The National Indicative Target (NIT) defines the minimum share of fuels from renewable energy sources (excluding fuels from biomass) and biocomponents contained in all the fuels used in all the transport modes in the total amount of liquid fuels and liquid biofuels used a year. The NITs in effect are as follows: 8.7% for 2021; 8.8% for 2022; 8.9% for 2023; 9.1% for 2024. The NIT also includes other renewable fuels and biocomponents contained in all the fuels used in all the transport modes rather than only in liquid fuels and liquid biofuels.
Act of 25 August 2006 on the Fuel Quality Monitoring and Control	The Act lays down the rules for the organisation and operation of a system for monitoring and controlling the quality of fuels intended for use in different types

Title	Description
System (Official Journal of the Laws of 2022, Item 1315, as amended)	of vehicles and for monitoring and using certain means of reducing greenhouse gas emissions in the lifecycle of fuels used in transport and electricity used in motor vehicles. The Act sets out the National Reduction Target (NRT), according to which the greenhouse gas emissions from fuels used in transport are to be reduced by 6% below 2010 levels.
Act of 16 March 1995 on the Prevention of Sea Pollution by Ships (Official Journal of the Laws of 2020, Item 1955, as amended)	The Act supports the application of the requirements of Regulation (EU) 2015/757 and implements into Polish law the requirements of the MARPOL Convention which relate, among others, to the energy efficiency of ships. Regulation (EU) 2015/757 lays down rules for the monitoring, reporting and verification of carbon dioxide (CO_2) emissions and of other relevant information from ships arriving at, within or departing from ports under the jurisdiction of EU Member States. The 2014 amendment to the Act introduced the energy efficiency requirements – the Energy Efficiency Design Index (EEDI) for new ships and the Ship Energy Efficiency Management Plan (SEEMP).
Regulation of the Minister of Transport, Construction and Maritime Economy of 9 October 2012 on the sustainable development plan for collective public transport for transport networks of interregional and international passenger carriage in rail transport (Official Journal of the Laws of 2020, Item 2328)	The Plan established under this Regulation lays down the basic rules for the functioning and development of interregional and international passenger carriage in railway transport, when carried out as carriage with the character of a service in the general public interest as part of collective public transport on the market subject to the rules governing regulated competition. The Plan is based, among others, on the provisions of strategic government documents programming the development of the country, which point out in the case of railway transport the need to minimise its adverse impact on the environment.

Source: Elaborated by the KOBiZE IOŚ-PIB

Policies and measures

Measure 29: Development of road infrastructure (a group of measures)

Greenhouse gases affected: CO_2, CH_4, N_2O

Status: implemented

The development of road infrastructure consists of a group of measures, including the following measures: the Intelligent Transport Systems (ITS) as part of the National Road Traffic Management System, the improvement of the coherence of national roads (including the construction of expressways, motorways in the TEN-T network and ring roads within the course of the existing national roads) and the Government Road Development Fund.

The main aim of this group of measures is to carry out investment projects, with significant support from the National Road Fund and the Government Road Development Fund. In consequence, the measures making up this group will contribute to improving road safety, relieving agglomerations and cities from transit traffic and, at the same time, reducing unit greenhouse gas emissions from road transport.

Intelligent Transport Systems (ITS)

Intelligent Transport Systems (ITS) assist in the operational management of road traffic, collective (passenger) transport, goods transport, rescue services and also assist in solving transport problems, while, at the same time, making it possible to confer the adequate priority to the handling of individual traffic streams. The aim of the measure is to build and implement a uniform, integrated system enabling the launch of ITS services with the highest importance for drivers. The project of

the National Traffic Management System includes the implementation of the ITS in a selected part of the TEN-T core network. The ITS system enables dynamic traffic management to improve safety and to increase road transport fluidity.

Improving the coherence of national roads

The priority of the measure is to build sections complementing the existing main transport corridors so as to ensure long-distance travel fluidity. The launched investment projects are adapted to the existing and expected traffic intensities. It is important to ensure coherence between national roads and other categories of public roads and their integration with other modes of transport. The measure includes investment priorities needed for the completion of the Trans-European Transport Network TEN-T (as part of the completion of the target network of motorways and expressways) and the construction of the ring roads of selected cities. The tasks are implemented as part of the Programme for the Construction of National Roads 2014–2023 (with an outlook until 2025).

Government Road Development Fund

The Fund is an instrument to support the implementation of road investment projects carried out by local governments as public road managers. The aim of the Fund is to improve the standard of living and quality of life of local communities and to enhance the efficacy of public institutions by developing safe, coherent, functional and effective road infrastructure to support the actions of municipal and county self-governments to build local roads of key importance for the sustainable socio-economic development of local communities. The development of local road infrastructure is a measure which is complementary to the initiatives launched at the national level to build a system of motorways and expressways, thus contributing to the creation of a coherent and integrated transport system.

As part of the Government Road Development Fund, support is provided for tasks consisting in:

- the construction, modification or repairs of county roads, called "*county tasks*" or the construction, modification or repairs of municipal roads, called "*municipal tasks*";
- the construction of bridges located within the course of provincial roads, county roads or municipal roads, called "*bridge tasks*";
- the construction of ring roads located within the course of provincial roads, called "*ring road tasks*";
- the construction, modification or repairs of provincial roads, county roads or municipal roads, managed by the mayor of a city with the rights of a county, which is the seat of a Voivode or the Voivodeship Assembly, called "*city tasks*";
- the construction, modification or repairs of access roads to intermodal terminals or the construction, modification or repairs of access roads to zones, called "*access tasks*";
- the construction, modification or repairs of provincial roads or the improvement of the safety of unprotected traffic participants, consisting in particular in the construction, modification or repairs of pedestrian paths, pedestrian and cycle paths, cycle paths, pedestrian crossings, cycle crossings and stop platforms, along with access paths to these platforms in provincial roads, called "*provincial tasks*";
- the construction, modification or repairs of provincial roads, county roads or municipal roads of importance for defence, called "*defence tasks*".

As part of the implementation of county and municipal tasks, co-financing can be provided, in particular, for tasks intended only to improve the safety of unprotected traffic participants, consisting

in particular in the construction, modification or repairs of pedestrian paths, pedestrian and cycle paths, cycle paths, pedestrian crossings, cycle crossings and stop platforms, along with access paths to these platforms.

As part of the implementation of county and municipal tasks, co-financing can be provided, in particular, for tasks consisting only in the repair of county and municipal tasks.

The effects of the existence of the Fund include the improvement of road traffic safety and the technical parameters of local road networks, as well as the improvement and enhancement of the attractiveness and accessibility of investment sites.

Measure 30: Development of collective transport (a group of measures)

Greenhouse gases affected: CO_2, CH_4, N_2O

Status: implemented

The development of collective transport involves a group of measures, including such measures as the development of urban transport networks, the Common Ticket project, the obligation to prepare plans for the sustainable development of collective public transport, the development of collective public transport plans in cities, the promotion of the use of public transport and the implementation of urban transport investment projects.

The group of measures implements the tasks set out in the Sustainable Transport Development Strategy until 2030 by developing collective public transport in cities or implementing the Common Ticket project. Such measures as the promotion of the use of public transport and the implementation of urban transport investment projects follow from the National Urban Policy 2023. The Act on Collective Public Transport, which was adopted in 2010, regulates the implementation of the development of urban transport networks and the obligation to prepare collective public transport plans.

The main aim of this group of measures is the development of effective and reliable collective transport networks in the urban functional areas and the promotion of a system of environmentally friendly solutions.

Development of collective public transport in cities

The aim of the development of collective public transport in cities is to enhance the use of low-carbon urban transport in the services provided for the residents of functional urban areas. Such measures are carried out, among others, in the Operational Programme Infrastructure and Environment 2014-2020 as part of Priority Axis VI Development of the low-carbon public transport in the cities. Support is given for both infrastructure and fleet/rolling stock investments to reduce the traffic congestion in the cities, to improve the traffic fluidity and to diminish the adverse impact of transport on the natural environment in the cities and their functional areas. The beneficiaries of the support include territorial self-government units and their unions, provincial capitals and their functional areas.

Common Ticket project

The project consists in the integration in terms of the ticket of passenger railway transport with other modes of collective public transport. The aim of the project is to provide a service by enabling travellers to buy one ticket for the whole journey, irrespective of the sales channel, carrier and routes travelled. The measure covers all the regions of Poland on the basis of the tariff integration

within the sector and operates within the framework of regional/commuter transport systems, offering an attractive alternative to individual road transport.

Development of urban transport networks

The aim of the development of urban transport networks is the development of effective and reliable transport networks in the urban functional areas, with special focus on the dissemination of collective transport and the promotion of cycling and walking.

Obligation to prepare plans for the sustainable development of collective public transport

The obligation to prepare the transport plans for the organisation of the carriage with the character of a public service was imposed on territorial self-government units by the Act of 16 December 2010 on Collective Public Transport. In particular, the transport plans define: the transport network where the carriage with the character of a public service is planned to be implemented; the assessment and projections of the carriage needs; the expected financing of the carriage services; preferences for the selection of the type of means of transport; the rules for the organisation of the carriage market; the desirable standard of the carriage needs in the case of the carriage with the character of a public service; and the expected manner of organising the passenger information system. Moreover, the plan defines the transport lines where the use of electric vehicles or those powered by natural gas is expected and the planned date when their use will start.

Coordination of the European Mobility Week (EMW) campaign at the national level

The Ministry of Infrastructure coordinates at the national level the EMW campaign, which was launched by the European Union in 2002 and has taken place every year on 16-22 September. The aim of the campaign is to promote sustainable mobility behaviour.

The local authorities, nongovernmental organisations and private entities are encouraged to organise events on the occasion of the EMW and to promote low- and zero-emission means of transport, in particular, to use public transport, to ride a bicycle and to walk. The Car-Free Day celebrated on 22 September is the climax of the campaign.

Measure 31: Development of zero-emission urban transport (a group of measures)

Greenhouse gases affected: CO_2, CH_4, N_2O

Status: implemented

The development of zero-emission urban transport involves a group of measures which include such measures as the promotion of zero-emission collective public transport, the promotion of cycling and walking, the Programme for Sustainable Urban Mobility Plans, as well as the NFOŚiGW programmes supporting the development of zero-emission public transport. The main aim of this group of measures is to avoid greenhouse gas emissions by co-financing projects to reduce energy and fuel consumption in public transport by developing zero-emission urban transport, improving the behaviour of the public and promoting the shift to alternative modes of transport, i.e. cycling and walking.

The reduction effect of this group of measures for 2020 and 2030 was estimated under the assumption that a specific number of diesel oil-powered buses would be replaced by the same number of electric buses. The data used in the calculations include the CO_2 emission factor for the electricity generation in Poland in 2020 and the number and average annual mileage of electric buses.

Setting up of clean transport zones

In order to prevent an adverse impact on human health and the environment caused by pollutant emissions from transport, in an area of compact housing with a concentration of public buildings, a clean transport zone can be established with restricted access for vehicles other than electric and hydrogen and natural gas powered ones. The list of vehicles authorised to use the zone can be expanded by the self-government of a given municipality to include internal-combustion vehicles meeting selected exhaust emission standards. Vehicles of city transport, uniformed and rescue services, disabled persons and low-emission and school buses are not subject to the prohibition of entry into a clean transport zone. The boundaries of a clean transport zone are marked with road signs, while the vehicles allowed to enter a clean transport zone carry relevant stickers. A clean transport zone is established by way of a resolution by the municipal council. A charge may be collected for the entry into such a zone by vehicles other than the three types specified above. At present, in selected cities, e.g. in Cracow, consultations are underway on the setting up a clean transport zone. It is expected that the operation of a clean transport zone in Cracow will start in March 2023.

Development of zero-emission collective public transport

The development of zero-emission collective public transport and the implementation of this measure impose on territorial self-government units new, additional requirements relating to the organisation of public transport. A territorial self-government unit, excluding municipalities and counties where the number of inhabitants does not exceed 50,000, provides the urban transport service or commissions its provision to an entity whose share of zero-emission buses in its vehicle feet used in the area of that territorial self-government unit is at least 30%.

Rybnik is an example of a city implementing the development of zero-emission collective transport. It will buy 20 hydrogen-powered buses. For this purpose, in 2022 the city received co-financing from the NFOŚiGW in an amount of PLN 45.5 million. Moreover, co-financing from the NFOŚiGW is also sought by the Municipalities of Andrychów, Świdnik and Wałbrzych, which have submitted applications for co-financing for a total of 28 hydrogen-powered buses and two hydrogen refuelling stations. At present, in many cities the bus fleet of the city transport also includes electric vehicles. For example in Warsaw the city transport uses 162 electric buses. Recently, as part of its programmes, the NFOŚiGW received applications from public transport organisers from all over Poland concerning investments including 340 electric buses.

Promotion of cycling and walking

The aims of the promotion of cycling and walking include the improvement of the behaviour of the public and the shift to alternative modes of transport, i.e. cycling and walking. Among others, its aim is to encourage travel by cycling due to:

- the expansion of the cycle paths and parking lots ensuring safe use of bicycles;
- the improvement of the public cycle hire scheme (Veturilo);
- the construction of parking lots in the Bike+Ride scheme;
- the capacity building of the urban units managing cycling traffic.

Pilot Project to Prepare Sustainable Urban Mobility Plans (SUMPs)

The Pilot Project to Prepare Sustainable Urban Mobility Plans (SUMPs) was addressed to all the interested cities and urban functional areas. The Pilot Project was launched by the Ministry of Development Funds and Regional Policy, in cooperation with the Ministry of Infrastructure, the European Commission, the Jaspers Initiative and the Centre for European Transport Projects. The main

aim of the Pilot Project was to encourage urban authorities to take comprehensive measures to shape urban mobility, including transport, environmental protection, health care, socio-economic development, to transfer knowledge and good practices to territorial self-government units and to support cities and urban functional areas in their preparation or update of Sustainable Urban Mobility Plans. The cities which expressed their interest in the SUMP issues were provided with advisory support from the Jaspers Initiative and an advisor from the Centre for European Transport Projects. Workshops were also organised for the cities to discuss the particular stages of the preparation of SUMPs and to present good practices in planning and managing sustainable mobility.

The Project was financed from the EU funds as part of the technical assistance under the Operational Programme Infrastructure and Environment 2014-2020.

NFOŚiGW programmes supporting the development of zero-emission urban transport

The NFOŚiGW implements a number of programmes supporting the development of zero-emission transport. Examples of programmes for zero-emission urban transport are listed in the table below.

Table 4.19. Key NFOŚiGW programmes supporting the development of zero-emission urban transport

Title	Short description
GEPARD II Programme	**Aim and scope:** Avoidance of the emissions of air pollutants by co-financing projects to diminish fuel consumption in public transport in the region of Silesia. The Programme provides for support for projects to avoid air pollutants and to reduce fuel consumption in collective public transport by developing zero-emission collective transport. **Beneficiaries:** Territorial self-government units and entrepreneurs. **Form of support**: Grant or loan **Source of financing**: NFOŚiGW
Green Public Transport Programme	**Aim and scope:** Co-financing of projects to reduce the use of emission-generating fuels in collective public transport by purchasing/leasing new electric buses using electricity stored by their connection to an external supply source or using electricity generated from hydrogen; purchasing/leasing new trolleybuses; the training of drivers/mechanics in the operation/maintenance of zero-emission vehicles; the modernisation or construction of infrastructure, including recharging points or hydrogen refuelling facilities. The infrastructure is used for public transport only. As part of the second edition of the Green Public Transport Programme, 67 municipalities and cities will receive co-financing for the implementation of zero-emission transport. The value of projects which were preliminarily qualified for the next step, i.e. the negotiations on the terms of co-financing, was estimated at more than PLN 1.26 billion. The NFOŚiGW received 101 applications from public transport organisers from all over Poland, including 69 applications for grants. The submitted applications concern investments in 340 electric buses, 48 hydrogen-powered buses, 277 charging points and 2 hydrogen refuelling stations. **Beneficiaries:** Operators and organisers of collective public transport, excluding the Minister responsible for infrastructure **Form of support:** Grant or loan **Source of financing:** NFOŚiGW

Source: Elaborated by the KOBiZE IOŚ-PIB

Measure 32: Development of electromobility (a group of measures)

Greenhouse gases affected: CO_2, CH_4, N_2O

Status: implemented

The development of electromobility involves a group of measures, including such measures as the promotion of the development of electromobility, the establishment of clean transport zones in cities, the obligation of the public administration to replace its fleet with electric vehicles, the construction of recharging infrastructure at public buildings, tax reliefs, the development of

the infrastructure for recharging electric vehicles, the application of soft instruments of support for the users of zero-emission vehicles, support for innovation in the area of electromobility and the programmes financed by the NFOŚiGW. The main aim of this group of measures is to create the conditions for the development of electromobility in Poland. Thus, the aim of the measures taken for this purpose is to cause an increased interest and support of the public for the development of electromobility and the dissemination of electric vehicles.

The reduction effect of this group of measures for 2020 and 2030 was estimated under the assumption that a specific number of petrol passenger cars with a spark ignition (SI) engine would be replaced by the same number of electric passenger cars. The data used in the calculations include the CO_2 emission factor for the electricity generation in Poland in 2020 and the number and average annual mileage of electric passenger cars.

Obligation of the public administration to replace its fleet with electric vehicles

The obligation of the public administration to replace its fleet with electric vehicles is a measure intended to trigger the development of electromobility by generating the future demand and causing a public interest in the topic of electromobility. Its aim is to reach at least the fleet electrification levels of 10% from 01.02.2022 and 20% from 01.01.2023 in the public administration.

Construction of recharging infrastructure at public buildings

The aim of the construction of recharging infrastructure at public buildings is to increase the interest of the public in electric vehicles. As a target, in 2025 each public building should be equipped at least with one recharging point having recharging capacity of not less than 3.7 kW.

Tax reliefs

There are tax reliefs in place in the scope of the excise duty and income tax for zero- and low-emission vehicles. They are instruments supporting the development of electromobility and encouraging the public to become interested in electromobility. The exemption from the excise duty applies to electric, hydrogen-powered (without a time limit) and plug-in hybrid vehicles with the internal-combustion engine capacity not exceeding 2,000 cm^3 (until 31.12.2022). At present, the draft Act Amending the Act on the Excise Duty and Certain Other Acts (No. UD 428 in the list of legislative and programming works of the Council of Ministers) has proposed an extension until 31 December 2029 of the exemption from the excise duty now in effect for passenger cars which are hybrid vehicles powered by an external energy source and having the internal-combustion engine capacity not exceeding 2,000 cm^3, which under the present legal status will be in effect until 31 December 2022. Excise duty rates reduced by half, which are different depending on the type of the hybrid vehicle and the internal-combustion engine capacity, have applied since 1 January 2020 to the other hybrid vehicles. Moreover, the exemption from the income tax applies to the co-financing from the resources of the NFOŚiGW for the purchases of new vehicles using liquid biofuels, compressed natural gas (CNG), liquefied natural gas (LNG), including the one derived from biomethane, hydrogen or those powered by electricity.

Development of the infrastructure for recharging electric vehicles

The development of the infrastructure for recharging electric vehicles consists in the creation of the conditions for the development of electromobility in Poland by the wide deployment of the recharging infrastructure and the stabilisation of the electricity grid by integrating vehicles with the grid. At the end of July 2022, there were 2,293 stations for recharging electric vehicles in Poland.

Application of soft instruments of support for the users of zero-emission vehicles

The application of soft instruments of support for the users of zero-emission vehicles introduces solutions for the users of electric vehicles; among others, by enabling them to use bus lanes, to park free of charge in the paid parking zones or to enter clean transport zones. The aim of the measure is to encourage purchases of electric vehicles.

Support for innovation in the area of electromobility

The aim of support for innovation in the area of electromobility is to co-finance the research needs of the electromobility industry. Moreover, its aim is to finance measures to develop and popularise the use of electricity and alternative fuels in transport. Co-financing is available for educational activities, research and development, as well as investment measures supporting the producers of biocomponents, the construction of recharging points, the distribution of alternative fuels and vehicle purchases by both territorial self-government units and entrepreneurs.

NFOŚiGW programmes supporting the development of electromobility

The NFOŚiGW implements a number of programmes supporting the development of electromobility which aim at avoiding greenhouse gas emissions by using the national resources of the NFOŚiGW to co-finance projects to reduce fuel consumption in transport. The table below lists the key NFOŚiGW programmes supporting the development of electromobility.

Table 4.20. Key NFOŚiGW programmes supporting the development of electromobility

Title	Short description
Kangur Programme - Safe and Environment-Friendly Road to School	**Aim and scope:** The possibility of buying new electric school buses, the training of drivers in the use of electric buses, the modernisation or construction of the infrastructure enabling the recharging of electric school buses. In the first call for applications, the amount of resources in the form of grants intended for co-financing of projects was PLN 20 million, while an amount of PLN 40 million was available in the form of loans. The NFOŚiGW received applications for co-financing of 4 projects. **Beneficiaries**: Rural municipalities and urban-rural municipalities **Form of support:** Grant or loan **Source of financing:** NFOŚiGW
Programme for the eVAN – An Electric Delivery Vehicle	**Aim and scope:** Support for the purchase of all-electric delivery vehicles. The Programme provides for the possibility of co-financing of projects to purchase/lease new electric vehicles powered only by electricity stored by their connection to an external supply source or to purchase a recharging point with a power of less than or equal to 22 kW. PLN 70 million was allocated to this Programme. As a total, it will enable the co-financing of 1,000 investments. It provides for grants of up to PLN 70,000 for purchasing/leasing electric vehicles and not more than PLN 5,000 for purchasing a recharging point with a power of less than or equal to 22 kW. **Beneficiaries:** Entrepreneurs **Form of support:** Grant **Source of financing:** NFOŚiGW
My Electric Vehicle Programme	**Aim and scope:** Avoidance of the emissions of air pollutants by co-financing projects to reduce the consumption of emissions generating fuels in transport by supporting the purchase/leasing of zero-emission vehicles. The Programme provides for the possibility of co-financing of projects to purchase new vehicles of category M1, powered only by electricity stored by their connection to an external supply source or electricity generated from hydrogen in fuel cells installed in them or only by an engine the duty cycle of which does not generate the emissions of greenhouse gases or other substances covered by the system to manage greenhouse gas emissions. **Beneficiaries**: Natural persons, entrepreneurs and persons other than natural ones **Form of support:** Grant **Source of financing:** NFOŚiGW
Program me of support for the	**Aim and scope:** Support for the infrastructure for recharging electric vehicles and the infrastructure for hydrogen refuelling in order to reduce the number of vehicles emitting CO_2 and NO_x. Co-

Title	Short description
infrastructure for recharging electric vehicles and the infrastructure for hydrogen refuelling	financing is available for the construction or re construction of recharging station with a powe r of not less than 50 kW and less than 150 kW. In Poland, 17,000 points for recharging electric vehicles and 20 hydrogen refuelling stations will be built. **Beneficiaries**: self-governments, companies, housing cooperatives and associations, farmers **Form of support:** Grant **Source of financing:** NFOŚiGW

Source: Elaborated by the KOBiZE IOŚ-PIB

Measure 33: Development of vehicles using alternative fuels (a group of measures)

Greenhouse gases affected: CO_2, CH_4, N_2O

Status: implemented

The development of vehicles using alternative fuels involves a group of measures, including the implementation of such measures as the development of the refuelling infrastructure for vehicles using compressed natural gas (CNG) and liquefied natural gas (LNG), the establishment of the Register of Alternative Fuels Infrastructure or the introduction of tax reliefs for vehicles using alternative fuels. Moreover, the measures entail support for innovation in the area of alternative fuels. The main aim of these measures is to introduce relevant instruments fostering the development of the market of vehicles powered by alternative fuels, including alternative fuels infrastructure, and the promotion of vehicles powered by alternative fuels.

The method for the ex-post assessment of the reduction effect of the measure for 2020 is based on the calculations using real (historical) data which are the input data to the COPERT Programme. The reduction effect of the measure was estimated by comparing the reference scenario (assuming that instead of a specific number of CNG-powered passenger cars and CNG-powered city buses the same number of cars and buses using conventional fuels would be used) and real data.

Development of refuelling infrastructure for CNG and LNG vehicles

The aim of the development of refuelling infrastructure for CNG and LNG vehicles is to ensure wider access to the refuelling infrastructure for vehicles using alternative fuels. The General Director of National Roads and Motorways prepares a location plan for generally accessible recharging stations and natural gas stations, taking into account CNG refuelling points and LNG refuelling points needed to meet the demand for alternative fuels from vehicles moving on the roads of the core TEN-T network. At the end of July 2022, in Poland there were 24 CNG refuelling stations and 5 LNG refuelling stations.

Establishment of the Register of Alternative Fuels Infrastructure

The aim of the establishment of the Register of Alternative Fuels Infrastructure, which is a public register, is to provide the users of electric vehicles and those using natural gas with information facilitating the use of these vehicles. The Register contains information on the locations of natural gas stations and generally accessible recharging stations, the current prices of alternative fuels and the availability of recharging points at generally accessible recharging stations.

Zero excise duty rate

The introduction of tax reliefs for CNG and LNG natural gas, biogas, biohydrogen and hydrogen intended to power internal-combustion engines means the application of the zero excise duty rate for natural gas intended to power internal-combustion engines, i.e. liquefied natural gas LNG, compressed natural gas CNG, biogas, hydrogen and biohydrogen. The zero excise duty rate for biogas, hydrogen

and biohydrogen will apply only after the quality standards are established for these fuels, enabling the application of the zero excise duty rate. At present, work is underway on the draft Regulation of the Minister of Climate and Environment on the quality requirements for hydrogen. It is planned that the Regulation will enter into effect in January 2023.

Measure 34: Promotion of biofuels (a group of measures)

Greenhouse gases affected: CO_2, CH_4, N_2O

Status: implemented

The promotion of biofuels involves a number of measures which aim primarily at introducing a scheme of incentives and support instruments needed to ensure the development of the biofuels market in Poland, and also supports the control and the system for the certification of the quality and use of biofuels in road transport. The measures enabling the promotion of biofuels include the incentive scheme encouraging farmers to produce biofuels for their own use, the system for the certification of the quality of biocomponents and the system for the verification of the minimum share of renewable fuel additives or biocomponents of fuels in liquid fuels or liquid biofuels.

Incentive scheme encouraging farmers to produce biofuels

The incentive scheme encouraging farmers to produce biofuels makes it possible for farmers to produce liquid biofuels for their own use. This is possible after they are entered into a dedicated register. When producing liquid biofuels for their own use, farmers are obliged to meet the following conditions: they need to have appropriate technical equipment and built structures meeting specific requirements, hold a permit for the operation of a tax warehouse or produce biofuels for their own use outside the tax warehouse with excise duty prepayments. The registration authority makes an entry in the farmers register on a written application from a farmer and after the submission of a declaration that the conditions listed above have been satisfied.

System for the certification of the quality of biocomponents

The system for the certification of the quality of biocomponents introduces a document accredited by the certifying body and confirming that the biocomponents placed on the market or used to produce fuels meet the quality requirements. The quality certificate of a biocomponent contains, in particular, the name of the accredited certifying body which has issued it and the names of the raw materials from which it has been produced. The quality certificate of a biocomponent is valid for a year from the date of its issue. The accredited certifying body may withdraw the quality certificate of a biocomponent in case the biocomponent has ceased to meet the quality requirements providing the basis for the issue of the quality certificate.

System for the verification of the minimum share of renewable fuel additives or biocomponents of fuels

The aim of the system for the verification of the minimum share of renewable fuel additives or biocomponents of fuels in liquid fuels or liquid biofuels is to achieve the share of biocomponents on the market of transport fuels at the level of the set target. The entity which implements the National Indicator Target is obliged to ensure in a given calendar year at least the minimum share of other renewable fuels or biocomponents contained in liquid fuels or liquid biofuels used in all the transport modes. As a result, an economic activity may be operated in the scope of the production of biocomponents or in the scope of imports or an intra-Community acquisition of biocomponents. The measure enables the operation of an economic activity in the scope of the placing on the market of biocomponents and liquid biofuels.

Measure 35: Shaping of environment-friendly attitudes of drivers (a group of measures)

Greenhouse gases affected: CO_2, CH_4, N_2O

Status: implemented

Environment-friendly attitudes in transport can be shaped by implementing such measures as the shaping of environmentally aware attitudes of drivers and users of transport services, the provision of consumers with information enabling them to make an informed choice in the purchase of vehicles or the promotion of shared use of the means of transport.

Shaping of environmentally aware attitudes of drivers and users of transport services

The shaping of environmentally aware attitudes of drivers and users of transport services consists in disseminating the technique of environmentally friendly driving as part of driving courses, e.g. as a mandatory element of driving courses for amateurs and professional drivers. Moreover, public campaigns are organised, e.g. those carried out on the occasion of the European Mobility Week (EMW) or Car-Free Day.

Provision of consumers with information enabling them to make an informed choice in the purchase of vehicles

The aim of the provision of consumers with information enabling them to make an informed choice in the purchase of vehicles is to assist consumers in the choice of vehicles using less fuel and, therefore, emitting less CO_2. The aim of the measure is to ensure that information relating to the fuel economy and CO_2 emissions of new passenger cars offered for sale or lease in the EU is made available to consumers in order to enable consumers to make an informed choice.

Promotion of the shared use of means of transport

The aim of the promotion of the shared use of means of transport is the dissemination of the environment-friendly behaviour of drivers and passengers, launched as civic initiatives to reduce the number of vehicles on the roads. These initiatives involve offers, among others, of ad hoc joint travels under the car-pooling formula (e.g. the "*Bla Bla Car*" or "*JEDZIEMYRAZEM*" initiatives) or the shared use of a means of transport: a bicycle (offered e.g. by the NEXTBIKE or GeoVelo operators), e-scooter, scooter or a car in the car-sharing system.

Measure 36: Requirements for improving the emission factors of vehicles (a group of measures)

Greenhouse gases affected: CO_2, CH_4, N_2O

Status: implemented

The classification based on the Euro standards defining the exhaust pollution limits for new passenger cars, light commercial vehicles, heavy-duty vehicles, buses, scooters and motorcycles has applied since the 1990s. This makes it possible to introduce more stringent requirements for emissions, thus reducing their impact on the environment, diminishing the costs of fuel consumption in new vehicles and increasing the importance of the European automotive industry.

The Euro 1 standard was adopted in 1993. In successive years, these standards were progressively updated and strengthened. The application of the most recent Euro standards for passenger cars and light commercial vehicles follows from Regulation (EC) 715/2007[41] of the European

[41] Regulation (EC) No 715/2007 of the European Parliament and of the Council of 20 June 2007 on type approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information (OJ L 171, 29.6.2007, p. 1–16)

Parliament and of the Council of 20 June 2007 on type approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 6). In addition, the Euro 6 standard was updated in 2012. Successive modifications of the Euro 6 standard, which reduced the emission limits for particular matter, were introduced from September 2018, September 2019 (Euro 6c) and September 2020 (Euro 6d). These modifications of the Euro 6 standard did not establish more stringent requirements but only the range of tolerance for deviations from the standard.

In accordance with Regulation (EU) 2019/631[42] of the European Parliament and of the Council of 17 April 2019 setting CO_2 emission performance standards for new passenger cars and for new light commercial vehicles, from 1 January 2020 new passenger cars may not emit more than 95 g CO_2/km on average into the atmosphere, while new light commercial vehicles may not emit more than 147 g CO_2/km on average into the atmosphere. Moreover, work is now underway in the European Parliament on a proposal for a Regulation of the European Parliament and of the Council amending Regulation (EU) 2019/631 as regards strengthening the CO_2 emission performance standards for new passenger cars and new light commercial vehicles in line with the Union's increased climate ambition. It introduces more stringent requirements to be met by 2030 and 2035 (zero emissions), thus ensuring a further reduction of carbon dioxide emissions from new passenger cars and light commercial vehicles. As a result of this, the increasingly large share of zero-emission vehicles in the structure of passenger cars and light commercial vehicles will contribute to improving air quality in urban agglomerations.

The method for the ex-post assessment of the reduction effect of the measure for 2020 is based on the calculations using real (historical) data which are the input data to the COPERT Programme. The reduction effect of the measure was estimated by comparing the reference scenario (assuming that instead of a specific number of heavy-duty vehicles and buses meting the Euro 5 and 6 standards the same number of heavy-duty vehicles and buses meting the Euro 4 standard would be used) and real data.

Measure 37: Measures for efficient railway transport (a group of measures)

Greenhouse gases affected: CO_2, CH_4, N_2O

Status: implemented

Measures for efficient railway transport support the development of railways and railway infrastructure and encourage the use of railway transport. The particular measures which support the efficient development of railway transport include the modernisation of railway infrastructure (including railway stations), the modernisation of railway rolling stock, the expansion of local and regional railway infrastructure, the integration of railway transport with the other transport modes, the Railway Fund (FK) and the promotion of collective rail transport.

Modernisation of railway infrastructure

The railway infrastructure is modernised in accordance with the assumptions of the National Railway Programme until 2023. Investment projects are carried out on railway lines, among others, to modernise railway infrastructure, i.e. lines, junctions and railway stations, thus contributing to the improvement of the quality of railway transport. Moreover, the measure focuses on the modernisation of the existing railway stops and the construction of new ones at localities through which railway lines

[42] Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting CO_2 emission performance standards for new passenger cars and for new light commercial vehicles, and repealing Regulations (EC) No 443/2009 and (EU) No 510/2011 (OJ L 111, 25.4.2019, p. 13–53)

run and in which there is no adequate infrastructure for passengers. The aim of the measure is also to support the implementation of the tasks of the managers of railway infrastructure, including the maintenance and repairs of railway infrastructure.

Modernisation of railway rolling stock

The modernisation of the rolling stock for the carriage of passengers and goods includes the adaptation of the railway rolling stock to meet the needs of disabled persons and those of the persons with reduced mobility, support for the purchase of locomotives, including multi-system locomotives, multiple units, light rail vehicles and carriages.

Expansion of local and regional railway infrastructure

The expansion of local and regional railway infrastructure is a measure aimed at complementing the railway network with railway connections between localities with more than 10,000 inhabitants without access to the passenger connections with the capitals of Voivodeships. The measure also supports the complementing of the railway network with railway connections to localities which have access to railway, but the existing connections need to be improved. The measure is supported under the assumptions of the Programme for Complementing the Local and Regional Railway Infrastructure (Railways Plus Programme) until 2028 which was adopted by the Council of Ministers in 2019.

Railway Fund (FK)

The aim of the Railway Fund (FK) is to gather financial resources for the preparation, construction, reconstruction, repairs and maintenance of railway lines and the liquidation of redundant railway lines. The resources of the Fund are used for the financing or co-financing by Voivodships of tasks in the scope of the purchase, modernisation and repair of railway vehicles intended for the carriage of passengers. The beneficiaries of the Fund are the managers of railway infrastructure which provide railway carriers with access to this infrastructure. The resources for the co-financing of investment projects come from the resources of Bank Gospodarstwa Krajowego (BGK).

Integration of railway transport with the other transport modes

The aim of the integration of railway transport with the other transport modes is to enhance the importance of railway transport, primarily in light of the large carrying capacity of railways, their favourable energy efficiency and low emission factor, and the problems occurring in road transport, i.e. congestion or the shortage of parking space. The aim of the measure is to expand the railway network and also to modernise railway infrastructure, i.e. to expand stations at the key transport junctions, e.g. at seaports or aerodromes. Moreover, collective rail transport is promoted by the development of public passenger transport (railways, including commuter and urban railways) and by integrating with it the other modalities of passenger transport or such solutions as e.g. Park&Ride. At the same time, the integration of travel information and tickets of different operators (the Common Ticket initiative) is underway.

Measure 38: Measures for the environmentally friendly development of maritime shipping

(a group of measures)

Greenhouse gases affected: CO_2, CH_4, N_2O

Status: implemented

Since ships sail on long routes, the maritime shipping is a significant source of fuel consumption and, in consequence, the emissions of pollutants and greenhouse gases. Given the transboundary character of this transport mode, the main measures to reduce its impact on the environment follow from the documents and regulations adopted at the international level (by the International Maritime Organisation (IMO)) and the EU level.

The maritime shipping is developed, among others, by ensuring appropriate access to Polish seaports (including adequately dredged and properly maintained fairways) and by monitoring vessel traffic, including the management and control of vessel traffic. Relevant measures are implemented for this purpose, i.e. the construction of new infrastructure and the improvement of the existing one at Polish seaports, as well as the implementation of the emission standards for harmful substances and innovative technologies to manage the traffic of Polish seagoing vessels.

Construction of new infrastructure and the improvement of the existing one at Polish seaports

The aim of the construction of new infrastructure and the improvement of the existing one at Polish seaports is to ensure good access to Polish seaports, among others, through the maintenance and expansion (including dredging) of the approach fairways to the ports from the sea (where the benchmark and natural limit are the depth of the fairways in the Danish straits) and other fairways. These measures are necessary for the investment projects made in the port infrastructure proper, relating to such flagship projects as e.g. the Central Port in Gdańsk, the External Port in Gdynia and the Container Terminal in Świnoujście. Investments in the port and approach infrastructures are complementary to each other. The measure created the conditions to enable the infrastructure of selected port terminals to handle intermodal transport and to expand the alternative fuels infrastructure, primarily for LNG, and electricity recharging points for vessels. Moreover, an important measure involves the construction and modernisation of road, railway and river infrastructure linking the ports with the related economic support facilities. The implementation of the measure fulfils the assumptions of the Programme for the Development of Polish Seaports until 2030 which was adopted by the Council of Ministers in 2019.

Implementation of innovative technologies to manage the traffic of Polish seagoing vessels

The main aim of the measure is to monitor vessel traffic, including the management and control of vessel traffic. As a result, the National System for Monitoring Vessel Traffic and Transmission of Information was established. The efficient management of vessel traffic enables the optimisation of navigation and, as a result, lesser fuel consumption.

Environmentally friendly standards

At present, increasingly stringent standards are adopted for the emissions of pollutants generated by fuel combustion on ships (mainly for SOx and NOx). These standards are introduced by both the European Union (Directive 2012/33/EU) and the International Maritime Organization (Annex VI to the MARPOL Convention). The emission levels can be achieved in different ways, e.g. by using systems to clean exhaust gases, burning fuels with low sulphur content or purchasing vessels powered by alternative fuels.

Moreover, in accordance with the IMO decisions, the Act of 7 November 2014 Amending the Act on the Prevention of Sea Pollution by Ships and Certain Other Acts (Official Journal of the Laws, Item 1554), introduced energy efficiency requirements: the Energy Efficiency Design Index (EEDI) for new ships and the Ship Energy Efficiency Management Plan (SEEMP). The EEDI Index enables the correct selection of equipment and the determination of the energy efficiency of a ship at the stage of

its design. The SEEMP plan contains a description of measures to limit energy consumption by equipment installed on ships and recommendations for the implementation of the appropriate strategy for planning sea voyages (to minimise energy consumption) and the promotion of behaviour conducive to energy efficiency among the crew and land-based personnel. These instruments make it possible to support and promote design solutions with higher energy efficiency and, thus, reduced CO_2 emissions during the operation of a ship.

Measure 39: Measures for the development of inland waterway transport (a group of measures)

Greenhouse gases affected: CO_2, CH_4, N_2O

Status: implemented

The measures for the development of inland waterway transport primarily focus on the development of the infrastructure of waterways, harbours and ports and on their connection and improved access to the TEN-T network. The aim of the measure is also to modernise and build new waterways in international navigability classes. This will also contribute to the development of transport using low-emission water transport.

Integration of inland waterways in Poland into the TEN-T network

The aim of the integration of inland waterways in Poland into the TEN-T network is the development of the infrastructure of waterways, harbours and ports and their connection and improved access to the TEN-T network. One of the main aims of the development of inland waterways of importance for transport is their construction or modernisation to reach the parameters of at least Class IV of navigability and to meet the requirements for the inland waterway transport infrastructure for the TEN-T network.

Implementation of the requirements for internal-combustion engines used in inland navigation

The aim of the measure is to introduce requirements for internal-combustion engines used in inland navigation. The aim of the measure is to reduce the emissions of gaseous pollutants and particulate matter from these engines. Before the engine manufacturers place them on the market they are obliged to obtain a type approval certificate for a given engine type.

Development of inland waterways of importance for transport

The aims of the development of inland waterways of importance for transport include the modernisation and construction of new inland waterways in international navigability classes. The development in this area will make it possible to move cargo from road transport to low-emission water transport and ensure better access to seaports. Moreover, the measure will restore navigability classes on waterways of regional importance – e.g. the measure will improve the operating parameters of waterways, including their betterment in selected sections of the Odra Waterway, which, as a target, should comply with the international parameters. The measure fulfils the assumptions for the development plans for inland waterways in Poland for the period from 2016 to 2020, with an outlook until 2030, which were adopted by the Council of Ministers on 14 June 2016.

Construction of the waterway linking the Vistula Lagoon and the Gulf of Gdańsk

The aim of the construction of the waterway linking the Vistula Lagoon and the Gulf of Gdańsk is to provide access to the Port of Elbląg with a navigation channel through the Vistula Spit. The implementation of this investment project will ensure Poland's free access from the Vistula Lagoon to the Baltic, bypassing the Russia-controlled Pilava Strait. Due to this solution, the Elbląg terminal will be able to receive lesser cargo, thus reducing the workload of Tri-City ports. The new waterway from

the Gulf of Gdańsk through the Vistula Lagoon to Elbląg is an almost 25 km long section. The navigation channel through the Vistula Spit was officially opened in September 2022.

River Information System (RIS)

This measure is implemented in the Lower Odra area to improve the safety level of navigation and to raise the effectiveness of the inland water transport, by a quick exchange of information on waterways in sections of inland waterways of international importance. Information provided from the RIS can be used to plan travels and to achieve a steadier travel speed and, thereby, to reduce fuel consumption. The aim of the measure is the further implementation of RIS-based intelligent transport systems in other inland waterways.

Inland Navigation Fund (FŻŚ)

The Inland Navigation Fund (FŻŚ) is a support scheme for the development and modernisation of inland navigation. Its aim is to provide financial assistance for the modernisation of navigation vessels and other projects to restructure the inland navigation sector, including projects to improve environmental protection and navigation safety. Beneficiaries are vessel owners who can receive preferential credits, grants and refinancing of the purchase of elements of vessel equipment. The source of financing is the NFOŚiGW.

Measure 40: Innovative measures for air transport (a group of measures)

Greenhouse gases affected: CO_2, CH_4, N_2O

Status: implemented

The aviation sector is an important source of GHG emissions not only at the national level but also as a result of flights between countries. Therefore, measures are taken at both the international (the International Civil Aviation Organisation - ICAO), EU and national levels to reduce the impact of this sector on the climate.

The aim of the Innovative measures for air transport is to improve the infrastructure of airports, to implement modern solutions in air traffic and to improve the operational efficiency of air transport, including the reduction of the emissions of harmful substances. The aviation sector is also covered by the EU ETS system (Measure 1).

Improvement of the infrastructure of airports

The aim of the measure is to expand airports so that they can handle the growing number of passengers and air operations. The aim of the measure is also to improve the connectivity between regional airports and the road and railway transport networks, in particular, with city centres via public transport and the domestic transport hubs - as part of the TEN-T network. An example of such a measure is the construction of the Central Transport Hub (CPK). This measure provides for the construction of a transport hub based on mutually integrated air and railway hubs and effectively integrated with the road network system.

Implementation of modern solutions in air traffic

The long-term sustainable development of the air transport market in Poland is fostered by the participation of national entities in the development and implementation of a modern air traffic management system delivered as part of the new generation European air traffic management system (SESAR). The timely, coordinated and synchronised implementation of the new system will make it possible to increase the capacity of the ATM (Air Traffic Management) network, while, at the same

time, maintaining the high level of safety and reducing costs so as to cope with the constantly growing number of air operations and, simultaneously, improve safety indicators.

Improvement of the operational efficiency of air transport

Another innovative measure which contributes to improving air transport is the enhancement of the operational efficiency of air transport. It is enhanced due to the systematic modernisation of the fleet which enables fuel savings and a substantial reduction of CO_2 emissions. Moreover, the measure contributes to optimising the air corridors and increasing the capacity of the airspace and also enhances the capacity of taxiways, thus reducing fuel consumption and CO_2 emissions. In order to make this measure fully feasible for implementation, it is necessary to expand and develop the Asynchronous Transfer Mode (Atm) in the radio communication infrastructure, which will improve the safety of air traffic by diminishing errors in information transmitted and decrease the number of voice calls. This purpose is also served by the Airport Collaborative Decision Making Solution (A-CDM) system, which consists in the cooperation of all the airport services and their sharing of information on the current and anticipated situations at the airport. Moreover, the Polish Air Navigation Services Agency has also implemented the Continuous Descent Approach (CDA) operational procedures. They consist in the continuous descent of aircraft until the moment when the pilot releases the landing gear. The CDA procedure makes it possible to diminish the landing time with enhanced engine power, which reduces CO_2 emissions.

Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)

In October 2016, the ICAO adopted a resolution to establish a global market-based measure in order to meet the challenges related to the reduction of CO_2 emissions from the international aviation sector. The resolution laid down the main goals, the key assumptions on which this measure is to be based and a work programme for its operationalisation.

The market-based measure set out in the resolution is the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), with the main objective of stabilising CO_2 emissions at their 2019 level (instead of the originally specified 2020; it was changed due to the outbreak of the COVID-19 pandemic). This is to be achieved by enabling airlines to offset their growing CO_2 emissions after 2020 and is to be a measure additional to technological, operational and fuel changes.

The CORSIA provides for three main implementation phases, with the voluntary participation in the first two phases (the pilot phase in 2021-2023 and the first phase in 2024-2026). In turn, the second phase (from 2027) will be obligatory for countries which had an individual share in total international aviation activities above 0.5% in 2018.

107 countries (including Poland) have announced their intention to participate in the CORSIA from 1 January 2022 and another 8 countries from 1 January 2023. This means that a total number of 115 countries now participate in it.

The EU intends to implement the CORSIA scheme, subject to the differences notified to the ICAO following Council Decision (EU) 2018/2027[43] and the manner in which the European Parliament

[43]Council Decision (EU) 2018/2027 of 29 November 2018 on the position to be taken on behalf of the European Union within the International Civil Aviation Organisation in respect of the First Edition of the International Standards and Recommended Practices on Environmental Protection — Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) (OJ L 325, 20.12.2018, p. 25)

and Council change the EU regulations. Commission Delegated Regulation (EU) 2019/1603[44] was adopted to appropriately implement the CORSIA provisions on the monitoring, reporting and verification of aviation emissions. The offset within the meaning of the international standards and recommended practices for the CORSIA[45] is calculated from CO_2 emissions verified in accordance with this Regulation.

At present, legislative work is underway to amend Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC in order to implement the detailed rules of the CORSIA scheme in the EU. The EU ETS system will cover flights within the EU (including Great Britain and Switzerland). In turn, the CORSIA scheme will apply to flights to/from third countries participating in this scheme.

4.2.6. Policies and measures in the sector of industrial processes

This Section presents documents of a strategic character, legal regulations, policies and measures associated with the sector of industrial processes which contribute to greenhouse gas emission reductions.

The greenhouse gas emissions from industrial processes are covered by the European greenhouse gas emissions allowance trading system (EU ETS), described as Measure 1 in the section on cross-sectoral policies and measures (Section 4.2.2). It is the fundamental policy on limiting the emissions of these gases in this sector. Moreover, measures are taken to improve the energy efficiency and to enhance the use of energy from renewable sources in industrial processes, as described in the Section on the energy consumption sector. The measure to limit the emissions of fluorinated greenhouse gases is described here.

Key strategies, plans and programmes

The table below presents information on the key strategies, plans and programmes in the sector of industrial processes which influence on its functioning and condition environmental protection and climate change mitigation.

Table 4.21. Key strategies, plans and programmes in the sector of industrial processes

Title	Description
Implemented	
Productivity Strategy 2030, adopted by the Council of Ministers on 12 July 2022	The Productivity Strategy 2030 is a document which has been prepared at the Ministry of Economic Development and Technology to set out the objectives and directions of state intervention in the areas of industrial policy, innovation policy or export policy. It also provides the basis for the spending of resources from the European Funds in the new perspective 2021-2027. The aim of the Strategy is to increase productivity on the basis of the use of knowledge and new technologies, especially digital ones. The Productivity Strategy 2030 is one of the 9 integrated strategies under the Strategy for Responsible Development and its expansion in the economic area. It analyses, complements and develops the Strategy for the Innovation and Effectiveness of the Economy "*Dynamic Poland 2020*", which had been in force until 2020.

[44]Commission Delegated Regulation (EU) 2019/1603 of 18 July 2019 supplementing Directive 2003/87/EC of the European Parliament and of the Council as regards measures adopted by the International Civil Aviation Organisation for the monitoring, reporting and verification of aviation emissions for the purpose of implementing a global market-based measure (OJ L 250, 30.9.2019, p. 10)

[45]The First Edition of the International Standards and Recommended Practices on Environmental Protection — Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) (Volume IV to Annex 16 to the Chicago Convention)

Title	Description
Industrial Policy of Poland (the document dated 9 June 2021)	The Industrial Policy of Poland focuses on solving the problems reported by entrepreneurs during the consultations carried out by the Ministry of Economic Development and Technology and responds to the needs of particular sectors, complementing the horizontal development policies implemented to improve the conditions for doing business for all the enterprises. The document concerns the following sectors: the automotive, iron and steel , chemical, furniture, paper, pharmaceutical, biotechnological, medical products, cosmetics, construction materials, electrotechnical, machine, rail transport, specialist ships and yachts, aerospace (including unmanned aerial vehicles – UAV), food processing, secondary materials recovery, battery and advanced energy technology industries. The Industrial Policy of Poland is based on five key development axes: Digitalisation, Green Deal, Safety, Localisation of Industrial Production and High Competence Society, which will be consistent with the directions of the development of sectors. In the scope of the environmentally friendly transition of industry, it is important to reduce the emissions of gases generated by production processes, primarily involving waste and greenhouse gases emitted as a result of industrial production. The greatest challenge related to emission reduction of air pollutants and greenhouse gases will be production and use of hydrogen fuels, biomethane and synthetic fuels, and the implementation of carbon capture and storage (CCS) or carbon capture and utilisation (CCU) technologies in industry.
	Other documents concerning the sector of industrial processes are described in Section 4.2.2. addressing cross-sectoral measures and in Section 4.2.4. regarding the energy sector (energy consumption).

Source: Elaborated by the KOBiZE IOŚ-PIB

Key legal acts

The table below lists the key legal acts concerning the sector of industrial processes which affect its functioning and condition environmental protection and climate change mitigation.

Table 4.22. Key legal acts in the sector of industrial processes

Title	Description
Implemented	
Act of 15 May 2015 on Substances That Deplete the Ozone Layer and Certain Fluorinated Greenhouse Gases (Official Journal of the Laws of 2020, Item 2065)	The Act implements the provisions of Regulation (EU) 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006 (OJ L 150, 20.05.2014, p. 195, as amended) and Regulation (EC) No 1005/2009 of the European Parliament and of the Council of 16 September 2009 on substances that deplete the ozone layer (OJ L 286, 31.10.2009, p. 1, as amended). Among others, it lays down the obligations of entities carrying out economic activity in the scope of production and services involving the use of substances that deplete the ozone layer or fluorinated greenhouse gases, the tasks of authorities in this respect and the penalties for a breach of regulations.
	Other legal acts concerning the sector of industrial processes are described in Section 4.2.4. concerned with the energy sector (energy consumption) and Section 4.2.2. addressing cross-sectoral measures.
Planned	
Proposal for a Regulation of the European Parliament and of the Council on fluorinated greenhouse gases, amending Directive (EU) 2019/1937 and repealing Regulation (EU) No 517/2014 COM(2022) 150 final[46]	The aim of the proposal of the Commission is to align Regulation (EU) 517/2014 with the European Green Deal and the European Climate Law and with the commitments for hydrofluorocarbons under the Montreal Protocol on Substances that Deplete the Ozone Layer adopted in Montreal on 16 September 1987. Moreover, the proposal provides for more stringent requirements for the reduction of the use of HFCs so as to achieve an additional reduction of F-gases emissions of 55% by 2030 and neutrality in terms of net carbon dioxide emissions by 2050. The aim of the proposed package of measures is to reduce emissions to 40 Mt CO_2 eq. by 2030 and 310 Mt CO_2 eq. by 2050, in addition to the reduction achieved under the present Regulation.

Source: Elaborated by the KOBiZE IOŚ-PIB

[46] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52022PC0150

Policies and measures

Measure 41: Limitation of the use of fluorinated greenhouse gases (a group of measures)

Greenhouse gases affected: HFCs, PFCs, SF_6

Status: implemented

The issue of the limitation of the use of fluorinated greenhouse gases is regulated at the EU level. In 2006, Regulation (EC) No 842/2006 of 17 May 2006 on certain fluorinated greenhouse gases introduced provisions aimed at the limitation of their use and, thus, also the emissions of these gases. These provisions were replaced by more stringent ones laid down in Regulation (EU) 517/2014 of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006. Regulation (EU) 517/2014 entered into force on 1 January 2015.

These provisions were implemented into the Polish law by the adoption of the Act of 15 May 2015 on Substances That Deplete the Ozone Layer and Certain Fluorinated Greenhouse Gases. This Act was amended by the Act of 12 July 2017 Amending the Act of 15 May 2015 on Substances That Deplete the Ozone Layer and Certain Fluorinated Greenhouse Gases (Official Journal of the Laws, Item 1567). This Act entered into force on 23 September 2017.

The measures to reduce the emissions of fluorinated greenhouse gases (so-called F-gases) consist, among others, in the phaseout of substances that deplete the ozone layer and also in limiting the accessibility and use of refrigerants exactly from the group of F-gases.

The main elements of these measures include:

- the responsibilities of undertakings carrying out economic activities involving the production and services related to the use of substances that deplete the ozone layer and fluorinated greenhouse gases (among others, concerning restrictions on the placing on the market of HFCs in bulk or contained in equipment);
- the penalties for a violation of the regulations on substances that deplete the ozone layer and fluorinated greenhouse gases, fire protection products, equipment and extinguishers and air-conditioning systems in certain motor vehicles containing these agents;
- the system for the certification of persons who perform specific activities and enterprises which carry out specific operations in the area of fluorinated greenhouse gases and substances that deplete the ozone layer;
- the obligation to keep electronic documentation on equipment and systems in the Central Operator Registry (CRO) and the obligation to prepare periodic electronic (annual) reports in the reporting database (BDS).

The measures taken to establish and manage two electronic databases (CRO and BDS) and the requirements set for servicing contractors and those in the area of fluorinated greenhouse gases contribute to a significant reduction of the emissions of certain fluorinated greenhouse gases into the atmosphere from the refrigeration, air-conditioning, fire protection and electricity sectors.

Under the EU regulations, the use of F-gases has been banned by Regulations (EC) No 842/2006 and (EU) No 517/2014. Moreover, since 1 January 2020 the use of virgin F-gases with GWP of 2,500 or higher for servicing or maintenance of refrigeration equipment and the use of F-gases for certain applications have been prohibited. Measures have also been taken, under Directive 2006/40/EC of the European Parliament and of the Council of 17 May 2006 relating to emissions from air conditioning systems in motor vehicles and amending Council Directive 70/156/EEC (OJ L 161, 14.06.2006, p. 12, as amended) and the national regulations implementing it, to restrict the placing on the market of passenger cars equipped with air-conditioning systems containing F-gases with GWP of 150 or higher.

The estimation of the reduction effects of this group of measures used the data from the report "*The preparation of inventories and analysis of data on the projected emissions of the substances: HFC, PFC, SF_6 and NF_3 in 2020, 2025, 2030, 2035 and 2040 in Poland. An estimation of the effects of policies and measures to reduce the use of fluorinated greenhouse gases or resulting in such reductions*", prepared on commission from the KOBiZE IOŚ-PIB in 2019.

Measure 42: Proposed adoption of more stringent requirements for the limitation of the use of fluorinated greenhouse gases

Greenhouse gases affected: PFCs, HFCs, SF_6

Status: planned

The aim of the EC proposal for an amendment to Regulation (EU) 517/2014 is to ensure the achievement of additional F-gases emission reductions so as to contribute, in consequence, to reaching a 55% emission reduction by 2030 and net carbon neutrality by 2050. In particular, this can be achieved by adopting more stringent requirements for HFCs, e.g. by establishing a stricter system of HFCs quota (to ensure an HFC phase-down) and reducing the quantity of HFCs placed on the market by 98% by 2050 (compared with 2015). The proposal also provides for new restrictions on the placing on the market of equipment containing fluorinated greenhouse gases and the use of fluorinated greenhouse gases in equipment. Moreover, the aim of the proposal is to ensure alignment with the Montreal Protocol, e.g. by taking steps to a phaseout after 2030, too, and dropping certain exemptions from the EU HFC phase-down which do not exist under the Montreal Protocol. The aim of the proposal of the Commission is also to enhance the implementation and enforcement of regulations, e.g. by making it easier for customs authorities and market surveillance authorities to enforce the controls on imports and exports, to facilitate the implementation and enforcement of regulations on illegal trade and the functioning of the quota system, and to meet the training needs related to substances alternative to F-gases. In addition, it is envisaged that more stringent and uniform penalties will be introduced in the EU. The aim of the proposal is also to put in place a comprehensive monitoring system, e.g. by covering a wider range of substances and activities and improving the reporting and data verification procedures.

Other measures affecting the greenhouse gas emissions from the sector of industrial processes are described in Section 4.2.2. addressing cross-sectoral measures and in Section 4.2.4. concerned with the energy consumption sector.

4.2.7. Policies and measures in the agriculture sector

This Section presents documents of a strategic character, legal regulations, policies and measures associated with the agriculture sector which contribute to greenhouse gas emission reductions.

In the agriculture sector, many measures are taken to protect the environment and to mitigate climate change. To a large extent, these measures are set out and supported in the EU Common Agricultural Policy (CAP). They are measures to restore, preserve and enhance ecosystems related to agriculture and, at the same time, to implement the objectives of rural development which include, among others, climate change mitigation and adaptation. The main measures which contribute to reducing greenhouse emissions in agriculture include: the rational management of agricultural and forest land, support for adaptation and emission reduction measures in agricultural holdings, agri-environment-climate measures and the development of agricultural biogas plants. This Section also includes policies and measures to reduce food waste and foodstuff and food losses.

Key strategies, plans and programmes

The table below lists the key strategies, plans and programmes associated with the agriculture sector which affect its functioning and condition environmental protection and climate change mitigation.

Table 4.23. Key strategies, plans and programmes in the agriculture sector

Title	Description
Implemented	
Strategic Plan for the Common Agricultural Policy 2023-2027, approved by the European Commission on 31 August 2022	The Strategic Plan for the Common Agricultural Policy 2023-2027 will support the sustainable development of Polish farms, the processing sector and the improvement of the living and working conditions in small rural localities. The CAP will support the sustainable farming methods protecting water, soil, air and biodiversity. It will encourage sustainable energy production and use. Economic diversity will be enhanced, including the bioeconomy, The Plan provides for interventions encouraging farmers to apply higher standards in agricultural production and environmentally friendly production methods reducing greenhouse gas emissions, improving soil quality and increasing water retention. Support will be given to investments enabling water recirculation and reducing the energy consumption in production.
Strategy for the Sustainable Development of Rural Areas, Agriculture and Fisheries 2030, adopted by the Council of Ministers on 15 October 2019 (SZRWRIR 2030)	The Strategy for the Sustainable Development of Rural Areas, Agriculture and Fisheries 2030 (SZRWRiR 2030) sets out the key directions of the development of rural areas, agriculture and fisheries until 2030. The Strategy presents an in-depth analysis of the development opportunities for rural areas, agriculture and fisheries in a regional dimension. The SZRWRiR 2030 will implement the assumptions of the SOR2020 as indicated in its three specific objectives: - Objective I. Increasing the profitability of agricultural and fisheries production; - Objective II. Improving the quality of life, infrastructure and the state of the environment; - Objective III. Developing entrepreneurship, non-agricultural jobs and active society. The measures planned until 2030 provide, among others, for the implementation of agricultural and fisheries production with respect for the principles of environmental protection and the adaptation of the agri-food sector to climate change.
Action Programme to Reduce Water Pollution Caused by Nitrates from Agricultural Sources and to Prevent Further Pollution, adopted by the Council of Ministers on 5 June 2018	The most important measures set out in the Programme include the establishment of the conditions for the agricultural use of nitrogen fertilisers near watercourses, on steeply sloping ground, on frozen, water-flooded or snow-covered ground, the adoption of the periods when the agricultural use of fertilisers is allowed, the determination of the storage conditions for natural fertilisers and the handling of leachates, the manner of calculating the annual dose of natural fertilisers containing not more than 170 kg N/ha and the introduction of the obligation to prepare a nitrogen fertilisation plan or the use of doses not exceeding the maximum N dose.
Rural Development Programme (RDP) for 2014–2020, approved by the European Commission on 12 December 2014	The Programme sets out the objectives, priorities and principles of support for the development of rural areas with the resources of the European Agricultural Fund for Rural Development (EAFRD) under Regulation (EU) 1305/2013 of the European Parliament and of the Council of 17 December of 2013 on support for rural development by the EAFRD (OJ L 347, 20.12.2013, p. 487, as amended). The most important objective of the Programme is to enhance the competitiveness of agriculture, while taking into account environmental objectives. The RDP for 2014-2020 is based on the implementation of six priorities, two of which directly concern the natural environment and climate change mitigation, i.e. the protection of ecosystems and the efficient management of natural resources. The Programme was extended until 31 December 2022 (by Regulation (EU) 2021/20220 of the European Parliament and of the Council of 23 December 2020 [OJ L.437, 28.12.2020, p. 1]).

Source: Elaborated by the KOBiZE IOŚ-PIB

Key legal acts

The table below lists the key legal acts associated with the agriculture sector which affect its functioning and condition environmental protection and climate change mitigation.

Table 4.24. Key legal acts in the agriculture sector

Title	Description
Implemented	
Act of 23 June 2022 on Organic Farming and Organic Production (Official Journal of the Laws, Item 1370)	The Act sets out the tasks and competence of authorities and organisational units in the scope of organic production in accordance with Regulation (EU) 2018/848 of the European Parliament and of the Council, the issues related to the performance of official controls and other official actions and the conditions of organic production.
Act of 19 July 2019 on the Prevention of Food Waste (Official Journal of the Laws of 2020, Item 1645)	The Act sets out the rules for the handling of food and the duties of food sellers to prevent food waste and the adverse social, environmental and economic effects caused by food waste.
Act of 20 July 2017 on Water Law (Official Journal of the Laws of 2021, Item 2233, as amended)	The Act regulates water management in accordance with the principle of sustainable development; in particular, the development and protection of water resources, the use of waters and the management of water resources. In order to protect waters from pollution caused by nitrates from agricultural sources, the Act introduced the obligation to prepare an action plan with the aim of reducing water pollution caused by the fertilisation of agricultural land with natural fertilisers (urine, slurry and manure) containing nitrogen compounds and preventing further pollution of this type (the nitrogen programme), and the Code of Good Agricultural Practice.
Act of 5 February 2015 on Payments under Direct Support Schemes (Official Journal of the Laws of 2022, Item 1775)	The Act defines the tasks and competence of authorities and organisational units in the scope of direct payments and the rules for their award to farmers.
Act of 20 February 2015 on the Promotion of Rural Development with Support from the Resources of the European Agricultural Fund for Rural Development under the Rural Development Programme for 2014-2020 (Official Journal of the Laws of 2022, Item 1234, as amended).	The Act defines the tasks and competence of authorities and organisational units in the scope of support for rural development, using the resources from the European Agricultural Fund for Rural Development, under the Rural Development Programme for 2014-2020, the conditions and procedure for the award, payment and recovery of financial assistance – in the scope unregulated in the regulations of the European Union or foreseen in these regulations to be regulated by a Member State of the European Union.
Act of 10 July 2007 on Fertilisers and Fertilisation (Official Journal of the Laws of 2021, Item 76, as amended)	The Act regulates, among others, the issues of the placing of fertilisers on the market and their use, the prevention of hazards for humans and livestock which may arise as a result of the transport, storage and application of fertilisers and agrichemical services in agriculture.
Act of 7 March 2007 on the Promotion of Rural Development with Support from the Resources of the European Agricultural Fund for Rural Development under the Rural Development Programme for 2007-2013 (Official Journal of the Laws of 2022, Item 2138)	The Act defines the tasks and competence of authorities and organisational units in the scope of support for rural development, using the resources from the European Agricultural Fund for Rural Development, under the Rural Development Programme, the conditions and procedure for the award, payment and recovery of financial assistance – in the scope unregulated in the regulations of

Title	Description
	the European Union or foreseen in these regulations to be regulated by a Member State of the European Union.
Act of 25 August 2006 on the Safety of Food and Nutrition (Official Journal of the Laws of 2022, Item 2132)	The Act sets out the requirements and procedures indispensable to ensure the safety of food and nutrition in accordance with the regulations of the European Parliament and defines the health-related requirements and those relating to compliance with hygienic requirements for: food and material and products intended for contact with food, as well as the requirements for control authorities.
Act of 21 December 2000 on the Commercial Quality of Agri-food Products (Official Journal of the Laws of 2022, Item 1688, as amended)	The Act regulates the issues related to the commercial quality of agri-food products and the organisation and the rules of operation of the State Agricultural and Food Inspection Authority.
Act of 3 February 1995 on the Protection of Agricultural and Forest Land (Official Journal of the Laws of 2021, Item 1326, as amended)	The Act regulates the principles of the protection of agricultural and forest land, their remediation and the enhancement of their utility value.
Regulation of the Council of Ministers of 1 February 2020 on the adoption of the Action Programme to Reduce Water Pollution Caused by Nitrates from Agricultural Sources and to Prevent Further Pollution (Official Journal of the Laws, Item 243)	The Regulation implements Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (OJ L 375, 31.12.1991, p. 1, as amended).
Regulation of the Minister of Agriculture and Rural Development of 23 October 2015 on the detailed conditions and procedure for the award and payment of financial assistance for operations of the type of "*Investments to protect waters against pollution by nitrates from agricultural sources*" under the sub-measure "*Support for investments in agricultural holdings*" included in the Rural Development Programme for 2014-2020 (Official Journal of the Laws of 2021, Item 1152, as amended)	The Regulation lays down the detailed conditions and procedure for the award, payment and recovery of financial assistance for operations of the type of "*Investments to protect waters against pollution by nitrates from agricultural sources*" under the sub-measure "*Support for investments in agricultural holdings*" included in the Rural Development Programme for 2014-2020.
Regulation of the Minister of Agriculture and Rural Development of 21 August 2015 on the detailed conditions and procedure for the award and payment of financial assistance for operations of the type of "*Modernisation of agricultural holdings*" under the sub-measure "*Support for investments in agricultural holdings*" included in the Rural Development Programme for 2014-2020 (Official Journal of the Laws of 2021, Item 2101)	The Regulation lays down the detailed conditions and procedure for the award, payment and recovery of financial assistance for operations of the type of "*Modernisation of agricultural holdings*" under the sub-measure "*Support for investments in agricultural holdings*" included in the Rural Development Programme for 2014-2020.
Regulation of the Minister of Agriculture and Rural Development of 18 March 2015 on the detailed conditions and procedure for the award of financial assistance under the "*Agri-environment-climate measure*" included in the Rural Development Programme for 2014-2020 (RDP 2014-2020) (Official Journal of the Laws, Item 415, as amended)	The Regulation indicates, among others, agricultural practices to be applied at beneficiaries' farm holdings, i.a. to protect soils against erosion and waters against pollution, and, in consequence, to enable the reduction of greenhouse gas emissions into the atmosphere.
Regulation of the Minister of Agriculture and Rural Development of 13 March 2015 on the detailed conditions and procedure for the award of financial assistance under the measure "*Organic farming*" included in the Rural Development Programme for 2014-2020 (Official Journal of the Laws of 2018, Item 1784, as amended)	The Regulation lays down the detailed conditions and procedure for the award, payment and recovery of financial assistance under the measure "*Organic farming*" included in the Rural Development Programme for 2014-2020.
Regulation of the Minister of Agriculture and Rural Development of 13 March 2015 on the detailed conditions	An amendment to the Regulation of 1 February introduced a new delimitation of areas facing natural or other specific

Title	Description
and procedure for the award of financial assistance under the measure "*Payments to areas facing natural or other specific constraints*" included in the RDP for 2014-2020 (Official Journal of the Laws, Item 364, as amended)	constraints (LFA)s in Poland from 2019. The aim of this measure is to facilitate farmers' continued use of land for agricultural purposes in less favoured areas, thus preventing their abandonment and erosion, and, in consequence, additional greenhouse gas emissions into the atmosphere.
Regulation of the Minister of Agriculture and Rural Development of 9 March 2015 on the standards of good agricultural and environmental conditions (Official Journal of the Laws, Item 344, as amended)	The Regulation lays down the standards of good agricultural and environmental conditions which famers need to meet in order to receive direct payments.

Source: Elaborated by the KOBiZE IOŚ-PIB

Policies and measures

Measure 43: Agri-environmental measures (a group of measures)

Greenhouse gases affected: CO_2, CH_4, N_2O

Status: implemented

In the agriculture sector, many measures are taken to protect the environment and to mitigate climate change. These measures are set out and supported in Pillar I (i.e. direct payments) and Pillar II (i.e. the Rural Development Programme – RDP) of the Common Agricultural Policy. They are measures to restore, preserve and enhance ecosystems related to agriculture and, at the same time, to implement the objectives of rural development policy which include, among others, climate change mitigation and adaptation.

Under the CAP a group of agri-environmental measures are defined. There are many incentives aimed at promoting the sustainable management system, consisting in the rational use of natural resources which makes it possible to limit the adverse impact of agriculture on the environment and prevents the loss of organic matter in soil. The key measures in this area are described below.

Measures supported in Pillar II (RDP):

Sustainable agriculture

The aim of the measure is to promote the sustainable management system and to prevent the loss of organic matter in soil. Support in grant form, financed from the RDP, is available to farmers having agricultural holdings with an area of more than 3 hectares. The payment is allocated annually for a 5-year commitment period to beneficiaries who voluntarily take on the agri-environment-climate commitment within this package.

The support promotes the rational use of natural resources, the limitation of the adverse impact of agriculture on the environment and the prevention of the loss of organic matter in soil. Each year the farmer is obliged, among others, to cultivate at least 4 crops on arable land. The share of the main crop and cereals as a total may not exceed 65%, while, at the same time, the share of each crop may not be less than 10% of the area of arable land. The beneficiary is obliged to apply appropriate crop rotation, consisting in the use of at least 3 groups of crops in a 5-year commitment period on a given parcel of agricultural land. The groups of crops used in crop rotation include plants with similar site-related requirements, i.e. the soil conditions, requirements for preceding crops and agronomic treatments. Under the package, there is also the obligation to annually prepare and comply with a fertilisation plan based a chemical soil analysis. During the 5-year commitment period, the farmer is

obliged to apply a practice intended to increase the organic matter content in soil twice on each agricultural parcel (intercrop, integration of straw/manure).

Soil and water protection

The aim of the measure is to ensure the correct use of soils, protect them against water erosion, prevent the loss of organic matter in soil and protect waters against pollution. The package consists in the promotion of agronomic practices preventing water erosion of soil, the loss of organic matter and the contamination of waters with components leached from soil. The measure in grant form financed under the RDP is available to all farmers. The beneficiary is obliged to apply at least one of the following agronomic practices on a given plot: a winter catch crop, a stubble catch crop or protective grassland belts laid out on arable land situated in areas susceptible to erosion (with an inclination of more than 20%) across the slope.

Support for the conservation of valuable habitats and endangered bird species

The measure provides support financed under the RDP for the conservation of valuable habitats and endangered bird species on Natura 2000 sites and outside Natura 2000 sites. The aim of the measure is to restore or maintain the traditional and extensive use of meadows and pastures, to prevent the decline of valuable natural habitats and to improve the nesting conditions of bird species associated with the agricultural landscape. As part of the requirements of the nature packages and their variants, it is forbidden to apply selected agronomic treatments, such as: harrowing, ploughing, reseeding, rolling, liming, the application of plant protection products, the creation and expansion of water drainage facilities. In addition to these general requirements, specific requirements apply; they are selected so as to ensure that when they are applied a valuable natural habitat or a bird breeding site is preserved in as good a condition as possible.

Measures supported in Pillar I of the CAP (direct payments):

Agricultural practices beneficial for climate and environment – Greening

Since 2015 all the farmers eligible to receive a single area payment have received payments for agricultural practices beneficial for the climate and the environment, i.e. greening. Depending on the area of arable land in their agricultural holdings, the share of permanent grassland and the presence of permanent grassland with natural values, the farmers are obliged to comply with greening practices. Greening is usually implemented through crop diversification, the maintenance of existing permanent grassland and the maintenance of ecological focus areas (EFAs). On a mandatory basis, 30% of the amount for direct payments will be allocated to greening. The payment is made under Pillar I of the CAP.

Principle of cross-compliance, including good agricultural environmental conditions (GAEC)

The purpose of the principle of cross-compliance is to encourage farmers to comply with the high EU standards of public health, plant health, as well as animal health and welfare. The principle of cross-compliance is of essential importance for ensuring the sustainable character of European agriculture. The amounts of direct and area payments to farmers under RDP 2007-2013 and RDP 2014-2020 depend on their fulfilment of the principle of cross-compliance, consisting in specific standards for maintaining the land within their agricultural holdings in good agricultural and environmental conditions (GAEC) and the statutory management requirements (SMRs).

The dependence of the amounts of payments received by farmers on their fulfilment of specific requirements and standards means that in case of failure to comply with the obligations described above the allocated direct payments are reduced accordingly.

The requirements of a good agricultural practises aim at strengthening the standards for environmental protection and climate change mitigation and their purpose is, among others, to ensure the correct soil management by compliance with the standards for the prevention of soil erosion, the limitation of degradation of organic matter, the prevention of changes in the soil structure, the correct management of water resources in agriculture and the protection of waters against pollution. Irrespective of whether they are supported under the CAP or not, all farmers must comply with the basic management requirements. These requirements include EU regulations on public health, plant and animal health, animal welfare and the environment. The cross-compliance requirements constitute a mechanism linking the payments under Pillar I of the CAP and certain RDP measures implemented under Pillar II of the CAP.

Measure 44: Supporting adaptation and mitigation measures in agricultural holdings (a group of measures)

Greenhouse gases affected: CH_4, N_2O, CO_2

Status: implemented

The agriculture sector can reduce its impact on the climate by changing its animal production, improving its manure management, enhancing its use of energy from renewable sources and also improving the energy efficiency of the buildings of agricultural holdings. Such measures are supported by the RDP for 2014-2020 and they are described below.

Investments for the restoration of agricultural land and production potential damaged by natural disasters, adverse climatic events and catastrophic events

The measure supports investments for the restoration of the potential of plant or animal production damaged by natural disasters, including animal diseases, adverse climatic events and catastrophic events. The aid is intended for the restoration of those assets of the production potential of an agricultural holding that have been destroyed or damaged as a result of the events listed above. In the case of disasters involving animal diseases, the production potential may be restored in the scope other than affected by a disaster.

Investments to protect waters against pollution by nitrates from agricultural sources

The aim of the measure is to protect waters against nitrates from agricultural sources by adapting agricultural holdings to ensure that they comply with the requirements laid down in the Action Programme to Reduce Water Pollution Caused by Nitrates from Agricultural Sources and to Prevent Further Pollution for the conditions of storage of natural fertilisers or silage produced at the agricultural holding or retrofitting of the agricultural holding with equipment for the application of natural fertilisers directly to the ground. Support is granted for retrofitting of the agricultural holding with slabs or tanks for storing natural fertilisers and silage and for the purchase of new machinery and equipment for the application of liquid natural fertilisers to the soil.

Modernisation of agricultural holdings

Support is granted for measures which contribute to improving the overall results of agricultural holdings. The improvement of the overall results of agricultural holdings is understood to mean improved competitiveness and enhanced profitability of agricultural holdings. The preferred measures which are eligible for support should contribute to environmental protection or climate change mitigation. They include:

- the construction or modernisation of livestock buildings or feed storage sites;

- the measures contributing to increasing a share in the market or diversifying agricultural production or those related to organic farming.

Restructuring of small agricultural holdings

Restructuring of small agricultural holdings is available for agricultural holdings with the economic size of less than EUR 13,000. Restructuring means fundamental changes in agricultural holdings with the aim of enhancing their competitiveness and profitability by increasing their economic size, in particular, as a result of a change in the profile of their agricultural production.

Premiums for young farmers

Support is available for starting and developing the agricultural activity at an agricultural holding as well as for preparing for sales of agricultural products produced at the agricultural holding. In accordance with the regulations in effect, support can be sought by persons who are not older than 40 years, have the relevant skills and start for the first time the agricultural activity at an agricultural holding as the only head of the agricultural holding.

As part of the restructuring of small agricultural holdings and premiums for young farmers, when establishing the order of the award of assistance, additional points may be given to applications for the award of assistance which include the investment projects specified in the list of investment projects contributing to environmental protection or climate change mitigation. Among others, these investment projects include the retrofitting of agricultural holdings with urine or slurry tanks, manure slabs with side walls and a urine tank and ventilation systems using air filters.

Measure 45: Organic farming

Greenhouse gases affected: CO_2, N_2O, CH_4,

Status: implemented

The production in an organic agricultural holding is carried out in accordance with the principles of sustainable development, activates biological processes by using natural means of production and ensures the durable fertility of soil and the viability of plants and animals. In particular, this production consists in the application of correct crop rotation and other natural methods to maintain or enhance the biological activity and fertility of soil, as well as the selection of plant species and varieties and animal species and breeds taking into account their natural immunity to diseases.

The aim of this measure, included in the RDP 2014-2020, is to support the voluntary commitments of farmers who undertake to maintain or shift to the production practices and methods laid down in the provisions relating to organic farming in the Regulation of the Minister of Agriculture and Rural Development of 13 March 2015 on the detailed conditions and procedure for the award of financial assistance under the measure "*Organic farming*" included in the Rural Development Programme for 2014-2020 (consolidated text in the Official Journal of the Laws of 2018, Item 1784, as amended).

The production by organic methods ensures a high quality of the product produced using to as large an extent as possible natural methods which do not affect the natural equilibrium. This principle applies to all the types and stages of production – both plant production and livestock rearing, aquaculture products and processing. In particular, this production consists in the application of correct crop rotation and other natural methods to maintain or enhance the biological activity and fertility of soil, as well as the selection of plant species and varieties and animal species and breeds taking into account their natural immunity to diseases.

The measure is addressed to farmers who commit to maintaining organic farming practices consisting in the resignation from using agricultural, veterinary and food-related chemicals. Organic farming involves, among others:

- maintaining and improving soil life, the natural fertility, stability and biodiversity of soil – thus enhancing the abundance of organic matter in soil and limiting the need for fertilisation;
- preventing and tackling soil erosion;
- using crop rotation – thus maintaining a positive balance of organic matter;
- resigning from the use of artificial fertilisers and plant protection products from chemical synthesis;
- using catch crops – thus enhancing carbon fixation in the biosphere, limiting erosion and, thereby, the decomposition of soil, and reducing the need for fertilisation;
- a closed circulation system by linking plant and animal production with the fertilisation level adapted to the nutritional needs of plants;
- sustainable fertilisation.

Measure 46: Rationalisation of fertiliser use (a group of measures)

Greenhouse gases affected: N_2O, CO_2

Status: implemented

The rationalisation of fertiliser use involves a group of measures including the Nitrate Programme, the ban on the use of urea in specific cases and the Soil Regeneration Programme. These measures are implemented pursuant to legal regulations (the Act on Water Law, the Act on Fertilisers and Fertilisation and the Act on the Main Inspectorate of Plant Health and Seed Protection).

Nitrate Programme

The Minister responsible for water management was obliged by the Act on Water Law of 20 July 2017 to develop a programme with the basic purpose of diminishing water pollution caused by the fertilisation of agricultural land with natural fertilisers (urine, slurry and manure) containing nitrogen compounds and preventing further pollution of this type. In consequence, in 2020 the Action Programme to Reduce Water Pollution Caused by Nitrates from Agricultural Sources and to Prevent Further Pollution was adopted.

The most important measures set out in the Programme include:

- the establishment of the conditions for the land application of nitrogen fertilisers near waters, on steeply sloping ground, on frozen, water-flooded or snow-covered ground;
- the adoption of the periods when the land application of fertilisers is allowed;
- the determination of the storage conditions for natural fertilisers and the handling of leachates;
- the manner of calculating the annual dose of natural fertilisers containing not more than 170 kg N/ha;
- the introduction of the obligation to prepare a nitrogen fertilisation plan.

The implementation of the Programme will involve the adaptation of the infrastructure of agricultural holdings to ensure that they comply with the requirements laid down in the Programme, i.e. the implementation of investment projects to build equipment for the storage of natural fertilisers and the preparation of a fertiliser balance and a nitrogen fertilisation plan.

In addition, the owners of agricultural holdings have been obliged to keep documentation, including records on the fertilisation with nitrogen-containing fertilisers, contracts concluded in the case of the transfer of natural fertilisers and the calculations of the maximum nitrogen dose or the use of nitrogen fertilisation plans.

All the agricultural holdings are obliged to comply with the rules for the application of nitrogen-containing fertilisers, i.e.:

- the periods of the application of fertilisers;
- the periods when the land application of fertilisers is inappropriate;
- the application of fertilisers to steeply sloping ground;
- the agricultural application of fertilisers to frozen, water-flooded, water-saturated or snow-covered ground;
- the fertilisation near natural watercourses, water reservoirs, canals, ditches and water intakes;
- compliance with the levels of nitrogen doses in natural and mineral fertilisers ensuring their appropriate use by crops and posing no risk of water pollution;
- ensuring the capacity and construction of storage vessels for livestock excreta (natural fertilisers) and preventing leachates from silage storage.

Ban on the use of urea in granulated form without a urease inhibitor or without a biodegradable coating

In 2020, an amendment to the Act on Fertilisers and Fertilisation and the Act on the Main Inspectorate of Plant Health and Seed Protection imposed a ban on the use of urea without a urease inhibitor or without a biodegradable coating. The ban has been in effect since 1 August 2021. This solution will improve fertilisation efficiency and air protection.

Soil Regeneration Programme

Soil liming is an important factor shaping the quality and safety of the natural environment in the specific soil and climate conditions. The NFOŚiGW manages the National Programme for Environmental Regeneration of Soils by Liming. The aim of the Programme is to support treatments to regenerate soils acidified as a result of the impact of anthropogenic factors. The Programme provides for soil regeneration in an area of at least 250,000 ha. Soil liming is an important factor shaping the quality and safety of the natural environment in the specific soil and climate conditions. The Programme will be implemented in the period from 2019 to 2023.

By 6 May 2021 agricultural producers had submitted more than 28,000 applications with the value of PLN 106.4 million, which will enable regeneration of about 118,000 ha of soils. Grants are awarded as part of *de minimis* aid in agriculture.

Measure 47: Research and scientific and educational projects in the scope of rational and low-emission agricultural production (a group of measures)

Greenhouse gases affected: CO_2, CH_4, N_2O

Status: implemented

At present, a number of research projects are carried out in Poland to develop rational and low-emission agricultural production. They include national and international projects.

AgroFossilFree – Agriculture free from fossil fuels

The aim of the AgroFossilFree project is to pave the way for zero-emission agriculture in the EU by diminishing the consumption of energy from fossil fuels, more efficient energy use, optimising agricultural production, reducing greenhouse gas emissions and enhancing economic, agronomic and environmental benefits.

AgroFossilFree is based on a "*multilateral approach*" including a consortium of scientists and researchers, organisations of farmers and industrial partners. In the project, Poland is represented by the Institute of Soil Science and Plant Cultivation – National Research Institute in Puławy and the Lublin Agricultural Advisory Center in Końskowola. The project is financed from the EU resources from the Horizon 2020 Programme.

The establishment of an effective model of an interactive system to support agrochemical decisions to optimise the fertilisation and the protection of waters against agricultural pollutants

The aim of the project is to establish of an effective model of an interactive system to support agrochemical decisions. The project includes the following tasks:

- the establishment of an effective model of an interactive system to support agrochemical decisions to optimise the fertilisation and the protection of waters against agricultural pollutants in arable land;
- the establishment of an effective model of an interactive system to support agrochemical decisions to optimise the fertilisation and the protection of waters against agricultural pollutants in grassland;
- the implementation of a model of an interactive system to support agrochemical decisions to optimise the fertilisation and the protection of waters against agricultural pollutants in grassland.

The project is co-financed by the National Centre for Research and Development from public resources as part of the Strategic R&D Programme GOSPOSTRATEG – "*Poland's Social and Economic Development in the Conditions of Globalising Markets*".

Rural development through renewable energy sources - Renew(able) your Region - RENALDO

The aim of the RENALDO Project is to provide expert support for the preparation of the first, pilot energy cooperatives in 6 municipalities in Kujawsko-Pomorskie and Podlaskie Voivodeships. The project is coordinated by *Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH* (GIZ), while the project is implemented by the 100 prozent erneuerbar stiftung from Germany, the ACTIVUS Institute of Community Development in Podlaskie Voivodeship and the Kujawsko-Pomorski Agricultural Advisory Centre in Kujawsko-Pomorskie Vovodeship).

As part of these actions, the energy demand and locally available renewable energy sources will be analysed in depth for each of the pilot energy cooperatives. Depending on the needs of a potential cooperative and its members, the proposed solutions will indicate the optimum selection of types and capacity of the installations of renewable energy sources and the complete founding and registration documentation for a given cooperative.

Mitigating greenhouse emissions from livestock systems (MELS)

The MELS project will build on the Global Research Alliance DATAMAN project by collating additional data on emissions from manure management and activity/ancillary data. The data will be used to generate functional relationships between emissions and activity/ancillary variables, enabling a refinement of national inventories and a better assessment of the cost-effectiveness of a range of mitigation measures. The MELS will assess and recommend improvements to existing farm-scale decision support systems (DSSs) in relation to GHG emissions from livestock production systems, including grazing ruminants, by refining the calculations used to account for emissions. A prototype farm-scale DSS will be developed for countries lacking such a tool and implemented in at least one country. This will allow the consequences of mitigation strategies on emissions and costs to be more accurately quantified and better documented, both at the national and farm scales. 9 partners, including the University of Zielona Góra in Poland, take part in the project.

Network for Innovation in Agriculture and Rural Areas (SIR)

The objective of the establishment of the Network for Innovation in Agriculture and Rural Areas is to support innovations in agriculture, food production, forestry and rural areas. The SIR operates within the framework of the National Rural Development Network and has an open character.

The structure of the SIR is based on the public agricultural advisory system. The operation of the SIR is supported by the state agricultural advisory centres: the Agricultural Advisory Centre in Brwinów (CDR) as the Network Coordinator and 16 Voivodeship Agricultural Advisory Centres as units carrying out the tasks of the Network in particular Voivodeships. The aims of the measure include:

- facilitating the creation and functioning of a contact network linking farmers, advisory bodies, research units, entrepreneurs in the agri-food sector and other entities supporting the implementation of innovations in agriculture and rural areas;
- facilitating the exchange of expertise and good practices in the area of innovation in agriculture and rural areas;
- assistance in the creation of the Operational Groups of the European Innovation Partnership and assistance in the development of projects by the Operational Groups and partnerships for innovation.

The partners within the network can be all the entities involved in the development of agriculture and rural areas, including scientific units, entrepreneurs, farmers, farmers' organisations and sectoral organisations.

Measure 48: Development of agricultural biogas plants (a group of measures)

Greenhouse gases affected: CH_4, CO_2

Status: implemented

A biogas plant is an installation which produces at the same time electricity, heat and environmentally friendly fertiliser. Agricultural biogas plants are a specific type of such plants. In their agricultural biogas production they use agricultural raw materials, agricultural side-products, liquid or solid manure, side-products, waste or residues from the processing of products of agricultural origin or forest biomass, or plant biomass collected from areas other than those registered as agricultural or forest land, excluding biogas generated from raw materials coming from wastewater treatment plants and waste landfills.

Energy generation at agricultural biogas plants contributes to alleviating the problem of the storage of agricultural waste and, at the same, reduces the methane emissions into the atmosphere from digestion of freely stored biomass. The processing of organic substances can also be the source of a valuable fertiliser for agriculture.

In accordance with the Act on Renewable Energy Sources, the economic activity to produce agricultural biogas or electricity from agricultural biogas in an installation other than a micro installation is a regulated activity within the meaning of the Entrepreneurs Law and requires entry into the register of agricultural biogas producers. At present, the register of agricultural biogas producers in Poland includes 123 agricultural biogas plants owned by 107 economic operators.

Until 2020 the Programme "Directions of the Development of Agricultural Biogas Plants in Poland was implemented in 2010-2020" was implemented in Poland. At present, agricultural biogas plants are supported under Part 2 of the Agroenergy Priority Programme.

The reduction effect of this measure was estimated on the basis of the data on the electricity and heat production at agricultural biogas plants from renewable raw materials, available in the register of agricultural biogas producers managed by the National Support Centre for Agriculture (KOWR) and using the CO_2 emission factor for the electricity production in Poland in 2020.

Education and promotion projects

The Foundation for the Development of Polish Agriculture (FDPA) implemented education projects on the construction and operation of biogas plants, such as training courses and regional conferences of agricultural advisors from Agricultural Advisory Centres, local governments and farmers. Moreover, publications were prepared, including e.g. "*Biogas plants – An opportunity for farmers and the environment*" in 20,000 copies; "*Agricultural biogas plants – Myths and facts*" in 1,000 copies; and "*Digested fertiliser for agriculture*" in 20,000 copies. In addition, the manual "*The Design of an Agricultural Biogas Plant – A Public Matter*" was prepared and published. It was dedicated to the representatives of city offices and sent out to all the rural and urban-rural municipalities in Poland. A website was also launched for the municipal staff wishing to become acquainted with the issues related to biogas plants. Since 2014 the agricultural schools supervised by the Ministry of Agriculture and Rural Development have educated in the profession "*technician of renewable energy generation equipment and systems*" which is attested by the certificate of an installer of micro- and small renewable energy generating installations. The education in this profession is delivered in 14 schools managed and supervised by the Minister of Agriculture and Rural Development and to date a total of 457 students have graduated from them. Since 2016 180 graduates have acquired professional qualifications in this field.

Agreement on cooperation for the development of the biogas and biomethane sectors in Poland

Moreover, Poland plans to introduce solutions enabling the production and use of biomethane. On the initiative of the Ministry of Climate and Environment, "*The agreement on cooperation for the development of the biogas and biomethane sectors*" was signed on 23 November 2021. The aim of the Agreement is to support the development of the biogas and biomethane sectors by working out solutions the implementation of which would stimulate their development. The initiative is expected to assist in increasing the share of Polish entrepreneurs and technologies in the supply chain for the construction and operation of domestic biogas and biomethane plants. The parties to the Agreement include the representatives of the government administration, as well as the representatives of entities participating in the supply chain for the biogas and biomethane sectors, business environment organisations, financing institutions and the representatives of science. The Agreement sets out a framework for the partnership between the Government and a wide range of stakeholders for the achievement of a common goal of using the national potential to build a modern, innovative and low-emission economy.

Measure 49: Reduction of food losses (a group of measures)

Greenhouse gases affected: CH_4, CO_2

Status: implemented

Food waste is one of the most important problems of the contemporary world. Food losses and waste occur at all the stages of the agri-food chain, starting from the primary production (agriculture), through storage, processing, transport and distribution, to consumption.

Obligation to reduce food waste in retail trade

The Act on the Prevention of Food Waste of 19 July 2019 introduced a mechanism mobilising the sellers of food to avoid its waste. It imposed on larger shops (with an area of more than 250 m^2) the obligation to sign agreements with non-governmental organisations and the obligation to transfer unsold food, which is still fit for consumption, to these organisations free of charge. It also provides for penalties for wasting food which could have been used and for failure to sign the agreements. Food will be transferred by the non-governmental organisations specified in the Act to those in need of such support. The penalties for food waste go to the account of the organisation with which the seller has signed an agreement. In case an agreement has not been signed, the charge goes to the bank account of the Voivodeship Fund for Environmental Protection and Water Management.

Programme to rationalise and reduce food waste (PROM)

The Project "*Developing a system for monitoring wasted food and an effective program to rationalize losses and reduce food waste*" (PROM) is the first research project to strengthen public institutions in the management of food losses and waste and to prepare a plan to prevent food losses and waste. It is financed by the National Centre for Research and Development.

The Project consists in the investigation stage and the stage of application in practice. The investigation stage included the estimation of food losses and waste in Poland, the development of a model for food losses and waste for the purposes of national and EU reporting, the assessment of opportunities for reducing food waste by enterprises, catering and consumers at the national and local levels, the development of the assumptions for monitoring the distribution of food for social purposes.

The stage of application in practice included: the development of the national strategy for reducing food losses and waste, the building of societal attitudes and social capital around the campaign "*Don't Waste Food*", the implementation of the monitoring of food redistributed for social purposes for the national and EU reporting and the execution of a feasibility study for a mini exchange of food donations. The recommendations contained in the strategy concern legislative and tax-related changes to support the reduction of food waste, the actions to address the causes and to estimate the extent of food waste, the actions intended to reduce food waste and the actions to raise the public awareness about the scale of food losses.

Community, non-governmental and intra-sectoral initiatives

The initiatives to reduce food waste which have gained popularity with the public and deserve special attention in light of their effects and positive impact include, among others:

- Food Banks – it is a community of 32 non-governmental organisations associated in the Federation of Polish Food Banks (FPBŻ). The aim of their activity is to prevent food waste and combat hunger. The Food Banks operate via charity foundations which are involved in the distribution and the provision of food to those in need. Food products are taken from places where there is excessive production, food shops where the use by date of products will soon expire, donors and sponsors. The mission of the Federation is also to raise public awareness based on the prevention of wasting food products;
- Food Cloud system – a good practice implemented to reduce food losses and waste is the Food Cloud system, which has also been developed by the FPBŻ. This scheme is dedicated to charity organisations. The Food Cloud enables them to be notified by shops about availability of food to be picked up and records the history of the pickups, thus allowing for a review of the donations collected;
- the public campaign "*I do not waste, I package it*" – the aim of the campaign is to reduce food waste in catering establishment (it promotes the option of taking home the uneaten part of

a meal, it is carried out by using yellow stickers to mark restaurants which support the option of taking home the uneaten part of a meal;
- the campaign "*Eat without Remorse*" – the aim of this education campaign is to develop the habit of consciously avoiding food waste in households, it is carried out by the IOŚ-PIB as part of the PROM project.

It is also important to note the procedure worked out as part of the MOST (the Model for Reducing Food Losses and Waste with Benefits for Society) Project. The aim of the Project is to develop and implement procedures for reducing food losses and waste using the MOST in enterprises in the food sector. The aim of the Project is to introduce a novel approach to the building of the social responsibility among all the participants in the food chain and to raise the public awareness about food losses in Poland. The basic solution as part of the Project is to transfer food, especially products with a short shelf life, to food banks.

A good practice, which has been applied for several years now in cooperation between the FPBŻ and the NFOŚiGW, is school-based education on avoiding food waste – ECO MISSION (EKO MISJA). This project requires knowledge and involvement of teachers and students.

Measure 50: Eco-schemes (a group of measures)

Greenhouse gases affected: CO_2, N_2O

Status: planned

The CAP Strategic Plan 2023-2027 provides for a new form of support for farmers – so-called eco-schemes. The EU Member States will have to allocate at least 20% of direct payments to this instrument. Eco-schemes are voluntary schemes of payments to farmers for the implementation of practices beneficial for the environment, climate and animal welfare which go beyond the obligations specified in conditionalities. The instrument has been designed so as to bring as many environmental benefits as possible and, at the same time, encourage farmers to actively engage in actions for environmental protection and climate change mitigation. Eco-schemes will be annual payments for the implementation of practices beneficial for the environment which go beyond the basic obligations.

Eco-scheme for carbon farming and nutrient management

The eco-scheme for carbon farming and nutrient management will include 8 practices, i.e.: the extensive use of permanent grassland with livestock, winter catch crops/undersown crops, the preparation of and compliance with a fertilisation plan – the basic option and the option with liming, a diversified structure of crops, manure mixing on arable land within 12 hours of application, the application of liquid natural fertilisers otherwise than by spraying, simplified cultivation systems and mixing straw with soil. This eco-scheme will be carried out on the basis of a scoring system, where 1 point given for each practice used corresponds to an amount of almost PLN 100.

Eco-scheme for water retention on permanent grassland

The aim of the eco-scheme is to promote water retention which improves water management and also reduces carbon dioxide emissions into the atmosphere (by limiting the decomposition of organic matter). The payment will be awarded to farmers making their permanent grassland available for water retention purposes, when it is situated on sites where in the growing period in a given year there are actually flooding and inundation events. The implementation of the eco-scheme will be based on satellite monitoring. This intervention provides an opportunity for compensation for possible losses caused by flooding and/or inundation of permanent grassland.

4.2.8. Policies and measures in the forestry sector

This Section presents documents of a strategic character, legal regulations, policies and measures associated with the forestry sector which contribute to greenhouse gas emission reductions and/or removals. The measures in the forestry sector mainly concern agricultural land and forest land and the augmentation of forest cover in Poland.

Key strategies, plans and programmes

The table below lists the key strategies, plans and programmes associated with the forestry sector which affect its functioning and condition environmental protection and climate change mitigation.

Table 4.25. Key strategies, plans and programmes in the forestry sector

Title	Description
Implemented	
Strategic Plan for the Common Agricultural Policy 2023-2027, adopted by the European Commission on 31 August 2022	The Strategic Plan for the Common Agricultural Policy 2023-2027 is addressed to farmers. In the new perspective, support will be available for investments to augment forest cover, improve the condition of forests in Poland and to strengthen their biodiversity.
Rural Development Programme (RDP) for 2014–2020, approved by the European Commission on 12 December 2014	The Programme sets out the objectives, priorities and principles of support for the development of rural areas with the resources of the European Agricultural Fund for Rural Development (EAFRD) under Regulation (EU) 1305/2013 of the European Parliament and of the Council of 17 December of 2013 on support for rural development by the EAFRD (OJ L 347, 20.12.2013, p. 487, as amended). The most important objective of the Programme is to enhance the competitiveness of agriculture, while taking into account environmental objectives. The RDP for 2014-2020 is based on the implementation of six priorities, two of which directly concern the natural environment and climate change mitigation, i.e. the protection of ecosystems and the efficient management of natural resources. The Programme was extended until 31 December 2022 (by Regulation (EU) 2020/2220 of the European Parliament and of the Council of 23 December 2020 [OJ L.437, 28.12.2020, p. 1]).
National Programme for the Augmentation of Forest Cover (KPZL), adopted by the Council of Ministers in 1995 and updated in 2014	The Programme lays down the tasks intended to augment the national forest cover to 30% by 2020 and 33% by 2050. It defines the area of agricultural land designated for afforestation and presents a comprehensive action plan to rationalise the structure of uses of the natural space in the country.
National Forestry Policy (PLP), adopted by the Council of Ministers on 22 April 1997	The document sets out the directions of actions in the area of forestry and indicates the linkages of forestry in intersectoral and international systems.

Source: Elaborated by the KOBiZE IOŚ-PIB

Key legal acts

The table below lists the key legal acts associated with the forestry sector which affect its functioning and condition environmental protection and climate change mitigation.

Table 4.26. Key legal acts in the forestry sector

Title	Description
Implemented	
Act of 16 April 2004 on Nature Conservation (Official Journal of the Laws of 2022, Item 916, as amended)	The Act sets out the scope of conservation necessary to effectively protect Natura 2000 sites, fulfilling obligations under Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (the so-called Habitats

Title	Description
	Directive) (OJ L 206, 22.07.1992, p. 7, as amended) and Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (the so-called Birds Directive) (OJ L 20, 20.01.2010, p. 7, as amended), and to achieve to the adequate extent the objectives of both Directives – to maintain or restore the favourable state of conservation of the objects of conservation in the Natura 2000 network.
Act of 3 February 1995 on the Protection of Agricultural Land and Forest Land (Official Journal of the Laws of 2021, Item 1326, as amended)	The Act regulates the principles of the protection of agricultural land and forest land, their remediation and the increase of their utility value and also defines the possible conversion of agricultural land and forest land to other uses.
Act of 28 September 1991 on Forests (Official Journal of the Laws 2022, Item 672)	The Act sets out the principles of the preservation, conservation and augmentation of forest resources and the principles of forest management in relation to other elements of the environment and the national economy. Their purpose is to preserve forests and their favourable effect on the climate, air, water, soil, human living conditions and health and on the natural equilibrium.
Regulation of the Minister of Agriculture and Rural Development of 26 March 2019 on the detailed conditions and procedure for the award of financial assistance under the sub-measure "*Support for afforestation and creation of woodland*" included in the Rural Development Programme for 2014-2020 (Official Journal of the Laws of 2022, Item 1931)	The Regulation lays down the detailed conditions and procedure for the award, payment and recovery of financial assistance under the sub-measure "*Support for afforestation and creation of woodland*" included in the Rural Development Programme for 2014-2020.
Regulation of the Minister of Agriculture and Rural Development of 26 March 2019 on the detailed conditions and procedure for the award of financial assistance under the sub-measure "*Support for investments improving the resilience and environmental value of forest ecosystems*" included in the Rural Development Programme for 2014-2020 (Official Journal of the Laws, Item 587, as amended)	The Regulation lays down the detailed conditions and procedure for the award, payment and recovery of financial assistance under the sub-measure "*Support for investments improving the resilience and environmental value of forest ecosystems*" included in the Rural Development Programme for 2014-2020
Regulation of the Minister of the Environment of 22 March 2006 on the detailed rules for the fire protection of forests (Official Journal of the Laws of 2022, Item 1065)	The Regulation lays down the detailed rules for the fire protection of forests.
Planned	
Draft Regulation of the Minister of Climate and Environment on the good practice requirements for forest management	The Regulation lays down the procedure to be followed by the forest owner during the preparation and implementation of forest management operations. On 30 June 2022, it was submitted for public consultations.

Source: Elaborated by the KOBiZE IOŚ-PIB

Policies and measures

Measure 51: Rational management of farmland and forestland - the protection of farmland and forestland

Greenhouse gases affected: CO_2

Status: implemented

In order to protect farmland and forestland, legal constraints have been imposed on their conversion. Only the land which is defined in the land register as uncultivated land may be used for

non-agricultural and non-forestry purposes and in its absence so can other lands with the poorest usefulness for production. In the construction of facilities related to industrial activity and also other built structures, solutions which reduce their adverse impact on land should be applied. Moreover, the use of farmland and forestland for non-agricultural and non-forestry purposes requires the consent of the competent institutions.

Measure 52: Forest area development and improvement of the viability of forests (a group of measures)

Greenhouse gases affected: CO_2

Status: implemented

The augmentation of forest cover is an important element of Poland's environmental, spatial and economic policies; in addition, it is one of the main objectives of the National Forest Policy. The implementation of this objective is based on the National Programme for the Augmentation of Forest Cover, adopted by the Council of Ministers in 1995 and updated in 2014. Its aim is to ensure the conditions for increasing the forest cover in the country to 30% of the total area of the country by 2020 (and to 33% in 2050), to optimally distribute afforestation projects and to set out the environmental and economic priorities and implementing instruments.

The measures to develop forest land and improve the viability of forests as included in the Rural Development Programme (RDP 2014-2020) also contribute to achieving the objective of augmenting the forest cover, increasing removals of CO_2 by improving the viability of forests, preventing deforestation, regeneration of forest stands in forest areas and afforestation. The measures to maintain and develop forest land and to improve the viability of forests are carried out in several directions. A system of additional measures related to sustainable forest management provides, among others, for the elaboration of programmes to modify the species composition of forest stands and the horizontal structure of forest stands. According to the GUS data, in the period from 1995 to 2020 283,700 ha was afforested (on average 10,900 ha annually). At the same time, the forest area in Poland grew from 8,756,000 ha in 1995 (29.4% of the area of the country) to 9,260,000 ha in 2020 (30.9%).

Support for afforestation and creation of woodland

Afforestation is hugely valuable for the protection of the climate, soils and waters. Forest areas absorb CO_2, accumulate carbon and improve the water regime of the area. Under the RDP 2014-2020, the measure *Investments in forest land development and improvement of the viability of forest* were continued. This Programme supports measures which directly contribute to sequestration of CO_2, i.e. the reduction of its emissions, with the simultaneous adaptation to climate change. The aim of the measure is to enlarge forest areas by afforestation and creation of woodland. The support is granted for land defined in the register of land and buildings as agricultural land, constituting arable land or orchards, designated for afforestation in the local land use plans and in the studies on the conditions and directions of spatial development. This measure is dedicated to agricultural land which is characterised by low usefulness for agriculture and constitutes a potential area for establishing forest plantations and also for shaping the landscape structure in rural areas. Since 2004 afforestation has been supported by the Rural Development Programme (RDP). Until 2020, this source had supported the afforestation of 80,200 ha, with the largest area afforested under the RDP 2004-2006 (39,300 ha).

Support for investments improving the resilience and environmental value of forest ecosystems

The aim of the sub-measure carried out as part of the RDP 2014-2020 since 2019 is to support investments improving the resilience and environmental value of forest ecosystems. This sub-measure includes investments contributing to restructuring of an unfavourable structure of a forest stand into one close to a natural or semi-natural one. Due to this support, investments are carried out in existing forests aged 11 to 60 years, consisting in diversifying the species composition of tree-stands, which will significantly enhance biodiversity and have a positive effect on soil conditions by protecting soils against harmful abiotic factors.

This sub-measure is addressed to private forests which need significant outlays to maintain them in a good condition. The aim of the support is to diversify the species composition of forest stands (mostly coniferous monocultures) by introducing broadleaved species under the canopy of a forest stand (the second storey, the understorey and filling in gaps), which significantly enhances biodiversity. At the same time, by protecting the soil against harmful abiotic factors, it has a positive effect on the soil conditions. In addition, it will improve the resilience of forest stands to harmful biotic factors by establishing forest clusters of specific tree and shrub species as birds' feeding and nesting sites and shelters (including, among others, fruit shrubs and trees) which grow quite densely, thus increasing the ecological stability of forests. The effective achievement of the objectives listed above is strengthened by the protection of underplanting against damage caused by animals, which will improve the biological resilience of forests. Tending cuts carried out in forest stands of younger age classes are intended to alleviate the impact of the extreme weather events and fires, as they enhance the resilience and health of ecosystems. This is particularly important in light of the need for adaptation to climate change. This sub-measure is addressed to private forests which need significant outlays to maintain them in good condition.

Forest Carbon Farms (LGW)

The aim of the measure implemented by State Forests is to demonstrate the role of forest areas in mitigating the adverse impacts of climate change and removing atmospheric CO_2. The measures related to the LGW are carried out in 23 Forest Districts. It is expected that they will be continued for 30 years and that their outcome will be monitored. In the selected Forest Districts, additional measures are taken, consisting in the expansion of the vertical structure of forests by introducing a new generation under the protection of old trees, applying different methods of forest regeneration and tending works to limit carbon emissions from soil and using species with greater natural ability to remove CO_2.

The works are carried out in selected forest areas and aim at storing additional carbon stocks. The pilot part covers a 10-year period (2017-2026), while the effects and their durability will be modelled for a period of 30 years. The expected effect of these works is the creation of an original Polish model of carbon balancing in a forest ecosystem. This model will enable an analysis (over a specific time) of changes in accumulated carbon stocks in all the forest layers, including the often ignored layers of undergrowth, understorey, litter or soil, taking different silviculture scenarios into account. The project as a whole is financed by State Forests from the Forest Fund.

The reduction effect of this group of measures was estimated as the product of the projected augmentation of forest cover and the greenhouse gas removal rate for afforested land.

4.2.9. Policies and measures in the waste sector

This Section presents documents of a strategic character, legal regulations, policies and measures associated with the waste sector which contribute to greenhouse gas emission reductions.

The aim of the measures in the waste sector is to develop water and wastewater management and waste management by implementing appropriate investment projects, among others, both to reduce the quantity of untreated wastewater and the amounts of pollutant loads and to pursue rational waste management.

Key strategies, plans and programmes

The table below lists the key strategies, plans and programmes associated with the waste sector which affect its functioning and condition environmental protection and climate change mitigation.

Table 4.27. Key strategies, plans and programmes in the waste sector

Title	Description
Implemented	
National Programme for Municipal Wastewater Treatment (KPOŚK), the last (sixth) update adopted by the Council of Ministers on 5 May 2022	The KPOŚK identifies the needs of agglomerations in the scope of wastewater management and sets out an action plan for equipping them with wastewater collecting systems and municipal wastewater treatment plants. The document provides information on investments planned to be carried out to build and modernise wastewater collecting systems and the measures to build, expand and/or modernise municipal wastewater treatment plants. The Programme is updated every four years. The most recent update is the sixth one (AKPOŚK 5). It estimated the needs and laid down the actions to further equip agglomerations with wastewater collecting systems and municipal wastewater treatment plants. The document covers 1,524 agglomerations with a population equivalent (p.e.) of not less than 2,000 and includes a list of investments which they plan and which would contribute to reducing the discharges of insufficiently treated wastewater and their adverse impact on the water environment. Territorial self-government units which make up an agglomeration are expected to implement these planned investments by the end of 2027.
Roadmap for Transition to the Circular Economy (CE Roadmap), adopted by the Council of Ministers on 10 September 2019	The idea of the circular economy (CE) is reflected in the Roadmap for Transition to the Circular Economy, which is one of the strategic projects included in the SOR2020. This document contains a set of instruments, both legislative and other than legislative ones, and its aim is to create the conditions for the implementation of the new economic model which the CE constitutes. The document includes measures which fall within the competence of different Ministries. The actions proposed in the CE Roadmap primarily include analytical and conceptual works, information, promotion and coordination in the individual areas covered by the Roadmap. Poland's CE priorities are as follows: - Innovation, the strengthening of the cooperation between industry and science and, as a result, the implementation of innovative solutions in the economy; - The creation of a European market of recyclables where their flows would be easier; - Ensuring high-quality recyclables which would result from sustainable production and consumption; - The development of the services sector.
Strategy for the Management of Municipal Sewage Sludge for 2019-2022, issued by the Minister of Environment on 18 November 2018	The aim of the Strategy is to create the conditions and mechanisms conducive to the solution of the growing problem of managing municipal sewage sludge which is waste. The tasks under the Strategy focus on the processes of treatment of municipal sewage sludge as waste.

Title	Description
National Waste Management Plan 2022 (Kpgo 2022), adopted by the Council of Ministers on 1 July 2016	The National Waste Management Plan 2022 is an update of the Kpgo 2014 and contains the characteristics of the current state of waste management in Poland, a description of the tasks and the objectives to be implemented in the period from 2016 to 2022 by 2030. The objectives of the Kpgo 2022 include, among others, the development of recycling (the targets for 2020, 20025 and 2030), the reduction of the deposition of municipal waste at landfills (to 10% in 2030), the improvement of the recycling levels for post-consumer waste, the establishment of systems for separate collection of green waste and other biowaste in all municipalities, the reduction (to 30% of the weight of the waste generated) of the incineration of municipal waste and waste from its treatment. The detailed measures to achieve waste management targets are defined along with the investment plans in the updated Voivodeship Waste Management Plans.
Planned	
Draft National Waste Management Plan 2028 (Kpgo 2028)	The Kpgo 2028 is an update of the Kpgo 2022 and contains an update of the waste management targets to be achieved in the period from 2023 to 2028 in the context of the current state of waste management in Poland. The expected effects of the implementation of the Kpgo 2028 will include: the reduction of waste generation, the increase of the quantity of waste to be recycled, the elimination of incorrect waste disposal, the raising of the public environmental awareness about waste prevention and the correct handling of waste. On 30 June 2022, the draft was submitted for consultations.

Source: Elaborated by the KOBiZE IOŚ-PIB

Key legal acts

The table below lists the key legal acts associated with the waste sector which affect its functioning and condition environmental protection and climate change mitigation.

Table 4.28. Key legal acts in the waste sector

Title	Description
Implemented	
Act of 20 July 2017 on Water Law (Official Journal of the Laws of 2021, Item 2233, as amended)	The Act regulates water management in accordance with the principle of sustainable development; in particular, the development and protection of water resources, the use of waters, the management of water resources and the issues related to waste water management.
Act of 11 September 2015 on Waste Electrical and Electronic Equipment (Official Journal of the Laws of 2022, Item 1622)	The aim of the Act is to create a waste and electrical waste management system by reducing the quantity and the adverse impact of waste in the form of waste electrical and electronic equipment on the environment, as a result of the imposition of an obligation to separately collect and recover it, including recycling.
Act of 14 December 2012 on Waste (Official Journal of the Laws of 2022, Item 699, as amended)	The Act sets out the principles of waste management in a manner which ensures the protection of human life and health and the environment in accordance with the principle of sustainable development. The Act establishes the waste hierarchy: 1) prevention; 2) preparing for re-use; 3) recycling; 4) other recovery processes; 5) disposal.
Act of 24 April 2009 on Batteries and Accumulators (Official Journal of the Laws of 2022, Item 1113)	The Act establishes the requirements for batteries and accumulators placed on the market and the rules for their placing on the market, as well as the rules for the collection, treatment, recycling and disposal of waste batteries and accumulators.
Act of 10 July 2008 on Extractive Waste (Official Journal of the Laws of 2021, Item 1972, as amended)	The Act sets out the rules for the management of extractive waste and unpolluted soil, the rules for the operation of an extractive waste facility, the procedures for obtaining permits for the management of extractive waste and the procedures for the prevention of major accidents at category A extractive waste facilities.

Title	Description
Act of 20 January 2005 on the Recycling of End-of Life Vehicles (Official Journal of the Laws of 2020, Item 2056)	The Act sets out the rules for dealing with end-of life vehicles in a manner which ensures the protection of human life and health and the environment in accordance with the principle of sustainable development.
Act of 13 September 1996 on the Keeping of Cleanliness and Order in Municipalities (Official Journal of the Laws of 2022, Item 1297, as amended)	The Act sets out the tasks of municipalities and the obligations of property owners related to the keeping of cleanliness and order, the conditions for the performance of operations consisting in the collection of municipal waste from property owners and its management and the conditions for granting permits to providers of services within the scope governed by the Act.

Source: Elaborated by the KOBiZE IOŚ-PIB

Policies and measures

Measure 53: Rational waste management (a group of measures)

Greenhouse gases affected: CH_4, CO_2, N_2O

Status: implemented

Rational waste management involves a measure including a database on products and packaging and on waste management (BDO) and the NFOŚiGW programmes for waste management, consisting of measures covering separate waste collection and waste prevention, waste management installations, the development of the circular economy and support for municipal waste management.

The common aim of this group of measures is to implement the principles of waste management, in particular, the waste management hierarchy by preventing waste generation, reducing the quantity of municipal waste landfilled, establishing and maintaining general systems for separate waste collection, maintaining in the country an integrated and adequate network of waste management installations, expanding or modernising the existing installations.

These directions reflect the assumptions of the National Waste Management Plan 2022 (Kpgo 2022) which provides, among others, for the achievement of the levels of recycling and preparing for re-use of paper, metals, plastic and glass from the municipal waste stream of 50% as a minimum by weight until 2020, 60% in 2025 and 65% in 2030, the reduction of the landfill of municipal waste to 10% as a maximum until 2030, the reduction of the quantity of biodegradable municipal waste deposited at waste landfills and the introduction of the standards of separate municipal waste collection throughout the county. This measure also implements Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98 on waste[47] and Directive (EU) 2018/850 of the European Parliament and of the Council of 30 May 2018 amending Directive 1999/31/EC on the landfill of waste[48].

The reduction effect of this group of measures was estimated under the assumption of the achievement of the objectives of the Kpgo 2022, on the basis of the difference between the projected emission levels and the emission levels in the reference year.

[47] Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98 on waste (OJ L 150, 14.6.2018, p. 109)

[48] Directive (EU) 2018/850 of the European Parliament and of the Council of 30 May 2018 amending Directive 1999/31/EC on the landfill of waste (OJ L 150, 14.6.2018, p. 100)

Database on products and packaging and on waste management *(BDO*)

The database on products and packaging and on waste management (BDO) is an IT system, set up under the provisions of the Act on Waste. The BDO enables the comprehensive collection and management of data on waste management covering:

- the waste arising from packaging and products in packaging placed on the national market, lubricating oils, tires, end of life vehicles, waste electrical and electronic equipment, batteries and accumulators;
- the achieved waste recovery and recycling levels;
- the types and quantities of waste generated;
- landfills of waste;
- the types of waste disposal installations.

Financial support of the NFOŚiGW and POIiŚ for the development of waste management

The table below presents the key information on these measures.

Table 4.29. Key NFOŚiGW and POIiŚ programmes to support the development of waste management

Title	Short description
Separate waste collection and waste prevention	**Aim and scope:** The co-financing of projects contributing to the implementation of the principles of waste management, in particular, the waste management hierarchy: by preventing waste generation and establishing and maintaining general systems for separate waste collection. The measures address the issues related to waste prevention and the maintenance of general systems for separate waste collection, including, among others, the construction or modernisation of stationary points of separate municipal waste collection, the development of technical infrastructure of logistics processes related to the acquisition, storage and distribution of unsold or unused food products, the development of the digitalisation of waste management processes through the purchase of software and hardware to operate the system for separate waste collection and the delivery of dedicated IT training to the staff concerned. **Beneficiaries:** Territorial self-government units and their unions, entrepreneurs, natural persons carrying out economic activities, state enterprises, commercial-law companies with legal personality, non-profit organisations having the status of public benefit organisations and performing the functions of "*food banks*", the Polish Hunting Association, the hunting clubs associated in the Polish Hunting Association. **Form of support:** Grant or loan **Source of financing:** NFOŚiGW
Waste management installations	**Aim and scope:** The aim of the measure is to establish and maintain in the country an integrated and adequate network of waste management installations, to expand or modernise the existing installations for: recovery, recycling, separately collected municipal waste, including biowaste, incineration of waste generated from municipal waste with heat recovery, installations for disposal of waste other than municipal waste in processes other than landfilling, intended to reduce the generated quantity of waste other than municipal one. The adaptation of the existing mechanical-biological treatment plants for the management of non-segregated (mixed) municipal waste to treat separately collected waste. **Beneficiaries:** Territorial self-government units and their unions, entrepreneurs, natural persons carrying out economic activities, state enterprises, commercial-law companies. **Form of support:** Grant or loan **Source of financing:** NFOŚiGW
Circular economy	**Aim and scope:** The dissemination of experiences in the implementation of waste management in a circular economy in selected municipalities with investment projects related, among others to: separate waste collection systems, waste recycling installations, environment-friendly transport, with particular consideration given to collective public transport, energy savings including heat or electricity, a circular economy in households, a circular economy in agriculture or processing of agricultural products, savings of water as a resource in households, municipal economy and enterprises.

Title	Short description
	Beneficiaries: Territorial self-government units, legal persons registered in the territory of the Republic of Poland, organisational units without legal personality to which legal capacity has been conferred by statute, natural persons. **Form of support:** Grant or loan **Source of financing:** NFOŚiGW
Measure 2.2 Municipal waste management, co-financed under the Operational Programme Infrastructure and Environment 2014-2020	**Aim and scopes:** The reduction of the quantity of municipal waste landfilled, among others, by developing infrastructure for waste disposal, incineration with energy recovery, separate municipal waste collection, recovery and mechanical and biological waste treatment. In accordance with the waste management hierarchy, projects are implemented to develop infrastructure enabling the use of the material properties of waste and the energy properties of mixed municipal waste, including the combustible fraction separated from municipal waste and waste from the processing of municipal waste through its incineration with energy recovery. **Beneficiaries**: Territorial self-government units and their unions, the organisational units operating on their behalf, entities providing public services as part of the fulfilment of the own responsibilities of the territorial self-government units, entrepreneurs **Form of support**: Grant **Source of financing:** POIiŚ 2014-2020
PRIORITY PROGRAMME Rational waste management Part 3) Use of alternative fuels for energy generation purposes	**Aim and scope:** Reducing the pressure of the economy on the natural environment and enhancing climate neutrality by transforming the energy sector towards greenhouse gas emission reductions and the improvement of energy efficiency by optimising heat and electricity management by means of alternative fuels instead of conventional ones, thus contributing to the improvement of air and climate quality. The use of treated waste as an alternative fuel diminishes the consumption of natural fuels by reducing the emissions of gases into the atmosphere which would be emitted during the combustion of conventional fuels. The support will be available for projects to build new incineration plants and to expand or modernise existing ones using waste generated from municipal waste with energy production under the conditions of high-efficiency cogeneration. **Beneficiaries:** Territorial self-government units and their unions, entrepreneurs **Form of support:** Grant or loan **Source of financing:** NFOŚiGW, Modernisation Fund

Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of information from the NFOŚiGW

Measure 54: Development of water and wastewater management (a group of measures)

Greenhouse gases affected: CH_4, N_2O

Status: implemented

The development of water and wastewater management is a measure including NFOŚiGW programmes for water and wastewater management which aim to reduce the quantity of untreated wastewater and the amounts of pollutant loads, in particular, those of nutrients, discharged together with treated wastewater into the natural environment.

The implementation of the programmes financed with the national and EU resources contributes to the achievement of the objectives of the National Programme for Municipal Wastewater Treatment (KPOŚK), its updates and the Act on Water Law. They also implement the Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment[49].

The KPOŚK identifies the needs of agglomerations in the scope of wastewater management and sets out an action plan for equipping them with wastewater collecting systems, as well as for the

[49] Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment (OJ L 135, 30.05.1991, p. 40, as amended)

construction, expansion and/or modernisation of municipal wastewater treatment plants. At present, the sixth Update of the KPOŚK of 2022 (AKPOŚK 2022) is in effect, containing a list of tasks planned to be carried out by self-governments in the period until 2027. The AKPOŚK 2022 covers 1,524 agglomerations with a population equivalent (p.e.) of not less than 2,000.

The table below presents the key programmes currently implemented to develop water and wastewater management in agglomerations.

Table 4.30. Key NFOŚiGW and POIiŚ programmes to support the development of water and wastewater management

Title	Short description
Part 1) Wastewater management under the National Programme for Municipal Wastewater Treatment	**Aim and scope:** The improvement of the status of surface wasters and groundwater by the provision of agglomerations with wastewater collection systems and wastewater treatment plants. **Beneficiaries:** Territorial self-government units and their unions, the entities providing public services as part of the fulfilment of the own responsibilities of the territorial self-government units **Form of support:** Loan **Source of financing:** NFOŚiGW
Part 2) Co-financing of the projects of the Operational Programme Infrastructure and Environment 2014-2020 Measure 2.3 Water and sewage management in agglomerations	**Aim and scope:** The co-financing of projects to increase the number of inhabitants using an improved system for municipal wastewater treatment ensuring enhanced nutrient removal. The expansion or modernisation of municipal infrastructure, among others, by using advanced technologies or ensuring enhanced nutrient removal or increased capacity of the system, to account for an expansion of the wastewater collection system. These measures should also contribute to the reduction of the energy intensity of systems and thus have a positive effect on climate policy and reduce the consumption of natural resources. **Beneficiaries**: Territorial self-government units and their unions, the organisational units operating on their behalf, entities providing public services as part of the fulfilment of the own responsibilities of the territorial self-government units **Form of support:** Grant **Source of financing:** POIiŚ 2014-2020

Source: Elaborated by the KOBiZE IOŚ-PIB on the basis of information from the NFOŚiGW

The reduction effect of this group of measures was estimated under the assumption of the achievement of the objectives of the KPOŚK, on the basis of the difference between the projected emission levels and the emission levels in the reference year.

4.2.10. Conclusions

Section 4.2. presented the policies and measures for the particular sectors, i.e. the cross-sectoral policies and measures and the policies and measures in the sectors of energy supply, energy consumption, transport, industrial processes, agriculture, forestry and waste. The table lists the key information on them and the available data on the estimated reduction effects. The scope of information presented in this table is the same as that of the information contained in the CTF Table 3 of the Biennial Report BR5.

Table 4.31. Summary information on the policies and measures in the particular sectors

Item	Measure	Included in the scenario WEM	Sector affected	Greenhouse gases affected	Aim and/or activity affected	Type of instrument	Status of implementation	Short description	Start year of implementation	Implementing institution	Estimated emission mitigation effect [kt CO_2 eq.]	
											2020	2030
1	Measure 1: Greenhouse gas emission allowance trading system (EU ETS)	Yes	Cross-sectoral	CO_2, N_2O, PFCs	The GHG emission reduction in the EU in a cost-effective manner according to the reduction targets set out for 2020 and 2030 compared with 2005 emission levels	Regulatory, economic	Implemented	The EU ETS system covers energy and industrial installations and aircraft operators, with the system covering only flights within the EU and the three European countries from the EEA area which have acceded to the system, i.e. Iceland, Liechtenstein and Norway. Each installation and aircraft operator covered by the system must annually account for their greenhouse gas emissions with their emission allowances (EUAs).	2005	Minister of Climate and Environment	NE	NE
2	Measure 2: Emission reductions in non-ETS sectors (a group of measures)	Yes	Cross-sectoral	CO_2, N_2O, CH_4, PFCs, HFCs, SF_6	GHG emission reduction in the EU from the sectors not covered by the EU ETS reduction targets set out for 2020 and 2030 compared with 2005 emission levels. As part of the achievement of these targets at the EU level, each MS has its individual target constituting its contribution to the achievement of the overall EU target	Regulatory	Implemented	The annual GHG emissions from the non-ETS area (transport, agriculture, waste, the municipal and housing sector, and the industrial sector outside the EU ETS) in each EU Member State are verified by the EU and, subsequently, each country accounts for them against its annual emission allocation (AEA).	2013	Minister of Climate and Environment	NA	NA
3	Measure 3: Our Climate Campaign	No	Cross-sectoral	CO_2	Raising the environmental awareness of the public about the actions for the purposes of climate change mitigation	Educational	Implemented	An information and education campaign aimed at raising the environmental awareness of the public about the individual actions which can be taken for the purposes of climate change mitigation.	2022	Minister of Climate and Environment	NE	NE

Item	Measure	Included in the scenario WEM	Sector affected	Greenhouse gases affected	Aim and/or activity affected	Type of instrument	Status of implementation	Short description	Start year of implementation	Implementing institution	Estimated emission mitigation effect [kt CO_2 eq.]	
											2020	2030
4	Measure 4: Implementation of nuclear energy	Yes	Energy supply	CO_2	Enhanced non-renewable low carbon generation (nuclear)	Regulatory	Implemented	The aim of the measure is to commission in Poland nuclear power units with the total net capacity of 6-9 GW in six units located at two nuclear power plants – successively in the period from 2033 to 2037 (NPP1) and from 2039 to 2043 (NPP2).	2014	Minister of Climate and Environment	0	0
5	Measure 5: Preferences for electricity generators using high-efficiency cogeneration	Yes	Energy supply	CO_2	Efficiency improvement in the energy and transformation sector	Regulatory	Implemented	Preferences for electricity generators using high-efficiency cogeneration in the scope of access to the electricity grid.	2007	Minister of Climate and Environment	NE	NE
6	Measure 6: Cogeneration premium	No	Energy supply	CO_2	Efficiency improvement in the energy and transformation sector	Economic	Implemented	Scheme of support for high-efficiency cogeneration based on premiums to the generated electricity acquired at auctions	2019	Minister of Climate and Environment	0	12814
7	Measure 7: Scheme of certificates of origin for RES (the green certificate scheme)	Yes	Energy supply	CO_2	Increase in renewable energy sources in the electricity sector	Economic	Implemented	A scheme of support for RES in the form of green certificates.	2005	Minister of Climate and Environment, President Energy Regulatory Office (URE)	NE	NE
8	Measure 8: Auction-based support scheme for RES	Yes	Energy supply	CO_2	Increase in renewable energy sources in the electricity sector	Economic	Implemented	A scheme of support for RES awarded at auctions held with a breakdown into baskets based on technology and capacity of the installations. It covers both smaller sources, i.e. with capacity of less than 1 MW, and larger ones, i.e. with capacity of more than 1 MW.	2016	Minister of Climate and Environment	1170	13411
9	Measure 9: Feed-in tariff and feed-in premium schemes for RES	Yes	Energy supply	CO_2	Increase in renewable energy sources in the electricity sector	Economic	Implemented	A scheme of support for small RES (i.e. with capacity up to 1 MW) in the form of feed-in tariff (FIT) and feed-in premium) (FIP).	2016	Minister of Climate and Environment	NE	NE
10	Measure 10: Obligation to purchase electricity generated at RES	No	Energy supply	CO_2	Increase in renewable energy sources in the electricity sector	Regulatory	Implemented	The obligated seller's obligation to purchase electricity from a RES installation of less than 500 kW	2018	Minister of Climate and Environment, power trading companies	NE	NE

Item	Measure	Included in the scenario WEM	Sector affected	Greenhouse gases affected	Aim and/or activity affected	Type of instrument	Status of implementation	Short description	Start year of implementation	Implementing institution	Estimated emission mitigation effect [kt CO_2 eq.]	
											2020	2030
	installations with total installed power capacity of less than 500 kW											
11	Measure 11: Reduction of methane emissions from fuel production and distribution processes	Yes	Energy supply	CH_4	Control of fugitive emissions from energy production	Regulatory	Implemented	Regulations on the hermetic storage, filling and emptying of petroleum products.	2005	Minister of Climate and Environment	NE	NE
12	Measure 12: Support for the development of offshore wind power – individual support and an auction-based scheme	No	Energy supply	CO_2	Increase in renewable energy sources in the electricity sector	Regulatory	Implemented	Implementation of a support scheme for offshore wind farms and the preferential treatment in the investment process	2021	Minister of Climate and Environment	NA	9685
13	Measure 13: My Power Priority Programme	No	Energy supply	CO_2	Increase in renewable energy sources in the electricity sector	Economic	Implemented	The Programme provides co-financing for the construction of micro photovoltaic installations by individual end-users.	2019	NFOŚiGW (In editions 3.0 and 4.0 of My Power, the NFOŚiGW is the beneficiary of a grant project as part of POIiŚ 2014-2020)	501	2738
14	Measure 14: Energy Plus Priority Programme	No	Energy supply	CO_2	Increase in renewable energy sources in the electricity sector; Efficiency improvement in the energy and transformation sector	Economic	Implemented	The Programme provides co-financing for projects carried out by enterprises to diminish their adverse impact on the environment, including an improvement in air quality.	2019	NFOŚiGW, Minister of Climate and Environment, Minister of Economic Development and Technology	0	90
15	Measure 15: Polish Geothermal Energy Plus Priority Programme	No	Energy supply	CO_2	Increase in renewable energy sources in the electricity sector	Economic	Implemented	The Programme provides co-financing for projects to enhance the use of geothermal resources in Poland.	2019	NFOŚiGW, Minister of Climate and Environment	0	49
16	Measure 16: District Heating Priority Programme	No	Energy supply	CO_2	Increase in renewable energy sources in the electricity sector;	Economic	Implemented	The Programme aims at diminishing the adverse impact of district heating enterprises on the environment,	2019	NFOŚiGW, Minister of Climate and Environment	0	80

Item	Measure	Included in the scenario WEM	Sector affected	Greenhouse gases affected	Aim and/or activity affected	Type of instrument	Status of implementation	Short description	Start year of implementation	Implementing institution	Estimated emission mitigation effect [kt CO_2 eq.]	
											2020	2030
					Increase in renewable energy sources in the heating and cooling sector; Efficiency improvement in the energy and transformation sector			including an improvement in air quality, by supporting investment projects to build, expand or modernise the existing production installations or industrial equipment, to modernise and expand district heating networks and to use geothermal resources for energy generation purposes.				
17	Measure 17: Agroenergy Programme	No	Energy supply	CO_2	Increase in renewable energy sources in the electricity sector	Economic	Implemented	Comprehensive support to limit the adverse impact of agricultural activities on the environment by co-financing the purchase and assembly of photovoltaic installations, wind installations, heat pumps and hybrid installations.	2019	NFOŚiGW, Minister of Climate and Environment	0	170
18	Measure 18: Research projects on methane removal using the technology of underground directional boreholes (DD-MET Project)	No	Energy supply	CH_4	Other energy supplies; Control of fugitive emissions from energy production	Research	Implemented	A research project to develop an advanced methane removal strategy using the technology of underground directional boreholes to prevent the main risk areas and to eliminate greenhouse gas emissions.	2019	Oil and Gas Institute, Research Fund for Coal and Steel	NE	NE
19	Measure 19: Other programmes supporting the development of RES and cogeneration (a group of measures)	Yes	Energy supply	CO_2	Efficiency improvement in the energy and transformation sector; Increase in renewable energy sources in the electricity sector	Economic	Implemented	The Programme provides co-financing for measures to build or modernise heating and electricity systems to enable the connection of RES and to build or modernise RES units and units generating heat and electricity in high-efficiency cogeneration.	2014	NFOŚiGW, Minister of Climate and Environment, WFOŚiGW in Katowice	276	3441
20	Measure 20: New Energy Programme	No	Energy supply	CO_2	Increase in renewable energy sources in the electricity sector	Economic	Implemented	The Programme provides support for projects in the areas of plus energy buildings, smart energy cities, multi-fuel units with heat or cold storage systems, hydrogen, stable zero-emission sources and self-sufficient energy clusters.	2021	NFOŚiGW, Minister of Climate and Environment	NA	NE

Item	Measure	Included in the scenario WEM	Sector affected	Greenhouse gases affected	Aim and/or activity affected	Type of instrument	Status of implementation	Short description	Start year of implementation	Implementing institution	Estimated emission mitigation effect [kt CO_2 eq.]	
											2020	2030
21	Measure 21: My Heat Priority Programme	No	Energy supply	CO_2	Increase in renewable energy sources in the heating and cooling sector	Economic	Implemented	The Programme provides support for the development of individual heating and the development of prosumer energy generation in the areas of air source heat pumps, ground source heat pumps, and water source heat pumps in new single-family residential buildings.	2022	NFOŚiGW, Minister of Climate and Environment	NA	65
22	Measure 22: White certificate scheme	Yes	Energy consumption	CO_2	Improvement of the energy efficiency of energy enterprises and the achievement of the final energy savings target	Regulatory, economic	Implemented	The scheme of energy efficiency certificates (the white certificate scheme) covering energy companies is the basic mechanism for supporting measures to improve the energy efficiency of the economy, to increase energy savings by end-users and to diminish the losses of electricity, heat or natural gas in transmission or distribution.	2013	Minister of Climate and Environment, Energy Regulatory Office (URE)	17770	48187
23	Measure 23: Energy audits and energy management systems	Yes	Energy consumption	CO_2	Improvement of energy efficiency; reductions of energy consumption in large enterprises	Regulatory	Implemented	The obligation of large entrepreneurs to carry out an energy audit on the energy consumption at their enterprises every 4 years.	2016	Minister of Climate and Environment, Energy Regulatory Office (URE)	9289	NE
24	Measure 24: Clean Air Priority Programme	No	Energy consumption	CO_2	The aims of the Programme include improving energy efficiency and reducing the emissions of greenhouse gases, particulate matter and other pollutants into the atmosphere from single-family residential buildings.	Economic	Implemented	Reduction of the emissions into the atmosphere of harmful substances arising from the heating of single-family houses with poor-quality fuel and using obsolete furnaces.	2018	Minister of Climate and Environment, NFOŚiGW	391	14000
25	Measure 25: Thermal Modernisation and Renovation Fund	Yes	Energy consumption	CO_2	The provision of financial assistance for measures to improve energy efficiency;	Economic	Implemented	The Thermal Modernisation and Renovation Fund (FTiR) is an instrument for providing financial assistance to investors for projects to	1999	Minister of Economic Development and Technology,	904	5682

Item	Measure	Included in the scenario WEM	Sector affected	Greenhouse gases affected	Aim and/or activity affected	Type of instrument	Status of implementation	Short description	Start year of implementation	Implementing institution	Estimated emission mitigation effect [kt CO_2 eq.]	
											2020	2030
					reduction of energy consumption in residential buildings			improve the technical condition of existing residential buildings and for the payment of compensations to the owners of residential buildings for the implementation of measures significantly contributing to reducing energy consumption in the buildings.		Bank Gospodarstwa Krajowego (BGK)		
26	Measure 26: Thermal modernisation relief	No	Energy consumption	CO_2	Support for measures to improve energy efficiency; reduction of energy consumption in residential buildings	Fiscal	Implemented	The possibility of detracting the outlays on construction materials, equipment and services related to the implementation of a thermal modernisation project in a single-family residential building from the income tax calculation base on the basis of a VAT invoice.	2019	Minister of Finance	NE	16235
27	Measure 27: Improvement of the operation of the energy efficiency system of buildings (a group of measures)	Yes	Energy consumption	CO_2	Improvement of the energy efficiency of buildings and the achievement of the final energy savings target	Regulatory, economic	Implemented	Improvement of the energy efficiency of buildings through the certification of the energy performance of buildings by means of energy performance certificates, the keeping of registers of data on the energy efficiency of housing stock and technical construction regulations.	1994	Minister of Economic Development and Technology, Minister of Climate and Environment, NFOŚiGW, WFOŚiGW in Katowice	93	5819
28	Measure 28: Warm Flat Priority Programme	No	Energy consumption	CO_2	Reduction of the emissions into the atmosphere of harmful substances arising from the heating of multi-family buildings with poor-quality fuel and using obsolete furnaces	Economic	Implemented	The aim of the measure is to improve air quality and reduce dust and greenhouse gas emissions by replacing inefficient heat sources and improving energy efficiency in housing units in multi-family buildings.	2022	Minister of Economic Development and Technology, NFOŚiGW	NA	189
29	Measure 29: Development of road infrastructure (a group of measures)	Yes	Transport	CO_2, CH_4, N_2O	Improvement of transport infrastructure	Planning, economic	Implemented	Implementation of investments to develop the road network in Poland in order to create a network of national roads, motorways and expressways and to improve the operating management of road traffic, thus	2015	Minister of Infrastructure	NE	NE

Item	Measure	Included in the scenario WEM	Sector affected	Greenhouse gases affected	Aim and/or activity affected	Type of instrument	Status of implementation	Short description	Start year of implementation	Implementing institution	Estimated emission mitigation effect [kt CO_2 eq.]	
											2020	2030
								contributing to improving road safety, relieving agglomerations and cities from transit traffic and, at the same time, reducing greenhouse gas emissions in urbanised areas.				
30	Measure 30: Development of collective transport (a group of measures)	Yes	Transport	CO_2, CH_4, N_2O	Shift to other modes of public or non-motorised transport and improvement of the behaviour of the public	Planning, economic, educational	Implemented	Development of effective collective transport networks in the urban functional areas and the promotion of a system of environmentally friendly solutions, e.g. Park and Ride.	2011	Minister of Infrastructure, Minister of Development Funds and Regional Policy, Centre for European Union Transport Projects (CUPT)	NE	NE
31	Measure 31: Development of zero-emission urban transport (a group of measures)	Yes	Transport	CO_2, CH_4, N_2O	Shift to other modes of public or non-motorised transport and improvement of the behaviour of the public	Planning, educational, regulatory, economic, information	Implemented	Development of zero-emission urban transport by co-financing projects to reduce energy and fuel consumption in public transport by developing zero-emission urban transport, improving the behaviour of the public and promoting the shift to alternative modes of transport, i.e. cycling and walking, thus contributing to avoiding greenhouse gas emissions. Measures aimed at supporting cities and functional areas in the preparation or updating of a Sustainable Urban Mobility Plan (SUMP), implemented as part of a pilot project.	2015	Minister of Infrastructure, Minister of Climate and Environment, NFOŚiGW, Minister of Development Funds and Regional Policy, Centre for European Union Transport Projects (CUPT)	23	71
32	Measure 32: Development of electromobility (a group of measures)	No	Transport	CO_2, CH_4, N_2O	Creation of the conditions for the development of clean transport	Regulatory, fiscal, economic, planning	Implemented	The measure supports the development of electromobility in Poland by generating a greater interest and support of the public for the development of electromobility and the opportunities for the dissemination of electric vehicles and the infrastructure for charging them.	2017	Minister of Climate and Environment, Minister of Finance, Minister of Economic Development and Technology, NFOŚiGW	12	969

Item	Measure	Included in the scenario WEM	Sector affected	Greenhouse gases affected	Aim and/or activity affected	Type of instrument	Status of implementation	Short description	Start year of implementation	Implementing institution	Estimated emission mitigation effect [kt CO_2 eq.]	
											2020	2030
33	Measure 33: Development of vehicles using alternative fuels (a group of measures)	No	Transport	CO_2, CH_4, N_2O	Introduction of instruments fostering the development of the market of vehicles powered by alternative fuels	Planning, information, fiscal	Implemented	The measure introduces instruments fostering the development of the market of vehicles powered by alternative fuels (e.g. CNG and LNG), including alternative fuels infrastructure, and the promotion of vehicles powered by alternative fuels.	2018	Minister of Climate and Environment, Minister of Economic Development and Technology, Minister of Finance	9	NE
34	Measure 34: Promotion of biofuels (a group of measures)	Yes	Transport	CO_2, CH_4, N_2O	Introduction of a scheme of incentives and support instruments needed to ensure the development of the biofuels market in Poland	Regulatory, economic	Implemented	Promotion of biofuels and increasing their consumption in road transport by introducing a scheme of incentives, support instruments, controls and the system for the certification of the quality and use of biofuels in road transport.	2006	Minister of Climate and Environment, Minister of Development Funds and Regional Policy, Minister of Finance	NE	NE
35	Measure 35: Shaping of environment-friendly attitudes of drivers (a group of measures)	Yes	Transport	CO_2, CH_4, N_2O	Shaping of environmentally aware behaviour of drivers and users of transport	Educational, information	Implemented	Measures addressed to drivers, passengers and vehicle producers in order to disseminate environmentally friendly solutions in road transport, such as e.g. the provision of consumers with information enabling them to make an informed choice in the purchase of vehicles or the promotion of the shared use of means of transport.	2004	Minister of Infrastructure, Minister of Economic Development and Technology	NE	NE
36	Measure 36: Requirements for improving the emission factors of vehicles (a group of measures)	Yes	Transport	CO_2, CH_4, N_2O	Reduction of the emissions of pollutants and CO_2 from vehicles	Regulatory	Implemented	The measure covers the application of the Euro standards laying down the limit values of the emissions of pollutants for passenger cars and light-duty commercial vehicles, for heavy-duty vehicles, buses, scooters and motorcycles, as well as the adoption of more stringent CO_2 emission standards for new passenger cars and light-duty commercial vehicles.	2013	Minister of Infrastructure, Minister of Climate and Environment	372	NE
37	Measure 37: Measures for efficient railway	Yes	Transport	CO_2, CH_4, N_2O	Support for the development of railways and railway	information, planning, economic	Implemented	Measures for efficient railway transport support the development of the railway network, the	2005	Minister of Infrastructure	NE	NE

Item	Measure	Included in the scenario WEM	Sector affected	Greenhouse gases affected	Aim and/or activity affected	Type of instrument	Status of implementation	Short description	Start year of implementation	Implementing institution	Estimated emission mitigation effect [kt CO_2 eq.]	
											2020	2030
	transport (a group of measures)				infrastructure and the creation of an incentive scheme to encourage the use of railway transport			implementation of the railway traffic management systems, the modernisation of railway infrastructure, the modernisation of railway rolling stock for the carriage of passengers and freight, as well as the promotion of collective rail transport by developing public passenger transport and integrating the other passenger carriage modes with it.				
38	Measure 38: Measures for the environmentally friendly development of maritime shipping (a group of measures)	Yes	Transport	CO_2, CH_4, N_2O	Development of the infrastructure of Polish seaports and the implementation of innovative technologies in the management of sea vessel traffic	Regulatory, economic	Implemented	Environmentally friendly development of maritime shipping by ensuring access to Polish seaports and fairways, building new infrastructure of seaports and improving the existing one, and implementing innovative technologies in the management of sea vessel traffic, among others, by monitoring vessel traffic, including the management and control of vessel traffic. Moreover, the implementation of increasingly stringent standards for the emissions of pollutants generated by ships.	2011	Minister of Infrastructure	NE	NE
39	Measure 39: Measures for the development of inland waterway transport (a group of measures)	Yes	Transport	CO_2, CH_4, N_2O	Development of infrastructure and improved access to the TEN-T network	Regulatory, economic	Implemented	The measures for the development of inland waterway transport focus on the development of the infrastructure of inland water transport, the infrastructure of harbours and ports, and on their connection and improved access to the TEN-T network.	2014	Minister of Infrastructure	NE	NE
40	Measure 40: Innovative measures for air transport (a group of measures)	Yes	Transport	CO_2, CH_4, N_2O	Improvement of the infrastructure of airports; implementation of modern solutions in air traffic; improvement of	Regulatory, economic	Implemented	Innovative measures for the development of air transport support the expansion of airports, thus enabling them to handle the growing number of passengers and air operations and improving the	2007	Minister of Infrastructure	NE	NE

Item	Measure	Included in the scenario WEM	Sector affected	Greenhouse gases affected	Aim and/or activity affected	Type of instrument	Status of implementation	Short description	Start year of implementation	Implementing institution	Estimated emission mitigation effect [kt CO_2 eq.]	
											2020	2030
					the operational efficiency of air transport			connectivity between regional airports and the road and railway transport networks. This will contribute to the sustainable development of the Polish air transport in the long-term, also on the basis of the implementation of an advanced air traffic management system.				
41	Measure 41: Limitation of the use of fluorinated greenhouse gases (a group of measures)	Yes	Industrial processes and product use	HFC, PFC, SF_6	Reduction of the emissions of fluorinated gases	Regulatory	Implemented	Measures to reduce the emissions of fluorinated gases by restrictions on the placing on the market of HFCs in bulk or contained in equipment, the obligation to keep documentation, the obligation to recover F-gases, the obligation to certify personnel and economic operators, from 1 January 2020 the ban on the use of F-gases with GWP of 2,500 or higher for servicing or maintenance of refrigeration equipment, the ban on the use of F-gases for certain other applications and restrictions on the placing on the market of passenger cars equipped with air-conditioning systems containing F-gases with GWP of 150 or higher.	2011	Minister of Climate and Environment	3489	7053-7389
42	Measure 42: Proposed adoption of more stringent requirements for the limitation of the use of fluorinated greenhouse gases	No	Industrial processes and product use	HFC, PFC, SF_6	Reduction of the emissions of fluorinated gases	Regulatory	Planned	Further adoption of more stringent requirements for the placing on the market and use of fluorinated greenhouse gases to adapt the requirements in this scope to the provisions of the European Green Deal and the European Climate Law, and to fulfil GHG emission reduction targets in the EU and the commitments for hydrofluorocarbons under the	2024	Minister of Climate and Environment	NE	NE

Item	Measure	Included in the scenario WEM	Sector affected	Greenhouse gases affected	Aim and/or activity affected	Type of instrument	Status of implementation	Short description	Start year of implementation	Implementing institution	Estimated emission mitigation effect [kt CO_2 eq.]	
											2020	2030
								Montreal Protocol, Regulation 517/2014 and amendments thereto.				
43	Measure 43: Agri- environmental measures (a group of measures)	Yes	Agriculture	CO_2, CH_4, N_2O	Reduction of the quantities of fertilisers used and the development other types of activities having a favourable effect on the management of cropland and pastures or grassland	Economic	Implemented	Measures to restore, preserve and enhance ecosystems related to agriculture and, at the same time, to implement the objectives of rural development policy which include, among others, climate change mitigation and adaptation.	2007	Minister of Agriculture and Rural Development, Agency for Restructuring and Modernisation of Agriculture (ARiMR)	NE	NE
44	Measure 44: Supporting adaptation and mitigation measures in agricultural holdings (a group of measures)	Yes	Agriculture	CH_4, N_2O, CO_2	Activities having a favourable effect on the management of pastures or grassland and the reduction of the quantities of fertilisers/manure applied on cropland; improvement of livestock farming; improvement of animal waste management	Economic	Implemented	Support for climate change mitigation investments undertaken by agricultural holdings, such as the construction of urine, slurry and manure tanks and machines and equipment for the application of fertilisers.	2007	Minister of Agriculture and Rural Development, Agency for Restructuring and Modernisation of Agriculture (ARiMR)	NE	NE
45	Measure 45: Organic farming	Yes	Agriculture	CO_2, N_2O, CH_4	Activities having a favourable effect on the management of pastures or grassland and the reduction of the quantities of fertilisers/manure applied on cropland; improvement of livestock farming; improvement of animal waste management; other types of activities having a favourable	Economic	Implemented	A measure supporting farmers who undertake to maintain or apply the practices and methods of organic farming by carrying out their production in accordance with the principles of sustainable development and resigning from using agricultural, veterinary and food-related chemicals in their food production.	2007	Minister of Agriculture and Rural Development, Agency for Restructuring and Modernisation of Agriculture (ARiMR)	NE	NE

Item	Measure	Included in the scenario WEM	Sector affected	Greenhouse gases affected	Aim and/or activity affected	Type of instrument	Status of implementation	Short description	Start year of implementation	Implementing institution	Estimated emission mitigation effect [kt CO_2 eq.]	
											2020	2030
					effect on the management of cropland							
46	Measure 46: Rationalisation of fertiliser use (a group of measures)	Yes	Agriculture	N_2O, CO_2	Reduction of the quantities of fertilisers used; other types of activities having a favourable effect on the management of cropland; types of activities having a favourable effect on the management of pastures or grassland	Economic, regulatory	Implemented	Measures to protect soils and waters, to reduce the soil pollution by fertilisation of agricultural land and to prevent soil degradation.	2020	Minister of Agriculture and Rural Development, Minister of Climate and Environment, Voivodeship Inspectorates for Environmental Protection, Agency for Restructuring and Modernisation of Agriculture (ARiMR)	NE	NE
47	Measure 47: Research and scientific and educational projects in the scope of rational and low-emission agricultural production (a group of measures)	No	Agriculture	CO_2, CH_4, N_2O	Reduction of the quantities of fertilisers/manure applied on cropland; improvement of livestock farming; improvement of animal waste management	Research, educational	Implemented	Research measures to develop rational and low-emission agricultural production; improvement of the state of knowledge about low-emission farming in rural areas.	2016	Minister of Agriculture and Rural Development, National Centre for Research and Development (NCBiR)	NE	NE
48	Measure 48: Development of agricultural biogas plants (a group of measures)	Yes	Agriculture	CH_4, CO_2	Improvement of the collection and use of CH_4, improvement of waste treatment technology, improvement of animal waste management, reduction of waste storage, enhanced use of energy from renewable sources	Economic	Implemented	A measure to increase the share of RES in the generation and consumption of energy using raw materials of agricultural origin by supporting the use of agricultural biogas for the purposes of electricity and heat generation.	2010	Minister of Agriculture and Rural Development, Agency for Restructuring and Modernisation of Agriculture (ARiMR), NFOŚiGW	513	1002

Item	Measure	Included in the scenario WEM	Sector affected	Greenhouse gases affected	Aim and/or activity affected	Type of instrument	Status of implementation	Short description	Start year of implementation	Implementing institution	Estimated emission mitigation effect [kt CO_2 eq.]	
											2020	2030
49	Measure 49: Reduction of food losses (a group of measures)	No	Agriculture	CH_4, CO_2	Reduction of food losses at the stages of production, processing, distribution and consumption at households; education on conscious consumer choice	Regulatory, research, educational	Implemented	A research measure to determine the directions of measures to reduce food losses, regulatory measures on the handling of unsold food which is fit for consumption and educational measures addressed to consumers.	2019	National Support Centre for Agriculture (KOWR), National Centre for Research and Development (NCBiR)	NE	NE
50	Measure 50: Eco- schemes (a group of measures)	No	Agriculture	CO_2, N_2O	Reduction of the quantities of fertilisers/manure applied on cropland; types of activities having a favourable effect on the management of pastures or grassland; improvement of the management of organic soils	Economic	Planned	Eco-schemes are voluntary schemes of payments to farmers for the implementation of practices beneficial for the environment, climate and animal welfare which go beyond the obligations specified in conditionalities.	2023	Minister of Agriculture and Rural Development, Agency for Restructuring and Modernisation of Agriculture (ARiMR),	NE	NE
51	Measure 51: Rational management of farmland and forest land - the protection of farmland and forestland	Yes	Forestry	CO_2	Prevention of deforestation; strengthening of the protection against catastrophic events; protection of carbon in existing forests	Regulatory	Implemented	Measures to protect farmland and forestland against their use for other purposes by adopting legal regulations limiting their conversion to non-agricultural and non-forestry uses.	1995	Minister of Agriculture and Rural Development, Minister of Climate and Environment, territorial self-government units	NE	NE
52	Measure 52: Forest area development and improvement of the viability of forests (a group of measures)	Yes	Forestry	CO_2	Protection of carbon in existing forests; increasing the production in existing forests; restoration of degraded areas	Economic	Implemented	The aim of the measure is to enlarge forest areas by afforestation and creation of woodland on agricultural land and other than agricultural land by introducing grants for afforestation and grants for tending forest plantations.	2007	Minister of Agriculture and Rural Development, Minister of Climate and Environment, territorial self-government units	133	1463
53	Measure 53: Rational waste management (a group of measures)	Yes	Waste	CH_4, CO_2, N_2O	Reduction of the quantity of waste by preventing its generation, enhancing	Regulatory, economic	Implemented	Measures to achieve the objectives of the National Waste Plan 2022 – the implementation of the principles of waste management by: waste	2002	Minister of Climate and Environment, NFOŚiGW, territorial self-government units	4273	7290

Item	Measure	Included in the scenario WEM	Sector affected	Greenhouse gases affected	Aim and/or activity affected	Type of instrument	Status of implementation	Short description	Start year of implementation	Implementing institution	Estimated emission mitigation effect [kt CO_2 eq.]	
											2020	2030
					recycling, improving waste treatment technologies and limiting its deposition at landfills			prevention, reduction of the quantity of municipal waste to be landfilled, the establishment and maintenance of system for general separate collection systems, the maintenance in the country of an integrated and adequate network of waste management installations or the expansion or modernisation of the existing installations.				
54	Measure 54: Development of water and wastewater management (a group of measures)	Yes	Waste	CH_4, N_2O	Improvement of wastewater management and intensification of the collection and use of methane	Regulatory, economic	Implemented	Measures to achieve the objectives of the National Programme for Municipal Wastewater Treatment – the reduction of the quantity of untreated wastewater and the amounts of pollutant loads, in particular, those of nutrients, discharged together with treated wastewater into the natural environment, improvement of the provision of agglomerations with wastewater collection systems and wastewater treatment plants.	2003	Minister of Infrastructure, NFOŚiGW, territorial self-government units, water and wastewater companies	2119	2734

Additional information:

1) In the case of a group of measures, the start year of the earliest measure in that group of measures is given as the start ye ar of implementation.
2) In the case of a group of measures, all types of measures making up a given group are presented in the "*Type of instrument*" column.
3) In the case where several greenhouse gases are listed in the "*Greenhouse gases affected*" column, the gas which is the most significantly affected by a given measure is specified as the first one.
4) For policies and measures reported as a group of measures, the estimated mitigation effects are also specified for a given gr oup of measures, in light of the mutual linkages among the individual measures included in a given group of measures.
5) The abbreviation NE (not estimated) is used in the case where it was impossible to estimate the mitigation effect in the abse nce of needed data.
6) The abbreviation NA (not applicable) is used for the effect of Measure 2, since the regulation at the EU level for the non-ETS sectors only sets out the reduction target and does not produce a reduction effect. Reduction effects can result from the launch of specific measures in the individual non-ETS sectors. Therefore, the reduction effects available are specified for the relevant measures in the sectors falling within the non-ETS area. Moreover, the abbreviation NA is used for the measures implemented after 2020 which, as a result of this, could not generate a reduction effect in 2020.
7) BR4 gave the estimated reduction effect for 2020 for Measure 1 concerning the EU ETS system. However, given the complexity of the issues related to the estimation of the reduction effect for the EU ETS and the related large uncertainty of the values estimated, it was decided that it would not be reported in this report. It should be pointed out that EU ETS is a market-based EU-wide instrument for the installations which it covers; therefore, it is difficult to determine its effects at the level of one Member State.

Source: Elaborated by the KOBiZE IOŚ-PIB

In order to ensure better transparency of the information on the effect of particular policies and measures on the emissions of specific greenhouse gases, Table 4.32 lists the measures presented in Section 4.2 and Table 4.31 arranged according to the greenhouse gases the emissions of which they affect.

Table 4.32. Policies and measures arranged according to the greenhouse gases the emissions of which they affect

Greenhouse gas	Measure
CO_2	**Measure 1: Greenhouse gas emission allowance trading system (EU ETS)** **Measure 2: Emission reductions in non-ETS sectors** **Measure 3: Our Climate Campaign** **Measure 4: Implementation of nuclear energy** **Measure 5: Preferences for electricity generators using high-efficiency cogeneration** **Measure 6: Cogeneration premium** **Measure 7: Scheme of certificates of origin for RES (the green certificate scheme)** **Measure 8: Auction-based support scheme for RES** **Measure 9: Feed-in tariff and feed-in premium schemes for** **Measure 10: Obligation to purchase electricity generated at RES installations with total installed power capacity of less than 500 kW** **Measure 12: Support for the development of offshore wind power – individual support and an auction-based scheme** **Measure 13: My Power Priority Programme** **Measure 14: Energy Plus Priority Programme** **Measure 15: Polish Geothermal Energy Plus Priority Programme** **Measure 16: District Heating Priority Programme** **Measure 17: Agroenergy Programme** **Measure 19: Other programmes supporting the development of RES and cogeneration** **Measure 20: New Energy Programme** **Measure 21: My Heat Priority Programme** **Measure 22: White certificate scheme** **Measure 23: Energy audits and energy management systems** **Measure 24: Clean Air Priority Programme** **Measure 25: Thermal Modernisation and Renovation Fund** **Measure 26: Thermal modernisation relief** **Measure 27: Improvement of the operation of the energy efficiency system of buildings** **Measure 28: Warm Flat Priority Programme** **Measure 29: Development of road infrastructure** **Measure 30: Development of collective transport** **Measure 31: Development of zero-emission urban transport** **Measure 32: Development of electromobility** **Measure 33: Development of vehicles using alternative fuels** **Measure 34: Promotion of biofuels** **Measure 35: Shaping of environment-friendly attitudes of drivers** **Measure 36: Requirements for improving the emission factors of vehicles** **Measure 37: Measures for efficient railway transport** **Measure 38: Measures for the environmentally friendly development of maritime shipping** **Measure 39: Measures for the development of inland waterway transport** **Measure 40: Innovative measures for air transport** **Measure 43: Agri-environmental measures**** Measure 44: Supporting adaptation and mitigation measures in agricultural holdings **Measure 45: Organic farming** Measure 46: Rationalisation of fertiliser use **Measure 47: Research and scientific and educational projects in the scope of rational and low-emission agricultural production**

Greenhouse gas	Measure
	Measure 48: Development of agricultural biogas plants Measure 49: Reduction of food losses **Measure 50: Eco-schemes** **Measure 51: Rational management of farmland and forest land - the protection of farmland and forestland**** **Measure 52: Forest area development and improvement of the viability of forests**** Measure 53: Rational waste management
CH_4	Measure 2: Emission reductions in non-ETS sectors **Measure 11: Reduction of methane emissions from fuel production and distribution processes** **Measure 18: Research projects on methane removal using the technology of underground directional boreholes (DD-MET Project)** Measure 29: Development of road infrastructure Measure 30: Development of collective transport Measure 31: Development of zero-emission urban transport Measure 32: Development of electromobility Measure 33: Development of vehicles using alternative fuels Measure 34: Promotion of biofuels Measure 35: Shaping of environment-friendly attitudes of drivers Measure 36: Requirements for improving the emission factors of vehicles Measure 37: Measures for efficient railway transport Measure 38: Measures for the environmentally friendly development of maritime shipping Measure 39: Measures for the development of inland waterway transport Measure 40: Innovative measures for air transport Measure 43: Agri-environmental measures ** **Measure 44: Supporting adaptation and mitigation measures in agricultural holdings** Measure 45: Organic farming Measure 47: Research and scientific and educational projects in the scope of rational and low-emission agricultural production **Measure 48: Development of agricultural biogas plants** **Measure 49: Reduction of food losses** **Measure 53: Rational waste management** **Measure 54: Development of water and wastewater management**
N_2O	Measure 1: Greenhouse gas emission allowance trading system (EU ETS) Measure 2: Emission reductions in non-ETS sectors Measure 29: Development of road infrastructure Measure 30: Development of collective transport Measure 31: Development of zero-emission urban transport Measure 32: Development of electromobility Measure 33: Development of vehicles using alternative fuels Measure 34: Promotion of biofuels Measure 35: Shaping of environment-friendly attitudes of drivers Measure 36: Requirements for improving the emission factors of vehicles Measure 37: Measures for efficient railway transport Measure 38: Measures for the environmentally friendly development of maritime shipping Measure 39: Measures for the development of inland waterway transport Measure 40: Innovative measures for air transport Measure 43: Agri-environmental measures ** Measure 44: Supporting adaptation and mitigation measures in agricultural holdings Measure 45: Organic farming **Measure 46: Rationalisation of fertiliser use** Measure 47: Research and scientific and educational projects in the scope of rational and low-emission agricultural production Measure 50: Eco-schemes Measure 53: Rational waste management

Greenhouse gas	Measure
	Measure 54: Development of water and wastewater management
PFCs	Measure 1: Greenhouse gas emission allowance trading system (EU ETS) Measure 2: Emission reductions in non-ETS sectors **Measure 41: Limitation of the use of fluorinated greenhouse gases Measure 42: Proposed adoption of more stringent requirements for the limitation of the use of fluorinated greenhouse gases**
HFCs	Measure 2: Emission reductions in non-ETS sectors **Measure 41: Limitation of the use of fluorinated greenhouse gases Measure 42: Proposed adoption of more stringent requirements for the limitation of the use of fluorinated greenhouse gases**
SF_6	Measure 2: Emission reductions in non-ETS sectors **Measure 41: Limitation of the use of fluorinated greenhouse gases Measure 42: Proposed adoption of more stringent requirements for the limitation of the use of fluorinated greenhouse gases**
NF_3	No measures***

* Bold print indicates the measures which have a primary effect on the reductions of the emissions of a given greenhouse gas.
** Measures 43 and 51 (in their part related to afforestation and creation of woodland) and 52 do not contribute to implementing the QEWER reduction target, since they concern the emissions from the LULUCF sector.
*** This gas is not covered by QEWER. Moreover, in Poland, there are no sources of the emissions of this gas.
Source: Elaborated by the KOBiZE IOŚ-PIB

4.3. Other information on policies and measures

4.3.1. Policies and measures no longer in place

The analysis carried out as part of the work on this Communication did not identify policies and measures which had become outdated or had been withdrawn. It should be noted that the strategic documents are systematically updated and replaced by newer documents upholding and expanding the objectives and assumptions of the development of particular sectors. E.g. in the energy consumption sector, the National Action Plan on Energy Efficiency for Poland 2014 was replaced by the National Action Plan on Energy Efficiency for Poland 2017 and then by the National Energy and Climate Plan for 2021-2030 (NECP). In the transport sector, the Transport Development Strategy until 2020 (with an Outlook until 2030) was replaced by its continuation, i.e. the Transport Development Strategy until 2030, while the National Road Transport Safety Programme 2013–2020 was replaced by its continuation, i.e. the National Road Transport Safety Programme 2021–2030.

4.3.2. Examples of innovative and replicable policies and measures

The table below lists examples of innovative and replicable policies and measures which are described in greater detail in Section 4.2.

Table 4.33. Innovative and replicable policies and measures

Measure	Sector affected
Measure 1: Greenhouse gas emission allowance trading system (EU ETS)	Cross-sectoral
Measure 6: Cogeneration premium	Energy supply
Measure 8: Auction-based support scheme for RES	Energy supply
Measure 12: Support for the development of offshore wind power – individual support and an auction-based scheme	Energy supply
Measure 13: My Power Priority Programme	Energy supply
Measure 21: My Heat Priority Programme	Energy supply
Measure 22: White certificate scheme	Energy consumption
Measure 27: Improvement of the operation of the energy efficiency system of buildings - System for the energy efficiency of buildings	Energy consumption
Measure 27: Improvement of the operation of the energy efficiency system of buildings - Central Register of Final Energy Savings	Energy consumption
Measure 28: Warm Flat Priority Programme	Energy consumption

Measure	Sector affected
Measure 30: Development of collective transport - Common Ticket project	Transport
Measure 31: Development of zero-emission urban transport – Pilot Programme to Prepare Sustainable Urban Mobility Plans	Transport
Measure 32: Development of electromobility	Transport
Measure 35: Shaping of environment-friendly attitudes of drivers - Provision of consumers with information enabling them to make an informed choice in the purchase of vehicles	Transport
Measure 35: Shaping of environment-friendly attitudes of drivers - Promotion of the shared use of means of transport	Transport
Measure 45: Measure 45: Organic farming	Agriculture
Measure 46: Rationalisation of fertiliser use – the Nitrate Programme	Agriculture
Measure 48: Development of agricultural biogas plants	Agriculture

Source: Elaborated by the KOBiZE IOŚ-PIB

Moreover, it is important to note the key institutional and financial mechanism supporting the implementation of climate policy which is the system for financing the measures to protect the environment, among others, by supporting energy efficiency improvements, the development of RES or promoting clean transport, based on the resources from the National Fund for Environmental Protection and Water Management (NFOŚiGW) and the Voivodeship Funds for Environmental Protection and Water Management (WFOŚiGW). Such an approach to the funding of investments in environmental protection and climate change mitigation is a unique solution. The support programmes now under implementation are described in the relevant parts of Section 4.2.

4.3.3. Examples of regional/local policies and measures

The table below lists examples of regional/local policies and measures which are described in greater detail in Section 4.2.

Table 4.34. Examples of regional/local policies and measures

Measure	Sector affected
Measure 1: Greenhouse gas emission allowance trading system (EU ETS)	Cross-sectoral
Measure 15: Polish Geothermal Energy Plus Priority Programme	Energy supply
Measure 16: District Heating Priority Programme	Energy supply
Measure 27: Improvement of the operation of the energy efficiency system of buildings - Improving air quality by replacing heat sources in multi-family buildings – a pilot project in Zachodniopomorskie Voivodeship	Energy consumption
Measure 27: Improvement of the operation of the energy efficiency system of buildings - Improving air quality in the most polluted municipalities – a pilot project in the Municipality of Pszczyna	Energy consumption
Measure 27: Improvement of the operation of the energy efficiency system of buildings - Improving air quality by replacing heat sources in multi-family buildings – a pilot project in Dolnośląskie Voivodeship	Energy consumption
Measure 30: Development of collective transport - Obligation to prepare plans for the sustainable development of collective public transport	Transport
Measure 31: Development of zero-emission urban transport - Setting up of clean transport zones	Transport
Measure 31: Development of zero-emission urban transport - Programme for Sustainable Urban Mobility Plans	Transport
Measure 31: Development of zero-emission urban transport - Gepard II Programme	Transport

Source: Elaborated by the KOBiZE IOŚ-PIB

4.3.4. Information on the minimisation of the adverse impacts of the policies and measures launched, including the assessments of their economic and social consequences

In accordance with the provisions of the Act of 3 October 2008 on the Provision of Information on the Environment and Its Protection, Public Participation in Environmental Protection and Environmental Impact Assessments (the EIA Act)[50], specific types of documents drawn up or approved by the public administration bodies or other competent authorities are subject to a strategic environmental impact assessment. The documents subject to this obligation include policies, strategies, plans and programmes in all the sectors of the economy the implementation of which can have a significant impact on the environment.

The process of a strategic assessment includes the preparation of a forecast of the environmental impact of a given policy or programme. The scope of the forecast is regulated in detail in the EIA Act and must contain, among others, information on the possible transboundary impact on the environment. The need to prepare an analysis of international environmental impacts of the policies under implementation follows from the Espoo Convention of the UNECE. The forecast of the environmental impact is made available to the public and the countries concerned can express their opinion and possible concerns about the proposed activities. When taking the decision to implement a policy, the responsible authority needs to take into account the results of consultations. When implementing a policy or programme, the responsible authority needs to monitor their impact on the environment (also abroad) and make the surveillance results available to the public.

The abovementioned regulations ensure that the possible adverse transboundary impacts of the implementation of policies need to be identified and taken into account at the stage of their design.

In addition, it should be pointed out that all the main policies, programmes and measures to tackle climate change in the EU Member States follow directly or indirectly from policies adopted at the EU level (in the form of documents and legal acts). When working on drafts of these documents, the European Commission prepares extensive analyses of the impact of the proposed solutions. Such an approach also applies to climate change mitigation policies and measures, such as the climate and energy package 2020, the climate and energy package 2030 or the "*Fit for 55*" Package. As part of these assessments, the EC takes into account the impacts on third parties with a view to minimising the adverse impacts of the proposed policies. On the basis, among others, of these impact analyses, all the EU Member States decide to adopt or not to adopt a given policy, programme or regulation. Thus, the EU decision-making process enables all the EU Member States, including Poland, to assess the possible adverse impacts on third parties already at the planning stage. The information from the analysis of the impact of the policies and measures implemented in the EU on third parties is provided in the EU National Inventory Reports and the EU Biennial Reports available on the UNFCCC website.

In addition to the impact analyses prepared for each policy, the EU analyses the adverse impacts of the climate policy pursued as part of the bilateral and regional cooperation. The EU measures in this scope are described e.g. in BR3 of the European Union (Section 4.4).

Moreover, information on the minimisation of the adverse impacts of the policies and measures launched, including the assessments of their economic and social impacts, is also provided in the Polish NIR of 2022 (Chapter 15) and BR4 (Section 4.3).

[50] Official Journal of the Laws of 2022, Item 1029, as amended

4.3.5. Impact of policies and measures on long-term emission trends

The impact of policies and measures on long-term emission trends can be assessed by analysing the estimated reduction effects of the policies and measures. Information in this scope is provided in Section 4.2.10 and also discussed in Section 5.8 on the assessment of the aggregated effect of policies and measures.

Given the limited availability of data, the data presented in Table 4.31 do not include the effects of all the policies or measures which are now implemented or planned. However, on the basis of the information presented there on the reduction effects of policies and measures, it can be concluded that the policies and measures indicated there, including those now implemented, will have a long-term effect on greenhouse gas emission reductions.

The information presented in Section 5.8 shows that the effects of the policies and measures now implemented will grow in the period until 2040. Compared with 2010, the effects of the policies and measures under implementation are estimated at an additional amount of about 12 Mt CO_2 eq. in 2030 and at an additional amount of about 84 Mt CO_2 eq. in 2040.

Moreover, as part of the LIFE Climate CAKE PL project[51] carried out by the KOBiZE/IOŚ-PIB at the established Centre for Climate and Energy Analyses (CAKE), analyses of the effect of the possible future policies and measures were carried out, with their scope including, among others, certain solutions and reduction effects now proposed at the EU level in the "*Fit for 55*" Package and the assumption that the EU will reach net climate neutrality in 2050.

These analyses cover, among others, the issues related to the transformation of particular sectors of the Polish economy, including the energy, transport and agriculture sectors. The analyses consider alternative scenarios of the effects of the possible policies and measures on the emission trends in the period until 2050. It follows from them that a 90% GHG emission reduction in 2050 compared with 1990 levels and the achievement of the net-zero emission level (under the neutrality scenario NEU) would be theoretically possible, but would require essential remodelling of the Polish energy sector, relevant transport measures and the introduction of new policies in the agriculture sector at the EU level, which would also generate related additional costs. Under the base scenario of those considered, i.e. the scenario providing for the implementation of the "*Fit for 55*" Package and the achievement of the net-zero target in 2050 (the NEU scenario), the marginal emission abatement cost will grow to about 145 EUR'2015/t CO_2 in 2030 and about 575 EUR'2015/t CO_2 in 2050. It should be noted that the implementation of the "Fit for 55" Package will likely contribute to reducing GHG emissions already in 2030.

The table below shows examples of the results of the abovementioned model analyses of the energy sector. They indicate that the implementation of the "*Fit for 55*" Package can result in an emission reduction in 2030 in the energy sector of about 20-30 Mt CO_2/year. It should be noted that, when compared with the EU as a whole, Poland has to carry out one of the most difficult tasks and that the process of the transformation of the whole economy and the energy sector is a huge challenge, given the large share of fossil fuels, particularly coal, at the present starting point. At the EU level and at that of Poland itself, under the NEU scenario this means a decrease in emissions by about a half by 2030 compared with 2020 and the achievement of emissions close to zero already in about

[51] Information on the project and the results of all the analyses carried out as part of the project are available on the website https://climatecake.ios.edu.pl/

2040, and in the further period, due to the use of BECCS technology, even a transition to negative net emissions.

Table 4.35. Overview of the main modelling results for the energy sector under the LIFE Climate CAKE PL project

		Poland 2030				Poland 2050			
		BASE	NEU	NEU_HRICE	NEU_LWIND	BASE	NEU	NEU_HRICE	NEU_LWIND
Emission reduction target [%] vs. 1990 for the EU		42	53	53	53	60	90	90	90
Marginal abatement costs in EU ETS [EUR'2015/tCO_2 eq.]		60	145	80	170	105	575	430	720
GDP PKB [bln EUR'2015]*		642	634	634	632	935	861	852	845
Household consumption [bln EUR'2015]*		368	355	350	354	535	523	518	518
Energy sector									
Emissions [Mt CO_2]		93	64	71	60	16	-17	-16	-14
Average costs of electricity generation [EUR'2015/MWh]		94	127	135	138	93	95	108	96
Demand level [TWh]	Electricity	200	190	195	185	345	360	345	330
	District heat	84	77	77	76	77	67	64	73
	Hydrogen form electrolysis	0	0	0	0	17	31	31	22

*For the assumed exchange rate of 1.33 USD for 1 EUR.

Source: CAKE/KOBiZE Report: POLSKA NET-ZERO 2050: Transformation of the Polish and EU energy sector until 2050, Warsaw, June 2022

CHAPTER 5. PROJECTIONS AND TOTAL EFFECT OF POLICIES AND MEASURES

5.1. Aggregated greenhouse gas emission projections

This Communication presents the national projections of greenhouse gas emissions and removals in two variants: in the so-called scenario "*with existing measures*" (WEM), which includes the projected levels of greenhouse gas emissions and removals taking into account the adopted and already implemented policies and measures to reduce GHG emissions, and in the so-called scenario "*with additional measures*" (WAM), which additionally includes planned measures.

The projections in both scenarios cover the following greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), HFCs (hydrofluorocarbons), PFCs (perfluorocarbons) and sulphur hexafluoride (SF_6). To date, no NF_3 emissions have been reported in Poland; therefore, the projections assume that there will be no NF_3 emissions in the subsequent years, either. The projections took into account the following sectors in accordance with the IPC source classification: *Energy* (including *Transport*), *Industrial processes and product use (IPPU)*, *Agriculture, Land use, land-use change and forestry (LULUCF)* and *Waste.*

The national greenhouse gas emissions in the period from 1988 to 2021 and in the two scenarios, excluding the balance of emissions and removals in sector 4[52], are presented in Fig. 5.1. It shows a fall in the emissions in 2020 as a result of the limitation of economic activity caused by the COVID-19 pandemic; however, the approximate estimates for 2021 indicate that the emissions grew in 2021. It should be pointed out that the assumptions for the projections do not take into account the possible effect of the COVID-19 pandemic and the war in Ukraine on the emissions.

The main differences between the scenarios result from the assumptions made in sector 1. *Energy*. The WEM scenario takes into account the implementation of current regulations on: the improvement of energy efficiency, the improvement of the security of fuel and energy supply, the diversification of the fuel structure in the energy sector, the enhancement of the use of renewable energy sources, the development of competitive fuel and energy markets and the limitation of the impact of the energy sector on the environment.

In turn, the WAM scenario assumes that Poland will take additional measures to fulfil its commitments under EU legislation and international agreements to reduce GHG emissions and air pollutants. They also include other specific objectives, i.e. those consisting in enhancing the share of renewable energy sources (RES), improving energy efficiency and the security of energy supply and the construction of a single energy market. The measures laid down for the area of energy supply in the *Strategy for Responsible Development until 2020 (with an Outlook until 2030)* will be implemented to improve energy security and energy efficiency, to develop technologies and to restructure the hard coal mining sector [the 2019 *Energy Policy of Poland 2040*]. These measures primarily aim at achieving the 2020 and 2030 GHG emission reduction targets.

In the scenario "*with existing measures*", the greenhouse gas emissions in Poland by 2040 will fall by 43% compared with 1988 and by 31% compared with 1990, with the largest reduction expected after 2030. In turn, for 2030 the expected greenhouse gas emission reduction levels will be 31% compared with 1988 and 16% compared with 1990.

[52] All the descriptions of changes in the emissions do not take into account the net balance in sector 4. *LULUCF*, unless specified otherwise

The WAM scenario projects that the greenhouse gas emissions in Poland by 2040 will fall by 53% compared with 1988 and by 43% compared with 1990 (Fig. 5.1). In turn, in 2030 the expected emission reductions will be 40% compared with 1988 and 27% compared with 1990. It should be added that the scenario "*with additional measures*" planned in the energy sector provides for the achievement of the reduction target for 2030 for the non-ETS sectors as specified for Poland in the EU climate and energy framework as –7% compared with 2005 r.

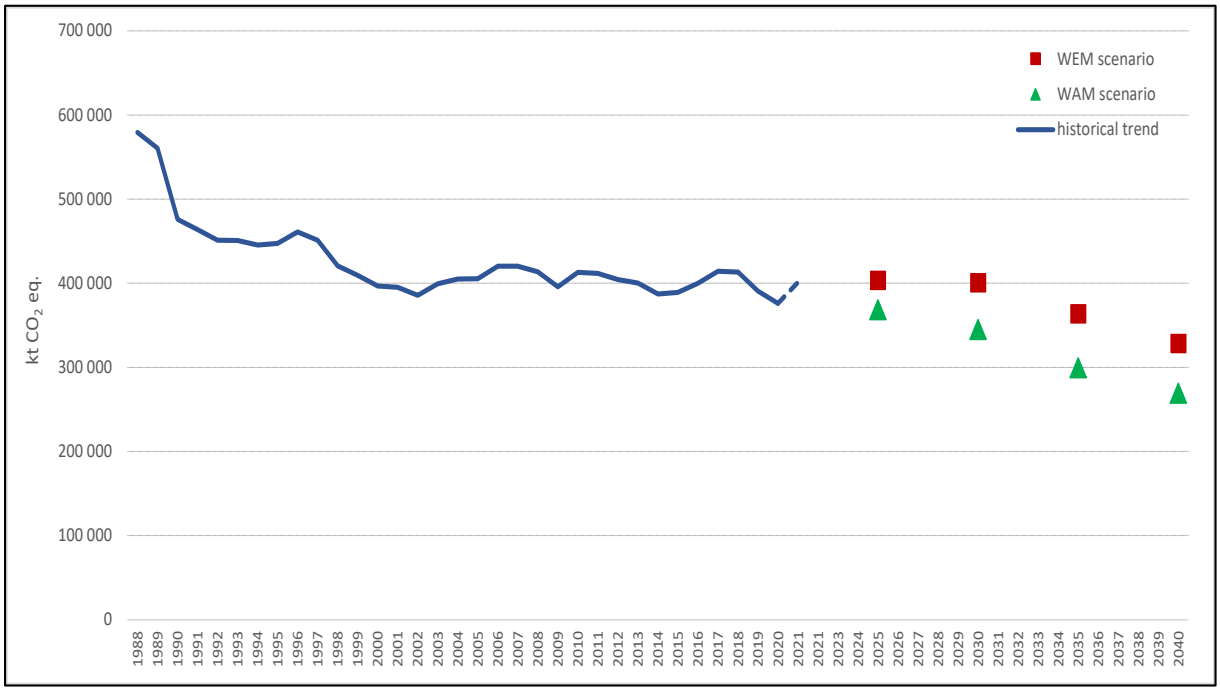


Fig. 5.1. Aggregated historical greenhouse gas emissions (excluding the balance of emissions and removals in sector 4) in the period from 1988 to 2020, the approximate emissions in 2021 and the emissions projected for 2025, 2030, 2035 and 2040

Source: KOBIZE IOŚ-PIB

5.2. Projections of greenhouse gas emissions and removals by gas

CO_2 has the largest share in the national greenhouse gas emissions and its emissions will change from nearly 472 million t to 332 million t in 2030 and 265 million t in 2040 in the WEM scenario (Table 5.1, Fig. 5.2). The expected fall in the CO_2 emissions in this scenario compared with 1988 will be 44% by 2040, from 472 million t to 265 million t CO_2 and 30% in the period from 1990 to 2040. The expected change in the CO_2 emissions from 1990 to 2030 will be 12%. In turn, the changes in the CH_4 emissions compared with 1988 represent reductions by 46% by 2040 and by 41% in the period from 1990 to 2040, while the N_2O emission reductions by 2040 will be, respectively: 36% compared with 1988 and 32% compared with 1990.

The projected share of CO_2 in the total emissions will fall from 81.5% in 1988 to 80.5% in 2040. In turn, the share of methane will fall from 12.7% in 1988 to 12.1% in 2040, while the share of nitrous oxide will grow from 5.8% in 1988 to 6.5% in 2040. Fluorinated gases will represent less than 1% of the emissions. To date, no NF_3 emissions have been reported in Poland; therefore, this assumption remains in place.

Table 5.1. Aggregated results of the projections of the GHG emissions by gas in the period from 2025 to 2040 (in the WEM scenario) compared with the historical emissions for selected years

Greenhouse gases*	1988	1990	2010	2018	2020	2025	2030	2035	2040
	kt CO_2 eq.								
CO_2	472 045	376 814	334 917	337 048	303 523	333 221	331 757	298 542	264 578
CH_4	73 520	67 612	50 262	47 189	44 356	45 218	43 678	41 015	39 864
N_2O	33 512	31 305	22 068	23 183	22 839	21 839	22 280	21 408	21 315
HFCs	NO, NA	NO, NA	5 603	5 589	5 221	3 298	2 882	2 678	2 696
PFCs	147	142	17	11	10	8	6	5	4
SF_6	0	0	35	107	90	125	151	176	199
NF_3	–	–	–	–	–	–	–	–	–
Total	**579 224**	**475 873**	**412 902**	**413 128**	**376 038**	**403 709**	**400 755**	**363 824**	**328 656**

* The reported levels do not include the emissions and removals in sector 4. *Land use, land-use change and forestry (LULUCF)*
Source: KOBIZE IOŚ-PIB

Similarly, in the WAM scenario, CO_2 has the largest share in the national greenhouse gas emissions. In this case, the expected fall in its emissions compared with 1988 will be 56% by 2040, from 472 million t to 209 million t CO_2 and 30% in the period 1990 to 2040 (Table 5.2, Fig. 5.3). The change in the CO_2 emissions in the period from 1990 to 2030 will be 26%. The projected changes in the CH_4 emissions compared with 1988 represent reductions by 46% by 2040 and by 41% in the period from 1990 to 2040, while the N_2O emission reductions by 2040 will be, respectively: 36% compared with 1988 and 32% compared with 1990.

The share of CO_2 in the total emissions will fall from 81.5% in 1988 to 77.4% in 2040. In turn, the shares of methane and nitrous oxide will grow, respectively, from 12.7% and 5.8% to 14.2 and 7.9% in 2040, while fluorinated gases will represent about 0.5% of the emissions. This scenario does not provide for NF_3 emissions, either.

Table 5.2. Aggregated results of the projections of the GHG emissions by gas in the period from 2025 to 2040 (in the WAM scenario) compared with the historical emissions for selected years

Greenhouse gases*	1988	1990	2010	2018	2020	2025	2030	2035	2040
	kt CO_2 eq.								
CO_2	472 045	376 814	334 917	337 048	303 523	298 939	278 159	237 351	208 715
CH_4	73 520	67 612	50 262	47 189	44 356	44 263	42 058	39 044	38 158
N_2O	33 512	31 305	22 068	23 183	22 839	21 806	22 190	21 290	21 167
HFCs	NO, NA	NO, NA	5 603	5 589	5 221	3 298	2 605	1 893	1 368
PFCs	147	142	17	11	10	8	6	5	4
SF_6	0	0	35	107	90	125	91	83	75
NF_3	–	–	–	–	–	–	–	–	–
Total	**579 224**	**475 873**	**412 902**	**413 128**	**376 038**	**368 438**	**345 110**	**299 665**	**269 486**

* The reported levels do not include the emissions and removals in sector 4. *Land use, land-use change and forestry (LULUCF)*
Source: KOBIZE IOŚ-PIB

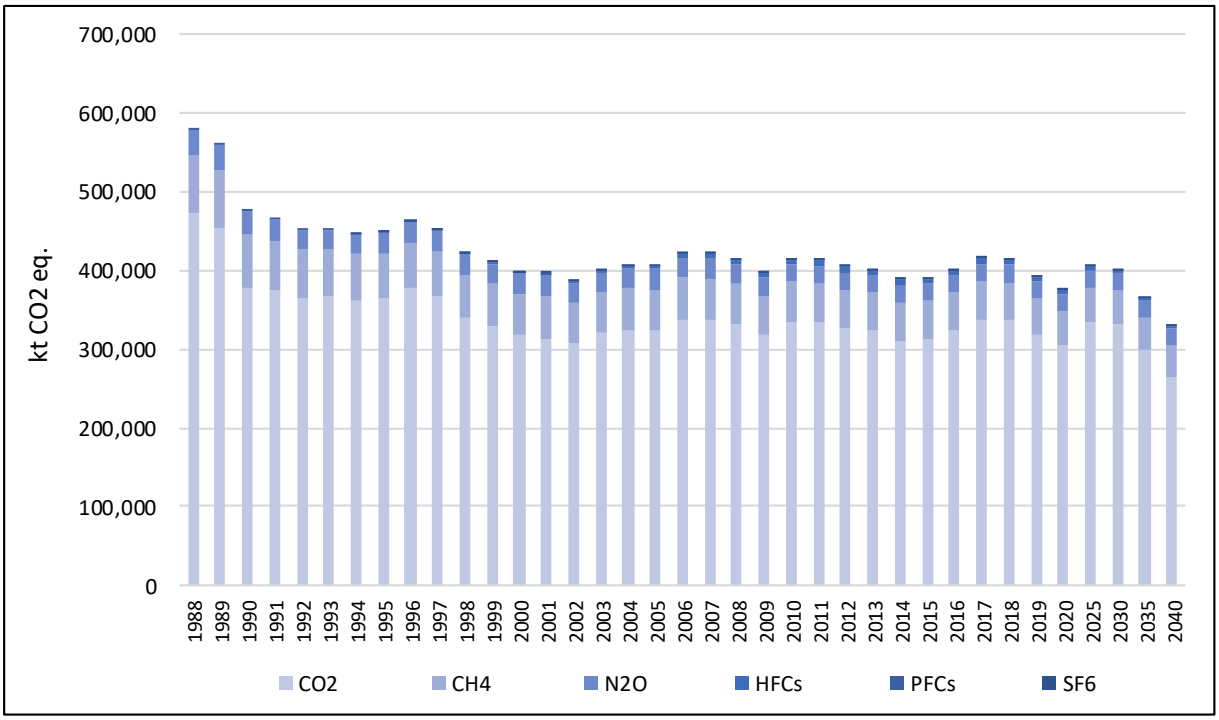


Fig. 5.2. Greenhouse gas emissions in Poland in the period from 1988 to 2020 and the emissions projected in the period from 2025 to 2040 (in the WEM scenario) by gas (excluding the LULUCF sector)

Source: KOBIZE IOŚ-PIB

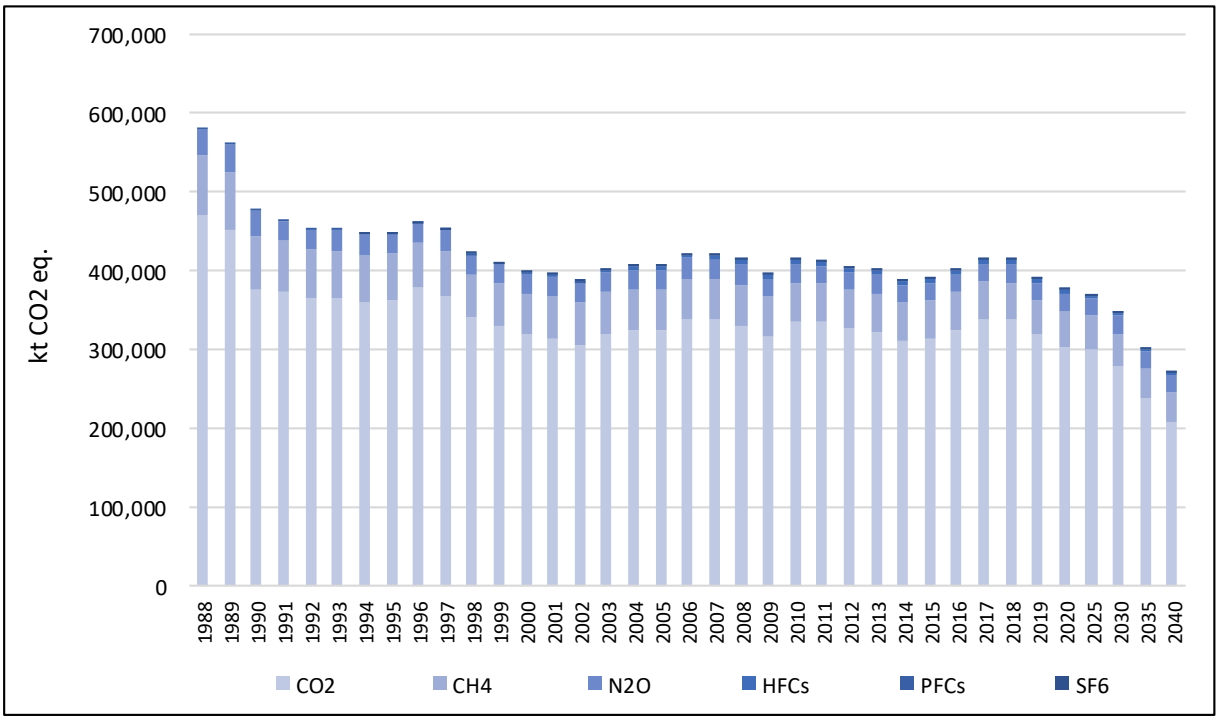


Fig. 5.3. Greenhouse gas emissions in Poland in the period from 1988 to 2020 and the emissions projected in the period from 2025 to 2040 (in the WAM scenario) by gas (excluding the LULUCF sector

Source: KOBIZE IOŚ-PIB

5.3. Projections of greenhouse gas emissions and removals by sector

As already mentioned in Section 5.1, two scenarios of the greenhouse gas emissions by 2040 in Poland were prepared: "*with existing measures*" (WEM) and "*with additional measures*" (WAM). The differences between the scenarios can be seen in two sectors: 1. *Energy* and 2. *Industrial processes and product use*. Only the WEM scenario was prepared for the other sectors: 3. *Agriculture*, 4. *Land use, land-use change and forestry* (LULUCF) and 5. *Waste*.

In both projection variants, the *Energy* sector has the greatest effect on changes in the future emissions, with its share in the total emissions expected to decrease from 82% in 1988 to 81% in 2040 in the WEM scenario and to 77% in 2040 in the WAM scenario. It is projected that in the WEM scenario in the period from 2025 to 2035 the emissions in this sector will stabilise at a level of about 330 million t CO_2 eq., to fall afterwards to 265 million t CO_2 eq. in 2040. In turn, in the WAM scenario the greenhouse gas emissions in the *Energy* sector will fall below 300 million t CO_2 eq. already in 2025, to reach 207 million t CO_2 eq. in 2040 (Figs. 5.4 and 5.5).

In turn, the projected emissions from *Industrial processes and product use* will slightly fall from almost 25 million t CO_2 eq. in 2020 to about 23 million t CO_2 eq. in the period from 2030 to 2040. In this sector, the emissions in the two scenarios are only different in the scope of fluorinated gases (sectors 2.F-G), where account is taken of the possible additional measures to reducing the emissions.

The projected emissions in the sectors of *Agriculture, Waste* and *Land use, land-use change and forestry* in the two projection variants are the same (Tables 5.3 and 5.4), since the values estimated for the WEM scenario were used in the WAM scenario.

The future greenhouse gas emissions in the *Agriculture* sector will remain at a similar level as in 2020, amounting to about 34 million t CO_2 eq., with the highest emissions in 2030 (more than 35 million t CO_2 eq.). In turn, the expected emissions in the *Waste* sector will systematically fall by 2040 from the present 11 million t CO_2 eq. to 5.4 million t CO_2 eq. The LULUCF sector will see a systematic fall in the net CO_2 removals from the present ones of nearly -18.1 million t CO_2 eq. in 2020 to about -6.7 million t CO_2 eq. in 2030 and in net emissions by 4.6 million t CO_2 eq. in 2040.

A comparison of the projection data on the total greenhouse gas emissions in the WEM scenario in the period from 2030 to 2040 with the data from the base year 1988 shows a decrease in the total emissions from all the sectors, by 31% in 2030 and by 43% in 2040, and, respectively, in the WAM scenario: by 40% in 2030 and by 53% in 2040. The largest projected reductions in the period from 1988 to 2040 can be seen in the sectors of: *Waste* (by 75%), *Energy* (by 44% in the WEM scenario and by 56% in the WAM scenario) and *Agriculture* (by 31%). In turn, the projected emissions from *Industrial processes and product use* will be lower in 2040 than in the base year by 24% in the WEM scenario and by 29% in the WAM scenario.

Table 5.3. Projections of the greenhouse gas emissions by sector in the period from 2025 to 2040 (in the WEM scenario) compared with the historical emissions for selected years

Sectors	1988	1990	2010	2018	2020	2025	2030	2035	2040
	kt CO_2 eq.								
1. Energy	476 159	382 401	342 046	340 990	305 336	334 737	334 006	300 249	265 017
1.A. Fuel combustion	446 999	355 910	320 083	316 929	283 965	310 895	310 052	276 775	242 174
1.A.1. Energy industries	258 114	235 395	173 697	163 453	139 757	159 467	160 060	130 965	99 742
1.A.2. Manufacturing industries and construction	55 232	42 836	29 621	31 714	29 196	27 836	25 627	23 587	22 909
1.A.3. Transport	24 570	20 757	49 410	65 151	63 238	68 260	70 186	69 441	68 317
1.A.4. Other sectors	109 083	56 922	67 356	56 611	51 773	55 332	54 180	52 781	51 205
1.B. Fugitive emissions from fuels	29 160	26 492	21 963	24 061	21 371	23 842	23 954	23 475	22 843
2. Industrial processes	31 040	22 548	23 466	26 040	25 074	24 488	23 459	23 132	23 638
3. Agriculture	50 186	49 425	32 006	34 035	34 315	34 332	35 605	34 110	34 630
4. Land use, land-use change and forestry (LULUCF)	-16 410	-27 655	-32 623	-36 073	-18 127	-14 972	-6 700	-1 058	4 639
5. Waste	21 839	21 498	15 384	12 064	11 314	10 152	7 684	6 333	5 371
Total excluding category 4	**579 224**	**475 873**	**412 902**	**413 128**	**376 038**	**403 709**	**400 755**	**363 824**	**328 656**
Total including category 4	562 814	448 218	380 279	377 055	357 911	388 737	394 055	362 766	333 294

(–) means CO_2 removals in the total balance of GHG emissions and removals in the LULUCF sector
Source: KOBIZE IOŚ-PIB

Table 5.4. Projections of the greenhouse gas emissions by sector in the period from 2025 to 2040 (in the WAM scenario) compared with the historical emissions for selected years

Sectors	1988	1990	2010	2018	2020	2025	2030	2035	2040
	kt CO_2 eq.								
1. Energy	476 159	382 401	342 046	340 990	305 336	299 466	278 699	236 970	207 300
1.A. Fuel combustion	446 999	355 910	320 083	316 929	283 965	276 475	256 022	215 044	185 694
1.A.1. Energy industries	258 114	235 395	173 697	163 453	139 757	143 123	132 753	101 203	86 586
1.A.2. Manufacturing industries and construction	55 232	42 836	29 621	31 714	29 196	22 258	18 848	16 705	15 208
1.A.3. Transport	24 570	20 757	49 410	65 151	63 238	65 514	66 580	63 398	53 251
1.A.4. Other sectors	109 083	56 922	67 356	56 611	51 773	45 580	37 841	33 738	30 650
1.B. Fugitive emissions from fuels	29 160	26 492	21 963	24 061	21 371	22 991	22 677	21 926	21 605
2. Industrial processes	31 040	22 548	23 466	26 040	25 074	24 488	23 123	22 252	22 185
3. Agriculture	50 186	49 425	32 006	34 035	34 315	34 332	35 605	34 110	34 630
4. Land use, land-use change and forestry (LULUCF)	-16 410	-27 655	-32 623	-36 073	-18 127	-14 972	-6 700	-1 058	4 639
5. Waste	21 839	21 498	15 384	12 064	11 314	10 152	7 684	6 333	5 371
Total excluding category 4	**579 224**	**475 873**	**412 902**	**413 128**	**376 038**	**368 438**	**345 110**	**299 665**	**269 486**
Total including category 4	562 814	448 218	380 279	377 055	357 911	353 467	338 410	298 608	274 124

(–) means CO_2 removals in the total balance of GHG emissions and removals in the LULUCF sector
Source: KOBIZE IOŚ-PIB

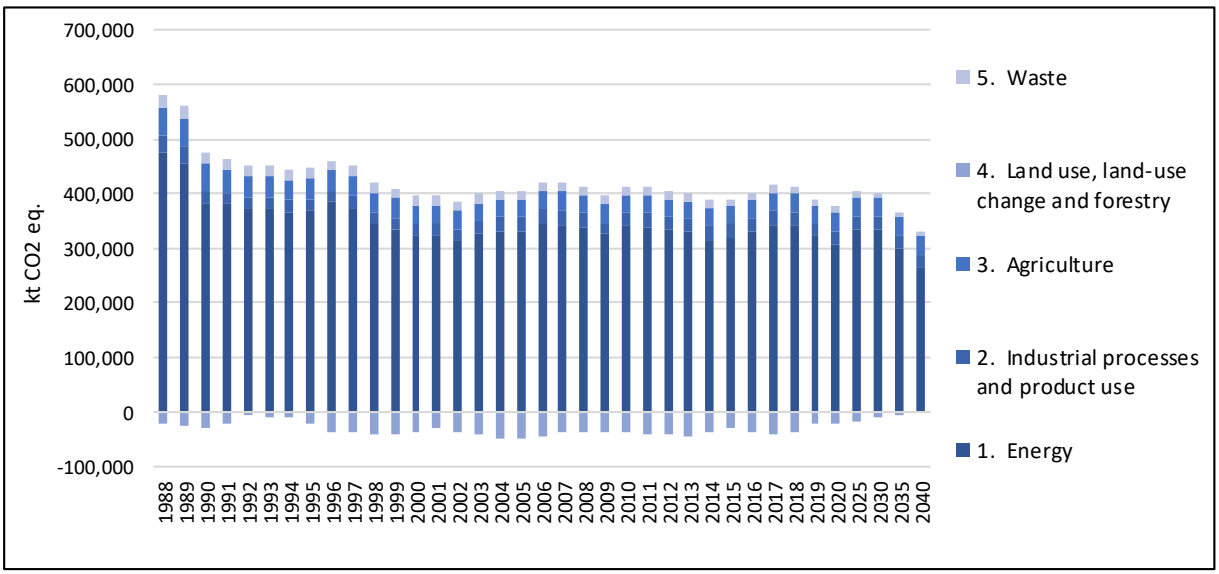


Fig. 5.4. Historical greenhouse gas emissions (1988-2020) and projected ones (2025-2040 in the WEM scenario) in Poland by sector

Source: KOBIZE IOŚ-PIB

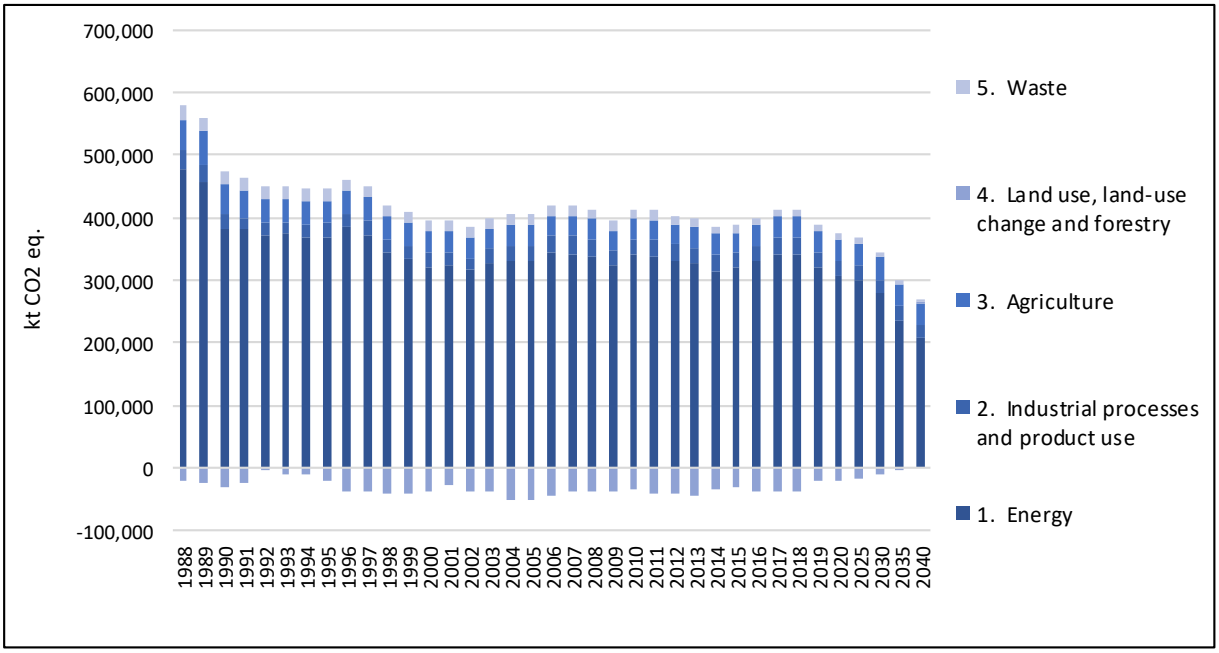


Fig. 5.5. Historical greenhouse gas emissions (1988-2020) and projected ones (2025-2040 in the WAM scenario) in Poland by sector

Source: KOBIZE IOŚ-PIB

Taking into account the projected fuel combustion in international transport (so-called bunker), which, in accordance with the applicable guidelines, is reported separately from the national emissions, only one scenario (the one "*with existing measures*" – WEM) was prepared. The projected emissions from international aviation and maritime shipping in 2040 will grow by about 69% compared with the emissions in 1988, with the emissions from international fuel bunker in aviation almost tripling over that time (Table 5.5). In the case of maritime shipping, a constant value representing an average from the last 3 years (2018-2020) was used.

Tables 5.6 and 5.7 present detailed results of the carbon dioxide emission projections by sector in the two scenarios. It follows from these data that in all the sectors (except for waste), significant CO_2 emission reductions are projected by 2040 compared with 1988. In the energy sector, which was responsible for 93% of the emissions of this gas in Poland in 2020, it is projected that its emissions will fall by 45% in the WEM scenario and by 58% in the WAM scenario in the period from 1988 to 2040 and, respectively, by 32% (WEM) and 47% (WAM) in the period from 1990 to 2040. This trend is related to the projected changes in the fuel consumption structure and level.

Table 5.5. Projections of the greenhouse gas emissions from fuel combustion in international aviation and maritime shipping in the period from 2025 to 2040 (in the WEM scenario) compared with the historical emissions for selected years

Sectors	1988	1990	2010	2018	2020	2025	2030	2035	2040
	kt CO_2 eq.								
International fuel bunker, including :	2 790	1 923	2 146	3 864	2 317	3 671	4 036	4 379	4 703
Aviation	1 021	645	1 449	3 007	1 361	2 719	3 084	3 428	3 751
Maritime shipping	1 769	1 278	697	857	957	951	951	951	951

Source: KOBiZE IOŚ-PIB

In the sector of industrial processes, the largest fall in CO_2 emissions compared with 1988 is expected in metallurgical industry, by 79% in 2030 and by 87% in 2040. This is related to the production shutdown in integrated steel plants. It is projected that from 2035 iron ore sinters, blast furnace pig iron and basic oxygen furnace steel will not be produced. In turn, steel production in electric furnaces is expected to gradually grow.

In agriculture, too, there will be a distinct fall in CO_2 by about 50% because of much lower consumption of calcium fertilisers. In the case of the waste sector, the expected rise in the CO_2 emissions will be caused by the projected increase in the quantity of incinerated municipal, industrial and medical waste and municipal sewage sludge.

Table 5.6. CO_2 emission projections by sector in the period from 2025 to 2040 (in the WEM scenario) compared with the historical emissions for selected years

Sectors	1988	1990	2018	2020	2025	2030	2035	2040
	kt CO_2							
1. Energy	442 977	354 870	315 454	282 319	310 500	309 747	276 754	242 415
A. Fuel combustion	438 905	350 634	310 618	278 094	305 370	304 553	271 490	237 089
1. Energy industries	256 917	234 294	162 625	138 996	158 603	159 159	130 195	99 099
2. Manufacturing industries and construction	54 955	42 621	31 403	28 878	27 555	25 349	23 313	22 636
3. Transport	24 010	20 277	64 368	62 474	67 507	69 382	68 624	67 488
4. Other sectors	103 022	53 441	52 222	47 746	51 705	50 663	49 358	47 866
B. Fugitive emissions from fuels	4 072	4 235	4 835	4 225	5 130	5 194	5 264	5 325
2. Industrial processes and product use, including:	25 903	18 687	19 588	19 147	20 429	19 790	19 643	20 103
A. Mineral industry	11 605	8 855	11 651	11 740	12 242	12 129	12 552	12 978
B. Chemical industry	5 758	3 802	4 620	4 867	5 261	5 331	5 387	5 444
C. Metal industry	7 571	5 652	2 608	1 824	2 207	1 600	968	960
3. Agriculture	2 717	2 907	1 345	1 459	1 321	1 331	1 314	1 299
4. Land use, land-use change and forestry, including:	-18 450	-29 593	-38 062	-20 095	-16 939	-8 488	-2 662	3 613
A. Forest land	-22 145	-33 924	-39 138	-21 960	-17 055	-7 668	-374	6 888
5. Waste	448	350	662	599	972	889	830	761

Sectors	1988	1990	2018	2020	2025	2030	2035	2040
	kt CO_2							
Total CO_2 emissions excluding category 4	**472 045**	**376 814**	**337 048**	**303 523**	**333 221**	**331 757**	**298 542**	**264 578**
Total CO_2 emissions including category 4	453 595	347 221	298 987	283 428	316 282	323 269	295 879	268 191

Source: KOBiZE IOŚ-PIB

Table 5.7. CO_2 emission projections by sector in the period from 2025 to 2040 (in the WAM scenario) compared with the historical emissions for selected years

Sectors	1988	1990	2018	2020	2025	2030	2035	2040
	kt CO_2							
1. Energy	442 977	354 870	315 454	282 319	276 217	256 149	215 564	186 552
A. Fuel combustion	438 905	350 634	310 618	278 094	271 524	251 449	210 832	181 769
1. Energy industries	256 917	234 294	162 625	138 996	142 237	131 836	100 429	85 892
2. Manufacturing industries and construction	54 955	42 621	31 403	28 878	21 953	18 530	16 389	14 887
3. Transport	24 010	20 277	64 368	62 474	64 770	65 810	62 641	52 584
4. Other sectors	103 022	53 441	52 222	47 746	42 563	35 273	31 374	28 406
B. Fugitive emissions from fuels	4 072	4 235	4 835	4 225	4 694	4 700	4 732	4 783
2. Industrial processes and product use, including:	25 903	18 687	19 588	19 147	20 429	19 790	19 643	20 103
A. Mineral industry	11 605	8 855	11 651	11 740	12 242	12 129	12 552	12 978
B. Chemical industry	5 758	3 802	4 620	4 867	5 261	5 331	5 387	5 444
C. Metal industry	7 571	5 652	2 608	1 824	2 207	1 600	968	960
3. Agriculture	2 717	2 907	1 345	1 459	1 321	1 331	1 314	1 299
4. Land use, land-use change and forestry, including:	-18 450	-29 593	-38 062	-20 095	-16 939	-8 488	-2 662	3 613
A. Forest land	-22 145	-33 924	-39 138	-21 960	-17 055	-7 668	-374	6 888
5. Waste	448	350	662	599	972	889	830	761
Total CO_2 emissions excluding category 4	**472 045**	**376 814**	**337 048**	**303 523**	**298 939**	**278 159**	**237 351**	**208 715**
Total CO_2 emissions including category 4	453 595	347 221	298 987	283 428	282 000	269 671	234 689	212 328

Source: KOBiZE IOŚ-PIB

The projected methane emissions will gradually fall from 2020, from nearly 3 million t in 1988 and about 1.8 million t in 2020 to 1.6 million t of CH_4 in 2040 in the WEM scenario (Table 5.8) and 1.5 million t of CH_4 in 2040 in the WAM scenario (Table 5.9).

The largest expected CH_4 emission reduction compared with 1988 can be seen in the waste sector, by 72% in 2030 and by 82% in 2040, as a result of the projected decrease in the quantity of waste disposed at landfills (including a reduction in the quantity of biodegradable waste), a decrease in the population using latrines and a greater extent of the disposal of sludge from municipal wastewater treatment plants.

A drop in the CH_4 emissions compared with 1988 is also projected in the *Energy* sector, primarily fugitive emissions from the extraction and processing of fossil fuels: by 27% in 2030 and 32% in 2040, as a result of a further decrease in coal extraction. In the case of agriculture, despite a significant reduction in the methane emissions compared with 1988: by 30% in 2030 and by 31% in 2040, they are projected to grow, mostly due to changes in the livestock population and a significant increase in the share of bedding-free cattle and pig rearing systems.

Table 5.8. CH_4 emission projections by sector in the period from 2025 to 2040 (in the WEM scenario) compared with the historical emissions for selected years

Sectors	1988	1990	2018	2020	2025	2030	2035	2040
	kt CH_4							
1. Energy	1 224.5	1 015.3	913.3	815.7	891.8	889.8	864.3	833.5
A. Fuel combustion	221.0	125.1	144.3	129.8	143.3	139.5	135.9	132.9
B. Fugitive emissions from fuels	1 003.5	890.2	769.0	685.8	748.5	750.4	728.4	700.7
2. Industrial processes and product use	2.8	2.5	2.5	2.3	3.0	2.9	2.6	2.7
3. Agriculture, including:	888.9	870.3	553.8	566.7	586.9	622.7	593.3	613.1
A. Enteric fermentation	802.2	786.0	503.3	516.7	510.2	537.8	507.5	527.2
B. Manure management	85.9	83.5	49.5	48.9	76.0	84.2	85.2	85.2
4. Land use, land-use change and forestry	2.0	2.0	0.7	0.8	1.0	1.1	1.0	1.0
5. Waste, including:	824.7	816.4	418.0	389.6	327.1	231.8	180.3	145.3
A. Solid waste disposal	560.5	563.1	329.1	301.8	258.3	164.8	113.4	79.5
Total CH_4 emissions excluding category 4	**2 940.8**	**2 704.5**	**1 887.6**	**1 774.2**	**1 808.7**	**1 747.1**	**1 640.6**	**1 594.5**
Total CH_4 emissions including category 4	2 942.8	2 706.4	1 888.3	1 775.0	1 809.7	1 748.2	1 641.6	1 595.6

Source: KOBiZE IOŚ-PIB

Table 5.9. CH_4 emission projections by sector in the period from 2025 to 2040 (in the WAM scenario) compared with the historical emissions for selected years

Sectors	1988	1990	2018	2020	2025	2030	2035	2040
	kt CH_4							
1. Energy	1 224.5	1 015.3	913.3	815.7	853.6	825.0	785.5	765.3
A. Fuel combustion	221.0	125.1	144.3	129.8	121.7	106.0	97.8	92.4
B. Fugitive emissions from fuels	1 003.5	890.2	769.0	685.8	731.9	719.1	687.8	672.9
2. Industrial processes and product use	2.8	2.5	2.5	2.3	3.0	2.9	2.6	2.7
3. Agriculture, including:	888.9	870.3	553.8	566.7	586.9	622.7	593.3	613.1
A. Enteric fermentation	802.2	786.0	503.3	516.7	510.2	537.8	507.5	527.2
B. Manure management	85.9	83.5	49.5	48.9	76.0	84.2	85.2	85.2
4. Land use, land-use change and forestry	2.0	2.0	0.7	0.8	1.0	1.1	1.0	1.0
5. Waste, including:	824.7	816.4	418.0	389.6	327.1	231.8	180.3	145.3
A. Solid waste disposal	560.5	563.1	329.1	301.8	258.3	164.8	113.4	79.5
Total CH_4 emissions excluding category 4	**2 940.8**	**2 704.5**	**1 887.6**	**1 774.2**	**1 770.5**	**1 682.3**	**1 561.8**	**1 526.3**
Total CH_4 emissions including category 4	2 942.8	2 706.4	1 888.3	1 775.0	1 771.5	1 683.4	1 562.8	1 527.4

Source KOBiZE IOŚ-PIB

Tables 5.10 and 5.11 show the results of the nitrous oxide emission projections compared with historical years, where following a significant reduction compared with 1988, in all the sectors, except for waste, a further drop in N_2O emissions can be seen – from nearly 77,000 t of N_2O in 2020 to about 71,000 t of N_2O in 2040 in both scenarios. The largest reduction in the N_2O in the period from 1988 to 2040 occurs in the sector of *Industrial processes and product use* (mainly in the chemical industry) – by 88% and in the sector of *Agriculture* – by 29%. In turn, in the sector of *Waste* the N_2O emissions can be seen to grow by 26% in the period from 1988 to 2040, as a result of the projected increase in the quantity of incinerated municipal, industrial and medical waste and an increase in the quantity of municipal sewage sludge treated in composting plants.

Table 5.10. N_2O emission projections by sector in the period from 2025 to 2040 (in the WEM scenario) compared with the historical emissions for selected years

Sectors	1988	1990	2018	2020	2025	2030	2035	2040
	kt N_2O							
1. Energy	8.6	7.2	9.1	8.8	6.5	6.8	6.3	5.9
2. Industrial processes and product use	16.5	12.3	2.3	1.8	1.9	1.9	1.9	1.9
3. Agriculture, including:	84.7	83.1	63.2	62.7	61.5	62.8	60.3	60.4
B. Manure management	13.8	13.7	9.4	9.9	9.8	10.7	9.7	9.9
D. Agricultural soils	70.9	69.4	53.8	52.8	51.7	52.0	50.6	50.5
4. Land use, land-use change and forestry	6.7	6.3	6.6	6.5	6.5	5.9	5.3	3.4
5. Waste	2.6	2.5	3.2	3.3	3.4	3.4	3.3	3.3
Total N_2O emissions excluding category 4	**112.5**	**105.1**	**77.8**	**76.6**	**73.3**	**74.8**	**71.8**	**71.5**
Total N_2O emissions including category 4	119.1	111.4	84.4	83.2	79.8	80.7	77.1	74.9

Source: KOBiZE IOŚ-PIB

Table 5.11. N_2O emission projections by sector in the period from 2025 to 2040 (in the WAM scenario) compared with the historical emissions for selected years

Sectors	1988	1990	2018	2020	2025	2030	2035	2040
	kt N_2O							
1. Energy	8.6	7.2	9.1	8.8	6.4	6.5	5.9	5.4
2. Industrial processes and product use	16.5	12.3	2.3	1.8	1.9	1.9	1.9	1.9
3. Agriculture, including:	84.7	83.1	63.2	62.7	61.5	62.8	60.3	60.4
B. Manure management	13.8	13.7	9.4	9.9	9.8	10.7	9.7	9.9
D. Agricultural soils	70.9	69.4	53.8	52.8	51.7	52.0	50.6	50.5
4. Land use, land-use change and forestry	6.7	6.3	6.6	6.5	6.5	5.9	5.3	3.4
5. Waste	2.6	2.5	3.2	3.3	3.4	3.4	3.3	3.3
Total N_2O emissions excluding category 4	**112.5**	**105.1**	**77.8**	**76.6**	**73.2**	**74.5**	**71.4**	**71.0**
Total N_2O emissions including category 4	119.1	111.4	84.4	83.2	79.7	80.4	76.7	74.4

Source: KOBiZE IOŚ-PIB

5.4. Projections of the emissions of the precursors of greenhouse gases and sulphur dioxide

The projections of the emissions of the precursors of greenhouse gases (NOx, NMVOCs and CO) and sulphur dioxide were prepared on the basis of the same assumptions and input data as those for the greenhouse gas emission projections presented in this Chapter of the Communication. The emissions of all the substances can be seen to fall in the period from 1990 to 2020 and the further reduction of their emissions is also expected by 2040, just as in the case of greenhouse gas emission predictions (Figs. 5.6 – 5.9).

Nitrogen oxides (NOx)

The largest source of the emissions of nitrogen oxides is fuel combustion in sectors: 1A3. *Transport* – 35%, where road transport is responsible for most emissions; moreover, 1A1. *Energy industries* – responsible for 21% and 1A4. *Other sectors* (including, among others, household emissions) – responsible for 19% of emissions in 2020. An analysis of the trend in the NO_X emissions from 1990 shows the emissions falling by 47% until 2020, while their expected decrease by 2040 will even amount to 61% in the WEM scenario and 69% in the WAM scenario.

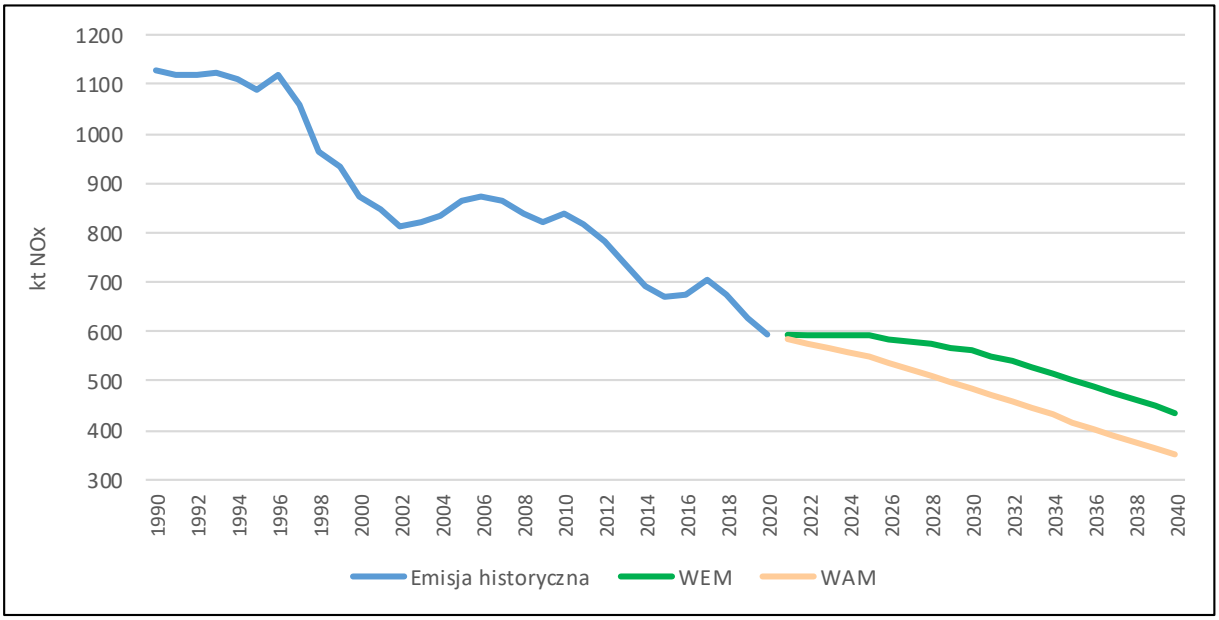


Fig. 5.6. Historical NOx emissions in the period from 1990 to 2020 and the projected emission levels until 2040 in the WEM and WAM scenarios

Source: KOBiZE IOŚ-PIB

Non-methane volatile organic compounds (NMVOCs)

Sector 2. *Industrial processes* has the largest share in the NMVOC emissions; it was 35% in 2020. Most of the emissions from industrial processes come from sector 2D. *Other solvent and product use*. Important sources of NVOC emissions also include sector 1A4. *Other sectors* with its share of 19% and sector 3. *Agriculture* with its share of 19% in 2020. In the period from 1990 to 2020, the NMVOC emissions fell by 19%, while the projected fall by 2040 will be 37% in the WEM scenario and 39% in the WAM scenario.

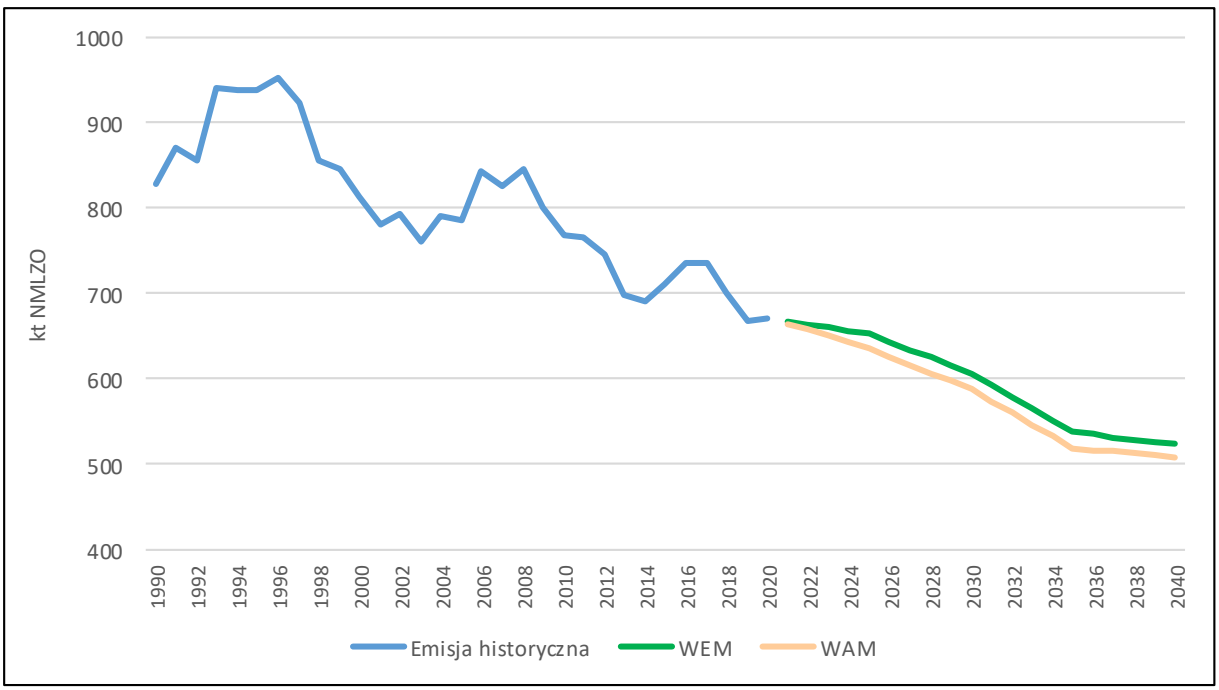


Fig. 5.7. Historical NMVOC emissions in the period from 1990 to 2020 and the projected emission levels until 2040 in the WEM and WAM scenarios

Source: KOBiZE IOŚ-PIB

Carbon monoxide (CO)

In 2020, fuel combustion in sector 1A4. *Other sectors* was the largest source of carbon monoxide emissions. This sector includes small combustion sources, such as households, institutions, etc.), which are responsible for 75% of the national carbon monoxide emissions. Another substantial source of carbon monoxide emissions is sector 1A3. *Transport*, which is responsible for 13% of the national emissions. In the period from 1990 to 2020, the CO emissions fell by 39%, while by 2040 they are projected to decrease by 86% in the WEM scenario and by 90% in the WAM scenario.

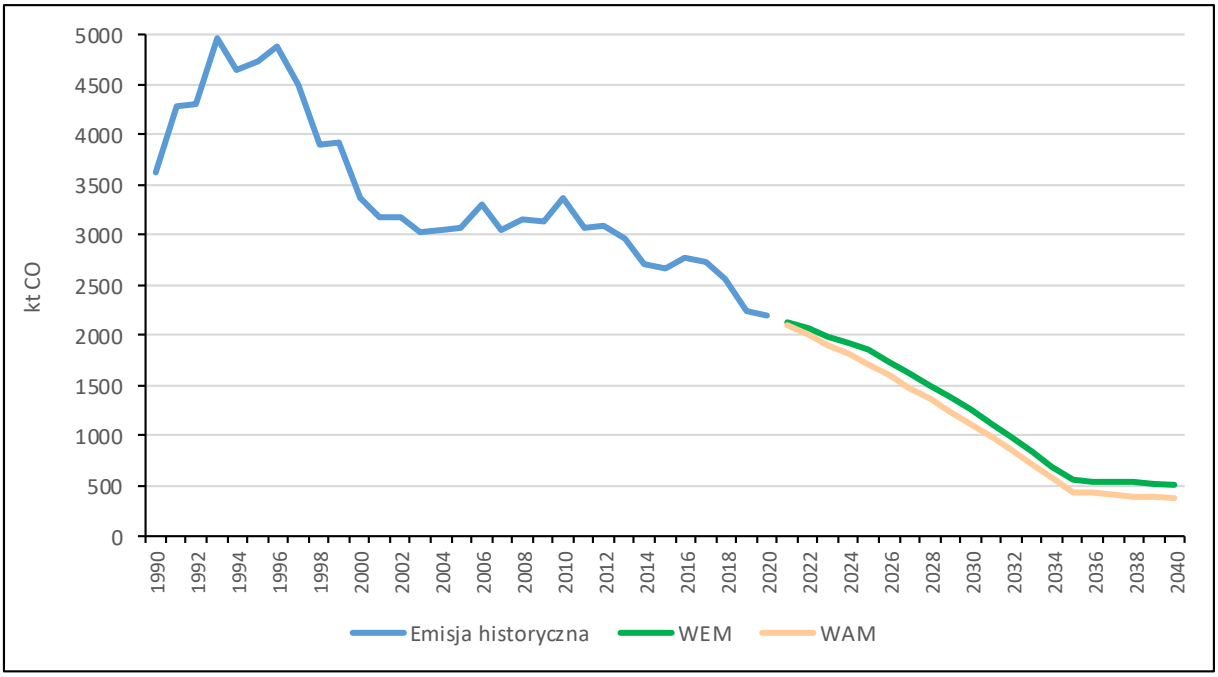


Fig. 5.8. Historical CO emissions in the period from 1990 to 2020 and the projected emission levels until 2040 in the WEM and WAM scenarios

Source: KOBiZE IOŚ-PIB

Sulphur dioxide (SO_2)

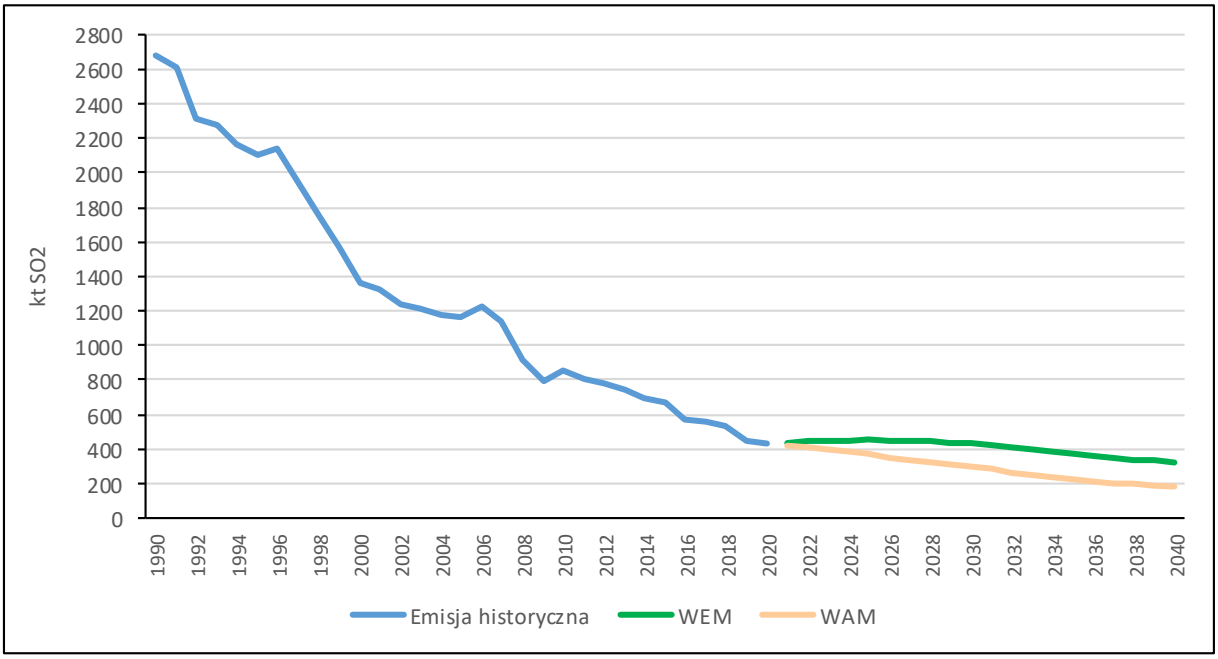


Fig. 5.9. Historical SO_2 emissions in the period from 1990 to 2020 and the projected emission levels until 2040 in the WEM and WAM scenarios

Source: KOBiZE IOŚ-PIB

The main source of sulphur dioxide emissions is fuel combustion (mostly coal) for energy generation purposes at stationary sources which were jointly responsible for 96% of the national sulphur dioxide emissions in 2020. In turn, 42% of the SO_2 emissions came from sector 1A1. *Energy industries*, 36% from sector 1A4. *Other sectors* and 18% from sector 1A2. *Manufacturing industries and construction*. In the period 1990 to 2020, the SO_2 emissions fell by 84% and its emissions are expected to decrease further by 2040 by 88% in the WEM scenario and by 93% in the WAM scenario.

5.5. Sensitivity analysis of the emission projections in the WEM and WAM scenarios

Referring to the definition presented by Morgan and Henrion (1990)[53] sensitivity analysis can be defined as the modelling of the impact of changes in the input parameters or assumptions on the final results of calculations. Data selected on the basis of an analysis of mathematical model of the inventory was subject to numerical analysis designed to examine the impact of changes of selected input data and some initial assumptions on the overall results of emission inventories. Changes in the parameters were grouped into three main scenarios, which were designed to cover all gases reported in the projections.

Preparation of sensitivity analysis scenarios was preceded by an in-depth analysis of trends in inventory data with particular attention to F-gases (IPCC 2. *Industrial Processes and Product Use*), CH_4 and N_2O (IPCC 3. *Agriculture*) and CH_4 (IPCC 5. *Waste*). For the numerical analysis simplified deterministic analysis method was selected, in which more than one input parameter at a time was subjected to changes. It has to be noted that sensitivity scenarios are not official projections data, however when sensitivity scenarios were set up, special attention was paid to ensure that they are not only synthetic data, but could reflect potential national market circumstances in the future.

Since submission 2021 analysis was extended to include additional base scenario and covers two projection scenarios: *With Existing Measures* (WEM) and *With Addition Measures* (WAM). Base year for this analysis was 2020 - last year of greenhouse gases emission inventory available at the moment of preparing projections. Below are presented three options of sensitivity analysis hereinafter referred to as sensitivity scenarios.

Sensitivity scenario 1 „*Gradual decrease in F-gases emissions*"

Scenario assumes introduction of environmental policies phasing out F-gases from the market and introduction of new technologies with lower annual leakage rates and new refrigerants (R1234yf). This scenario affects IPCC sector 2. Modification of the input parameters were done for IPCC category 2.F.1 Refrigeration and Air-Conditioning, which is major contributor to the national F-gases emissions.

It was assumed that in 2025 emission from category 2.F.1 will be 80% of the originally projected emissions. For year 2030 assumed ratio is 70%, for 2035 – 60% and for 2040 – 50% respectively.

Gases affected: F-gases [HFCs]

Sensitivity scenario 2 „*Increase in livestock by 20%*"

Scenario assumes 20% increase of livestock population for every projected year in reference to base scenarios WAM and WEM in IPCC 3. *Agriculture* sector. In this case of that scenario input parameters were modified for IPCC categories 3.A *Enteric fermentation* and 3.B *Manure management*.

[53] Morgan, M.G., Henrion, M. (1990). *Uncertainty. A Guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis*. Cambridge University Press. ISBN 0-521-42744-4

Scenario is based on the assumptions that new environmental and economic policies (higher demand for milk production) will result in increasing of cattle population and associated CH_4 and N_2O emissions connected with feeding and maintenance of livestock reported in 3.A and 3.B subsectors.

Gases affected: CH_4, N_2O

Sensitivity scenario 3 „*Increase in solid waste disposal by 15%*"

Scenario assumes that waste management policies will result in increased stream of solid wastes delivered to solid waste disposal sites (managed, unmanaged and uncategorized). Input parameters for IPCC category 5.A *Solid Waste Disposal* were modified to include effect of increasing of solid wastes disposed in reference to base scenarios WAM and WEM. Constant change by 15% was introduced in the same way for all years in projection trend.

Gases affected: CH_4

Summary results of the sensitivity analysis are presented in the tables 5.12 and 5.13.

Table 5.12. Summary results of the sensitivity analysis for WEM projections

WAM [kt of CO_2 equivalent]	2020	2025	2030	2035	2040
Original projections	376 038.46	403 709.06	400 754.57	363 823.85	328 655.56
Sensitivity scenario 1	376 038.46	403 049.41	399 889.87	362 752.53	327 307.59
Sensitivity scenario 2	376 038.46	407 223.32	404 503.14	367 365.27	332 309.00
Sensitivity scenario 3	376 038.46	404 677.69	401 372.66	364 249.04	328 953.78

Source: KOBIZE IOŚ-PIB

Table 5.13. Summary results of the sensitivity analysis for WAM projections

WAM [kt of CO_2 equivalent]	2020	2025	2030	2035	2040
Original projections	376 038.46	368 438.37	345 110.16	299 665.48	269 485.79
Sensitivity scenario 1	376 038.46	367 778.72	344 328.51	298 908.42	268 801.93
Sensitivity scenario 2	376 038.46	371 952.63	348 858.72	303 206.90	273 139.23
Sensitivity scenario 3	376 038.46	369 407.00	345 728.24	300 090.67	269 784.01

Source: KOBIZE IOŚ-PIB

Table 5.14 and 5.15 presents example total results for year 2040 affected by implemented modifications for each of the sensitivity scenarios compared to originally projected data.

Table 5.14. Change in total emission for year 2040 for each of the sensitivity scenarios compared to originally projected data (WEM), with detailed information by IPCC sectors

WEM 2040 [kt of CO2 equivalent]	Original data	Sensitivity scenario 1	Sensitivity scenario 2	Sensitivity scenario 3
Total excluding LULUCF	328 655.56	327 307.59	332 309.00	328 953.78
1. Energy	265 016.58	265 016.58	265 016.58	265 016.58
2. Industrial processes and product use	23 638.04	22 290.07	23 638.04	23 638.04
3. Agriculture	34 629.53	34 629.53	38 282.98	34 629.53
5. Waste	5 371.40	5 371.40	5 371.40	5 669.62

Source: KOBIZE IOŚ-PIB

Table 5.15. Change in total emission for year 2040 for each of the sensitivity scenarios compared to originally projected data (WAM), with detailed information by IPCC sectors

WAM 2040 [kt of CO_2 equivalent]	Original data	Sensitivity scenario 1	Sensitivity scenario 2	Sensitivity scenario 3
Total excluding LULUCF	269 485.79	268 801.93	273 139.23	269 784.01
1. Energy	207 299.75	207 299.75	207 299.75	207 299.75

WAM 2040 [kt of CO_2 equivalent]	Original data	Sensitivity scenario 1	Sensitivity scenario 2	Sensitivity scenario 3
2. Industrial processes and product use	22 185.11	21 501.24	22 185.11	22 185.11
3. Agriculture	34 629.53	34 629.53	38 282.98	34 629.53
5. Waste	5 371.40	5 371.40	5 371.40	5 669.62

Source: KOBIZE IOŚ-PIB

Table 5.16 and 5.17 presents relative change of national total for each of the scenarios compared to the original projections indicated as percent resulting from introducing modifications of data in line with sensitivity analysis 1-3.

Table 5.16. Relative change in total emission for year 2040 for each of the sensitivity scenarios compared to originally projected data (WEM), with detailed information by IPCC sectors

WEM 2040 Change in national total [%]	Original data	Sensitivity scenario 1	Sensitivity scenario 2	Sensitivity scenario 3
Total excluding LULUCF	0.00%	-0.41%	1.11%	0.09%
1. Energy	0.00%	0.00%	0.00%	0.00%
2. Industrial processes and product use	0.00%	-5.70%	0.00%	0.00%
3. Agriculture	0.00%	0.00%	10.55%	0.00%
5. Waste	0.00%	0.00%	0.00%	5.55%

Source: KOBIZE IOŚ-PIB

Table 5.17. Relative change in total emission for year 2040 for each of the sensitivity scenarios compared to originally projected data (WAM), with detailed information by IPCC sectors

WAM 2040 Change in national total [%]	Original data	Sensitivity scenario 1	Sensitivity scenario 2	Sensitivity scenario 3
Total excluding LULUCF	0.00%	-0.25%	1.36%	0.11%
1. Energy	0.00%	0.00%	0.00%	0.00%
2. Industrial processes and product use	0.00%	-3.08%	0.00%	0.00%
3. Agriculture	0.00%	0.00%	10.55%	0.00%
5. Waste	0.00%	0.00%	0.00%	5.55%

Source: KOBIZE IOŚ-PIB

On the figures 5.10 and 5.11 was presented influence of the sensitivity scenarios compared to original projection results for 2020, 2025, 2030, 2035 and 2040 for WEM and WAM projections.

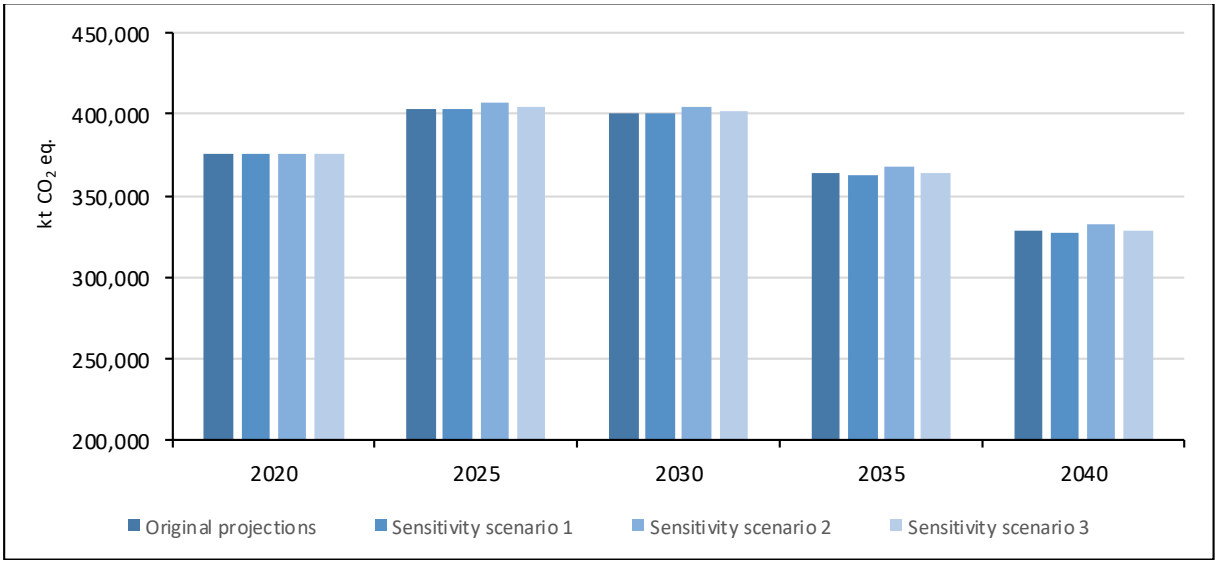


Fig. 5.10. Comparison of original WEM scenario projections and implemented sensitivity scenarios 1-3
Source: KOBIZE IOŚ-PIB

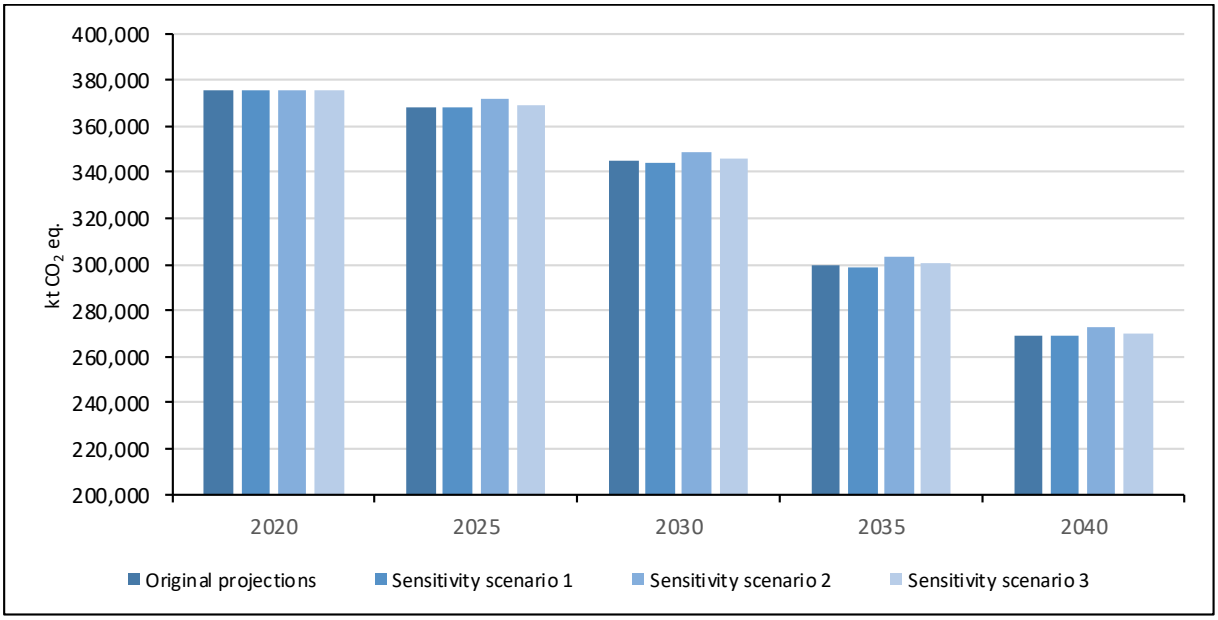


Fig. 5.11. Comparison of original WAM scenario projections and implemented sensitivity scenarios 1-3
Source: KOBIZE IOŚ-PIB

On the figures 5.12 and 5.13 was presented influence of the sensitivity scenarios compared to original projection results for the year 2040 (for WEM and WAM base scenarios), with information for IPCC sectors.

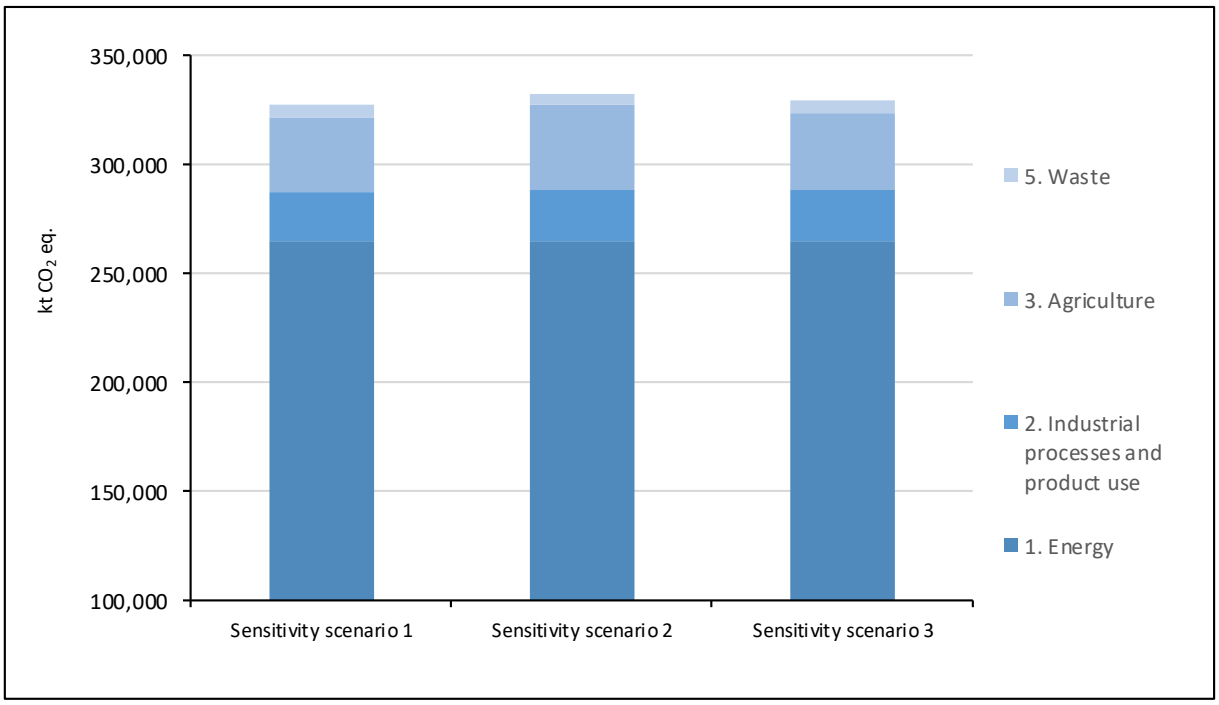


Fig. 5.12. Comparison of original projections from WEM base scenario and implemented sensitivity scenarios for 2040 with information for IPCC sectors
Source: KOBIZE IOŚ-PIB

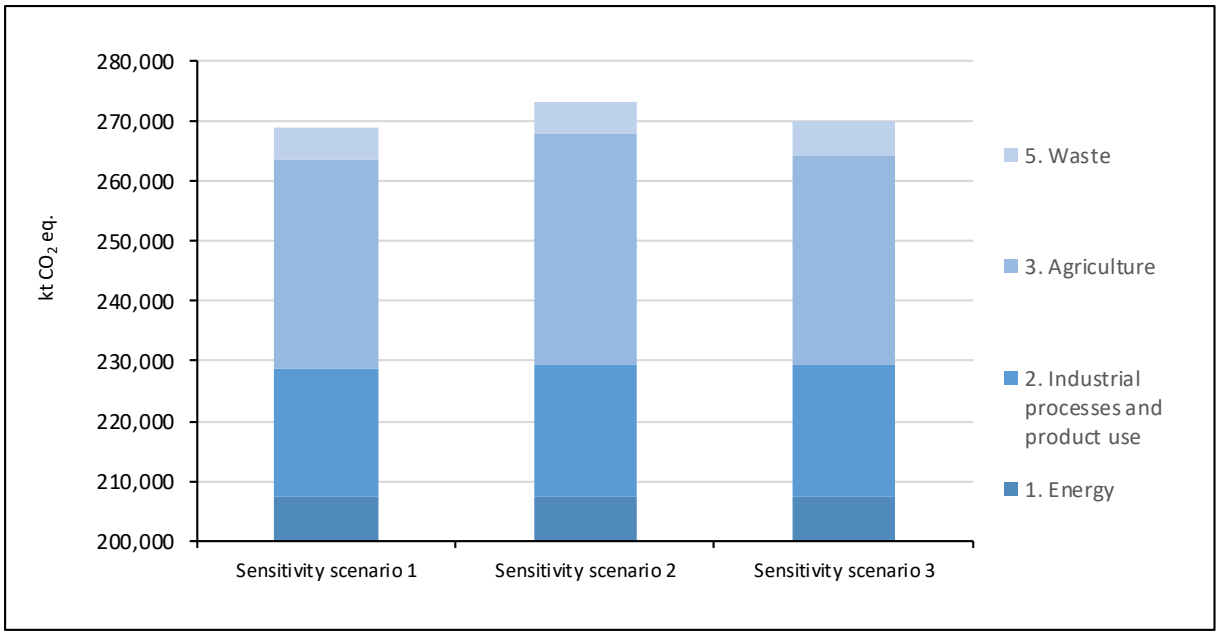


Fig. 5.13. Comparison of original projections from WAM base scenario and implemented sensitivity scenarios for 2040 with information for IPCC sectors
Source: KOBIZE IOŚ-PIB

In case of Poland mathematical model of the inventory is visibly responding even to seemingly insignificant changes in the parameters.

Response of the inventory calculation model is strongest in case of scenario 2 (increase in total 1.11% and 1.36% for WEM and WAM respectively), which affects IPCC sector 3. *Agriculture*. It is reasonable result, due to fact that this sector is significant contributor to national totals, with visible growing significance in the future.

Regarding scenarios 1 affecting HFC emissions in IPCC sector 2. *Industrial processes and product use* (decrease in national total -0.41% and -0.25% for WEM and WAM respectively) – it is visible that emissions from those sectors have much lower contribution to national totals, thus modifications of the input parameters in those sectors is resulting in weaker reaction of the inventory model, than in case of scenario 2. It is also visible that share of F-gases in national total emission is decreasing in future, resulting in weaker response of the model to changes in input data for last years of projections.

Regarding last analysed scenario 3 affecting IPCC sector 5. *Waste* (increase in national total 0.09% and 0.11% respectively for WEM and WAM respectively) – it is visible, the same as in case of scenario 1, that emissions from those sectors have much lower contribution to national totals, thus modifications of the input parameters in those sectors is resulting in weaker reaction of the inventory model, than in case of scenario 2, but comparable with reaction of the model to scenario 1.

Analysing changes within the sectors it is visible that biggest change in sector is in case of scenario 2 (10.55% increase in agriculture sector for both WEM and WAM) and scenario 1 (5.70% increase in IPPU sector in WEM and 3.08% in WAM scenario)

Uncertainty analysis for the IPCC sector 1. *Energy* indicates low uncertainty of output data, however, its dominant contribution to the total emissions means that it should be subjected to further numerical study.

5.6. Methodology and assumptions applied in the projections

5.6.1. Energy

In the *Energy* sector, the data input was prepared in two scenarios: WEM and WAM. The source of the main activity data for the projections of the greenhouse gas emissions in the category was the *National Energy and Climate Plan for 2021-2030* (Attachment 1) prepared by the Ministry of Energy. The GHG emission projections were calculated using a methodology consistent with the one applied in the national greenhouse inventories, complying with the applicable guidance laid down in the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC 2006 GL). The data input to the projections within this category in the WEM scenarios is shown in Tables 5.18–5.20.

Table 5.18. Projected fuel input for electricity and heat generation [ktoe] in the period from 2025 to 2040 in the WEM scenario

Specification	2025	2030	2035	2040
Power plants				
Coal	6 248	6 201	6 201	5 684
Petroleum products	2	2	2	1
Gas	0	0	0	0
RES, waste	436	397	397	289
CHP plants				
Coal	24 926	25 347	17 197	9 418
Petroleum products	147	142	112	87
Gas	3 241	3 462	6 484	8 624
RES, waste	2 296	2 817	3 208	3 745
Nuclear fuel	0	0	2 668	8 003
Heat plants				
Coal	2 045	1 960	1 788	1 875
Petroleum products	17	15	13	12
Oil	174	171	160	188
Petroleum products	56	72	81	92

Source: Ministry of Energy (2019): National Energy and Climate Plan for 2021-2030

Table 5.19. Projected final energy consumption by sector (excluding non-energy use) [ktoe] in the period from 2025 to 2040 in the WEM scenario

Sector	2025	2030	2035	2040
Industry	16 271	16 462	16 645	16 831
Transport	24 897	25 790	25 744	25 434
Households	20 989	21 615	22 071	22 415
Services	9 431	9 936	10 286	10 518
Agriculture	3 491	3 523	3 555	3 585
TOTAL	**75 078**	**77 327**	**78 300**	**78 784**

Source: Ministry of Energy (2019): National Energy and Climate Plan for 2021-2030

Table 5.20. Projected final energy consumption by fuel and carrier [ktoe] in the period from 2025 to 2040 in the WEM scenario

Specification	2025	2030	2035	2040
Electricity	13 247	14 255	15 151	16 019
District heat	6 013	6 202	6 376	6 558
Coal	11 081	10 291	9 591	8 969
Petroleum products	25 656	26 178	25 890	25 407
Natural gas	10 819	11 583	12 053	12 293
Biogas	104	121	142	170
Solid biomass	5 324	5 469	5 610	5 744
Biofuels	1 681	1 739	1 715	1 673
Municipal and industrial waste	704	714	725	738
Solar panels, heat pumps, geothermal energy	450	777	1 047	1 213
TOTAL	**75 078**	**77 327**	**78 300**	**78 784**

Source: Ministry of Energy (2019): National Energy and Climate Plan for 2021-2030

The source of the data on the projected greenhouse gas emissions in the WAM scenario in category 1. *Energy* was the *National Energy and Climate Plan for 2021-2030* under the Energy and Climate Scenario (PEK) prepared by the Ministry of Energy and updated in December 2019. The assumptions followed in the WAM scenario correspond with the assumptions of the 2019 draft *Energy Policy of Poland until 2040*.

The projections in this scenario take into account political decisions which constitute the boundary values as the analytical assumptions, e.g. including the imposition of the requirement for the fulfilment of the EU commitments regarding the share of RES in the energy balance. The model applied for the projections selected generation sources on the basis of their cost-effectiveness, but also took into account the security conditions for the operation of the grid. This means that even if one of RES technologies (dependent on the weather conditions) were significantly cheaper than the other available ones, the model would not choose these sources as the only ones, given the uncertainty related to their use. In such a situation, a source which would be a backup for RES sources was selected. Moreover, in light of technical conditions, the rate at which the sources using individual technologies would be connected to the power grid was limited.

The data input to the projections in the *Energy* category is presented in Tables 5.21–5.23.

The GHG emission projections were calculated using a methodology consistent with the one applied in the national greenhouse inventories.

Table 5.21. Projected fuel input for electricity and heat generation [ktoe] in the period from 2025 to 2040 in the WAM scenario

Specification	2025	2030	2035	2040
Power plants				
Coal	5 925	5 990	6 047	4 796
Petroleum products	5	5	6	3
Gas	188	571	1 587	2 019
RES, waste	447	416	416	0
CHP plants				
Coal	22 282	19 746	12 223	9 681
Petroleum products	334	324	301	289
Gas	2 562	3 018	3 582	4 277
RES, waste	3 473	4 592	4 909	5 414

Specification	2025	2030	2035	2040
Nuclear fuel	0	0	4 624	6 936
Heat plants				
Coal	1 278	856	565	394
Petroleum products	21	20	21	24
Gas	127	111	105	109
RES, waste	193	404	423	448

Source: Ministry of Energy (2019): National Energy and Climate Plan for 2021-2030

Table 5.22. Projected final energy consumption by sector (excluding non-energy use) [ktoe] in the period from 2025 to 2040 in the WAM scenario

Sector	2025	2030	2035	2040
Industry	14 902	14 763	14 664	14 596
Transport	22 075	21 049	20 827	20 492
Households	18 506	17 513	17 505	17 657
Services	8 586	8 700	8 853	9 079
Agriculture	3 613	3 485	3 379	3 287
TOTAL	**67 682**	**65 509**	**65 229**	**65 112**

Source: Ministry of Energy (2019): National Energy and Climate Plan for 2021-2030

A comparison of the assumptions adopted for the WAM and WEM scenarios shows a fairly significant difference in the assumed heat consumption (Tables 5.23 and 5.20). The lower energy consumption in the WAM scenario results, among others, from the assumption of higher energy efficiency of buildings and the Clean Air Programme. Table 5.24 shows a comparison of the projected primary and final energy consumption in the economy in the two scenarios.

Table 5.23 Projected final energy consumption by fuel and carrier [ktoe] in the period from 2025 to 2040 in the WAM scenario

Specification	2025	2030	2035	2040
Electricity	13 041	14 202	15 349	16 520
District heat	5 436	5 090	5 080	5 132
Coal	7 117	4 899	3 735	2 842
Petroleum products	22 602	20 911	20 063	19 124
Natural gas	10 353	10 327	10 277	10 108
Biogas	131	165	201	237
Solid biomass	5 916	6 439	6 681	7 036
Biofuels	1531	1413	1364	1317
Municipal and industrial waste	871	891	905	919
Solar panels, heat pumps, geothermal energy	685	1 172	1 574	1 876
TOTAL	**67 682**	**65 509**	**65 229**	**65 112**

Source: Ministry of Energy (2019): National Energy and Climate Plan for 2021-2030

Table 5.24. Comparison of the projected primary and final energy consumption (excluding non-energy use) in the WEM and WAM scenarios [ktoe] in the period from 2025 to 2040

Specification	2025	2030	2035	2040
Primary energy consumption (WAM)	94 396	91 317	88 963	87 736
Primary energy consumption (WEM)	102 217	104 778	103 199	102 680
Primary energy savings (WAM-WEM)	-7 821	-13 462	-14 235	-14 944
Final energy consumption (WAM)	67 682	65 509	65 229	65 112
Final energy consumption (WEM)	75 078	77 327	78 300	78 784
Final energy savings (WAM-WEM)	-7 396	-11 818	-13 071	-13 672

Source: Ministry of Energy (2019): National Energy and Climate Plan for 2021-2030

5.6.2. Industrial processes and product use

The greenhouse gas emission projections in the sector of *Industrial processes and product use* were only prepared in the WEM scenario, except for the projection for fluorinated gases, as described below.

The GHG emission projections in the sector of industrial processes were calculated using a methodology consistent with the one applied in the national greenhouse inventories, complying with the applicable guidance laid down in the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC 2006 GL).

The data used to prepare the projections of activity changes in the sector of industrial processes included primarily the data from the *National Energy and Climate Plan for 2021-2030* (NECP) and, in addition, the data acquired during the cooperation with sectoral associations, the expert study of the Wood Technology Institute (ITD) and the literature-based assumptions for the projections of activity changes.

The data on most activities drawn from the NECP included, among others: the production of lime, ceramics, ammonia, nitric acid, caprolactam, zinc and lead. In turn, the data input to the projections of the cement clinker production and cement production was obtained from the Polish Association of Cement Producers, while the data on the projected pig iron and steel production (in electric and basic oxygen furnaces) and the iron sinter production were acquired from the Polish Steel Association. The main data input to the projections of the emissions from industrial processes is presented in Fig. 5.25.

Table 5.25. Main data input to the emission projections in the WEM scenario for the main sources in sector 2. *Industrial processes and product use*

Industrial processes and product use	Industrial production [kt]			
	2025	2030	2035	2040
2.A. *Mineral industry*				
Cement clinker production	15 000	14 700	15 400	16 100
Lime production	2 027	2 020	2 013	2 010
2.B. *Chemical industry*				
Ammonia production	2 805	2 831	2 851	2 873
Nitric acid production	2 427	2 446	2 461	2 477
Black carbon production	40	41	42	44
Styrene production	157	161	164	167
Ethylene production	597	614	629	642
Caprolactam production	166	167	167	167
2.C. *Metal industry*				
Sinter production	6 700	3 700	0	0
Pig iron production	4 200	2 100	0	0
Basic oxygen steel production	5 000	2 500	0	0
Electric steel production	5 000	7 000	9 000	9 000
Ferroalloys production	65	65	65	65
Lead production	91	90	86	78
Zinc production	105	101	98	95

The projections of the emissions of fluorinated gases used the results of the analysis carried out for the purposes of preparing the projections for report BR4 in 2019, entitled *The preparation of inventories and analysis of data on the projected emissions of substances: HFCs, PFCs, SF_6 and NF_3 in the years 2020, 2025, 2030, 2035 and 2040 in Poland. The estimation of the effects of policies and measures intended to limit the use of fluorinated greenhouse gases or resulting in such limitation*.

That analysis included the estimation of the effects of policies and measures intended to limit the use of fluorinated greenhouse gases or resulting in such limitation.

In light of the commitments under the Climate Convention, in the scope of work covering the period from 1995 to 2040, all the estimates were derived using the methodology described in the 2006 *IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC 2006 GL).

On the basis of that analysis, an emission scenario was prepared, including the implemented and approved policies and measures, called the scenario with existing measures (WEM). The time schedule for the reduction of the quantities of fluorinated gases of the HFC group to be placed on the market in specific years plays a significant role in the projected emissions, as presented in Table 5.26.

Table 5.26. Percentage reduction schedule for the quantities of HFCs to be placed on the market in given years compared with 2015 in the WEM scenario

Years	Reduction schedule for the quantities of HFCs placed on the market compared with 2015*
2015	100%
2016–2017	93%
2018–2020	63%
2021–2023	45%
2024–2026	31%
2027–2029	24%
2030	21%

* HFC phase-down will be permanently tightened in the revised schedule of Regulation 517/2014, which is expected to be published in 2024

In the case of fluorinated greenhouse gases, a scenario with additional measures (WAM), resulting from the implementation of EU regulations, was also prepared. The assumption for it included consideration of the effects of the following measures:

- The prohibition of the placing on the market from 1 January 2026 of electric switchboards which contain sulphur hexafluoride or the operation of which depends on sulphur hexafluoride;
- The prohibition of the placing on the market from 1 January 2028 of refrigeration units of refrigerated trucks and their trailers which contain HFCs of GWP of not less than 150 or the operation of which depends on HFCs;
- The prohibition of the placing on the market from 1 January 2030 of stationary refrigeration equipment which contains HFCs of GWP of not less than 1500 or the operation of which depends on HFCs;
- The prohibition of the placing on the market from 1 January 2030 of stationary air-conditioning equipment which contains HFCs of GWP of not less than 750 or the operation of which depends on HFCs;
- The prohibition of the placing on the market from 1 January 2028 of fire protection equipment which contains HFC-236fa or the operation of which depends on HFC-236fa.

The effects of the future unimplemented policies and measures were estimated in the scope and form consistent with the reporting requirements for policies and measures as set in:

- Regulation (EU) No 525/2013 of the European Parliament and of the Council (Article 13);
- Commission Implementing Regulation (EU) No 749/2014 (Articles 20 and 22 and Annex XI, Tables 1 and 2).

5.6.3. Agriculture

The estimation of the projected emissions in the agriculture sector applied the methodology used in the national emission inventories, complying with the applicable guidance laid down in the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC 2006 GL), for the same categories

of emission sources and greenhouse gases: *3.A. Enteric fermentation (CH_4), 3.B. Manure management (CH_4, N_2O), 3.D. Agricultural soils (N_2O), 3.F. Field burning of agricultural residues (CH_4, N_2O), 3.G. Liming (CO_2)* and *3.H. Urea application (CO_2).* The greenhouse gas emissions in the agriculture sector only include the WEM scenario.

The main data on the expected rate of changes in activities in sector 3. *Agriculture* were elaborated on commission of the Ministry of Agriculture and Rural Development (MRiRW) with the participation of the representatives of scientific institutes, specifically: the Institute of Agricultural and Food Economics – National Research Institute (IERiGŻ – PIB), the Plant Breeding and Acclimatisation Institute – National Research Institute (IHAR-PIB), the Institute of Technology and Life Sciences (ITP), the Institute of Soil Science and Plant Cultivation – National Research Institute (IUNG-PIB) and the Institute of Animal Production – National Research Institute (IZ-PIB) (Table 5.27). Given the dynamically changing situation when the projections were prepared and the absence of knowledge about the planned policy and specific solutions, the scale of their application and their impacts on agriculture in Poland, the projections were prepared only for one scenario, i.e. the scenario with existing measures (WEM).

The projections of changes in activities took into account the possible external factors in the expected timeframe which are shaped, among others, by:

- the Common Agricultural Policy (CAP), including to a large extent the factors contained in the EU framework strategy of the European Green Deal[54] (including the Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system[55] and the EU Biodiversity Strategy for 2030[56]), i.e. those targeting the reduction of fertiliser use by 20% and the limitation of nutrient losses by 50% without reducing the fertility of soils;
- the World Trade Organization, affecting the raw material, product and capital markets;
- the present and future international agreements – the Comprehensive Economic and Trade Agreement (CETA) and TTIP the Transatlantic Trade and Investment Partnership (TTIP).

The restrictions on the use of mineral fertilisers as laid down in the Field to Fork Strategy can cause an increase in the area of the cultivation of legumes. These plants enhance the diversification of crops and enable the sustainable use of the resources of the natural environment. The presence of legumes in crop rotation ensures a positive balance of organic matter, while the nitrogen fixed by rhizobacteria in symbiotic association with legumes is better used by plants than mineral nitrogen. The cultivation of legumes enriches the sorption complex of soil, improves its aggregate and crumbly structure, and increases its organic matter content, improving the capacity of the soil to sequestrate (fix) CO_2 and thus mitigating climate change. By using legumes in crop rotation, farmers can also diminish the production costs of succeeding plants as a result of the lower consumption of nitrogen fertilisers.

The projections were mainly built on the basis of mathematical modelling using historical data. The purpose of this was to indicate the trends developing on the market and the directions of the producers' actions. Given the dynamic changes in the legal regulations and policies associated with the agriculture sector in the EU and Poland, the impacts of certain measures may have been omitted or underestimated in the projections.

[54] COM(2019) 640
[55] COM(2020) 381
[56] COM(2020) 380

Animal production

In the period from 2020 to 2040, the cattle population may show a slightly growing trend, to exceed 6,5 million head. The further concentration of production is and will be a distinct process in the rearing of milk cows. This may result from the slowly halting growth rate of the exports of dairy products, resulting from the slow loss of competitive advantages over the leading EU Member States. The mean milk yield per cow in 2040 can be 7,765 kg/year. This results from a medium-term trend (since 2002) of the growing milk yield per cow in Poland. The yield projections took into account the changes unfolding in commercial farms (the concentration of milk production in larger herds) which could result in a quicker yield increase and, at the same time, the resignation from production in small, unprofitable farms. The growing milk yield from cows results from large progress in the genetic improvement of the animals, reproduction biotechnology, the use of modern technologies for the preparation and distribution of feeds and the higher specialisation and concentration of agricultural holdings. However, consideration should be given to the existence of the limiting factors in the form of the intensification of the adverse effects of intensive animal farming leading to a deterioration of the heath conditions of cows and their excessive culling, i.e. the deliberate removal of animals which are undesirable from the rearing point of view from the herd.

To some extent, milk production can be replaced by meat production; therefore, in the long term, the falling trend in the dairy cattle population can be reversed by the growing meat cattle population. This results from the increasing demand for beef and veal. This is mainly the case with young cattle, as well as bulls, oxen and fattening cattle. As a result, further growth can be expected. It is favoured by the large potential in the scope of the resources of production inputs, the potential for feed production, the beneficial soil and climate conditions and the well-established tradition of cattle farming.

The total sheep population will diminish further as a result of the fact that in Poland mutton production is a niche business. In spite of the beneficial effect of sheep grazing on the natural environment, corresponding with such CAP objectives as support for sustainable development, biodiversity conservation and landscape maintenance, no major changes should be expected in this sector of agricultural production, i.e. an increased interest in sheep farming cannot be expected. The sheep population should follow the existing trend line and in 2040 it can be about 126,000 head. The importance of sheep production is increasingly low and its marginalisation can rather be expected, to be mainly limited to the keeping of conservation stock.

Just as in the case of sheep, the goat population will diminish further, since goat meat production is a niche activity in Poland. Goat farming is characterised by even greater fragmentation than sheep farming. In Poland, there are no producer groups keeping goats for meat only. One producer group rears sheep and goats used for two purposes: to produce milk and meat.

In recent years, there was a strong reversal of the growing trend in the pig population, with pig production given up in recent years primarily by farms rearing at a smaller scale, following the progressing consolidation of the processing sector and in relation to the more stringent qualitative and quantitative requirements set for suppliers by livestock purchasers, as well as more demanding sanitary standards (biosecurity) related to the African swine fever (ASF). Until 2040 it would be rather difficult to expect a reversal of this trend, given the strong international competition within this sector, e.g. on the part of foreign businesses, mainly corporations. The rearing will be concentrated in increasingly large herds, including the form of so-called contract fattening carried out by larger meat concerns.

The horse population will will diminish further. The structural changes in rural areas (the concentration of production in larger farms) will most probably lead to the complete resignation from the rearing of commercial breeding of draught horses.

The total poultry population results from the projected populations of particular species (laying hens, broiler chickens, turkeys and the other poultry). The population is expected to grow further, mainly broiler chickens, and it is also envisaged that the laying hen population will be sustained, with a slight falling tendency. The factors which may contribute to increasing the poultry population include: the expected higher demand for poultry meat, the opportunities for improving the profitability of production by using innovative technology and progress in rearing, the crisis on the pork market caused by ASF in the world, the cooperation on the international markets to build the Polish brand, the development of niche segments of the market, e.g. organic ones or water poultry, the use of bird droppings for energy generation and the pro-health consumption trends. The factors limiting the growth of the poultry population include the changes in cage farming. They will slow down the growing trend, but they will not limit it.

For a number of years the shrinking resources of living labour have contributed to increasing the share of bedding-free systems in pig and dairy cattle farming. Given the structural changes in pig farming, as a target, in 2040 even 70% of the population can be kept without bedding, while for dairy cows this share may reach 65%.

Plant production

Historical data indicate a growing trend in cereal production which should continue. The higher total cereal production results from the enhanced concentration and intensity of agricultural production, including more rational fertilisation, among others, through the expected increase in liming. At the same time, the limiting factors can emerge, including a decrease in the area of agricultural land and the use of part of its area for organic farming. The decrease in the area will mainly result from the conversion of agricultural land to non-farming uses. Irrespective of these risks, a growing trend was adopted for the projected production. In Poland, in recent years, the maize cultivation area strongly grew, exceeding 1 million ha and showing a steady growing trend. On the basis of the historical data on the sown area of maize, a further increase in the cultivation area of this crop should be projected. The increase in the area of the maize cultivation and harvest results from its versatile use, both for feed production and for food and industrial purposes (including energy generation purposes. The potential maize cultivation area in Poland is estimated at 2 million ha.

The vegetable production in the period analysed will be characterised by a growing trend. This results from the increasing demand for vegetables on the national market and abroad. An additional, but a far less important factor is the temperature change, which will favour vegetable production. A limiting factor is the demand for water the availability of which in the growing season may fall with progressing climate change.

Poland is an important world producer of vegetables and processed vegetables. The basic factor increasing the production of this group of food products will be the growing demand in Poland and abroad. It is envisaged that the national fruit consumption will also grow.

Fertiliser consumption

As a result of political factors (the Farm to Fork Strategy as part of the European Green Deal and the *Fit for 55* package[57]) the consumption of nitrogen fertilisers is expected to fall. These

[57] COM(2021) 550

projections need to take into account, among others, the improved agrochemical condition of soils, the diminished shares of acid and very acid soils, the increased area of organic crops, the moderate rationalisation of fertilisation (particularly with nitrogen), the better use of fertiliser components (new forms), the development of precision farming and the limitation of allowable maximum nitrogen doses in the fertilisation plans prepared. Moreover, the price of these fertilisers may grow due to rising energy prices. It is projected that the share of ammonium nitrate in the group of nitrogen-containing fertilisers can grow (by 0.5 p.p. every 5 years), as a result of the high concentration and quick availability of this component to plants, as well as its universality and easy application. The share of the urea form of fertiliser, which is assimilated more slowly and can even be phytotoxic to sprouting plants, will also diminish (by 0.5 p.p. every 5 years). The limitation of the use of urea, which contributes to ammonia emissions into the environment, is consistent with the direction of EU actions and the assumptions of the Green Deal. The shares of ammonium phosphate, ammonium phosphate and calcium nitrate will probably not change significantly in the period from 2020 to 2040, while there is no doubt that the share of multi-component easy-to-use fertilisers in increasingly large plantations will grow (by about 0.5 p.p. every 5 years).

Liming of agricultural soils

Acid soils dominate the agricultural land in Poland; therefore, they need to be systematically limed. Moreover, the use of calcium fertilisers improves the soil structure, which is very important in the conditions of intensification of agriculture, involving in particular the application of heavy, self-propelled machines and the collection of crops with heavy means of transport. A basic factor contributing to the application of liming are programmes of support for liming, provided that they are continued in the successive programming periods under the CAP Strategic Programme for 2023-2027. As a result of this, the total lime consumption in 2040 may be higher than the present one. If the CaO dosage increases to the one applied in the early 21st century, it can lead to the higher consumption of this component.

Table 5.27. Main data input to the projections for the emission sources in sector 3. *Agriculture* in the WEM scenario

Population/Activity	Unit	2025	2030	2035	2040
Cattle population	thous. head	6 506	7 009	6 609	6 769
including dairy cattle	thous. head	2 270	2 220	2 171	2 128
Mean annual milk yield per cow	kg/year	6 224	6 755	7 285	7 765
Sheep and goat population	thous. head	238	212	188	165
Horse population	thous. head	138	122	112	103
Pig population	thous. head	10 918	10 567	10 218	9 911
Poultry population	million head	242	251	262	269
including hens	million head	216	223	233	243
Nitrogen fertiliser consumption	thous. t N	1 075	1 043	1 020	998
Calcium fertiliser consumption	thous. t	972	1 045	1 067	1 089
Cereal production	thous. t	29 020	29 136	29 018	29 642
Legume production	thous t	597	689	714	739
Oil plant production	thous. t	2 923	3 095	3 151	3 206
Root crop production	thous. t	21 993	21 692	21 443	21 194
Vegetable production	thous. t	5 242	5 438	5 565	5 692
Fruit production	thous. t	4 619	4 917	5 215	5 513

Source: The institutes: IERiGŻ – PIB, IHAR-PIB, ITP, IUNG-PIB and IZ-PIB on commission from the Ministry of Agriculture and Rural Development

Both the factors listed above and the payments envisaged in the provisions of the EU and national agricultural policies will affect the growth rate of the consumption of calcium fertilisers (by

3% every 5 years). The growth of the supply and consumption of calcium magnesium fertilisers will probably be slightly lower (by 1.5% every 5 years) in the period from 2020 to 2040 as a result of the costs of the production and application of calcium fertilisers.

5.6.4. Land use, land-use change and forestry

The data on the projected pace of changes in activities in the sector of *Land use, land-use change and forestry* (LULUCF) are presented in Table 5.28. The land use in Poland is dominated by the impacts of agriculture and forestry. In this area, significant changes could be seen over recent years, which was taken into account in the preparation of projections. For this purpose, on the basis of available statistical data, a dynamic analysis of changes in the directions of land use in the period from 1988 to 2019 was carried out. In the period in question, the area of agricultural land was found to have a steady tendency to decrease in favour of other forms of land uses, mainly forest, infrastructure, etc. The changes observed in the area of permanent crops indicate that after the accession to the EU the structural transformations in agriculture were to an increasing extent influenced by the Common Agricultural Policy (CAP) and the related financial instruments implemented. These measures include, among others, financial support available for landowners who, on a voluntary basis, use practices contributing to environmental protection, mitigating climate change and contributing to the adaptation of the agriculture and forestry sectors to climate change. The measures in the scope of afforestation, sustainable forest management and the protection of soils and waters make the greatest contribution to the reduction of greenhouse gas emissions.

It should be noted that all the farmers eligible since 1 January 2015 to receive a single area payment are obliged to implement greening activity. Greening is implemented through: crop diversification (in the case of farmers who have at least 10 ha of arable land), as well as the maintenance of existing permanent grassland. Crop diversification consists in maintaining an appropriate number and area of crops on arable land in an agricultural holding in a given year, while the practice applicable to permanent grassland consists of two elements: the obligation to maintain the designated permanent grassland with environmental values (ecological focus areas) situated on Natura 2000 sites at the level of an agricultural holding and to maintain the area of permanent grassland at an unchanged level compared with its area determined in the reference year at the scale of the country.

The maintenance of permanent grassland including the designated permanent grassland with environmental values (ecological focus areas) involves:

- the ban on ploughing or conversion of the designated permanent grassland with environmental values (ecological focus areas). In case they have been ploughed or converted, the farmer is obliged to reconvert this area into permanent grassland (the reconverted grassland will be recognised as an ecological focus area) not later than by the date of the submission of the application for a payment for the next year;
- the ban on conversion of permanent grassland when the ratio of permanent grassland to total agricultural land diminishes by more than 5% compared with the ratio established in the reference year at the country level. In such a case, the farmers who have converted permanent grassland are obliged to restore or establish it at the latest by 31 May of the year following the year of the submission of the application for a payment. The percentage change of the ratio for a given year with respect to the ratio of the reference year is determined annually, by 30 November, in a notice of the Minister of Agriculture and Rural Development.

The permanent grassland reference ratio is 18.34%. It was defined in the Notice of the Minister of Agriculture and Rural Development of 28 November 2018 changing the reference ratio of the area of permanent grassland to total agricultural land[58].

Moreover, it also follows from the analysis that the intensity of agricultural production has a major effect on the pace and directions of land use changes. In this context, the changes unfolding in the use of the agricultural space seem to ensue from the economic development, investments, agricultural policy and law-based measures to protect the landscape. Another important factor is a change in consumption needs and styles, indicative of the growing affluence of society. These processes are driven by a number of social and economic factors, with the strength of their impact, in the context of the waning economic importance of the agricultural sector, contributing to lowering the production potential of this sector. However, it should be stressed that this process can also promote the restructuring of agriculture and is a consequence of the dynamic economic development of the whole country. This is particularly important in the context of the recent economic, social and political transition which significantly affected the structure of land use. The ongoing process of concentration of the population, the subsequent development of urban agglomerations and the declining importance of industry in the national economy self-evidently influenced the structural changes in agriculture. All these processes were accompanied by changes in the land use structure and the competition for space between the different functions, subject to certain rules which ordered the principles of spatial management and environmental protection.

The projections of the expected pace of changes in land use activities in the sector of *Land use, land-use change and forestry* were prepared on the basis of the data acquired from the Ministry of Climate and Environment and the Ministry of Agriculture and Rural Development, as well as the own analyses of the KOBiZE IOŚ-PIB.

In the preparation of the projections of emission and removal balances, use was made of the results of the work of the following teams:

- the Expert group for the Elaboration of National Plans Related to Accounting for Greenhouse Gas Emissions and Removals Resulting from Forestry Activities (established on 4 August 2017 and consisting of experts from the Bureau for Forest Management and Geodesy, the Forest Research Institute, the KOBiZE IOŚ-PIB, the Wood Technology Institute, the representatives of the Directorate General of the State Forests National Forest Holding and the representatives of the Ministry of Climate and Environment);
- the Expert team for the Prognostic Data on Greenhouse Gas Emissions and Removals Resulting from Forestry Activities (established on 20 February 2018 and consisting of the representatives of the Ministry of Climate and Environment, the Directorate General of the State Forests National Forest Holding, the KOBiZE IOŚ-PIB, the Forest Research Institute and the Bureau for Forest Management and Geodesy).

In addition, in the preparation of the projections of emission and removal balances, use was made of the projections of wood harvesting and harvested wood products (sawnwood, wood-based panels, cardboard and paper) and the prospects for foreign trade laid down in the expert study "*Elements of the projection of the market of wood raw material and wood-based materials in Poland until 2040*", prepared by the Department of Strategic Studies and Analysis at the Wood Technology Department in March 2021. This expert study was carried out for the purposes of preparing emission

[58] Monitor Polski of 2018, Item 1173

and removal projections as part of the work of the Expert team for the Prognostic Data on Greenhouse Gas Emissions and Removals Resulting from Forestry Activities. These projections revised the earlier materials prepared for the Forestry and Hunting Department of the Ministry of Climate and Environment:

- "*Elements of the projection of the market of wood raw material and wood-based materials in Poland until 2040" of 2017;*
- *"Elements of the projection of the market of wood raw material and wood-based materials in Poland until 2030*" of 2018.

The expert study mentioned above used materials from the Forestry and Hunting Department of the Ministry of Climate and Environment containing a projection of round wood harvesting in the of the the State Forests National Forest Holding and the other forests in the period from 2019 to 2040, prepared by the Bureau for Forest Management and Geodesy. In addition, use was made of the information prepared for the purposes of the National Forestry Accounting Plan by the Team for the Elaboration of National Plans Related to Accounting for Greenhouse Gas Emissions and Removals Resulting from Forestry Activities.

Forest land is the largest carbon sink in the LULUCF sector. The estimated amount of CO_2 removal is mainly generated by the increment of living biomass. It is important to note that the definition of a forest used in reporting to the Climate Convention is the same as the definition of a forest used in the 1991 Act on Forests, which specifies that a forest is:

1) a compact area of at least 0.10 ha, covered with, or temporarily deprived of, forest vegetation (forest plantations): trees, shrubs and forest undergrowth, which:
   a) is intended for forestry production, or
   b) constitutes a nature reserve or a part of a national park, or
   c) has been entered into the register of monuments;
2) is associated with forest management, occupied for the purposes of forest management: buildings and structures, water amelioration facilities, forest spatial division lines, forest roads, areas under power lines, forest nurseries, wood storage areas, as well as used for forest parking lots and tourist facilities.

The forest area in Poland, excluding the land related to forest management, is 9,260,000 ha (according to GUS Forestry – as of 31 December 2020), which represents a forest cover of 29.6%. Including the land related to forest management, the forest area in Poland is 9,464,000 ha (according to GUS Forestry – as of 31 December 2020). The ownership structure of forests in Poland is dominated by public forests – 78.9%, including the forests managed by the State Forests National Forest Holding – 75.2%. This structure has hardly changed in the whole post-war period. In the period from 1995 to 2020, the share of private forests increased by 2.8 percentage points to the current 19.5%. At the same time, the share of public forests decreased from 83% to 80.5%. In the period from 1945 to 2020, the species structure of Polish forests underwent significant changes, manifested, among other things, by an increasing share of forest stands with a predominance of broadleaved species. On the land managed by the State Forests National Forest Holding (State Forests), where it is possible to trace this phenomenon on the basis of annual updates of the forest area and wood resources, the area of broadleaved stands increased from 13% to 24.4%.

The forest habitat structure is dominated by broadleaved habitats, occurring in 50.2% of the forest area, while the coniferous habitats cover 49.8%. In both groups, upland habitats are also distinguished, occupying as a total 6.7% of the forest area, and so are mountain habitats occurring in

8.5% of the forest area. Coniferous species dominate in 66.9% of Poland's forest area. Pine, which according to the National Forest Inventory (WISL) occupies 58.2% of the forest area under all forms of ownership, i.e. 60.3% of the area of State Forests and 57.7% of private forests, has found in Poland the most favourable climatic and habitat conditions within its Eurasian range and as a result of this it has managed to produce many valuable ecotypes (e.g. the Taborska pine or the Augustowska pine).

Over the last 40 years of the 20th century, there was a step-like decrease in the area of regeneration and, in consequence, in the share of forest stands of the youngest age classes. Since the beginning of the 21st century this trend can be seen to have changed. Measures are taken to stabilise forest ecosystems. In addition, the increase in the share of natural regeneration in the total area of regeneration, to be seen since the early 1980s, should be noted. In the period from 1976 to 1980, this share was 3.4%, then 6.5% in the period from 1991 to 1995, 10.5% in the period from 1996 to 2010 and 13.8% in the last six years.

The basis for afforestation works in Poland is the National Programme for the Augmentation of the Forest Cover (KPZL). At the initiative of, and on commission from, the Ministry of Environmental Protection, Natural Resources and Forestry, the programme was developed by the Forest Research Institute and approved for implementation by the Council of Ministers on 23 June 1995. The main objective of the KPZL is to increase the country's forest cover to 30% in 2020 and 33% in 2050 and to ensure the optimal spatial and temporal distribution of afforestation activities, as well as to establish environmental and economic priorities and implementing tools.

A steady increase in wood resources has been recorded since 1967 when the first update of wood resources was carried out in State Forests, A reliable source of data for the country in recent years, e.g. revealing private forest resources, are the WISL results. According to the WISL data for the periods 2005-2009 and 2013-2017, the total wood resources in the country increased on average 35 million m^3 annually. Unfortunately, since 2019, this growth has clearly slowed down.

According to the WISL measurements carried out in the period from 2015 to 2020 and referred to the forest area as of the end of 2019, wood resources reached a volume of 2.656 million m^3 of round wood with bark. Almost half (49.2%) of the resources are forest stands of the age classes III and IV. Together with the restocking class (KO), the class for restocking (KDO) and the class with a selection structure (BP), the share of the volume of the forest stands aged over 100 years in the total volume is 40.3%.

According to the WISL results from the period from 2015 to 2020, the average growing stock of forests in Poland is 287 m^3/ha.

Poland carries out a number of activities aimed at protecting, maintaining and increasing carbon stocks in forest and agricultural areas. Most of the activities are of a continuous nature. These activities result from adopted policies or programming documents described in Table 5.29.

Table 5.28. Area of particular land uses [ha]

Item	Activity	Historical data					Base year	WEM projections			
		2015	2016	2017	2018	2019	2019	2025	2030	2035	2040
1	Forest land, including:	9395171	9395171	9395171	9395171	9395171	9395171	9609474	9751434	9893394	10035354
	forest land	9395171	9395171	9395171	9395171	9395171	9395171	IE	IE	IE	IE
2	Cropland, including:	14023261	14023261	14023261	14023261	14023261	14023261	13578674	13323394	13068114	12812834
	arable land	13736468	13736468	13736468	13736468	13736468	13736468	IE	IE	IE	IE

Item	Activity	Historical data					Base year	WEM projections			
		2015	2016	2017	2018	2019	2019	2025	2030	2035	2040
	orchards	286793	286793	286793	286793	286793	286793	IE	IE	IE	IE
3	Grassland, including:	4172971	4203036	4168045	4176187	4181494	4181494	4181116	4180801	4180486	4180171
	permanent meadows	2252568	2243661	2239848	2233944	2228134	2228134	IE	IE	IE	IE
	permanent pastures	1600862	1589487	1585176	1577574	1570028	1570028	IE	IE	IE	IE
	woodland and shrubland	319541	131266	108452	99561	95203	95203	IE	IE	IE	IE
	woodland and shrubland on farmland	NO	238622	234569	265108	288129	288129	IE	IE	IE	IE
4	Wetlands, including:	1369747	1371364	1373748	1373924	1374024	1374024	1374624	1375124	1375624	1376124
	land under waters, including:	644779	649041	650637	652020	658210	658210	IE	IE	IE	IE
	(a) marine internal waters	79104	79197	80889	81826	82671	82671	IE	IE	IE	IE
	(b) running surface waters	513378	514036	515550	517925	518043	518043	IE	IE	IE	IE
	(c) standing surface waters	56559	57404	55582	58459	57286	57286	IE	IE	IE	IE
	(d) ditches	NO	NO	NO	NO	NO	NO	IE	IE	IE	IE
	land under ponds	82317	81602	84378	84714	86327	86327	IE	IE	IE	IE
	land under ditches	130906	130080	128945	129136	129366	129366	IE	IE	IE	IE
	uncultivated land	469505	465892	465036	461504	459832	459832	IE	IE	IE	IE
	ecological sites	37978	43153	43369	40360	40499	40499	IE	IE	IE	IE
5	Urbanised land, including:	2209027	2248288	2265663	2286472	2309774	2309774	2449586	2566096	2682606	2799116
	residential areas	333296	340442	348555	358693	367860	367860	IE	IE	IE	IE
	industrial areas	121492	123589	122836	124861	127064	127064	IE	IE	IE	IE
	other built-up areas	151623	152360	155250	158167	160730	160730	IE	IE	IE	IE
	urbanised unbuilt-up areas	55765	56790	53799	54730	54610	54610	IE	IE	IE	IE
	recreation and rest areas	66065	66254	67010	68139	68697	68697	IE	IE	IE	IE
	transport areas, including:	921356	924740	927257	927431	932706	932706	IE	IE	IE	IE
	(a) roads	807561	808281	812636	815715	819495	819495	IE	IE	IE	IE
	(b) railway areas	100404	102630	100862	98925	98592	98592	IE	IE	IE	IE

Item	Activity	Historical data					Base year	WEM projections			
		2015	2016	2017	2018	2019	2019	2025	2030	2035	2040
	(c) other built-up transport areas	13391	13829	13759	13387	13472	13472	IE	IE	IE	IE
	(d) land designated for construction of public roads or railway lines	IE	8088	11460	12791	14619	14619	IE	IE	IE	IE
	mining areas	28643	28375	29080	29831	30124	30124	IE	IE	IE	IE
	built-up farmland	530789	547650	550417	551233	554510	554510	IE	IE	IE	IE
	Other land, including:	100349	86829	84195	81777	81102	81102	77052	73677	70302	66927
6	Different areas	100349	86829	84195	81777	81102	81102	IE	IE	IE	IE
7	Adjustment area	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

IE – included in a different category, NO – absent
Source: Elaborated by the KOBiZE IOŚ-PIB

Table 5.29. Characteristics of the national strategies and policies adopted in the area of the forest strategy, forest management and land use

Title	Description
Act of 28 September 1991 on Forests (Official Journal of the Laws of *2018 , Item 2129, as amended)*	The Act sets out the principles of the preservation, conservation and augmentation of forest resources and the principles of forest management in relation to other elements of the environment and the national economy.
National Forestry Policy (PLP), adopted by the Council of Ministers on 22 April 1997	The document sets out the directions of actions in the area of forestry and indicates the linkages of forestry in intersectoral and international systems.
National Programme for the Augmentation of Forest Cover (KPZL), adopted by the Council of Ministers in 1995	The National Programme for the Augmentation of the Forest Cover is a strategic study. It is a forest policy instrument for shaping the country's natural space and contains general guidelines for drawing up regional spatial development plans in the field of increasing the forest cover. The methodological assumptions and criteria for determining afforestation preferences adopted in the KPZL may be helpful in the creation of original regional and local solutions. The objective of the KPZL is to increase the country's forest cover to 30% by 2020 and 33% after 2050 and to ensure the optimal distribution of afforestation activities, as well as to set the environmental and economic priorities and to adapt implementing tools. New afforestation projects are an element of the multifunctional and sustainable development of the country.
Act of 7 June 2001 on Forest Reproductive Material (Official Journal of the Laws of 2019, Item 1097)	The Act regulates the registration of basic forest material, the marketing of forest reproductive material, the control of basic forest material and the forest reproductive material marketed, and seed regionalisation.
Act of 3 February 1995 on the Protection of Agricultural and Forest Land (Official Journal of the Laws of *2017*, Item *1161)*	The Act regulates the principles of the protection of agricultural and forest land and the reclamation and improvement of the utility value of the land, as well as lays down the possible conversion of forest areas for non-forestry purposes. The solutions contained in the Act are intended to counteract irrational farming and forest production space management. This objective can be achieved through regulations: • limiting agricultural land uses other than agriculture and forestry, preventing agricultural land degradation and devastation processes and losses in agricultural production resulting from non-agricultural activities and mass earth movements, • reclamation and use of land for agricultural purposes, • preservation of peatbogs and ponds as natural water reservoirs, • limiting changes in the natural relief of the terrain.

Title	Description
Act of 16 April 2004 on Nature Conservation (Official Journal of the Laws of *2018, Item 1614, as amended)*	The Act sets out the scope of conservation necessary to effectively protect Natura 2000 sites, fulfilling obligations under the Habitats Directive and the Birds Directive and achieving to the adequate extent the objective of both Directives – to maintain or restore the favourable state of conservation of the objects of conservation in the Natura 2000 network.

It should be noted that the forest policy provides for the continued implementation of the objectives specified in the 1997 National Forest Policy (PLP), established on the basis of the Act of 28 September 1991 on Forests. The main objectives of the 1997 PLP include, among others, the following:

1) The need to ensure the sustainability of forests, *inter alia*, their multi-functionality, which will be achieved by increasing the country's forest resources, including:
   a) an improvement in the condition of forest resources and their comprehensive protection;
   b) the reorientation of forest management from the previous dominance of the raw material model to an environmentally friendly and economically sustainable model of multifunctional forest management corresponding to the criteria formulated for Europe in the Helsinki process, taking into account the specificity of Polish forestry.
2) Increasing forest resources through:
   a) the augmentation of the country's forest cover to 30% in 2020 and 33% in the middle of the 21st century by gradual afforestation of land unsuitable for agriculture and the implementation of a spatially optimal forest structure in the landscape which will be achieved by the protection and full use of the productive potential of habitats;
   b) the restitution and rehabilitation of forest ecosystems, mainly by reconstruction, in suitable habitats, of single-species forest stands into mixed forest stands and by means of bio-melioration measures;
   c) the regeneration of devastated and neglected forest stands in private forests, followed by their ecological rehabilitation.

In order to improve the condition and protection of forests so that they can more broadly fulfil their various functions, account has been taken of the need to continue the following forest management activities:

1) improving the health and resilience of forest stands to harmful abiotic and biotic factors by the dissemination of biological and ecological methods of forest conservation;
2) restricting the use of chemical substances (e.g. pesticides, mineral fertilisers) to the essential needs;
3) the provision of protective and social functions by forests in such a manner that these activities may not endanger the sustainability of forests and do not adversely affect the condition of forest stands;
4) assuming that:
   a) the use of wood resources regulated by the harvest limit results from the needs arising from the objectives of forest breeding and conservation and is intended to ensure the continuity of production of as much wood of the best quality as possible;
   b) the volume of wood harvested in tending treatments should not exceed the current increment, but should guarantee the accumulation of wood in forest stands, providing the basis for extended reproduction;
   c) the volume of wood harvested from mature forest stands should take into account the limitations resulting from the implementation of protective and social functions, the current and future forest species and age structure of forests and the degree of its compatibility with the characteristics of the habitat, the level of achievement of the planned economic objective and the needs for restocking and reconstruction of forest stands;

d) the abundance of game animals will be adjusted to a level which does not jeopardise the objectives of silviculture and forest protection;
e) the recreation and tourism in forest areas will be regulated and targeted in a manner which reconciles the social functions of forests with their protective and productive functions;
f) the effectiveness of the legal protection of all forest land will be improved.

It should be noted that the methodology for the projections of greenhouse gas emissions and removals for IPCC category IPCC 4.A *Forest land* within the LULUCF sector is based on the use of the constant values of the quantified effects of management practices (in the form of the intensity indicators of final felling and pre-final cuts) determined for the period from 2010 to 2017. Moreover, as part of prognostic simulations carried out using the Carbon Budget Model of the Canadian Forestry Sector (CBM-CFS), it was assumed that the climatic conditions would be constant over time. The modelling process itself was based on the following elements:

- using unit areas represented by homogeneous (uniform) age and species groups of forest stands, taking into account the nature and forest regions;
- using the three main groups of disturbances of the development dynamics of wood resources, i.e. pre-final cuts, final felling and fires;
- using data quantifying specific disturbances in the form of volume-based wood harvest data, broken down into years, the individual species and age groups and the nature and forest regions.

The range of the measures taken in the area of land use reflects the scope of the opportunities and limitations of the policies described in Table 5.29. In the preparation of the projections of GHG emissions and removals, use was made of the harvesting intensity indicators adapted to the progressing climate and environmental change, representing quantified forest management practices in the period from 2010 to 2019, which were determined for age classes and subclasses as the ratio of harvesting broken down into final felling and pre-final cuts to the total volume of round wood resources.

Table 5.30. Harvest intensity indicators of final felling and pre-final cuts for age classes and subclasses in the forests managed by the State Forests National Forest Holding and in the other forests in the WEM scenario

Item	Age classes and subclasses	Harvesting intensity indicators in the WEM scenario			
		Final felling	Pre-final cuts	Final felling	Pre-final cuts
		State Forests		Other forests	
1	Ia (1-10)	0.0000	0.5668	0.0000	0.4227
2	Ib (11-20 years)	0.0008	0.5271	0.0003	0.3931
3	IIa (21-30 years)	0.0014	0.2323	0.0005	0.1732
4	IIb (31-40 years)	0.0038	0.2109	0.0013	0.1573
5	IIIa (41-50 years)	0.0049	0.1854	0.0017	0.1382
6	IIIb (51-60 years)	0.0066	0.1766	0.0023	0.1317
7	IVa (61-70 years)	0.0285	0.1418	0.0099	0.1058
8	IVb (71-80 years)	0.0508	0.1302	0.0176	0.0971
9	Va (81-90 years)	0.1973	0.0733	0.0685	0.0547
10	Vb (91-100 years)	0.2868	0.0487	0.0995	0.0363
11	VI (101-120 years)	0.3376	0.0264	0.1171	0.0197
12	VII and older (more than 120 years)	0.2254	0.0154	0.0782	0.0115
13	KO - restocking class, KDO - class for restocking and BP - class with a selection structure	0.6610	0.0004	0.2293	0.0003

These harvest intensity indicators for the forest management in the historical period (2010-2019) were estimated separately for the distinguished stratas, i.e. for the forests managed by State Forests and for the other forests. It was assumed that within the distinguished categories of harvest (i.e. within final felling and pre-final cuts) there were similar relationships between the harvesting intensity indicators in forests for the two distinguished strata (i.e. final felling is more intensive in older age classes than in younger age classes, while pre-final cuts are more intensive in younger age classes than in older age classes). There are differences between the strata, however, in the shares of final felling and pre-final cuts. The share of final felling is higher in the forests managed by State Forests, while the share of pre-final cuts is higher in the other forests.

The harvest intensity indicators of final felling and pre-final cuts by age classes and subclasses translate into the following annual volumes of harvested wood in the forest strata distinguished. Table 5.30 shows the volume of harvested wood (in m^3 of round wood without bark) in the WEM scenario in the period from 2017 to 2030. In the case of data on the wood harvest in the period from 2031 to 2040, use was made of the extrapolation of values based on the period from 2017 to 2030.

Table 5.31. Development of wood harvest in the period from 2017 to 2030 in the WEM scenario

Forest management scenario	Period	Cutting category	Wood harvest		
			State Forests	Other forests	Total
			thousand m^3 of round wood without bark/year		
WEM	2017-2020	Total	40 504	5887	46391
	2021-2025	Total	42104	6230	48334
	2026-2030	Total	43880	6696	50576

In the case of the data in the WEM scenario, the available information on forest management practices, their characteristics, including the rules on forest use and the species and age structure of forests, was analysed. The division of forests in Poland into two strata as applied in the preparation of the projections is justified, in particular, by: the differences in the intensity and structure of the harvest, as well as in the availability and reliability of data on the condition and management of forests.

Since 2010 the main source of data on forests under all forms of ownership has been the National Forest Inventory (WISL). It provides, among other things, information on the structure and volume of wood resources. Due to successive inventory cycles, it is also used to monitor changes in the forests in Poland. Based on the WISL results and more detailed data available on the forest management, State Forests adopted a division into two strata:

- the forests managed by State Forests – covering most of the forest area and wood resources of Poland (about 77%), where uniform practices based on the methods laid down in the instructions and internal regulations on forest management in effect in State Forests are applied;
- the forests other than those managed by State Forests (also called "*the other forests*"), including forests under other forms of ownership, with the total area and volume of resources representing approximately 23% of the total forest area in Poland. The other forests include forests under private ownership, forests managed by national parks, the Agricultural Property Stock of the State Treasury, other forests of the State Treasury and municipal forests. The forests under private ownership dominate in this group, while other properties represent a small percentage of Poland's forest area. This group is characterised by a different manner of forest management, expressed, among others, by significantly lower ratios of harvest than that in stratum 1, i.e. the forests managed by State Forests.

Table 5.32. Projected structure of the wood volume of growing stock

Species	Volume [million m³]				
	Years				
	2020	2025	2030	2035	2040
Pine	1 634.64	1 637.23	1 637.23	1 697.97	1 723.53
Spruce	167.79	163.45	163.45	166.08	163.59
Fir	110.96	114.42	114.42	125.99	131.46
Other coniferous	29.77	32.69	32.69	34.36	67.19
Total coniferous	**1 943.16**	**1 947.79**	**1 947.79**	**2 024.40**	**2 056.55**
Beech	184.03	185.24	185.24	194.71	198.64
Oak	175.91	179.80	179.80	194.71	201.57
Hornbeam	40.60	43.59	43.59	51.54	55.50
Birch	132.61	133.48	133.48	140.30	143.14
Alder	148.85	152.55	152.55	166.08	172.35
Poplar	2.71	2.72	2.72	2.86	2.92
Aspen	18.94	21.79	21.79	22.91	26.29
Other broadleaved	56.83	59.93	59.93	62.99	67.19
Total broadleaved	**763.19**	**776.39**	**776.39**	**838.97**	**864.69**
Grand total	2 706.35	2 724.18	2 724.18	2 863.36	2 921.24

Source: Data from the Forestry and Hunting Department of the Ministry of Climate and Environment

In the case of the projections of greenhouse gases for the other IPCC categories within the LULUCF sector, the methodology follows the estimation patterns applied in greenhouse gas inventories as described in the 2022 National Inventory Report 2022. In the absence of prognostic data necessary to update the emission indicators, use was made of values extrapolated from the data available from the period from 1990 to 2020. A similar approach was applied in the absence of activity data (the values estimated for the WEM scenario were used in the WAM scenario).

5.6.5. Waste

The projections of the greenhouse emissions in the waste sector were only prepared in the WEM scenario (the values estimated for the WEM scenario were used for waste in the WAM scenario). The estimation of the greenhouse gas emissions in the waste sector was based on the own analyses of the IOŚ-PIB and the KOBiZE IOŚ-PIB carried out, among others, on the basis of information acquired from sectoral associations. The projections of changes in activities in the waste sector were based on prognostic documents available for this sector, including:

- National Waste Management Plan 2022 (Kpgo 2022),
- Fifth Update of the National Programme for Municipal Wastewater Treatment – V AKPOŚK 2017;
- Draft Sixth Update of the National Programme for Municipal Wastewater Treatment – VI AKPOŚK 2020;
- Projections of changes in activities in the waste sector for the purposes of carrying out the tasks under Article 9 of the Act on the System to Manage the Emissions of Greenhouse Gases and Other Substances, 2021, IOŚ-PIB;
- The population projection for 2014-2050, GUS;
- Analyses acquired from the sectoral association – the Union of Producers and Employers of Biogas Industry.

The main assumptions developed under the Kpgo 2022 and expert predictions taken into account in the WEM projections are as follows:

- the projected quantity of solid municipal waste generated in Poland will be 15.3 million t in 2025 and 16.7 million t in 2030;
- by 2030 not more than 10% of municipal waste generated will be landfilled;

– by 2020 not more than 30% of municipal waste may be incinerated;
– by 2022 the deposition of municipal sewage sludge at landfills will cease completely.

In the absence of data projected for milestone years, the emission projections were estimated using the methods of interpolation and extrapolation. In the cases where the use of extrapolation was not substantively justified, the value equal to a known value projected for the most distant perspective was adopted.

5.7. Description of the models applied in the activity projections in the energy sector

The STEAM-PL and MESSAGE models were used to prepare a forecast of the national energy demand and its results were then used to estimate the greenhouse gas emissions from the energy sector. The block diagram presenting the forecasting method, along with the models used to determine the electricity and district heat demand in the country and the optimum manner of its satisfaction, is shown in Fig. 5.14.

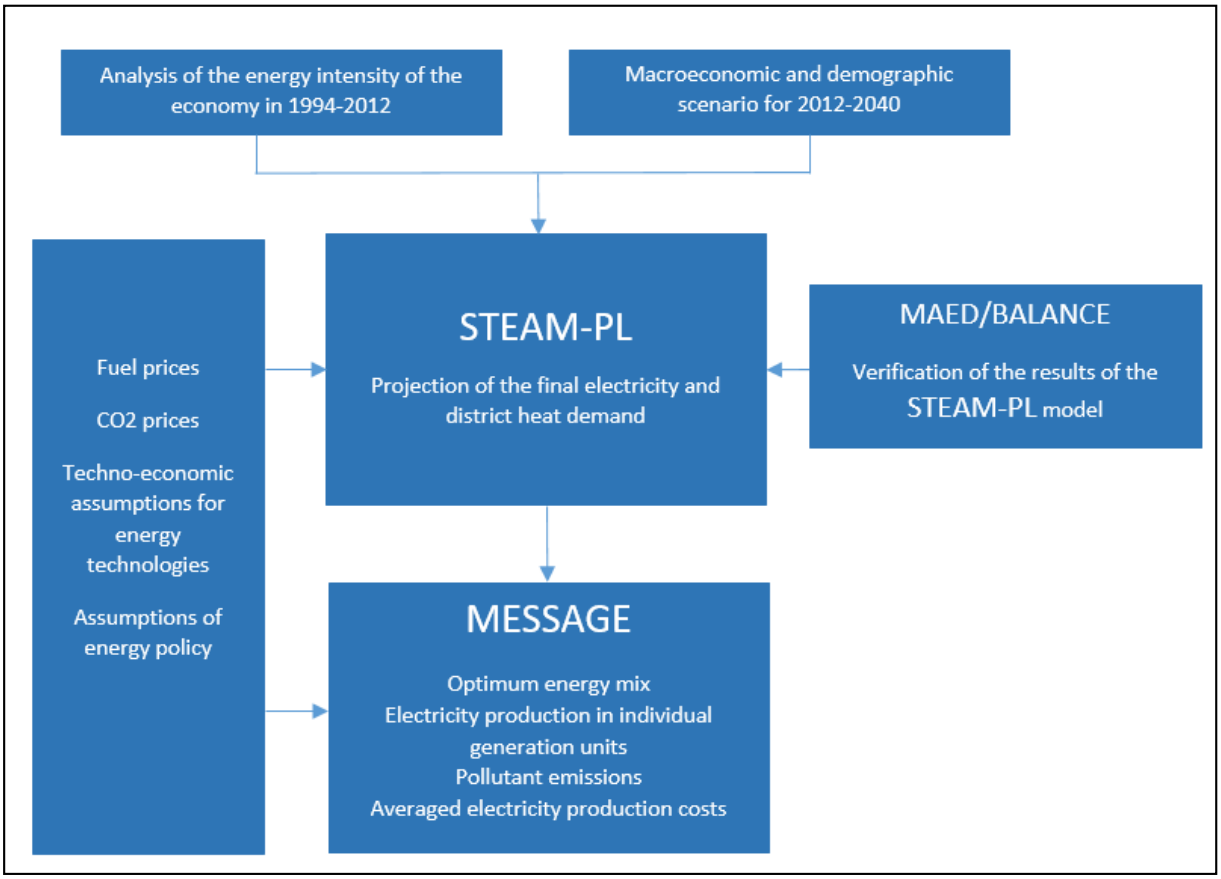


Fig. 5.14. Block diagram of the calculation procedure of the model

In accordance with the method applied, the main factors were adopted as ones affecting the development of energy demand in the country: economic growth (GDP and values added in the individual sectors of the national economy) described by the following macroeconomic indicators:

– demographic processes,
– changes in the lifestyles of society,
– technological progress,
– processes to improve energy efficiency.

The electricity demand projections were prepared using the STEAM-PL model (Set of Tools for Energy Demand Analysis and Modelling), a tool which was developed in ARE S.A. in 2012-2016, which fully aligns the relationships contained in it with the changing operating conditions of energy markets,

including the foreseeable technological progress. The projections generated using this model were built on the basis of a single consistent scenario, including macroeconomic and demographic assumptions and the assumptions for the foreseeable technological progress and the related rate of energy efficiency improvement. The base year In this model is 2012.

The outputs of the STEAM-PL model were inputs to the MESSAGE model (Model for Energy Supply Strategy Alternatives and their General Environmental Impacts), where on the basis of the identified electricity and district heat demand, the optimum structure of the generation sector and the demand-driven production by individual generation units were determined. The selection of the optimum – from the point of view of the economy – generation structure (energy mix) in the MESSAGE model is based on the minimisation of the total discounted systemic costs over the entire time interval considered.

STEAM-PL model

STEAM-PL is an "*end-use*" consumption model dedicated to the national fuel and energy system, reflecting in detail the technical aspects related to energy use in the particular sectors of the economy. It is an integrated hybrid model which makes it possible at the same time to determine the future energy demand for useful energy (using the classical "*bottom-up*" approach) and the ways of meeting the demand (using the "*top-down*" approach). The model is based on a calculation algorithm which is used to simulate the behaviour of energy consumer reacting to changes in the price relations between fuels and technologies, enabling an analysis of the substitution of energy generation technologies and energy carriers on the basis of costs related to the provision of specific energy services. To this end, the model uses the econometric modelling of the shares in the market in the form of a logit function (the market share algorithm – the mathematical approach applied in the BALANCE and WEM models).

STEAM-PL has a modular structure, which means that a relevant module is dedicated to a sector of the national economy defined in it, with its calculation algorithms taking into account a number of characteristics distinguishing a given sector (Fig. 5.15).

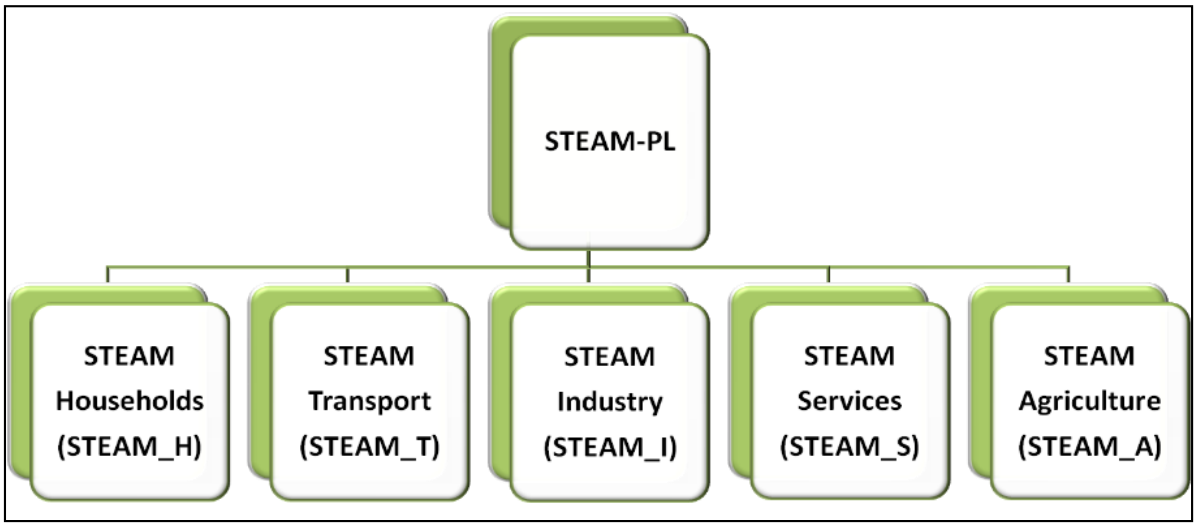


Fig. 5.15. Division of the structure of the STEAM-PL model into modules

The model uses the division of the sectors of the national economy into subsectors, thus making it possible to capture the specific operating characteristics of the individual economic areas (Table 5.33). Energy uses are defined for each sector and subsector (Table 5.34).

Table 5.33. The division of the sectors of the national economy into subsectors as used in the model

Sector	Subsector
Households	Urban households
	Rural households
Transport	Passenger transport
	Freight transport
Industry	Manufacture and casting of metals
	Manufacture of non-ferrous metals
	Manufacture of chemical and petrochemical products
	Manufacture of non-metallic mineral products
	Manufacture of paper and paper products, printing and manufacture of wood
	Manufacture of food products, beverages and tobacco products
	Manufacture of other industrial products (manufacture of textile products, garments, hides and leather, manufacture of machinery and equipment, manufacture of motor vehicles, trailers and semi-trailers, manufacture of other transport equipment, metal ore mining, other mining and quarrying, construction, other manufacture of products)
Services	Non-commercial services
	Commercial services

Table 5.34. Energy uses identified for each sector and subsector

Sector	Use
Households	Electrical equipment
	Lighting
	Air-conditioning and ventilation
	Preparation of meals
	Room heating
	Preparation of domestic hot water
Transport	Transport performance (passenger transport)
	Transport performance (freight transport)
Industry	Electric drives
	Lighting
	Room heating and ventilation
	Furnace heat
	Process steam
Services	Room lighting
	Street lighting
	Ventilation
	Air-conditioning
	Room heating
	Preparation of domestic hot water
	Electric drives
	Technological equipment
	Electrical office equipment
	Refrigeration equipment

Sector	Use
	Preparation of meals
Agriculture	Motor fuels
	Other fuels
	Electrical loads

The calculation procedure applied in the model can be characterised as follows: in the first step the model determines the usable energy demand based on the assumed rate of the national economic growth and social, technological and regulatory factors taken into account as drivers.[59]

In the next step, the set of technology and equipment enabling the meeting of the demand for individual energy services and the intensity of their use are determined. The following was used e.g. to identify the initial state: the results of a cyclical (every three years) survey of energy and fuel consumption carried out by the GUS among households[60], the results of the statistical survey on "*Fuel and energy balances*"[61] and the results of analyses performed by recognised research centres and sectoral institutions[62]. The final energy consumption is calculated on the basis of the projected number of items of equipment, their techno-economic characteristics and the foreseen intensity of their use. The improvement of the energy efficiency of electrical equipment is taken into account through the assumptions for technological equipment (the energy efficiency class). The pace of the replacement of existing equipment by new one in a higher energy efficiency class is adopted on the basis of an analysis of historical trends as the result of a prediction developed in relevant econometric models and on the basis of sales data acquired from manufacturers for each item of equipment separately. The division into energy efficiency classes is applied to all the items of electrical equipment defined in the model (e.g. the module dedicated to households defines 72 different types of electrical equipment for everyday use and 6 types of air-conditioning and ventilation equipment). For such energy uses as heating and the preparation of domestic hot water, the market share algorithm mentioned earlier is used to determine the manner of satisfying the energy needs.

In the manufacturing sector, the model applies a slightly different approach than the one for services and households. In the first step, output projections are developed for energy-intensive industrial products and then, on the basis of historical date, the energy intensity indicators are determined for given product groups. These indicators are extrapolated as an element reflecting the course of the processes of improving energy efficiency. The energy demand thus determined is divided into the individual uses within which, using the market share algorithm, the ways of meeting this demand are simulated for the particular groups of dedicated technologies, described by a number of techno-economic parameters (with preset limitations). Fig. 5.16 presents the structure of the model and the individual elements defined in the STEAM-PL model.

[59] The identified factors which condition to the largest extent the scope and pace of changes in energy demand
[60] "*Energy consumption in households*" – Statistics Poland (GUS), Warsaw, 2002, 2009, 2012 and 2015
[61] Annual Statistical Survey Programmes of Public Statistics, the project "*Fuel and energy balances*"
[62] Including e.g. Leonardo Energy, KAPE, FEWE and NTUA

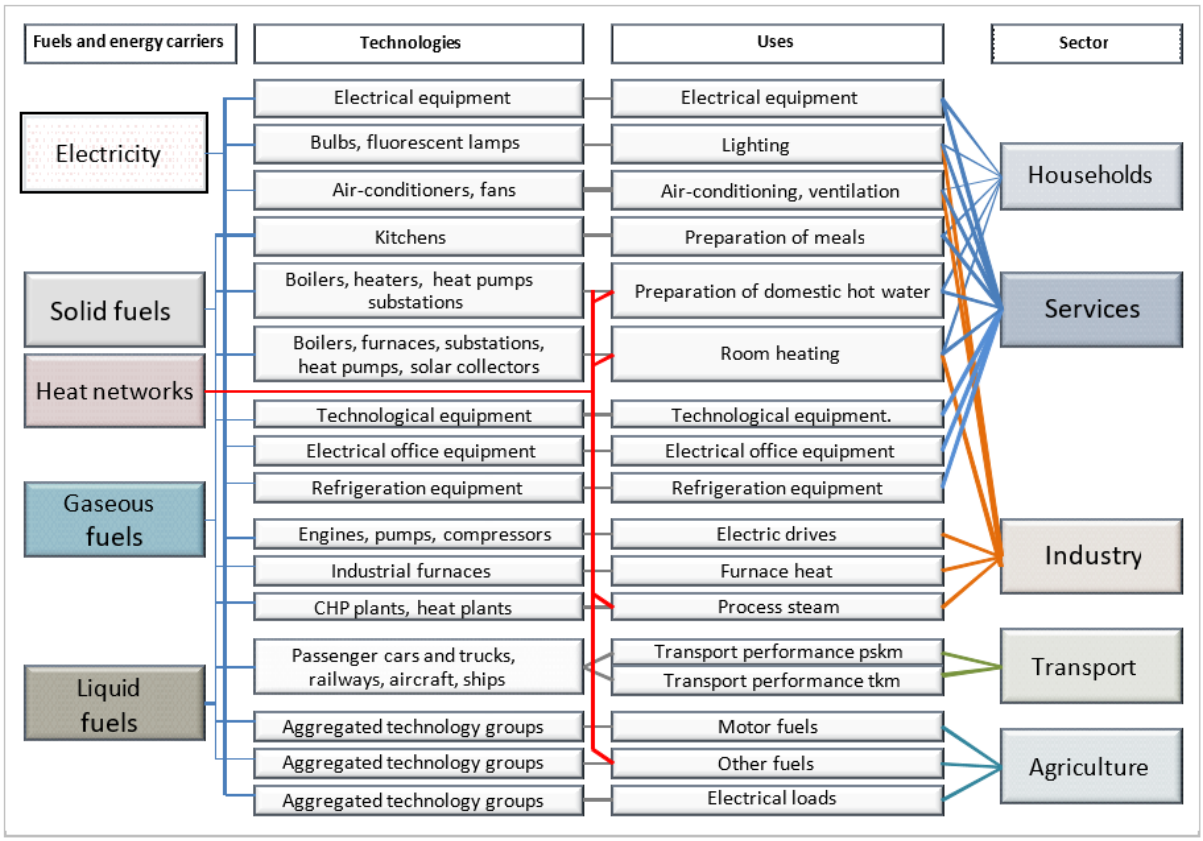


Fig. 5.16. Structure of the STEAM-PL model

Model strengths cover a detailed bottom-up modelling approach considering the dynamics of technologies and socio-economic drivers. The model allows to address various research questions related to energy demand including scenarios for the future demand of individual energy carriers, calculating energy saving potentials and the impact on greenhouse gas (GHG) emissions as well ex-ante policy impact assessments. For all types of investment decisions, the model follows a simulation approach rather than optimization in order to better capture the real-life behaviour of companies and households. The resulting technology development is price sensitive, however the investment decision in the model implemented as logit-function approach, ensures that even if one technology choice is more cost-effective than the others, it will not gain a 100% market share. This effect reflects heterogeneity in the market, niche markets and non-rational behaviour of companies and households.

The simulation algorithm and the vintage stock approach are well suited to simulate most types of energy-efficiency policies:

- Government policies that override allocation decisions based strictly on relative fuel price
- minimum energy performance standards (MEPS), e.g. for appliances or buildings, can easily be modelled by restricting the market share of new appliances starting in the year the standards come into force;
- energy taxes for end-consumers can be modelled explicitly on the basis of individual energy carriers;
- EU emissions trading can be modelled in the form of a CO_2 tax for energy-intensive industries, etc.

The main economic input like energy balances, employment, value added or energy prices are calibrated to most recent EUROSTAT/IEA/national statistics whenever possible. Besides, ODYSSEE database, country specific research studies and various technology studies of which many are EU projects are used to fill the data gaps.

The weaknesses of the model relate to the requirement for a large amount of data and regular updating. Uncertainties related to the values of logit-function parameters – price sensitivity parameters, premium multipliers (determine user's preferences), lag parameters (the lag function determines what portion of the market is able to adjust to a change in prices) increase with the extension of the time horizon of the analysis. In general, recent historical values of market shares and relative prices are analysed to determine a reasonable value for the price sensitivity parameters at each of the decision nodes located throughout the energy network.

MESSAGE-PL model

On the basis of the identified electricity and district heat demand, in the next step, the optimum structure of the generation sector and the demand-driven production by individual generation units in the MESSAGE-PL model was determined. The operating principle of the MESSAGE[63] model is based on the minimisation of the total discounted systemic costs over the entire time interval considered, using linear programming methods or, integer programming for certain tasks (e.g. the selection of generators with specified capacity – large coal-fired and nuclear units).

MESSAGE operates on a predefined energy flow network, starting from the extraction or supply of primary energy, though conversion (e.g. electricity and heat generation), transmission and distribution, up to end-users (Fig. 5.17).

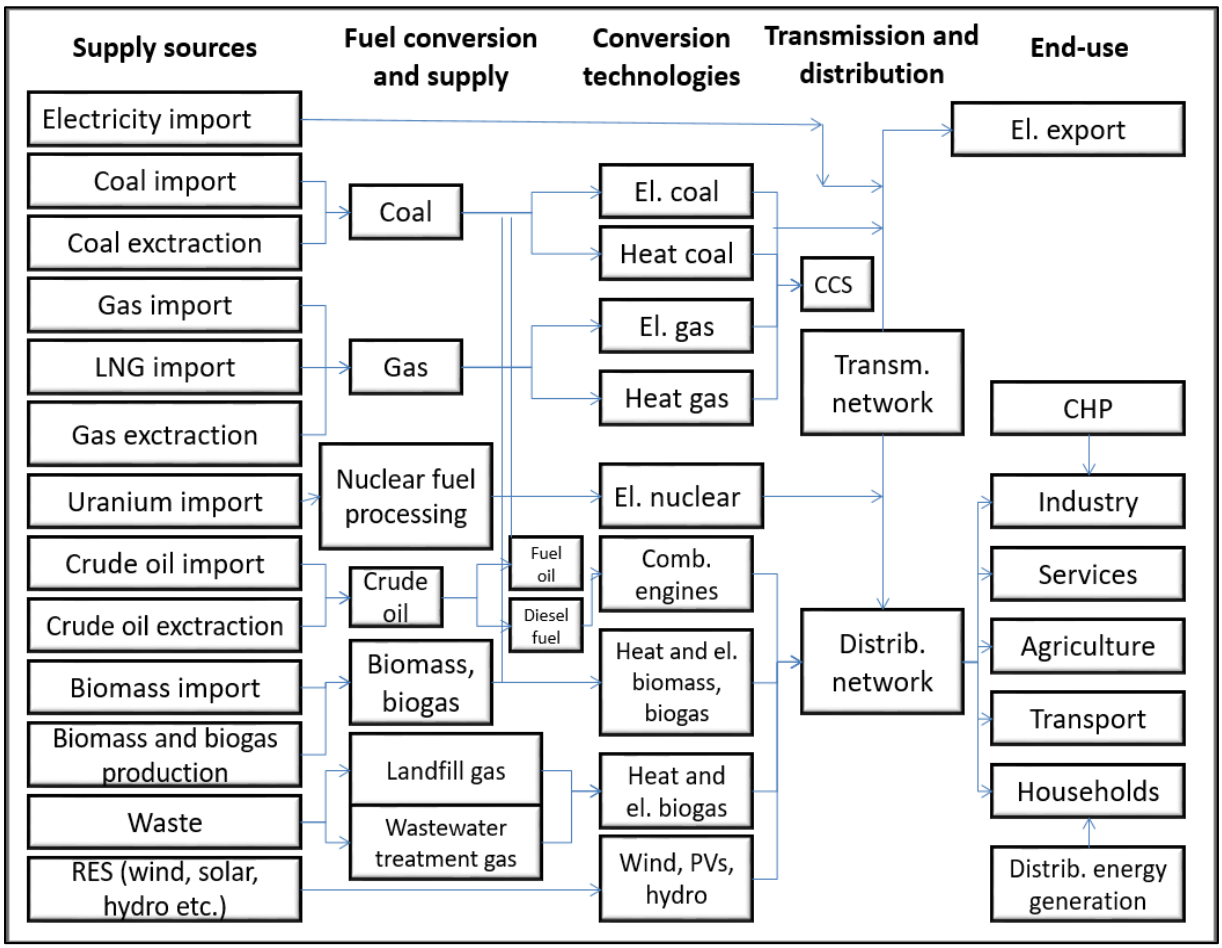


Fig. 5.17. Simplified block diagram of the energy system in the MESSAGE model

[63] MESSAGE – Model for Energy Supply Strategy Alternatives and the General Environmental Impacts, User Manual, IAEA, 2007

Both existing technologies and new generation units are part of the network. At present, the model contains more than 80 existing generation units and new types of technologies (among others, high-efficiency coal and gas technologies without and with CO_2 capture, technologies using renewable sources, nuclear power plants, CHP technologies). The model takes into account the long-term objectives of the emissions of air pollutants and CO_2 emissions (including constraints on emission allowances under the EU ETS regulations) and the national policy instruments promoting RES and combined heat and power generation.

An important advantage of the MESSAGE model is the possibility of differentiating the level of demand for a given energy carrier depending on the season of the year, the type of day and the time of day. This information provides the basis for determining the technology mix and the operating mode of installed units (the operation under base, near peak and peak load). The equivalent load curve used in the MESSAGE model for KSE (the Polish Power System) (Fig. 5.18) is plotted on the basis of the data from the transmission system operator on the load levels in the historical periods and projected changes in this curve.

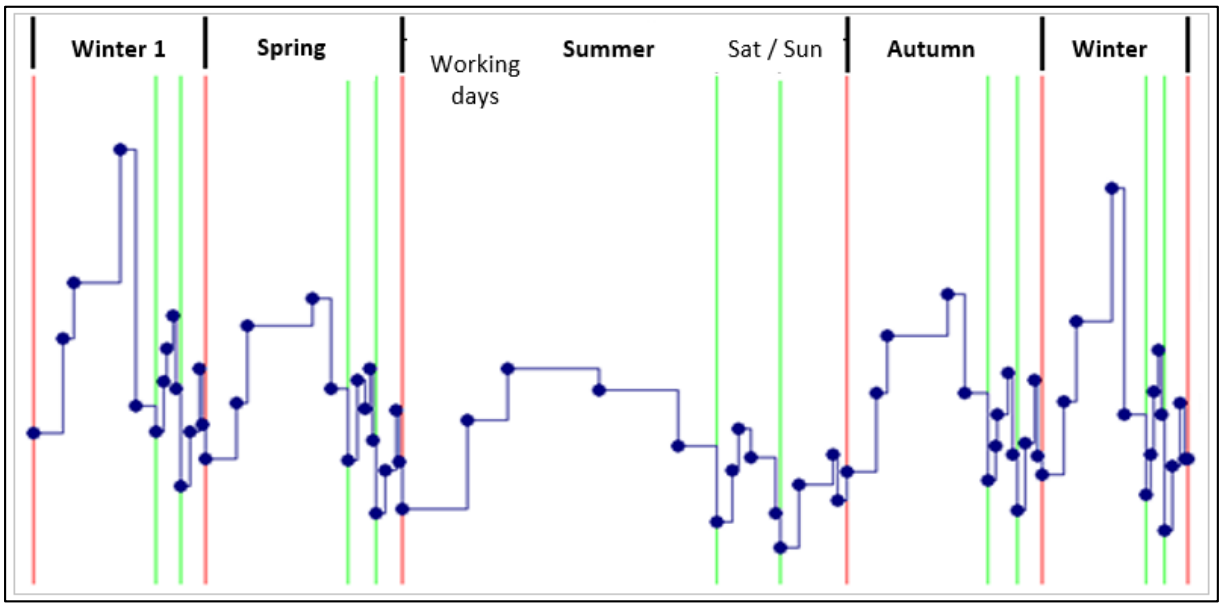


Fig. 5.18. Equivalent load curve applied in the MESSAGE model

The MESSAGE model generator has been created and is now developed at the International Institute for Applied Systems Analysis in (IIASA) in Laxenburg (Austria). Under a special agreement between the IIASA and the International Atomic Energy Agency (IAEA), it can be used by the IAEA and its member states. At ARE S.A. it has been adapted to the Polish conditions.

On the basis of the optimum structure of the generation sector (and the demand-driven production by individual generation units) identified using the MESSAGE model, the averaged unit electricity generation costs in Poland were determined in the timeframe considered.

Strengths of the a bottom-up optimization type model of Polish electric power and district heating system cover:

- determining optimal energy mix;
- evaluating options & reviewing different ways to meet future demand;
- exploring "*what if...*" questions;
- backcasting;
- understanding trade-offs;
- evaluating investment requirements;

- modelling different energy/environmental policies and their impact assessments;
- user defined variables and constraints.

Additionally one year time step with load (e.g. electricity, heat, natural gas) variation during a year is represented by load regions and load curves. MESSAGE model has rich technology data base, and parameters are dynamic: they can change over time. Market penetration of new technologies is controlled based on scenario assumptions, energy policy or regulations. Fuel prices are varying within a year and over years. Emission control limits are imposed on individual plants, group(s) of plants or entire electricity or district heating systems and emission trading among plants/EU ETS is taken into account.

The weaknesses of the MESSAGE model relate to its primal focus being on Polish electricity and district heat generation sectors and transmission/distribution network and interconnections with neighbouring countries re represented in a simplified way. Additionally the closure of generating units is determined ex-ante as declared by owners or by its vintage and technical life length. A general weakness of the whole modelling suite is the time consuming iteration process between its sub models (STEAM, MESSAGE and CGE if used) since they run independently.

Any overlap or synergies that may exist between different policies and measures were resolved in direct contacts with the persons supervising the study on behalf of the government.

5.8. Evaluation of the aggregated effects of policies and measures

The aggregated effects of the policies and measures to reduce greenhouse gas emissions in the scenario "*with existing measures*", primarily intended to improve energy efficiency, to increase the use of renewable energy sources, to diversify the fuel structure in the energy sector or to implement advanced technologies, are presented in Fig. 5.19. It shows the emission reductions achieved before and after 2010 compared with the projected emissions.

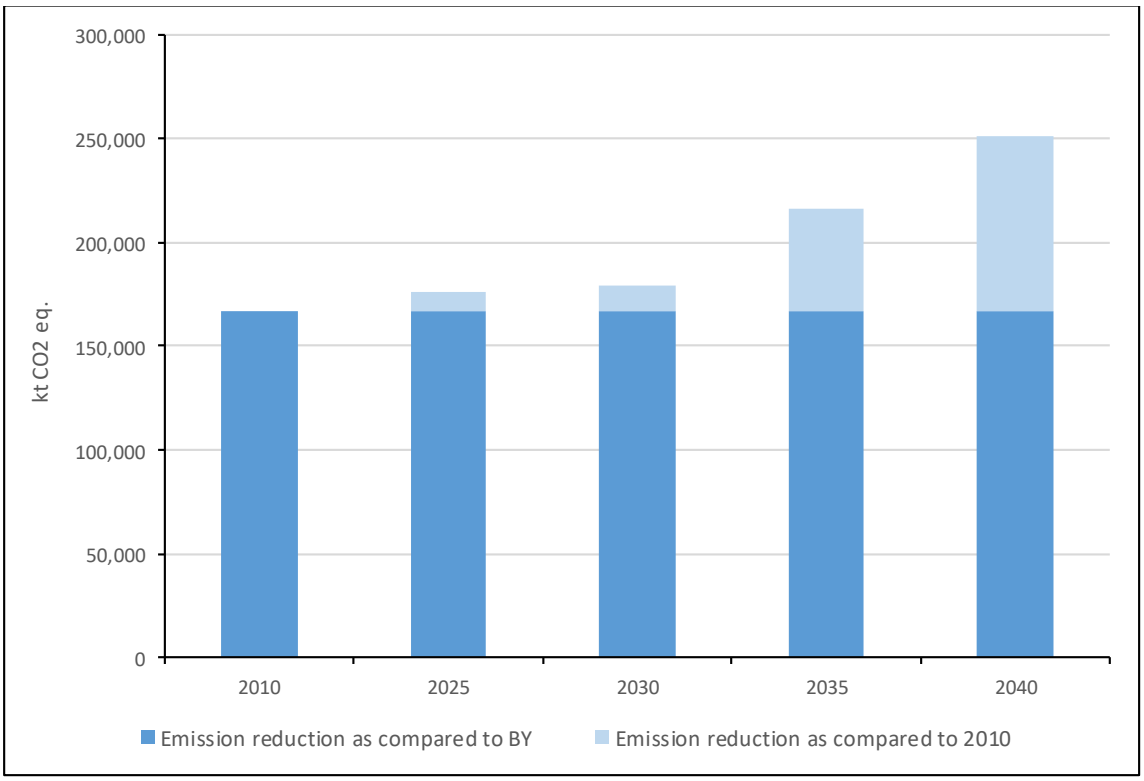


Fig. 5.19. Aggregated effects of the policies and measures implemented in the scenario "*with existing measures*" for the period from 2025 to 2040 (excluding sector 4. LULUCF)

5.9. Comparison of the results of the present emission projections with those included in the Fourth Biennial Report

Fig. 5.20 and Tables 5.35 and 5.36 show a comparison of the present greenhouse gas emission projections with those included in the *Fourth Biennial Report* (BR4). A comparison of the total greenhouse gas emissions (excluding the LULUCF sector) in the present Communication with those in BR4 shows slight differences: from +0.02% in 2025 to -16% in 2040 in the WEM scenario and from +1.35% in 2025 to -0.60% in 2040 in the WAM scenario.

An analysis of changes in the projected emissions in both scenarios by gas indicates that the differences are the lowest for CO_2 (from -0.7% in 2040 in the WEM scenario to 3.6% in 2030 in the WAM scenario), while the differences for methane amount to even -11.2% in 2030 in the WEM scenario and -5,1% in the WAM scenario. In turn, at present, higher nitrous oxide emissions are projected: by 6.9% in 2030 in the WEM scenario and by 7.4% in 2030 in the WAM scenario. The projected emissions of fluorinated gases are the same as those in BR4.

A comparison of the projected emissions by category shows the largest differences in the sectors of: agriculture (8% in 2030 and 4% in 2040), waste (-35% in 2030 and -52% in 2040) and LULUCF (-56% and -110%, respectively, in 2030 and 2040). Slight differences between the projections can be seen primarily in the sector of *Energy*, as a result of the application of the same main energy assumptions in both reports prepared by the Ministry of Energy for the purposes of the first *National Energy and Climate Plan for 2021-2030* (NECP) (Figs. 5.21 and 5.22).

The reason for the greatest difference in the projected greenhouse gas emission levels between BR4 and the present Communication is the update of the data input and factors for the sectors of industry (except for fluorinated gases). These are the projected outputs for cement clinker, glass, soda ash and the activities associated with iron production.

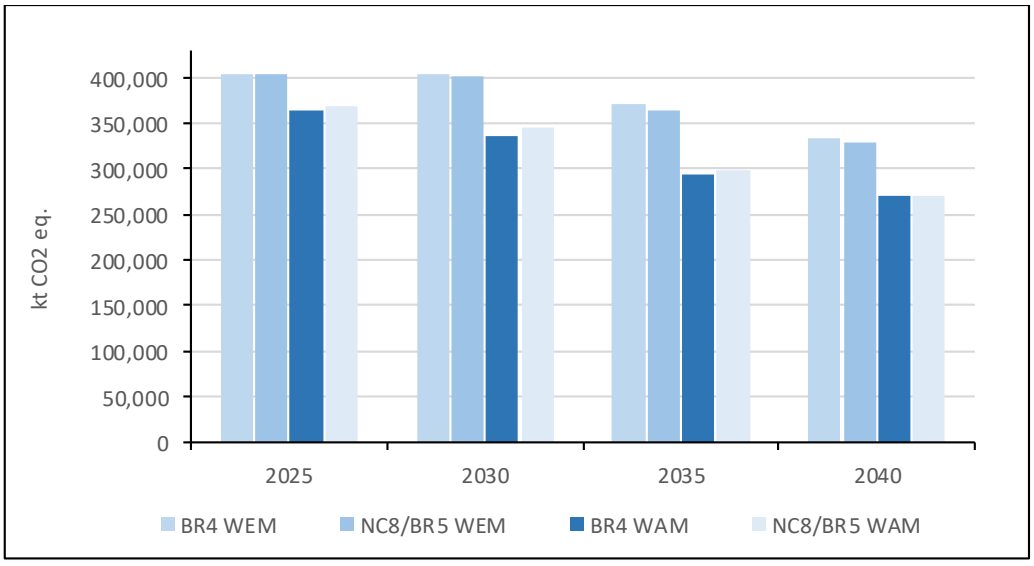


Fig. 5.20. Comparison of the projected greenhouse gas emissions between the *Fourth Biennial Report* (BR4) and the present Communication (NC8/BR5) (excluding sector 4. LULUCF)

Table 5.35. Comparison of the present greenhouse gas emission projections with those presented in the *Fourth Biennial Report (BR4*), by gas

Greenhouse gases	BR4 WEM		NC8/BR5 WEM		BR4 WAM		NC8/BR5 WAM	
	2030	2040	2030	2040	2030	2040	2030	2040
	kt CO_2 eq.							
CO_2	331 695	266 408	331 757	264 578	268 601	208 894	278 159	208 715
CH_4	49 171	43 757	43 678	39 864	44 295	40 119	42 058	38 158
N_2O	20 834	20 805	22 280	21 315	20 654	20 651	22 190	21 167
HFCs	2 882	2 696	2 882	2 696	2 605	1 368	2 605	1 368
PFCs	6	4	6	4	6	4	6	4
SF_6	151	199	151	199	91	75	91	75
NF_3	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA
Total emissions excluding category 4	**404 740**	**333 870**	**400 755**	**328 656**	**336 253**	**271 110**	**345 110**	**269 486**

Source: KOBiZE IOŚ-PIB

In the case of agriculture, in addition to an update of the activities related to animal and plant production contributing to changes in the expected emissions, methodological changes as applied in the national emission inventories in the last 2 years for livestock excreta and soils were also made.

In the waste sector, the present Communication shows lower projected greenhouse gas emissions than those in BR4 (Table 5.36.), as a result of the expansion of the projections with new activities and the related inclusion of additional policies and measures.

In the LULUCF sector, the projected net balance of greenhouse gas emissions and removals is lower in the present Communication than in BR4, as a result of an update of the value of the net balance of greenhouse gas emissions and removals for forest land, in particular, the verification of the historically used levels of final felling and pre-final cuts in the forest land strata analysed, which led to a change in the originally assumed pace of the growth of wood resources of growing stock (for species and age classes) as well as to a change in the originally assumed pace of changes in deadwood resources (for species and decomposition classes).

It should be noted that the projections used time-invariant values of the quantified effects of management practices specified for the historical period. This gives the certainty that the WEM scenario is the best possible estimate of the values of emissions and removals which would occur in the absence of the impacts of policies pursued and measures applied, and those of any changes in such policies and measures, or any new policy or measure put into effect after the prognostic period. At the same time, the same climate conditions as those for the historical period were used for the WEM projections. It should be pointed out that significant changes unfolding in the short term still continue to be unpredictable (so it is a serious challenge to include them in a projection) and that their impact should be considered in the context of major differences in the relations between the projected vs. recorded sectoral values of the net balances of greenhouse gas emissions and removals.

Table 5.36. Comparison of the present greenhouse gas emission projections with those presented in the *Fourth Biennial Report (BR4)*, by sector

Sectors	BR4 WEM		NC8/BR5 WEM		BR4 WAM		NC8/BR5 WAM	
	2030	2040	2030	2040	2030	2040	2030	2040
	kt CO_2 eq.							
1. Energy	336 042	265 071	334 006	265 017	267 891	203 764	278 699	207 300
2. Industrial processes and product use	23 942	24 246	23 459	23 638	23 605	22 793	23 123	22 185
3. Agriculture	32 881	33 249	35 605	34 630	32 881	33 249	35 605	34 630
4. Land use, land-use change and forestry	-21 693	-14 021	-6 700	4 639	-21 693	-14 021	-6 700	4 639
5. Waste	11 875	11 304	7 684	5 371	11 875	11 304	7 684	5 371
Total emissions excluding category 4	**404 740**	**333 870**	**400 755**	**328 656**	**336 253**	**271 110**	**345 110**	**269 486**

Source: KOBiZE IOŚ-PIB

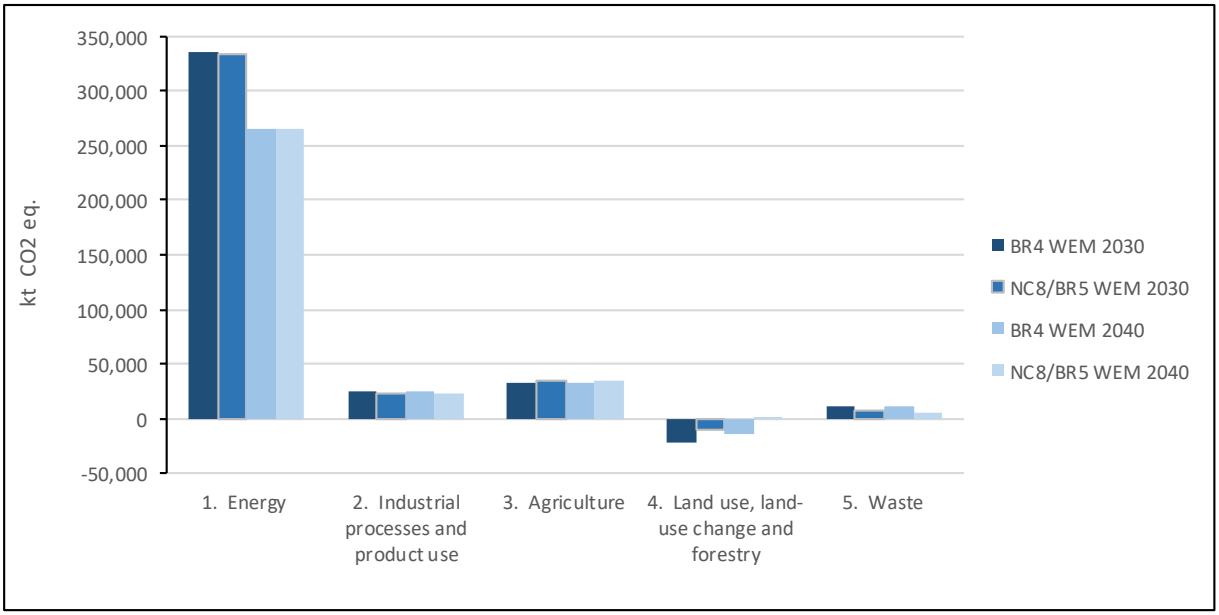


Fig. 5.21. Comparison of the present greenhouse gas emission projections with those presented in the *Fourth Biennial Report (BR4)* for 2030 by sector in the WEM scenario

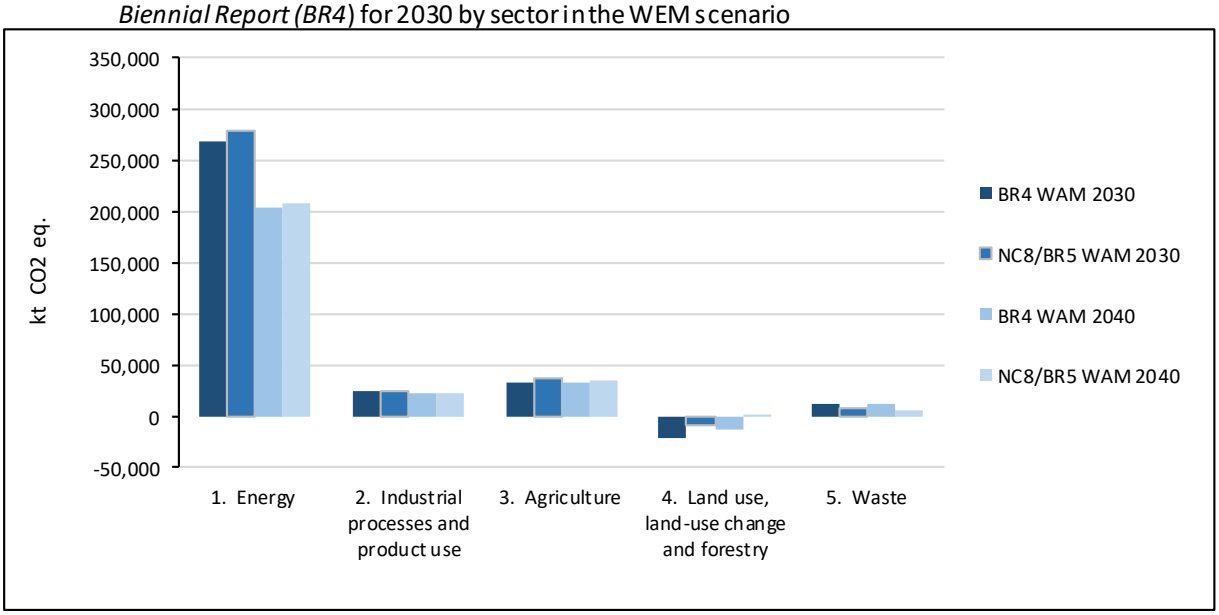


Fig. 5.22. Comparison of the present greenhouse gas emission projections with those presented in the *Fourth Biennial Report (BR4)* for 2030 by sector in the WAM scenario

CHAPTER 6. VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES

6.1. Climate change observed and predicted in the future

Compared with the results presented in the Seventh National Communication, no major changes in the climate conditions were found, indicating fairly stable climate change trends in Poland.

6.1.1. Contemporary climate change in Poland

The temperature and precipitation conditions over the last several dozen years in Poland have shown changes with the nature of a trend. Since the mid-20th century the mean annual air temperatures have risen at a rate of 0.29˚C per 10 years, reaching a value higher by 2.0˚C in the second decade of the 21st century. Over the last several dozen years in Poland warming has been clearly seen throughout Poland, although the rate of temperature changes has been regionally diversified. The greatest temperature rise (by more than 2.1°C) occurred in the Lake Districts and the weakest one (almost 1.8°C) in the Sudety Mountains.

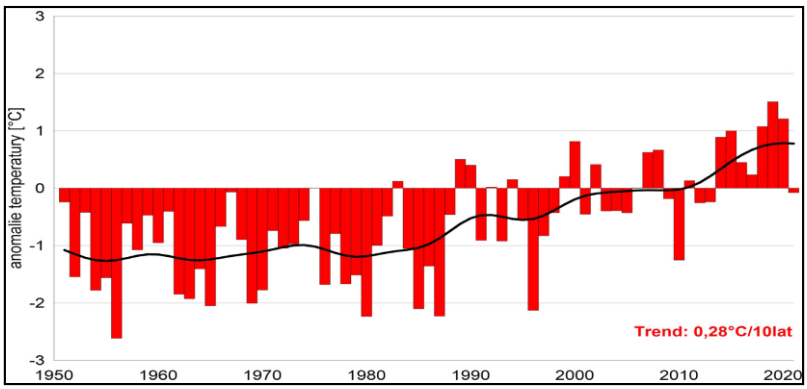


Fig. 6.1. Variability of the mean annual air temperature in Poland in the period from 1951 to 2020
Source: IMGW-PIB

The last three decades have been the warmest ones since the mid-20th century. In the 30 years from 1991 to 2020, the years 2019, 2020, 2018, 2015, 2014, 2008 and 2007 were the warmest, with the mean annual temperatures (°C) in Poland, respectively, of: 10.2; 9.9; 9.8; 9.7; 9.6; 9.4 and 9.4 (Fig. 6.1). Poland's climate has demonstrated a characteristic air temperature variability between the years, manifested by the occurrence of years which are clearly colder than the mean ones, although this is much less frequent than before 1991.

The air temperature rise could be seen in all the seasons of the year. It was the greatest in the summer and the spring, mainly as a result of a large increase in the mean temperature in July (on average by 1.52°C) and April (on average by 1.23°C), with the weakest increase in the only slightly warmer autumn (by less than 0.3°C) than in the long term (1961-1990).

The long-term changes could also be seen in the frequency of high temperatures. The number of hot days (with the maximum temperature of 30°C and more) varied from single cases in 1981 to several or a dozen or so days, even 20 days in 2015. In Southern Poland, their number has doubled compared with the earlier years. There has still been clearer increase in the number of extremely hot days, which is now even four times as high as before 1991. The average winters have become warmer, reducing the number of very cold days (with the minimum temperature of -10°C or less) and extremely cold days (with the minimum temperature of -15°C or less). However, there are still winters with long and intensive cold waves. In the case of frost waves during which the temperatures on successive days

continuously fall to below -15°C, one cannot speak of an observed trend indicating that such periods become shorter in most of the country.

The other basic element – precipitation – is characterised by strong variability between the years and seasons, as well as even greater regional diversification. The annual precipitation totals increase in Poland; however, these changes are not statistically significant all over its territory. A clearer increase can be seen in Northern Poland (Fig. 6.2).

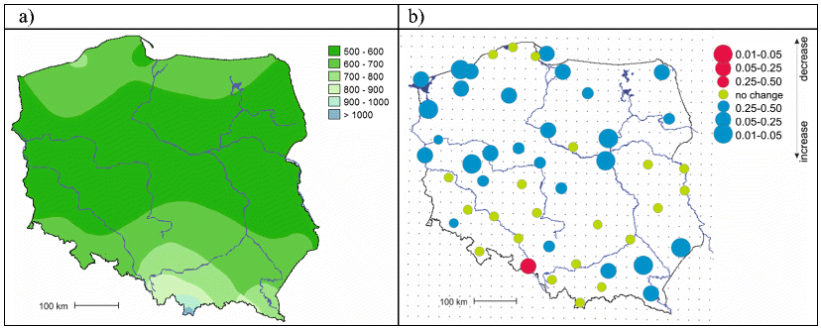


Fig. 6.2. Annual precipitation totals in the period from 1951 to 2013 in Poland: (a) mean values [mm]; (b) the significance levels of changes in the annual precipitation totals in the period from 1951 to 2013 based on the Mann-Kendall test

Source: Szwed M., 2019

There has been a clear change in the seasonal precipitation pattern. The summer precipitation total, calculated from the values observed at 50 stations in the period from 1951 to 2013 did not change in most of Poland's territory. Weak falling trends in the share of summer precipitation in the annual precipitation total are most pronounced in the South (Fig. 6.3.a). In turn, the share of winter precipitation in its annual total can be seen to grow, particularly in North-western and Western Poland (Fig. 6.3.b). There are no changes in the winter precipitation totals in East and Southeast. The growth or stabilisation of the winter precipitation totals increase their share in the annual precipitation total.

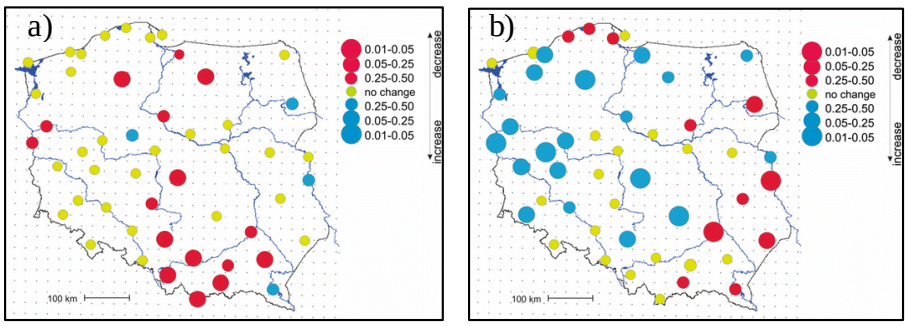


Fig. 6.3. Confidence levels in the changes in the share of the summer precipitation (JJA) in the annual precipitation in the period from 1951 to 2013 (a) and that of the winter precipitation (DJF) in the annual precipitation in the period from 1952 to 2013 (b) based on the Mann-Kendall test

Source: Szwed M., 2019

The greatest variability of precipitation totals can be seen in July and June, i.e. in the period with the highest mean precipitation totals (representing more than 40% of the annual total), while the most stable period is the one from January to March, with the minimum precipitation in the year. The greatest increase in the monthly precipitation totals and in their share in the annual total can be seen in the colder half of the year, particularly in March. A statistically significant growing trend in the share of the March precipitation in the annual total has been found for several stations in Northern and Central Poland, while weaker or no trends can be seen in the other regions.

In the most part of Poland's territory, there has been a change in the precipitation structure, consisting in a large increase in the number of days with heavy precipitation. Heavy showers with intensities exceeding 5 mm/min, with the seasonal probability (May-September) of 10% or more, occur most frequently in Southern Poland.

6.1.2. Expected climate change

Diversified scenarios of climate change in Poland in the 21st century have been prepared by different national research centres. One of the more comprehensive studies is the one prepared as part of a project co-financed from the resources of the Operational Programme Infrastructure and Environment and carried out at the Institute of Environmental Protection – National Research Institute.

Following the approach of many European experiments, the future climate conditions for Poland's territory were determined on the basis of climate simulations for the period from 2006 to 2100 made available as part of the EuroCORDEX project. Use was made of the regional climate model simulations for Europe, in a regular grid with the resolution of 0.11 deg. (about 12.5 km).

Analyses of temperature and precipitation changes were carried out for two development scenarios entitled with the acronyms RCP4.5 and RCP8.58. The moderate RCP4.5 scenario projects a further increase in the carbon dioxide concentration in the air – to 540 ppm in 2100 – and radiative forcing reaching a level of 4.5 W/m^2, while the RCP8.5 extrapolation scenario provides for an increase in the carbon dioxide concentration to 940 ppm in 2100 and a continuous increase in radiative forcing to a level of 8.5 W/m^2.

All the possible simulations were drawn from the EuroCORDEX repository for the parameters: the mean daily temperature, the maximum daily temperature, the minimum daily temperature and the daily precipitation total. A dozen or so simulations were available for each parameter. A single unique simulation was unambiguously defined by the global climate model (GCM), the results of which were used as the so-called boundary conditions for the simulation, and the regional climate model (RCM) was used as a computation tool for dynamic downscaling.

The final climate scenario for Poland was calculated using, in addition, statistical scaling based on historical data derived from observations in the reference period from 2006 to 2018 and the ensemble approach enabling the uncertainty assessment of the projection.

On the basis of four basic weather parameters (the mean temperature, the minimum temperature, the maximum temperature and the precipitation total), a set of indices was calculated to enable an assessment of a change in exposure caused by the mean and extreme temperature and precipitation conditions. The changes in the future climate conditions were represented as a trend described by a 10-year moving average and the differences for selected indices between the decade from 2051 to 2060 and the decade from 2011 to 2020.

The men annual air temperature in Poland's territory shows a growing trend until the end of the 21st century (Fig. 6.4). Over the century its value grows by 1.3˚C compared with the current decade in the RCP4.5 scenario and even by more than 3˚C in the RCP 8.5 scenario. While until 2035 the temperature changes in both scenarios are quite aligned, in the second half of the century a much larger increase is projected in the RCP8.5 scenario. The greatest temperature will occur in Eastern and North-eastern Poland. The distribution of the mean monthly temperature as averaged for Poland's territory shows a rise in all the seasons, with the largest changes projected in the winter months (December, January and February) and the summer ones (June, July and August).

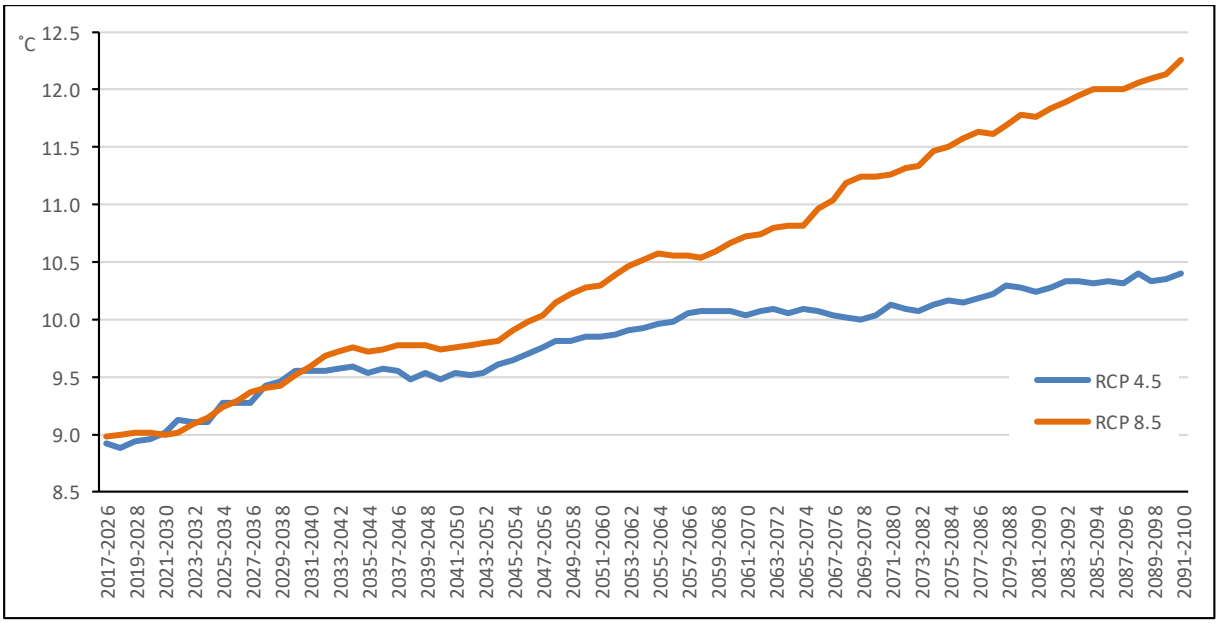


Fig. 6.4. Mean annual air temperatures in Poland in the period from 2017 to 2100 in the RCP 8.5 and RCP 4.5 scenarios

Source: IOŚ-PIB

The distribution and frequency of other temperature characteristics will also change in Poland's territory. The number of hot days (with the maximum temperature of 30°C and more) in the year will grow (Fig. 6.5) on average by 3 (RCP4.5) to 6 days (RCP8.5). The greatest changes will come in the South and Southeast (RCP4.5) or South and Southwest (RCP8.5). The number of tropical nights with the minimum temperature above 20°C shows a growing trend, quite similar in both scenarios until 2060 and six times as large at the end of the century than in the current decade in the RCP 8.5 scenario (Fig. 6.6). The number of frost days (with the maximum temperature below 0˚C) will diminish, on average by 10 days until 2060 compared with the decade from 2011 to 2020, particularly in Eastern ad North-eastern Poland (Fig. 6.7).

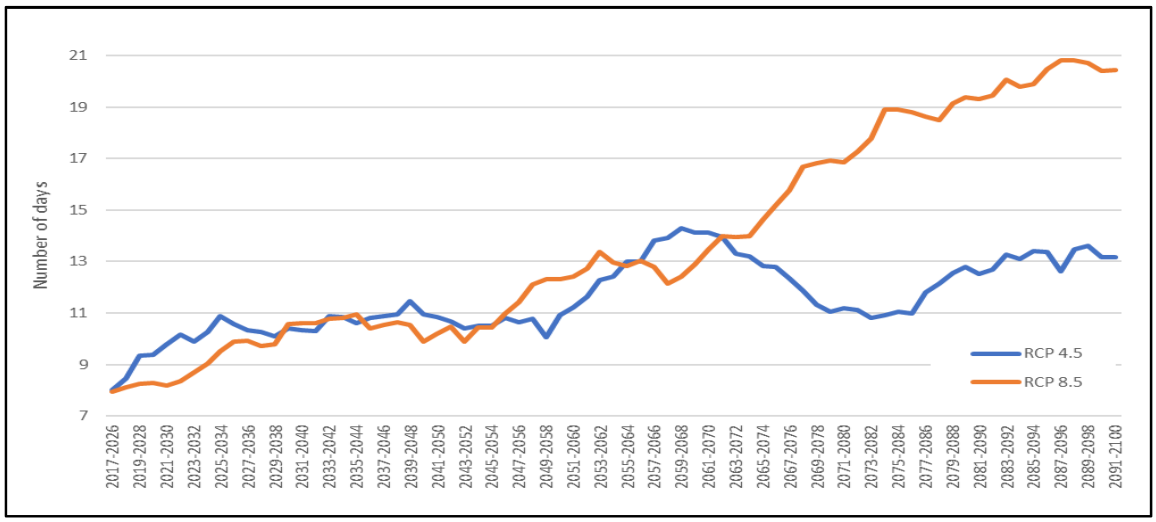


Fig. 6.5. Annual number of days with the maximum temperature above 30˚C in Poland in the period from 2017 to 2100 in the RCP 8.5 and RCP 4.5 scenarios

Source: IOŚ-PIB

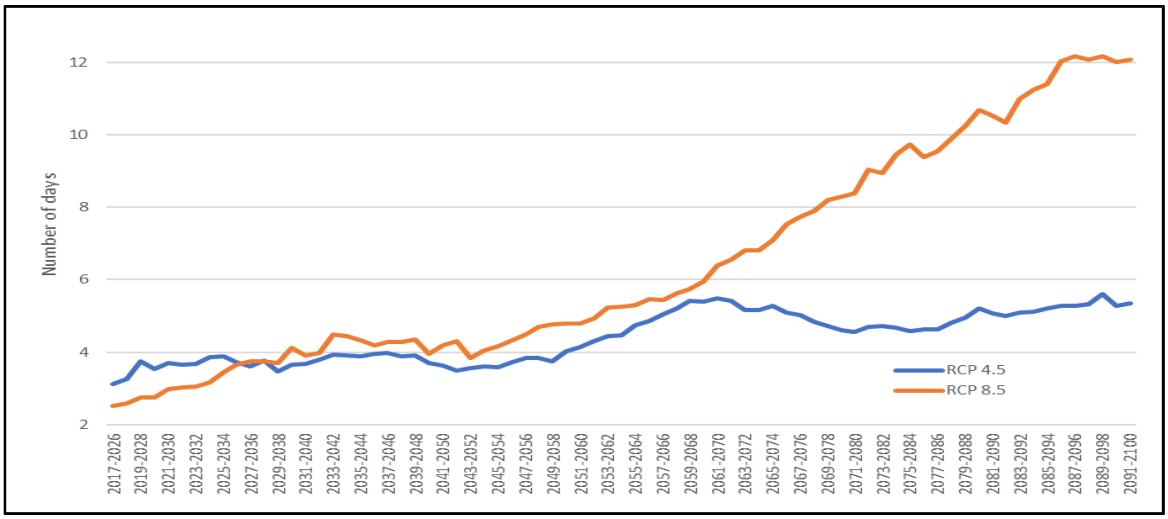


Fig. 6.6. Annual number of days with the minimum temperature above 20˚C in Poland in the period from 2017 to 2100 in the RCP 8.5 and RCP 4.5 scenarios

Source: IOŚ-PIB

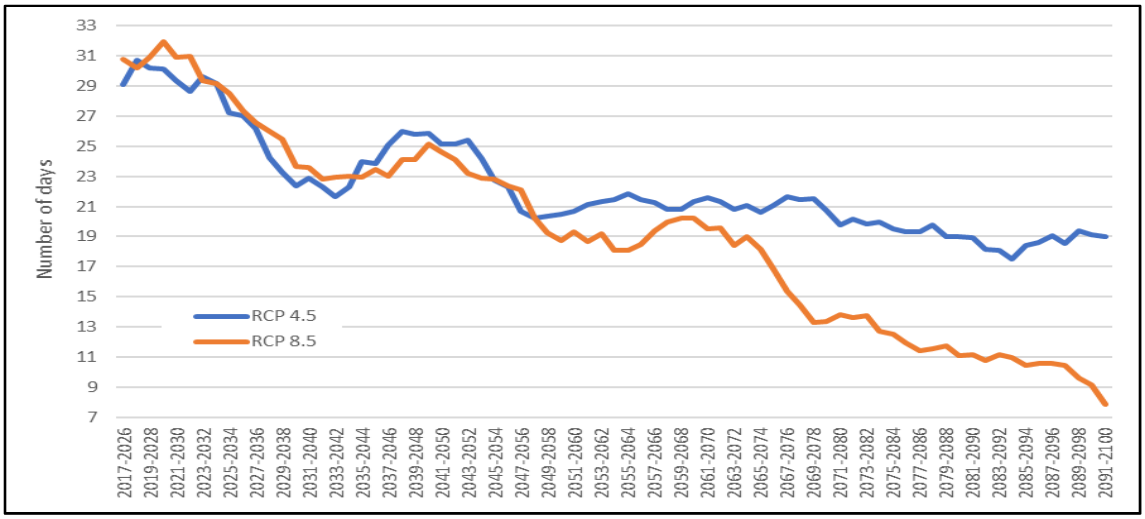


Fig. 6.7. Annual number of days with the minimum temperature below 0˚C in Poland in the period from 2017 to 2100 in the RCP 8.5 and RCP 4.5 scenarios

Source: IOŚ-PIB

The precipitation projections are less unequivocal, since they do not show one-direction trends and are characterised by more or less wet periods. By the end of the century, the annual precipitation total will grow compared with the present climate by almost 50 mm in RCP4.5 and by almost 100 mm in RCP8.5 (Fig. 6.8). The changes will come primarily in Eastern Poland, the mountains and the coast, while in Central and Western Poland the precipitation increase will be the lowest.

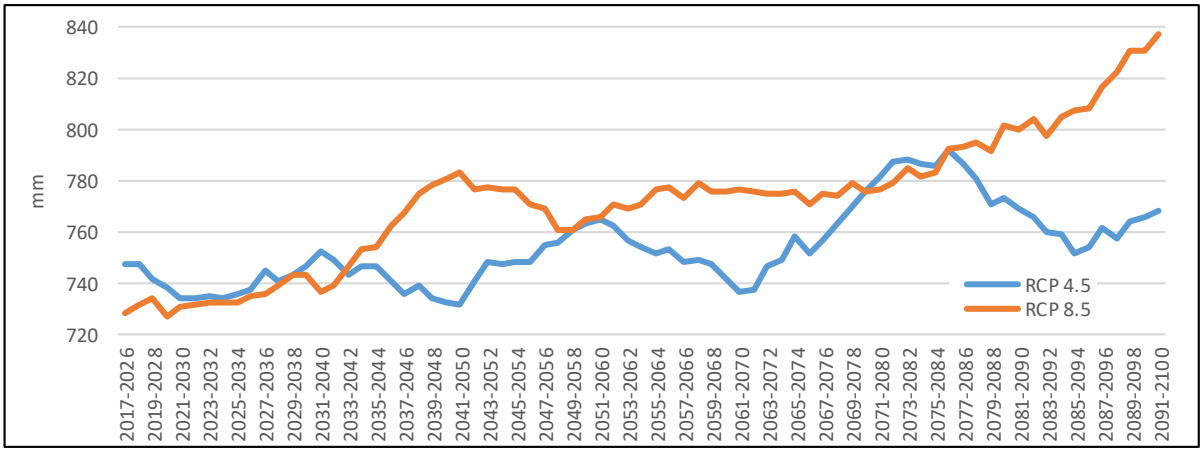


Fig. 6.8. Annual precipitation totals in Poland in the period from 2017 to 2100 in the RCP 8.5 and RCP 4.5 scenarios

Source: IOŚ-PIB

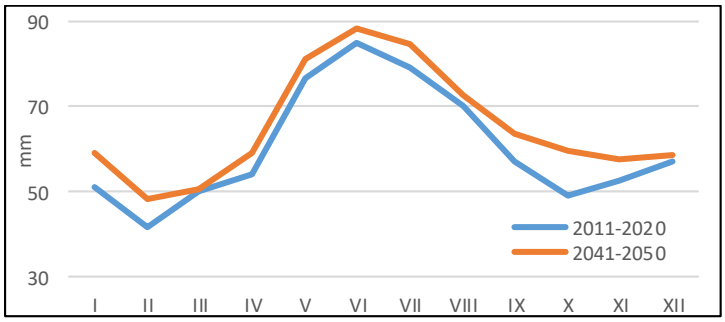


Fig. 6.9. Monthly precipitation total in Poland in the periods from 2011 to 2020 and from 2041 to 2050 in the RCP 8.5 scenario

Source: IOŚ-PIB

The largest precipitation changes in the year based on averaged 10-year values in the RCP 8.5 scenario should be expected in the autumn months, particularly in October, and the winter months, i.e. in January and February (Fig. 6.9).

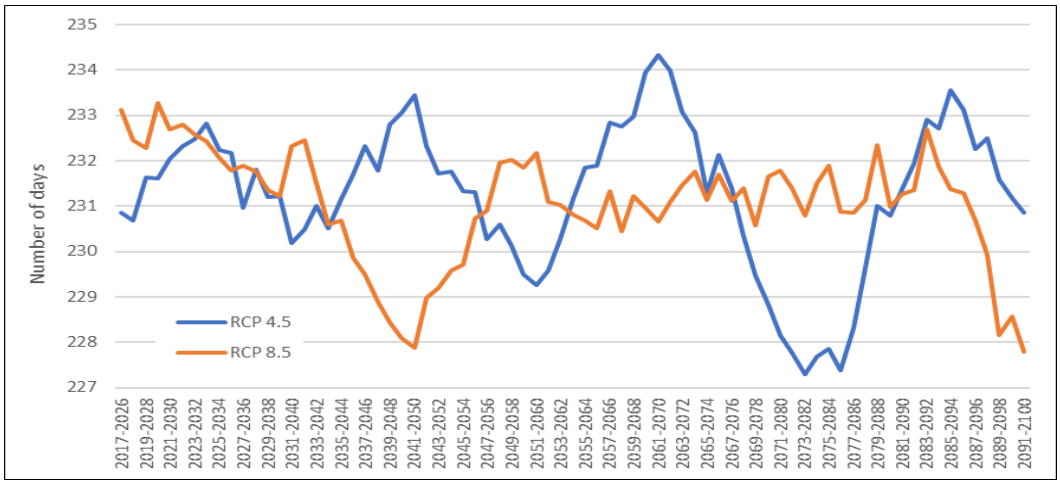


Fig. 6.10. Annual number of days without precipitation in Poland in the period from 2017 to 2100 in the RCP 8.5 and RCP4.5 scenarios

Source: IOŚ-PIB

The total number of days with precipitation slightly grows, while the number of days without precipitation slightly diminishes, by about 4 days (RCP4.5) to 6 days (RCP8.5). The changes show different distributions in the successive decades (Fig. 6.10). The number of days with precipitation usually grows in Northern and Eastern Poland.

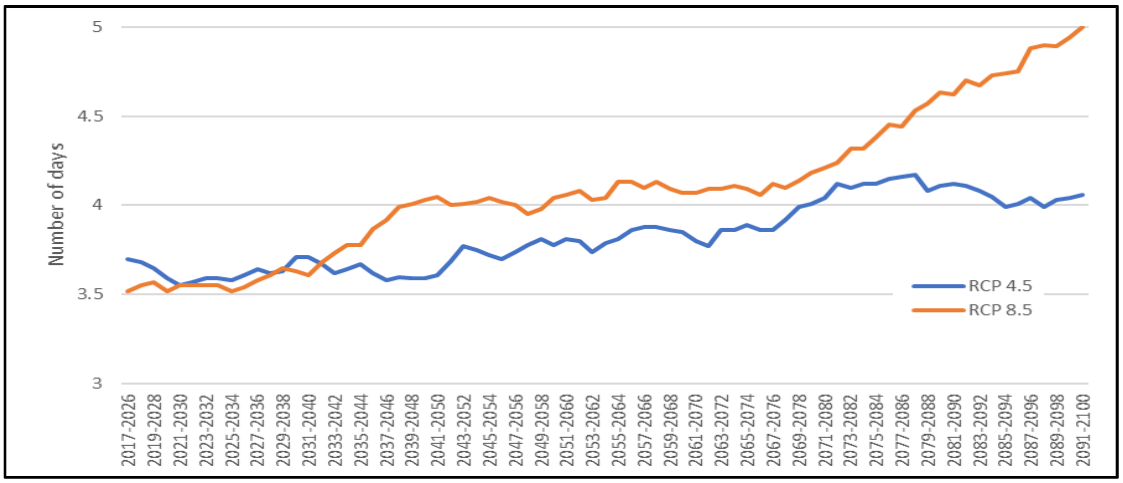


Fig. 6.11. Annual number of days with precipitation above 20 mm in Poland in the period from 2017 to 2100 in the RCP8.5 and RCP 4.5 scenarios

Source: IOŚ-PIB

The precipitation structure has changed mainly in the warm season of the year. The rainfall events are torrential, short-lasting and destructive, increasingly often causing flash floods. The number of intensive rainfall events above 20 mm/day will grow (Fig. 6.11). The largest changes in the frequency and size of rainfall events will come in North-eastern Poland, with the lesser ones in Western Poland.

6.2. Assessment of the risk and vulnerability to climate change

Both the natural variability of the climate and the anthropogenic impact on the climate system increase the risk posed by the potential effects of climate change. The main aim of the continuously developed conceptual framework for the analysis of the climate change-related risk is primarily to diagnose the key factors affecting the potential adverse consequences for the present and future generations, treating mankind as, on the one hand, the perpetrator of the intensified climate change and, on the other hand, as a species endangered by this change. An objective approach to the assessment of the climate change-related risk enables the optimisation of the mitigation and adaptation processes, taking into account the environmental, economic and social aspects.

6.2.1. Concept of the risk assessment

The assessment of the climate change-related risk was carried out for territorial self-government units (municipalities) as part of the project "*The knowledge base on climate change and adapting to climate change effects, together with knowledge dissemination channels, to strengthen economic, environmental and societal resilience as well as to support management of extraordinary risks associated with climate change (with the acronym Klimada 2.0)*". Its purpose was to present in a spatial approach changes in the risk level for the projected climate change. The analyses covered the key sectors most vulnerable to the climate change-related hazards.

A method for the multi-criteria risk analyses based on the system of concepts described in the IPCC reports (Fig. 6.12) was developed for the purposes of the risk analysis. It is estimated that this risk primarily depends on the frequency, intensity, range (location) and duration of the extreme weather and climate events. In the world literature, there are many conceptual models of risk assessment; nevertheless all of them provide for the integration of the physical and socioeconomic factors affecting the risks posed by climate hazards.

For this reason, the risk analysis process needs to address the key elements reflecting the mutual linkages of the climate change impacts on ecosystems, biodiversity, human health or the

economy in terms of the potential effects observed or predicted in different regions, sectors and communities (IPCC, 2022). It is assumed that in the context of climate change, the risk level should result from the dynamic interactions among:

- the **hazards** related to the changing climate,
- the **exposure level** of the elements which are potentially vulnerable to these hazards,
- **vulnerability** (resilience or the lack of resilience) of the elements exposed or potentially vulnerable to these hazards.

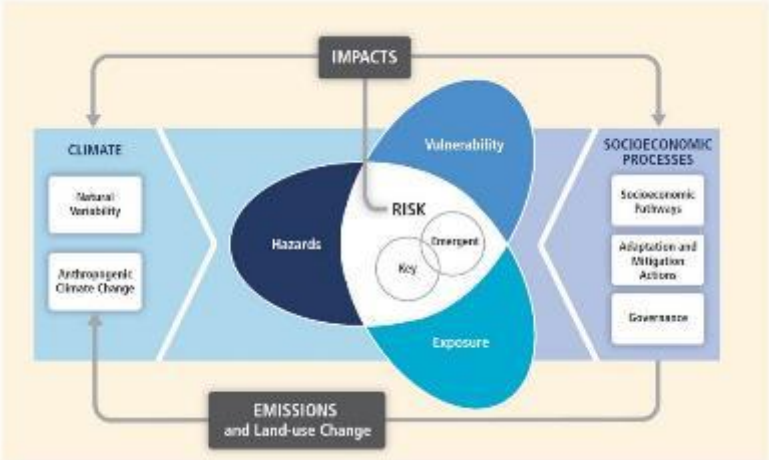


Fig. 6. 12. A simplified flow chart of the analysis of the climate-change related risk
Source: IPCC, 2014

Climate hazards, defined in the risk assessment, include the occurrence of potentially harmful physical phenomena or events (often called the extreme phenomena) and human activities affecting the climate system. These hazards can cause specific adverse effects on human life and health, lead to damage to and loss of property and infrastructure, or influence the condition of livelihoods, the social and economic relations, or the state of the environment, among others, limiting the so-called ecosystem services. The climate hazards can have adverse impacts suddenly, both directly (e.g. as a result of heat waves, droughts, hurricanes, heavy rains et.) and indirectly, to be often seen after a long time has passed since a given hazard occurred (e.g. long-term changes in both the climate system and the temperature or precipitation regime). The adequate understanding and definition of climate change-related hazards are the key elements of the risk analysis the results of which can not only inform about the scale of a hazard, but also indicate the directions of climate policy or the planned adaptation measures to be implemented at the national, regional and local levels. A high level of hazard does not yet need to represent a high risk, in particular in the absence of the extreme phenomena (no exposure) or elements which are highly sensitive to these hazards in the area analysed.

The **exposure** to climate hazards is defined by the presence of sensible elements vulnerable to climate change-related hazards (e.g. people or property, valuable ecosystems, critical infrastructure or the elements of energy, food security, etc.). The absence of such elements now or in the future in the area analysed means, in consequence, the absence of risk.

Vulnerability to climate hazards is defined by the conditions determined by physical, social, economic and environmental factors or processes which increase or decrease the sensibility of the elements exposed to given hazards in the area under assessment. It should be pointed out that the vulnerability is diversified spatially, within a community and among societies, regions and countries, and also variable in time, which follows from the planned and implemented adaptation measures or the natural and anthropogenic changes unfolding in a given area. The vulnerability depends on many factors and is determined primarily by the following factors:

- social factors (e.g. the socioeconomic status of the population, the level of its awareness or the ability to change its behaviour);
- economic factors (e.g. the availability of financial resources for maintaining and improving the state of the natural environment or for strengthening the resilience of infrastructure or the availability of the appropriate adaptation technology);
- the state (e.g. the natural resilience of ecosystems to a given hazard);
- the importance for the functioning of a given element in the system assessed (e.g. the critical infrastructure or transformability).

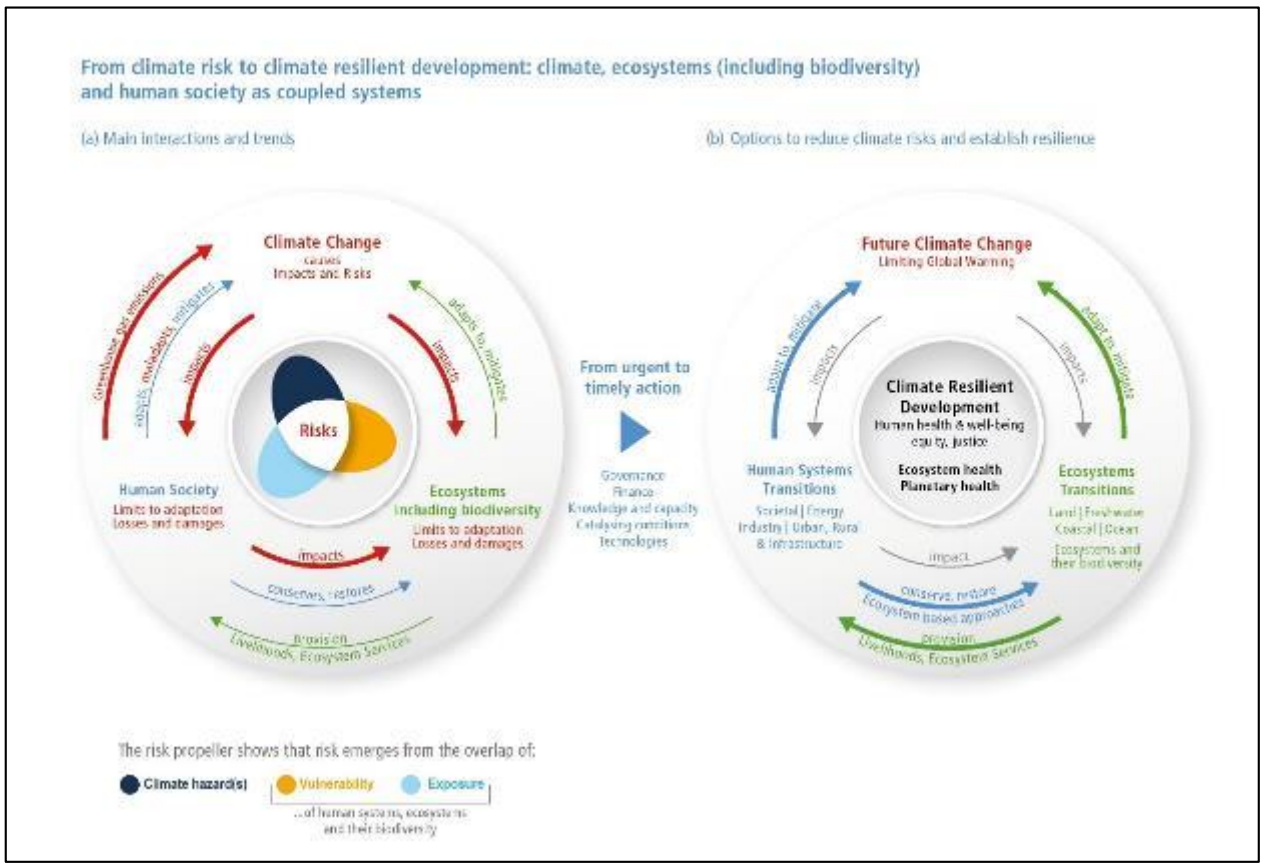


Fig. 6. 13. A general flow chart of the integration and linkages of changes in the climate-change related risks, with an indication of the elements of hazard, exposure and vulnerability in the present and future climate
Source: IPCC, 2022

The adaptation measures play a key role in both the reduction of the exposure level and the strengthening of the resilience to climate change. E.g. the adaptation of ecosystems includes, among others, their autonomous adaptation through ecological and evolutionary processes, while in the population system it can have an anticipatory character and/or that of a transformation of behaviour and, quite frequently, of the socioeconomic system in relation to the expected climate change and its potential effects. In consequence, the main aim of the measures to enhance the resilience to climate change is to maintain the present level or a return to the state prior to the potential hazard. The adaptation measures planned to be implemented in a given area can be included in the risk assessment taking into account the prepared method in the same way as the climate scenarios and thus their effectiveness and efficiency can be assessed with respect to the projected hazards. In light of this, vulnerability is not only the ability to preserve an important function, identity or structure of a given area or the element analysed in the risk assessment concept, but also their ability to transform. The high vulnerability of elements sensitive to climate change which are present in a given area can lead to higher risks, even with a potentially low hazard.

The consideration of the interactions among the climate system, ecosystems, society and economy in the risk assessment concept is the basis for the correct, reliable and objective identification of the levels of the hazards arising from climate change and the assessment of their potential effects, the human pressures on the climate system and those exerted by the climate on ecosystems. In light of this, the risk level can justify the need to take adaptation measures.

The method adopted for the risk assessment took into account the multidimensionality and interactivity of the applied indicators of hazard, exposure and vulnerability. For this reason, all the indicators were normalised so that they could be compiled and compared. As a result of this, it was possible to include at the same time both the qualitative indicators (e.g. the significance level of a given indicator in relation to a climate hazard or the need to protect a given ecosystem, the presence or absence of an element vulnerable to a hazard in a given area) and the quantitative indicators (e.g. a change in the temperature or precipitation levels, the amount of resources allocated to adaptation or the number of persons vulnerable to a given hazard). Due to such an approach, it was possible not only to analyse risk changes in time (e.g. with consideration given to climate change scenarios or the timetable of planned adaptation measures within a specific time period), but also to carry out a spatial analysis (using maps of indicator changes in the area analysed, e.g. the distribution of the precipitation amount and frequency, the population density or the presence of ecosystems or critical infrastructure).

The inclusion of the multi-criteria and multi-indicator approach to determine the hazard, vulnerability and exposure in the climate risk assessment made it possible, on the one hand, to avoid its overestimation caused only by the assessment of the hazard level (i.e. the distribution and variability of climate factors) and, on the other hand, to almost completely eliminate the subjective assessment of the perception of the hazard. At present, the spatial risk assessment for the areas of municipalities in Poland was carried out for public health, biodiversity, forest, road transport, agriculture, tourism and water management. The methodology applied has demonstrated a large application and information capacity and can be used to assess the risks for other types of areas and sectors (or their individual elements) in different timeframes.

The rules for the application of the multi-criteria analysis of climate-related risks were described using as an example the assessment of the hazard posed by heat to the Polish population (Fig. 6.14). The heat hazard was defined using the time and space variability of the climate indicators elaborated at the IOŚ-PIB as part of the RCP4.5 and RCP 8.5 climate scenarios, i.e. heat waves, hot days and tropical nights. The normalised indicator of the hazard assessment took values from 0 (no hazard) to 1 (very high hazard). The exposure to the heat hazard resulted from the dependences of the demographic factors, with account taken of the size of the population at risk and its structure (including the shares of the elderly and children in a given population). Just as for the hazard, the exposure result had the dimension of a normalised value from 0 (no exposure) to 1 (very high exposure). For all the areas, each of the vulnerability levels of the particular municipalities to heat was determined, taking into account many dependences, including the size of green areas and water covered ones, the population density, the vulnerability of the population to heat-related diseases (e.g. cardiovascular diseases), the access to the medical infrastructure or the resources spent on healthcare per capita. The vulnerability result also had a normalised dimension from 0 (invulnerable area) to 1 (very high vulnerability). The risk level was determine as the resultant of the three elements mentioned above, i.e. hazard, exposure and vulnerability. This value was normalised on a scale from 1 to 5 (1 means no risk, 2 – low risk, 3 – moderate risk, 4 – high risk and 5 – very high risk). In order to illustrate the time

and space changes, the results of the RCP4.5 scenario for the present decade (2011-2020) and those of the RCP8.5 scenario for the decade at the end of the century (2091-2100) were presented.

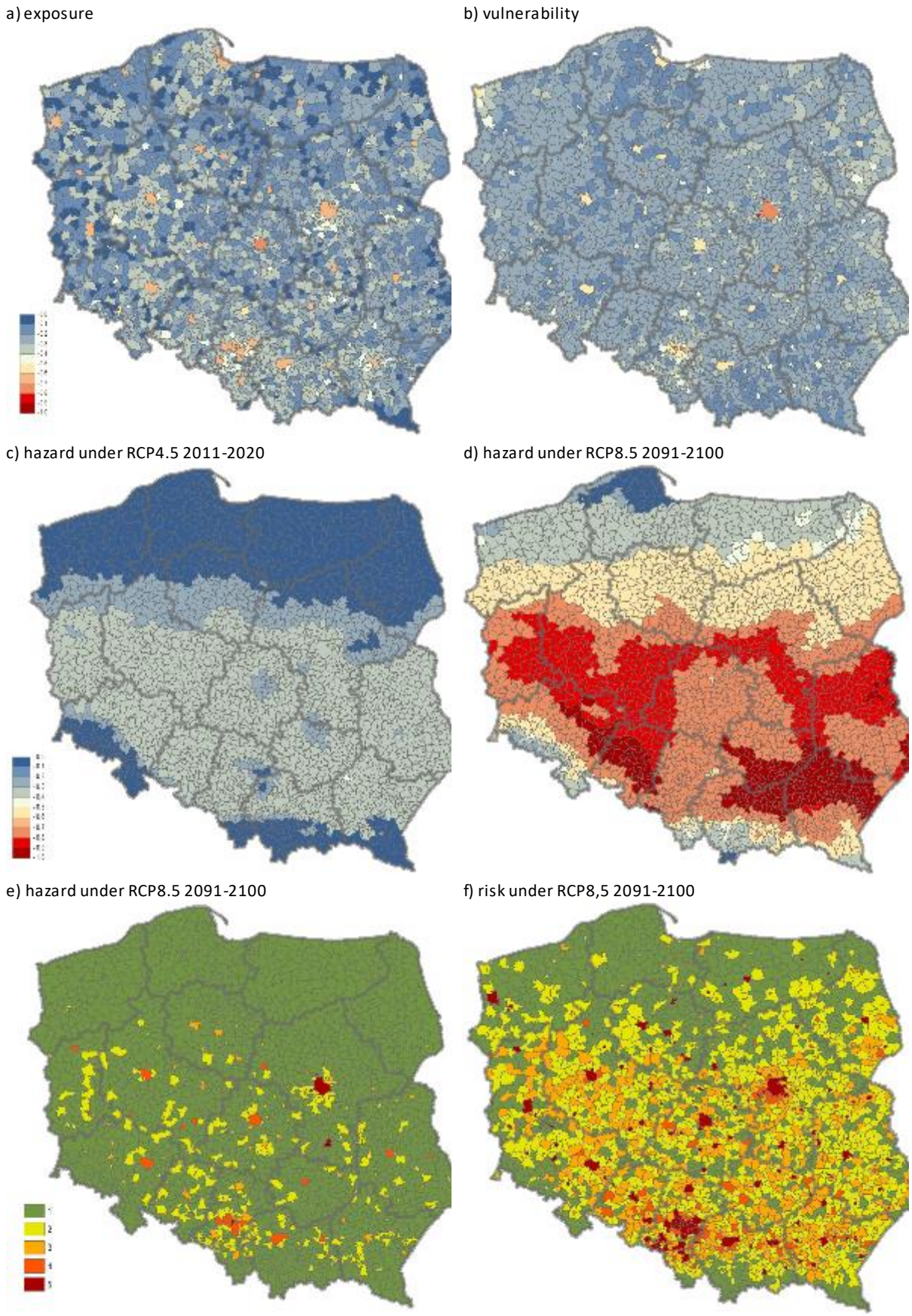


Fig. 6.14. Results of the assessment of the risk of a heat hazard for Poland's population (spatial analyses)
Source: IOŚ-PIB, 2022

In order to estimate the potential impact of climate change only on the health risk for Poland's population, including the changes resulting from the climate scenarios in the successive decades, so as to exclude the impacts of other factors, the vulnerability and exposure indicators were left unchanged in the calculations. It should be emphasised that in this case the final results of the risk level should, on the one hand, be considered underestimated in light of the vulnerability growing due to the ageing of society and a negative birth rate, while, on the other hand, they can be overestimated, among others, due to failure to include e.g. planned adaptation measures or the strengthening of the resilience of the system of public health services in the future, in the vulnerability analyses. At present, however, these trends are very difficult to estimate and are characterised by substantial uncertainty.

6.2.2. Analysis of the climate change-related risk in Poland

The analyses carried out by the IPCC indicate simultaneous and diverse changes in the climate hazard levels all over the world. This primarily entails the growth of hazards related to the occurrence of very high temperatures (including the higher risk of heat waves) and the decline of those related to low temperatures. This is the case with increases in the intensity and amount of levels of precipitation events causing foods; with the qualification that in the case of Europe, it is estimated that they will not be as harmful as in the other regions of the world. Indeed, climate change will cause an increase in the frequency and, thus, the estimated effects of droughts (particularly in agriculture and ecosystems). The projected average sea level rise, contributing to a significant increase in the frequency of the extreme water rises and coastal floods in low-lying areas, as well as the erosion of most sandy coasts (IPCC 2021), are also of importance for coastal zones. In Section 6.1.1. Contemporary climate change in Poland, the most important indicators of the climate change-related risk in Poland were addressed.

The assessment of the climate change-related risk primarily focuses on the assessment of the broadly understood impacts of the identified hazards to human safety, including the well-being, health and life, and property protection. For this reason, the most often identified types of hazards include: extreme temperatures (heat and cold waves), extreme precipitation events, water deficits and droughts, and wind-related hazards in the course of extreme events (including hurricanes, tornadoes or storms). Quite often, in many reports and studies, climate hazards are associated with climate change effects, including, among others, river and coastal floods, inundations, forest fires or landslides. Such an approach often makes it difficult to correctly identify a hazard as the cause related to climate change and prevents the exclusion of human activity as the cause of the effects. E.g. a forest fire can be caused by arson and break out with large probability, irrespective of the climate conditions (which can contribute to its intensity and the speed of its spreading), while local inundations can result from excessive urbanisation or degradation of ecosystems (which would not have occurred in the absence of human intervention into the environment).

Therefore, most studies on the climate risk assessment indicate analyses focusing on man as their main aim. The risk for humans results from both direct and indirect impacts of climate change [Watts et al. 2015]. In the case of direct impacts posing the risks of bodily injury, death or substantial property losses, reference is made to the effects caused by extreme phenomena, such as strong winds, tornadoes and hurricanes, as well as intensive hailstorms and torrential rains. In Poland's case, the health risk related to these hazards, especially the wind, is relatively low and its cases are sporadic. The case is different with property losses; this results to a substantial extent from the large vulnerability to these hazards and affect, in particular, old houses and commercial buildings. The issues of importance also include the increase in vulnerability resulting from expanding urbanisation and the lack of thought-through solutions in the scope of city adaptation or settlements in areas at a high flood

risk. The greatest increase in the climate risk for human health and entire populations is caused by the growing frequency of heat waves (Fig. 6.15) and the falling frequency of cold spells [Hales S. et al., 2014]. It should be noted that the adaptation measures in urbanised and densely populated areas, consisting in reducing the intensity of urban heat island effects (understood to mean the air temperature difference between non-urbanised areas and a given urban area in hot weather) diminish the vulnerability of a given area to heat by expanding the blue-green infrastructure. Ecological corridors and so-called ventilation corridors play similar mitigating functions; unfortunately, quite often they are built up.

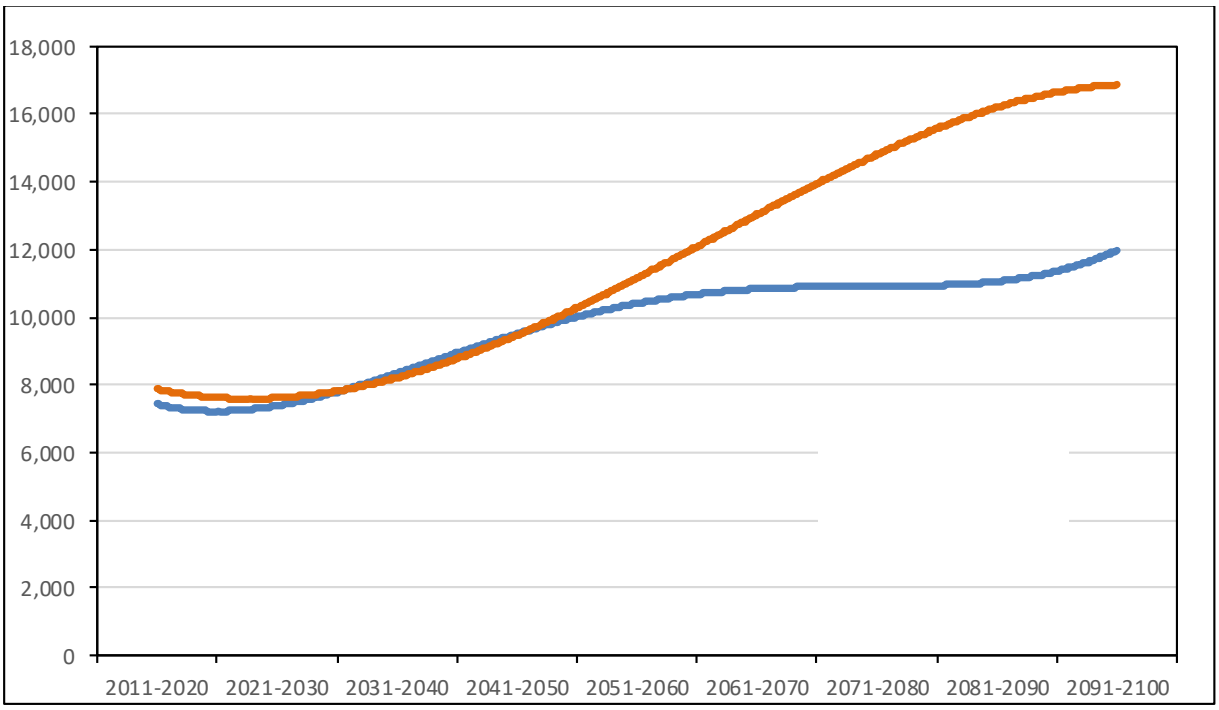


Fig. 6.15. Number of persons in Poland at high or very high risks of a heat hazard
Source: IOŚ-PIB, 2022

The assessment of the risk that heat may occur also relates to safeguarding energy security, in particular when the basic adaptation measure to reduce the vulnerability of residential, office and service buildings is the installation of air-conditioners. In this case, the risk of failure of the energy sector, which is potentially hardly vulnerable to climate change, grows and this can possibly lead to the lack of power supply in period of enhanced energy demand and cause a substantial increase in the vulnerability to heat in the health sector.

A change in the boundaries of the climate zones, higher temperatures, no frost, a longer growing season and a change in the precipitation pattern in Poland cause an increase in the risk of the development and range of vectors (e.g. mosquitoes or ticks), i.e. the species transmitting viruses and bacteria. This enhances the risk that many pathogens may appear in the environment, leading, in consequence, to the growth of vector-borne diseases (Fig. 6.16). The adaptation measures mitigating the effects of heat, particularly unordered greenery which can foster vector growth, are also of importance for increasing the risk related to vectors in urbanised and densely populated areas. In addition, as a result of a longer growing season, the risk related to enhanced exposure to allergens has been seen to grow.

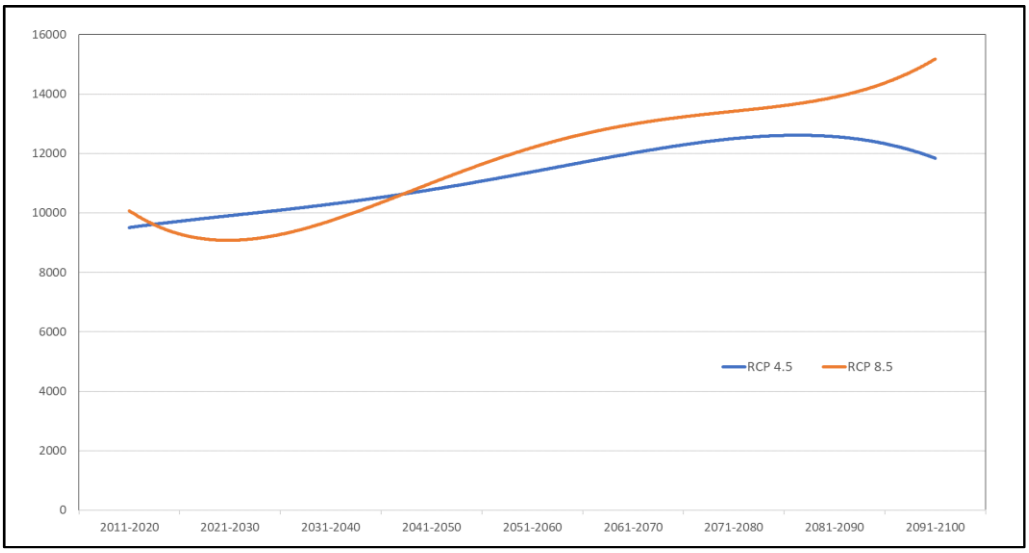


Fig. 6.16. Number of persons in Poland at high or very high risks of vector hazards
Source: IOŚ-PIB, 2022

The changes in the precipitation patterns in the climate scenarios indicate a potential increase in the risks of floods and local inundations, which as a rule cause the greatest economic effects related to climate change. Floods and inundations can be caused by both snowmelt (depending on the thickness and retention time of snow cover) and intensive rainfall events (so-called heavy rains). The climate change scenarios indicate a decreased risk of snowmelt floods in Poland due to milder winters and an increased risk hazard of rain floods, mainly as a result of local inundations during heavy rains (Fig. 6.17). This risk can grow in urban areas in light of the observed growth of urbanisation processes, with no or inadequate adaptation of such areas to climate change.

Intensive precipitation can be particularly dangerous in mountain and submontane areas, leading to slope erosion and, in consequence, causing landslides. The probability of the risk that landslides may occur for climate-related reasons, i.e. the saturation of the surface soil layer as a result of long-lasting heavy rains, will diminish due to the projected change in the precipitation regime in Europe.

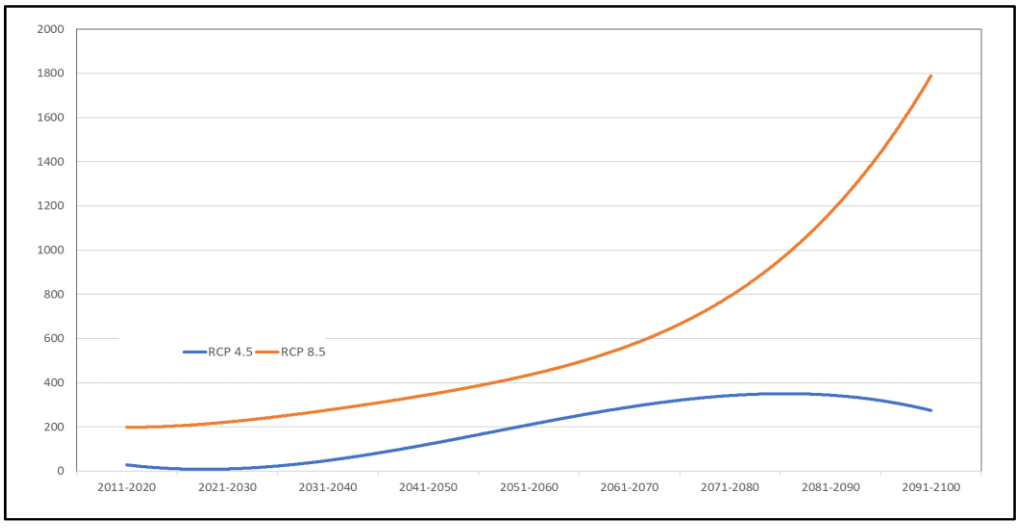


Fig. 6.17. Length of roads at high and very high risks of flood and inundation hazards
Source: IOŚ-PIB, 2022

Given the projected changes in the temperature and precipitation patterns and in the boundaries of the climate zones, the risk related to the occurrence of complex events, i.e. high

temperatures and drought, will grow. There are multidimensional impacts generating the drought-related risk and they are associated with both food security (agriculture and animal farming) and the conservation of ecosystems, including forests. The levels of the drought-related risk for ecosystems and crops (Figs. 6.18 and 6.19) are determined not only by an increased hazard caused by the absence of precipitation and the duration of the period with no precipitation, but also by the vulnerability of soils to a water shortage (among others, the retention capacity of soils), the crop types used and the habitat types (fauna and flora species).

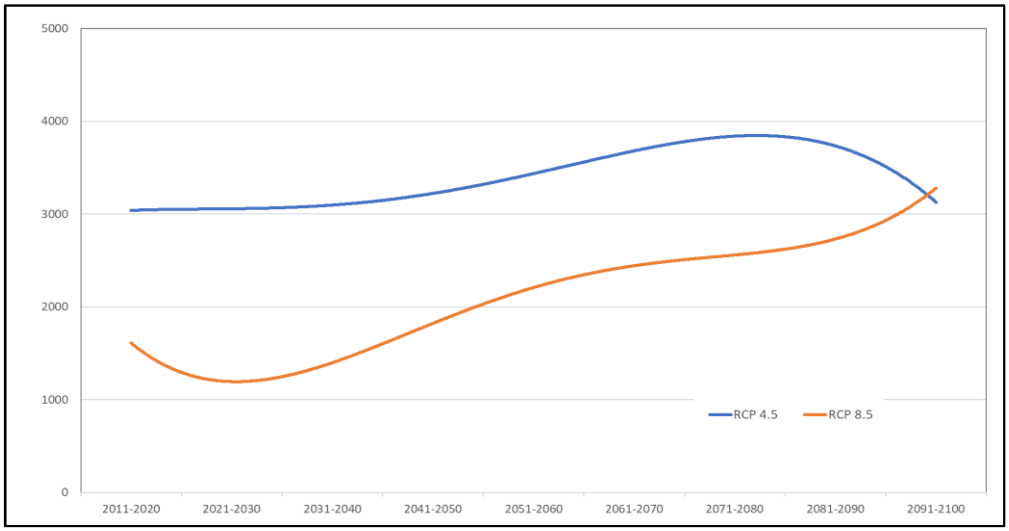


Fig. 6. 18. Poland's area at high and very high risks of the hazard posed by the water content in the soil profile below the optimum value for plant growth [km^2]
Source: IOŚ-PIB, 2022

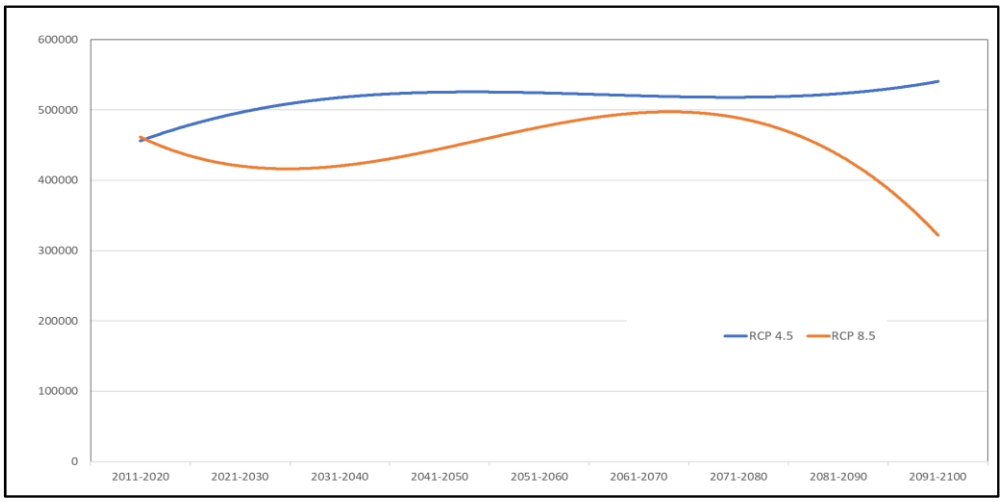


Fig. 6.19. Forest area in Poland at high and very high risks of the hazard posed by a water shortage [ha]
Source: IOŚ-PIB, 2022

6. 3. Present and future impacts of climate change

The climate change observed in Poland has not yet had a significant hazardous effect; however, as it progresses increased hazards for human safety and health, the environment and the economy, as a result, in particular, of the occurrence of extreme phenomena, can be expected.

6.3.1. Extreme climate hazards and their effects

In the past, the sporadically or seasonally occurring extreme phenomena usually caused severe losses for the population and economy. As the climate changes, the frequency and intensity of many such phenomena as heat waves, floods, droughts, strong storms or hurricanes grow, affecting human mental and physical health and life, the economy and the natural environment.

The extreme phenomena posing hazards to life, health, infrastructure and environment, are increasingly often the causes of fire service interventions, requiring the provision of assistance and the launch of actions to respond to the effects of destructive phenomena (Fig. 6.20).

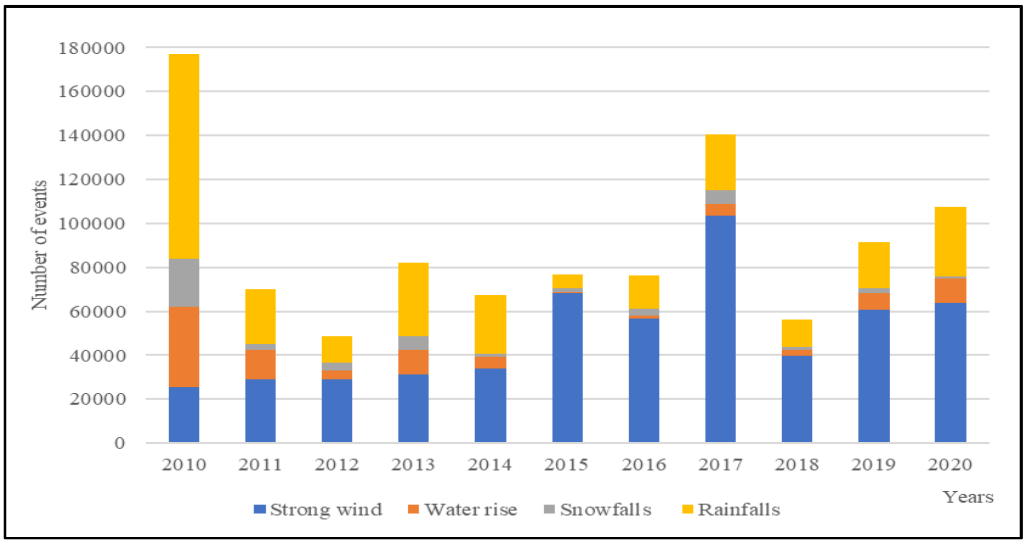


Fig. 6. 20. Variability of local hazards in Poland in the period from 2010 to 2020
Source: Elaborated by the IOŚ-PIB on the basis of the data from the National Headquarters of the State Fire Service (2021)

In recent years, the hazards resulting from strong winds (more than 54% interventions) and intensive rainfalls (30% interventions) gained in large importance. When combined with the wind, rainfalls most often cause water rise, inundations or landslides (Fig. 6.21).

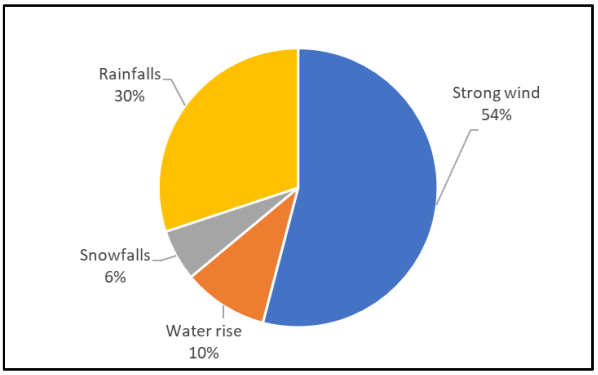


Fig. 6.21. Percentage shares of the causes of the SFS interventions to respond to extreme phenomena in the period from 2010 to 2020
Source: Elaborated by the IOŚ-PIB on the basis of the data from the National Headquarters of the State Fire Service (2021)

Atmospheric discharges are very seldom the causes of forest fires (representing barely 1% of the total forest fires). In Poland, in the period from 2009 to 2020 there were 653 forest fires caused by atmospheric discharges which burned 110.21 ha of forests (on average 9.18 ha a year) (Fig. 6.22). However, in the favourable conditions which are a combination of climate conditions (e.g. prolonged drought) and human activity (e.g. decreased water retention in a given areas as a result of progressing urbanisation processes), a fire can spread quickly, causing substantial loses of forest resources.

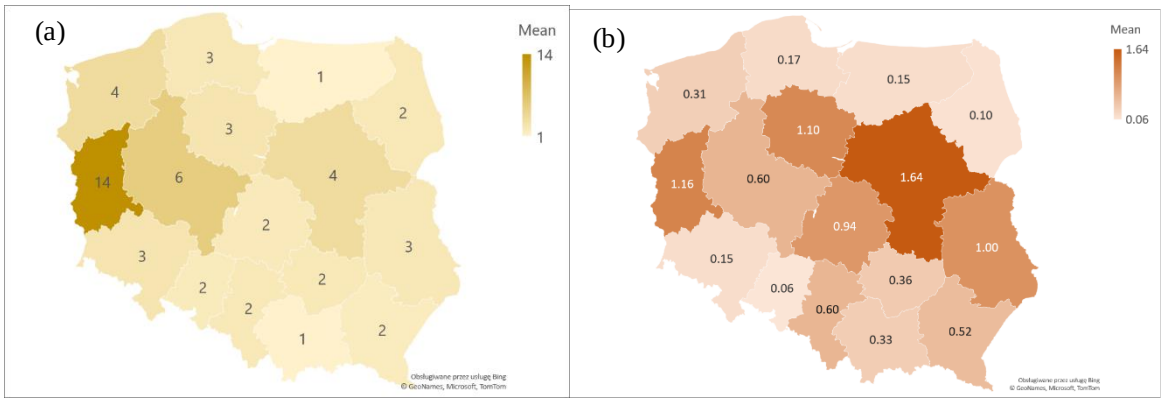


Fig. 6.22. Mean annual number of forest fires (a) and the mean forest area burnt in fires (b) caused by atmospheric discharges in the period from 2009 to 2020

Source: Elaborated by the IOŚ-PIB on the basis of the data from the GUS 2021

The extreme weather phenomena cause fatalities, which, according to estimates, exceeded 2,200 persons in the period from 1990 to 2019. Analyses of the financial losses caused by the extreme phenomena, carried out by the IOŚ-PIB on the basis of data from the period from 2001 to 2019, which were collected from several bodies of the central and self-government administrations, showed that as a result of the extreme phenomena Poland lost on average PLN 6 billion a year; thus, over less than two decades the extreme weather phenomena caused as a total about PLN 115 billion of direct losses (Fig. 6.23).

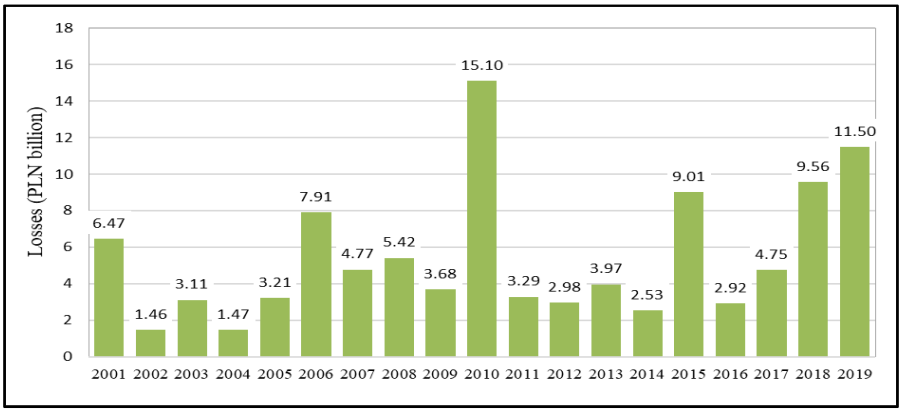


Fig. 6.23. Estimated losses caused by the extreme phenomena in the period from 2001 to 2019 in current prices

Source: IOŚ-PIB

The most frequent causes of climate change-related losses included floods, droughts and adverse weather phenomena, i.e. the lack of snow cover in the winter, severe freezing temperatures, spring frost or soil and agricultural droughts which could cause substantial crop losses (with agriculture accounting for 50% of the losses). In recent years, this problem also affected the areas of the cities where there were inundations caused by intensive rainfalls with a growing share of sealed surfaces (Fig. 6.24).

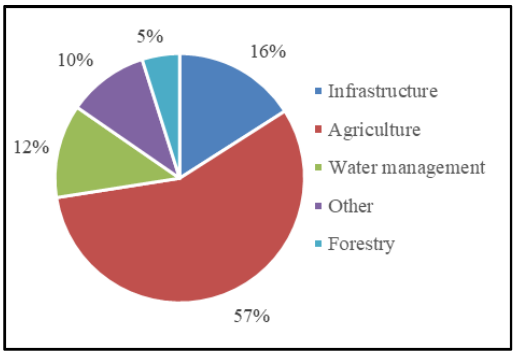


Fig. 6.24. Share of the losses in the particular sectors caused by the extreme phenomena in the period from 2001 to 2019 (in current prices)
Source: IOŚ-PIB

It is predicted that in the coming years the main climate change-related hazards in Poland will include droughts causing problems with crops and lower yields, heat waves and drinking water shortages, which, under the worst-case scenario, can affect as many as about 15 million Poles.

6.3.2. Floods

Floods and inundations are some of the most frequent and greatest hazards related to the climate conditions. The phenomena of the extreme and often of the flash nature, occasionally occur practically all over Poland (Fig. 6.25).

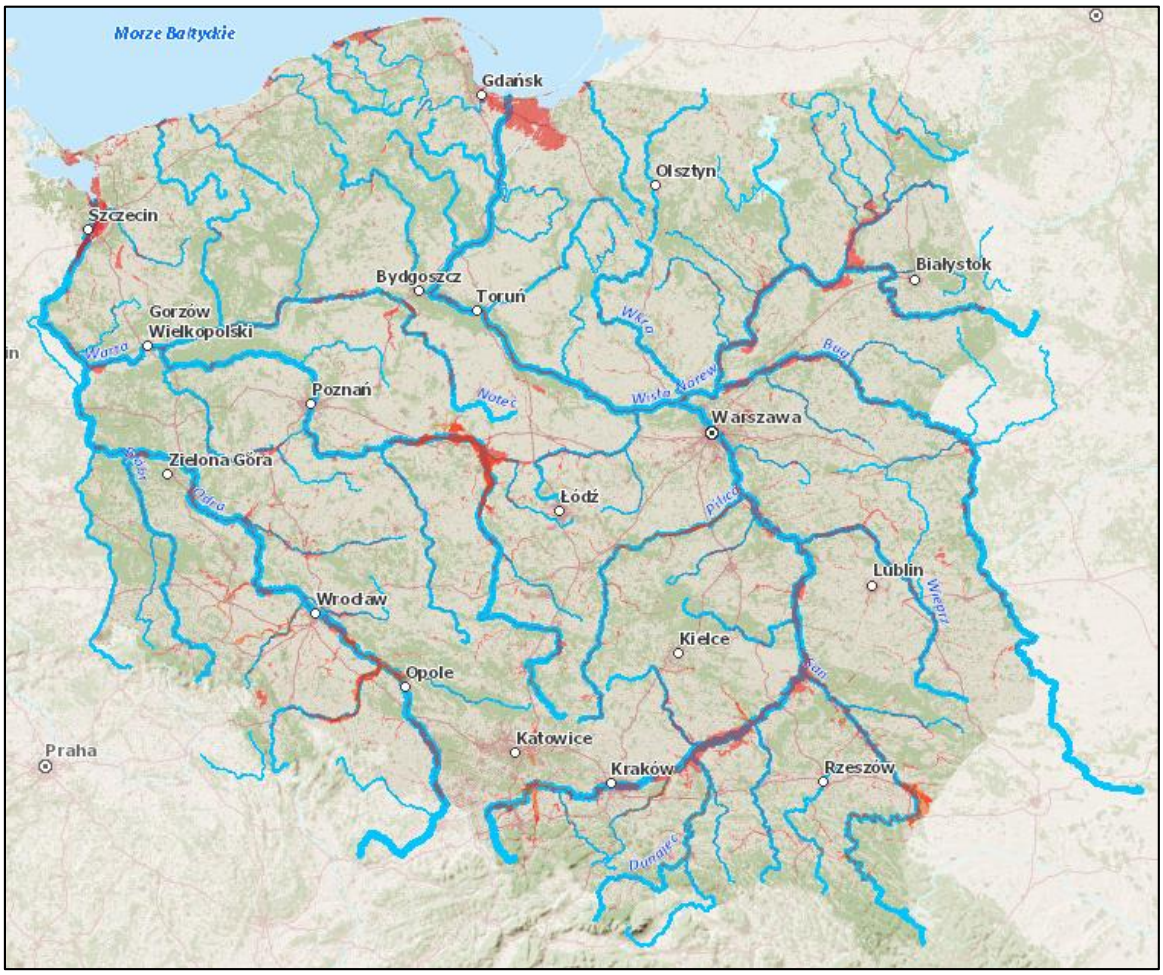


Fig. 6.25. Areas at flood risk in Poland
Source: https://wody.isok.gov.pl

The areas at the greatest risk of river floods, caused by intensive or prolonged rainfalls, include the southern parts of Małopolskie, Podkarpackie, Śląskie, Opolskie, Świętokrzyskie and Dolnośląskie Voivodeships in the Upper and Middle Odra catchments, including the catchments of its mountain tributaries, and the areas in the Upper and Middle Vistula catchments (up to the mouth of the Wieprz River), including the catchments of its mountain and submontane tributaries. The analyses carried out on the Upper Odra indicate that the frequency of the maximum flows grows.

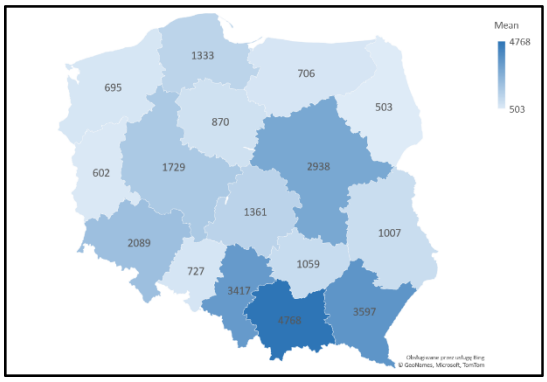


Fig. 6.26. Mean annual number of SFS interventions related to rainfalls in the period from 2010-2020
Source: Elaborated by the IOŚ-PIB on the basis of the data from the National Headquarters of the State Fire Service (2021)

Given the growing frequency of intensive rainfalls, the frequency of floods also increases. They are particularly dangerous in mountain and submontane areas, where they cause substantial damage through slope, destroy forest stands and trigger landslides, and in urbanised areas, where they can result in inundations and flooding (Fig. 6.26). The increased frequency of heavy rains causing flash water rise and slope erosion intensifies the transport of carried and floating debris, silting many sections of rivers and reservoirs. This is conducive to the shallowing of riverbeds and increases the flood risk.

In the case of a snowy winter, in the snowmelt period, the areas at risk are those along the Middle and Lower Odra River and the Middle and Lower Vistula River, those along the lowland tributaries of the Odra (the Barycz, Warta and Noteć Rivers) and the lowland tributaries of the Vistula (the Bug, Narew, Bzura and Drwęca Rivers), as well as the rivers draining directly into the Baltic Sea in Zachodniopomorskie and Pomorskie Voivodehips. The most dangerous ice jam floods occur on the largest lowland rivers at the points where ice jams form (at shallow sites and in river mouth sections), mostly in Mazowieckie, Kujawsko-Pomorskie, Pomorskie and Zachodniopomorskie Voivodeships. It is predicted that snowmelt and winter floods will continue to demonstrate a decreasing frequency. In turn, the coastal flooding poses a risk to the areas in the mouth sections of the rivers draining into the Baltic Sea, the coastal zone and the Vistula Fens.

In the case of minimum runoffs, their further decrease (by 10 to 30%) can be expected in all the Voivodeships. Lower flows in rivers and mountain creeks will cause water shortages in submontane localities and aggravate the economic problems, while higher water temperatures will foster eutrophication of lakes and flood control reservoirs.

6.3.3. Drought and water deficit

A drought is usually the result of many complex factors which mutually affect one another. Their occurrence is manifested by deviations from the normal conditions (i.e. the average conditions determined on the basis of long-term data) of many characteristics, among which, in addition to the precipitation total, the position of the groundwater table, river flows or soil humidity need to be considered.

The drought phenomenon has intensified in Poland in recent years, becoming an increasingly major problem, given the damage to the natural environment and the economy, as well as an annoyance and even a hazard to the population. The increased number of years with drought results from observed climate change, producing longer periods without precipitation and higher air temperatures increasing evaporation.

The risks posed by the different drought types across the country result from the character of this phenomenon. Its emergence is mainly caused by an insufficient amount of precipitation, but also the incorrect rainwater management. The most important issue from the point of view of mitigating the drought effects is increasing the retention in areas where rainfalls occur, i.e. increased landscape and soil retention, among others, by reducing evaporation from the soil surface, slowing down surface water runoff and retaining water where it falls.

The atmospheric drought, which is directly caused by the absence or a prolonged deficit of precipitation, occurs in Poland on average once every 2 to 3 years. The atmospheric and agricultural droughts pass relatively quickly, while the hydrological and hydrogeological droughts usually last a long time, even several seasons, since the restoration of water resources requires long-lasting rainfalls with an average and uniform intensity, enabling the gradual replenishment of the resources of surface waters and groundwater. The overlapping of drought periods on each other as a result of their greater frequency makes it impossible to restore the resources of surface waters and groundwater and this can result in the permanent lowering of deeper groundwater aquifers which constitute the main drinking water resource in Poland.

In the period from 1987 to 2018, the areas at the greatest risk of the atmospheric drought were those in Wielkopolska, partly Kujawy and Lower Silesia and the westernmost part of Łódzkie Voivodeship. Most often, the range of the atmospheric drought covered Western and Central Poland, while in 2015 the largest precipitation deficit occurred in the area extending from Lower Silesia and Upper Silesia in a narrowing belt towards Mazovia.

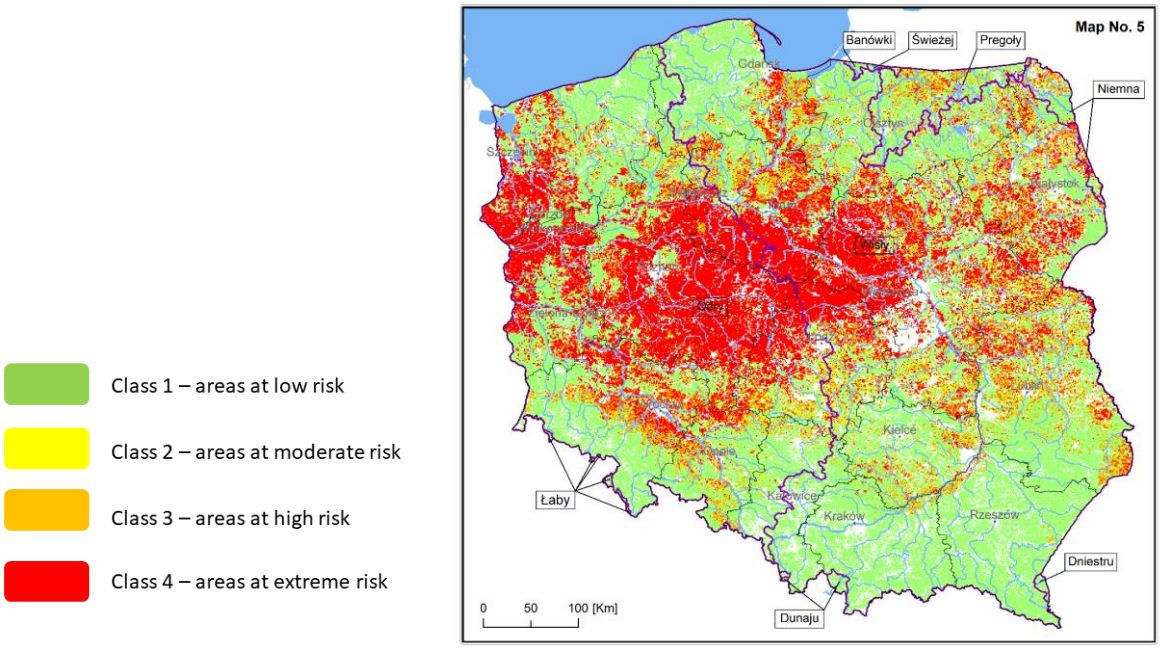


Fig. 6.27. Risks of agricultural drought in agricultural and forest land
Source: Drought Prevention Plan, 2021

Agricultural droughts affect to a varying extent the whole area of Poland. In the period from 1997 to 2017, the greatest hazard posed by excessively dry soil, causing the unavailability of water to plants in the growing season, affected agricultural and forest land in the Szczecin Lowland, the northern and western parts of Lubuskie Voviodeship, Wielkopolska and Kujawy, the northern parts of Łódzkie Voivodeship and North-western Mazovia (Fig. 6.27). The drought is the most frequent in these areas; moreover, due to a large water deficit, it is also the most severe here. The agricultural drought is less frequent north and south of this belt. It very often affects the cultivation of spring cereals, fruit shrubs, legumes and less frequently rapeseed, potatoes, tobacco and winter cereals. The analyses carried out for the purposes of the Drought Prevention Plan demonstrated that almost 45% of agricultural and forest land is at risk of the agricultural drought.

The hydrological drought is manifested by a lower water table in water reservoirs, lakes and rivers and a lower groundwater level. The mountain and submontane areas, the catchments of the Warta and Noteć Rivers, the Lublin Upland, the Vistula River catchment from Sandomierz to Warsaw, the Pilica River catchment and also the rivers in Central Pomerania (Fig. 6.28) were at the highest risk in this respect in the period from 1987 to 2017. The hydrogeological drought is identified when groundwater resources decrease and the groundwater table is lower, preventing the use of water from dug and shallow drilled wells, and even causing them to dry up. In the period from 1987 to 2018, this type of drought was the most severe in the Wielkopolska Lowland, the Wielkopolska Lake District, the Silesian Lowland and the Małopolska Upland.

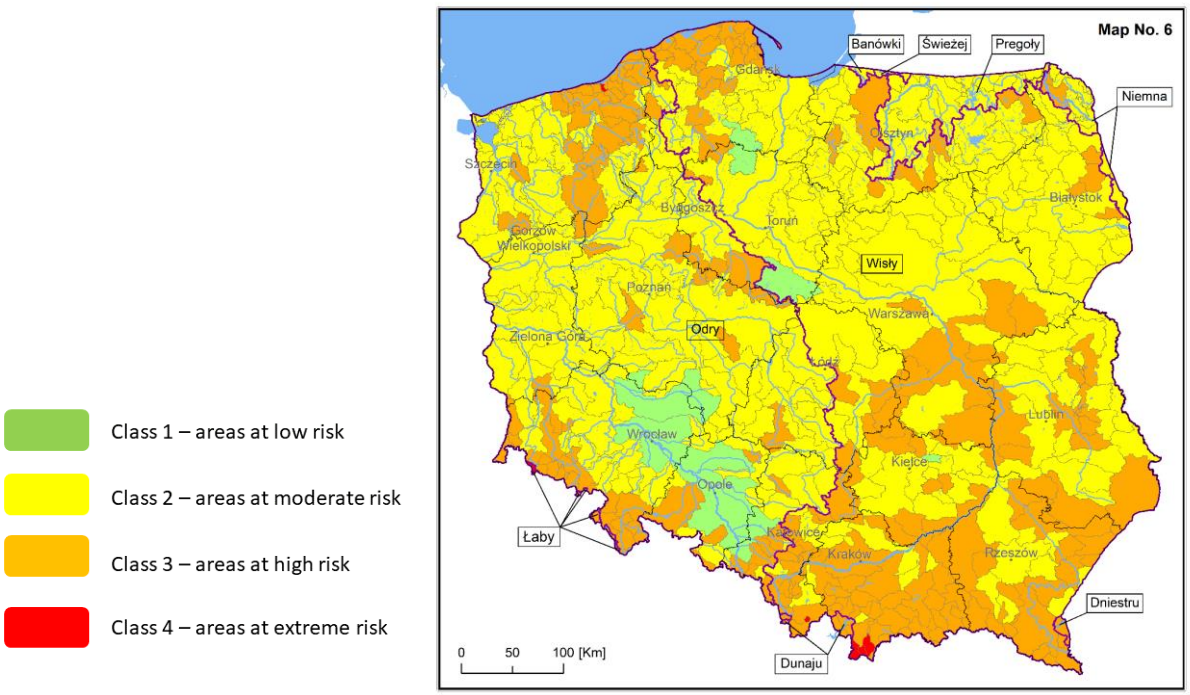
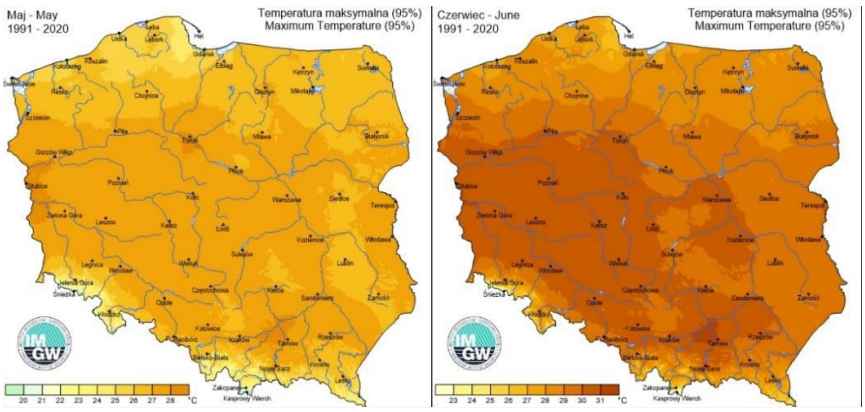


Fig. 6.28. Risk of the hydrological drought
Source: Drought Prevention Plan, 2021

6.3.4. Heat waves

The temperature phenomena which are adverse and burdensome for the environment and society include heat waves and series of hot days ($t_{max} \geq 30°C$). Hot days occur in Poland in the period from June to August and are sporadically recorded in September, May and even April. The largest number of hot days occurs on the North European Plain (on average 5 to 7 days in a year), while they are the fewest on the Baltic coast, in Pomerania and in the mountain areas (Fig. 6.29).

(a) May (1991-2020) (b) June (1991-2021)



(c) July (1991-2020) (d) August (1991-2020)

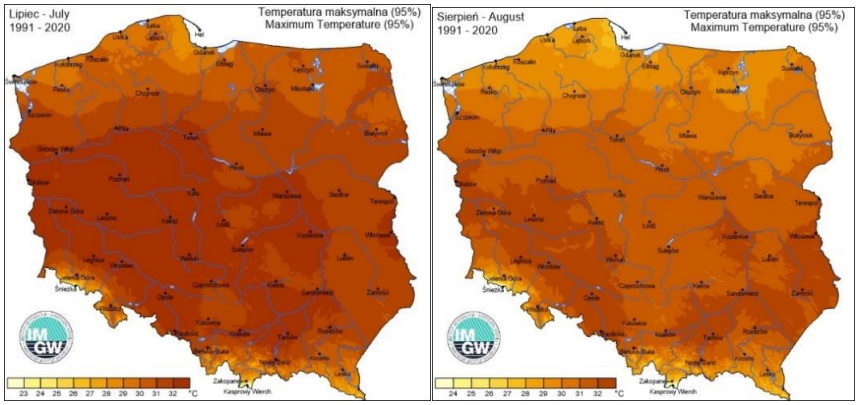


Fig. 6.29. Maximum daily air temperatures with the 5% probability of occurrence in selected months
www.klimat.imgw.pl

Heat waves cause a severe stress for the human body, particularly in the case of persons suffering from chronic diseases or worse thermoregulation. Analyses of the data from the period from 1999 to 2017 show a statistically significant increase in the mortality rate in Poland during heat waves, particularly high among men and the elderly (aged more than 65+) (Fig. 6.30). The greater sun exposure itself translates into a higher number of cases of malignant skin cancers, including melanoma.

a) Total b) Total 65+

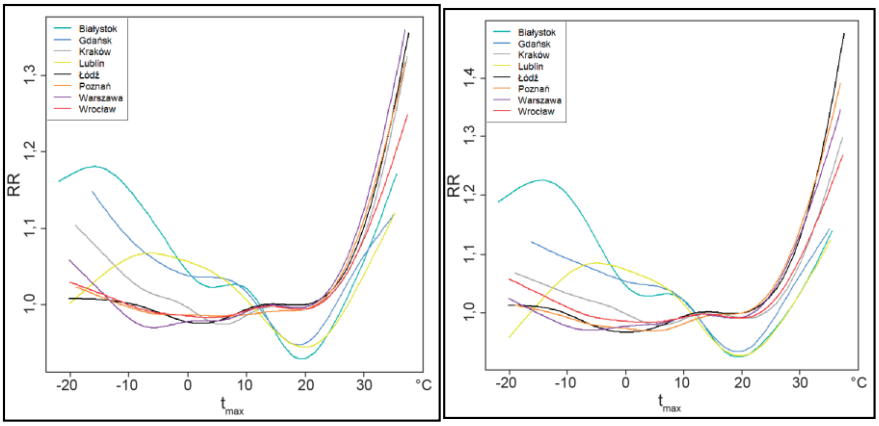


Fig. 6.30. Total relative risk (RR) of death in the whole population and among persons aged more than 65 years (65+) and the maximum air temperature (t_{max}) in selected cities
Source: Kuchcik, 2017

The growing water temperatures promote algal blooms and microbial growth which can cause epidemics of water-borne diseases. Two bacterial species – *Legionella* and *Vibrio* – can increasingly often cause human infections in Poland.

The dynamics of infectious diseases transmitted by food, rodents or air due to the warming, which fosters the survival of pathogens and their vectors, also causes changes in the geographical distribution of tick or mosquito species. Ticks can be the vectors of *Babesia* protozoa (causing babesiosis in animals and humans) or the *Anaplasma phagocytophilum* bacterium which causes granulocytic anaplasmosis in humans. Ticks can also transmit viruses; in Poland this is the virus of tick-borne encephalitis (TBE). Due to milder winters and favourable conditions for animals which are the basic hosts of ticks and a reservoir for the TBE virus, the TBE incidence grows in Poland; it is now 100-350 a year.

6.3.5. Landslides

A particularly dangerous phenomenon is a landslide which is a result of the full saturation of the surface layer of soil or rocks caused by prolonged heavy rains. In consequence of such rains, landslides form and become active on a so far unprecedented scale and this trend will continue. The areas at high risk include Southern Poland, especially the slopes in the Carpathians (90% of landslides in Poland) and to a lesser extent the steep river banks and upland areas (Fig. 6.31).

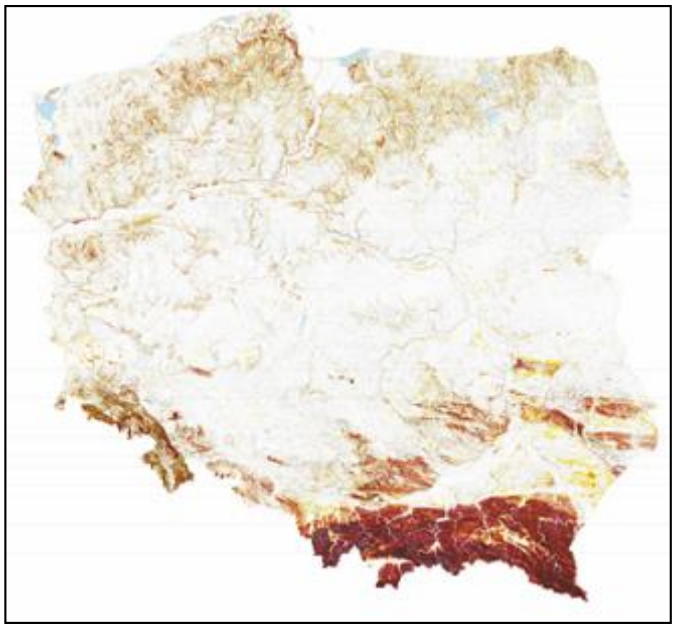


Fig. 6.31. Poland's landslide vulnerability
Source: osuwiska.pgi.gov.pl

Landslides are some of the most dangerous and most frequent geohazards in Poland's territory. They cause damage to infrastructure, crops, forest stands and general degradation of sites affected by mass earth movements. Every year landslides cause huge losses, but above all they threaten the residents' livelihoods or even life.

6.3.6. Strong winds

Poland is exposed to very strong winds caused by the movement of low pressure systems from the Atlantic over Europe. Such strong winds most often blow from November to March in the central and eastern parts of the Baltic Coast from Koszalin up to Rozewie and Hel and in the wide latitudinal belt in Northern Poland up to the Suwałki region, the areas of the Silesian and Żywiec Beskid

Mountains, the Silesian Foothills, Podhale, the Dynowskie Foothills, Central Poland with Mazovia and Eastern Wielkopolska (Fig. 6.32).

Extremely strong gusts of wind and particularly dangerous whirlwinds also accompany certain storms and extensive convection. These phenomena very often have a local character. They most frequently occur from June to August, sometimes in April and May. In recent years, the greatest damage caused by the strike of a whirlwind was observed in Central Poland: in Opolskie, Śląskie, Łódzkie and Kujawsko-Pomorskie Voivodeships, although each other region of the country has also experienced such phenomena.

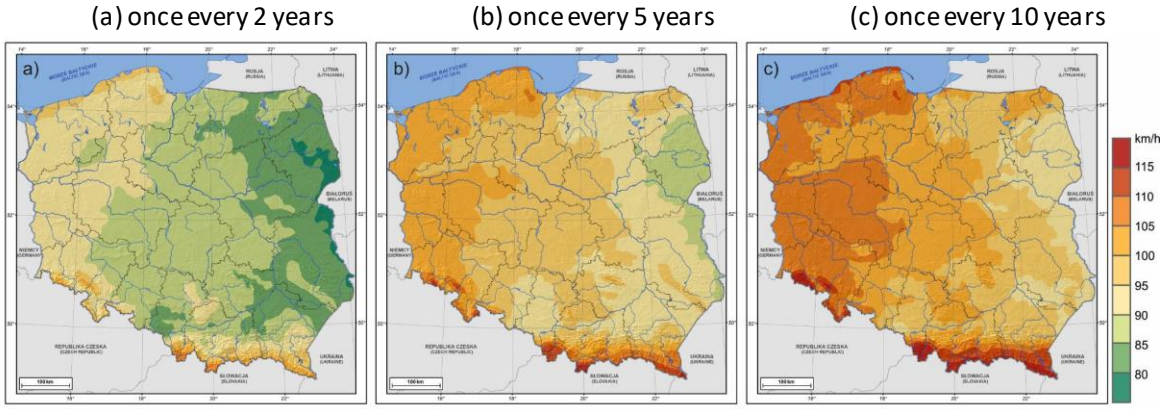


Fig. 6.32 Modelled speed distribution of gusts of wind with the probability of occurrence: (a) once every 2 years; (b) once every 5 years; (c) once every 10 years (1981-2010)
Source: Ustrnul Z. et al., 2014

In recent years, hazards resulting from strong winds took on large importance. They represent the causes of more than 54% of SFS interventions, most often in Śląskie and Mazowieckie Voivodeships (Fig. 6.33).

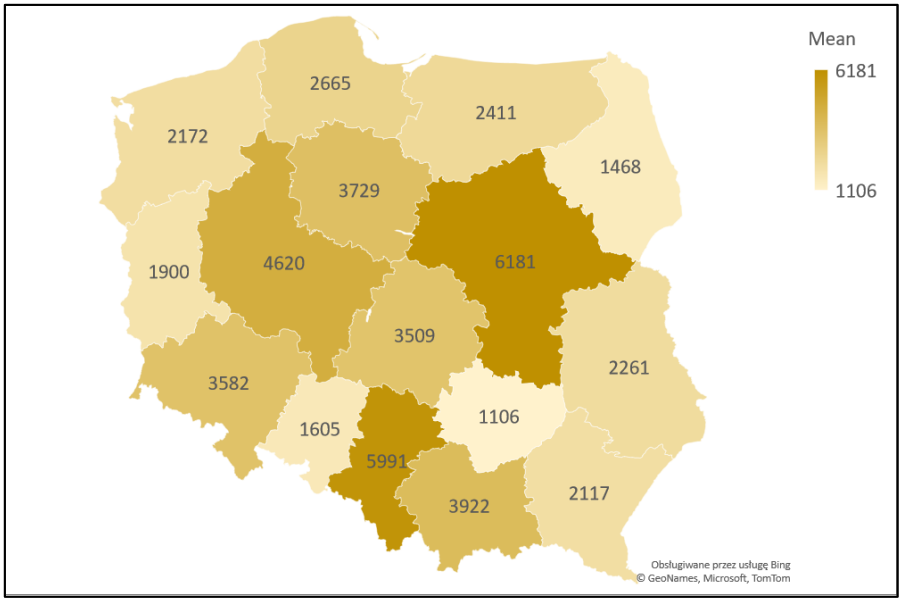


Fig. 6. 33. Mean annual number of SFS interventions related to strong winds in the period from 2010 to 2020
Source: data from the National Headquarters of the SFS

6.3.7. Climate change effects in the Baltic Sea

The conditions in the Baltic Seas will modify as a result of progressing climate change. The temperature of the surface water layer is expected to grow. The largest changes will occur in the summer in the Gulf of Bothnia and the Bothnian Sea and in the spring in the Gulf of Finland. The water

temperature will grow in the summer by about 2°C in the south of this body of water and by about 4°C in its northern part. The temperature changes will affect primarily the near-surface water layer, thus also contributing to enhanced thermal stratification of the sea.

The projected climate change will likely contribute to diminishing the salinity of the Baltic Sea. The largest changes will come in the area of the Danish Straits, while the smallest ones will occur in the Northern and Eastern Baltic. The projected changes will be uniform throughout the year. The predicted changes in the salinity of sea waters will result from changes in river runoff. It is expected to increase by several to a dozen or so per cent.

In the last 10 years (2011-2021) the sea level – in the Baltic Sea, too – rose by 4.8 cm, while in the earlier two decades it had risen, respectively, by 3.4 cm and 3.3 cm (Fig. 6.34). The projections of the rise of the level of the Baltic Sea in the 21st century are very diversified, depending on the modelling approach, the confidence level and uncertainty. The values given by experts vary between 0.6 and 1.1 m.

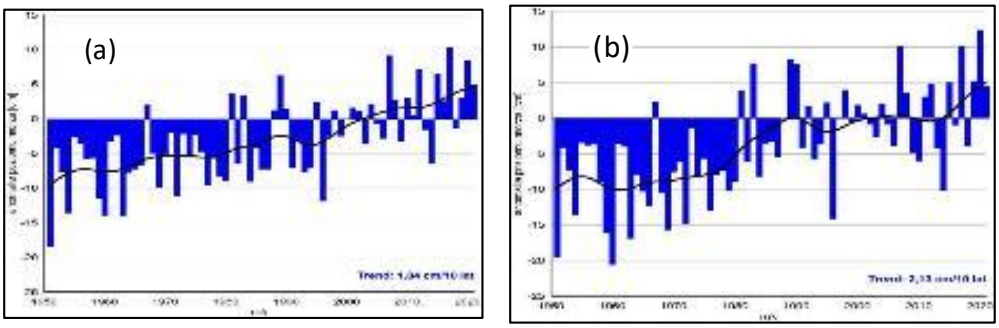


Fig. 6.34. Anomalies of the level of the Baltic Sea in the period from 1951 to 2021:
(a) Świnoujście, (b) Władysławowo
Source: IMGW-PIB

As a result of the rising sea level, probably by 2050 and in later decades a part of the Polish coast will be flooded at least once a year by the sea. The waves can force their way deep into the vicinity of Gdańsk, Szczecin or Elbląg, while several lakes will periodically become bays (Fig. 6.35).

Fig. 6.35. Effects of the sea level rise by 2050
Source: coastal.climatecentral.org

One of the major problems is the eutrophication of the Baltic Sea. As a result of the excessive supply of nutrients, mainly nitrogen and phosphorus compounds, this process affects 96% of the area of this body of water. Particularly adverse conditions in this respect exist in about 12% of the area of the Baltic Sea. The eutrophication process is inherently linked to the decreasing oxygen content in the water and the formation of so-called oxygen deserts. Coupled with favourable temperature conditions, significant nutrient concentrations lead, among other things, to more frequent algal and cyanobacterial blooms. They can cause the poisoning of humans and animals living in the Baltic Sea. Moreover, the process of their decomposition uses significant amounts of oxygen, thus producing areas with its deficit where organic life cannot develop correctly. At present, in consequence of the oxygen deficit, macrofauna is absent from as much as 70,000 km^2 of the Baltic Sea.

The Polish sea areas are considered to be adversely affected by eutrophication; primarily, as a result of very poor oxygenation of the deep water benthic zone, excessive phytoplankton blooms and the associated exceedance of the limit values of chlorophyll and water transparency. The good status criteria are not met by the concentrations of nutrients: phosphorus and nitrogen, either.

6.3.8. Impact of climate change on biodiversity

The habitat conditions will modify as a result of climate change, including the intensification of the phenomenon of drought, leading in some places to biodiversity loss at the species and habitat levels and in many places to a reconstruction of the species structure in the long-term. Water and water dependent species and ecosystems are particularly vulnerable to the progressing phenomenon of drought and so are natural peat deposits. In the future, the aggravating phenomenon of drought can lead to irreversible changes: the gradual decline or shift of the ranges of water and dependent species and the associated habitats with natural values.

As a result of progressing climate change, the species composition and types of forests can change. With falling humidity in forests, the fire risk grows. The strong weakening of forests makes them more vulnerable to damage caused by insect pests and pathogens.

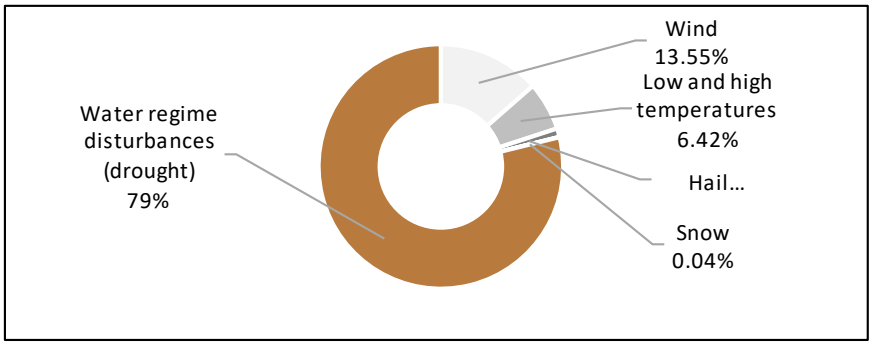


Fig. 6.36. Percentage shares of abiotic damage to the area of forest stands in State Forests in 2020 (Directorate General of State Forests)

Source: State Forests 2020

It follows from the data gathered by State Forests (in the period from 2015 to 2018 and in 2020) that the disturbances of the water regime are the main abiotic factors damaging and weakening forest stands. In the recent 6 years, the area of forests damaged by severe drought was more than 300,000 ha, representing more than half the total area where abiotic and anthropogenic factors occurred. In 2020, the share of damage caused by drought was more than 78% all over the territory of the country (in the Regional Directorates of State Forests, respectively, of: Zielona Góra – 99%, Radom – 98%, Szczecinek and Poznań – 97%, Piła – 94% and Toruń – 90%).

6.4. Climate change adaptation policy in Poland – the national policy and local adaptation plans

The national adaptation policy was formulated for the first time in a comprehensive form in 2013 in the Strategic Adaptation Plan for Sectors and Areas Vulnerable to Climate Change with an Outlook until 2030 (SPA 2020). This was the most important document on adaptation which set out the priority directions of actions until 2020 in the areas most vulnerable to climate change. The new strategic documents published in the successive years were usually integrated into sectoral socioeconomic policies. In light of the issues related to the adaptation to climate change, the most important document was the National Environmental Policy 2030 – the Strategy for the Development in the Areas of Environment and Economy (PEP2030), under which the provisions of the SPA 2020 were implemented.

In the recent years, the Government launched many initiatives in the scope of strategic planning and programming in Poland and the comprehensive development management system. The restoration of the national management system started in 2017 was a consequence of the adoption of the Strategy for Responsible Development until 2020 (with an Outlook until 2030) – SOR. The Strategy was a key national document formulating medium-term and long-term policies at the national level, creating the basis for updating the development strategy. The issues of climate change mitigation and adaptation and the management of the risk of natural disasters were addressed in the National Environmental Policy 2030 – the Strategy for the Development in the Areas of Environment and Economy (PEP2030). That strategy specified and operationalised the Strategy for Responsible Development until 2020 in the areas of environment and economy.

Detailed solutions of the development management system were incorporated into the amended content of the Act on the Principles of Development Policy which entered into force on 13 November 2020. Its aim was to integrate the socioeconomic and spatial development in strategic documents. It is planned that the National Development Concept (KRK 2050) will be adopted as a vision document to guide Poland's development over the nearest 30 years.

The system of national documents is consistent with the system of documents applicable in relation to Poland's membership in the EU. The response to the requirements of cohesion policy is the Partnership Agreement, under which the Recovery and Resilience Facility will be implemented through the National Recovery and Resilience Plan (KPO).

It is planned that in 2023 the strategic document on adaptation will be updated to take into account the conclusions of the evaluation of the existing policy and the most recent knowledge, experiences and good practices worked out over the last 10 years. In addition, the update process will be supported by the implementation of the project "*Strengthening Coordination in Climate Change Adaptation Policy Between Local, Regional And National Authorities*" as part of the European Commission Technical Assistance Facility.

In several sectors, work is underway on the preparation of adaptation plans and it is at different stages of implementation. The adoption of new strategic documents, especially including the planned National Development Concept 2050, the EU financial perspective and the National Recovery and Resilience Plan, will be taken into account in adaptation policy.

6.4.1. Environmental policy

With a view to ensuring the conditions for stable socioeconomic development in the face of climate change-related risks, the Strategic Adaptation Plan for Sectors and Areas Vulnerable to Climate

Change until 2020 with an Outlook until 2030 (SPA 2020) was prepared and adopted on 29 October 2013. This document set out the directions of adaptation actions which needed to be taken until 2020, with an outlook until 2030, in the areas most vulnerable to climate change, such as: water management, agriculture, forestry, biodiversity, health, energy, construction and spatial management, urbanised areas, transport, mountain areas and coastal zones. In accordance with the multi-level governance principle and given the horizontal character of adaptation and the existing institutional framework for the implementation of development policy in Poland, the SPA 2020 did not provide for the establishment of new institutions or bodies to be responsible for coordination. Adaptation actions are implemented under the relevant regulations and using relevant legal, financial and organisational instruments within the framework of development policy.

It follows from the evaluation of the SPA 2020 that the issues of adaptation to climate change were incorporated into the operations of sectors to a very different extent. Most actions were taken at the Government administration level in the sectors of energy and environment. The actions in this scope at the local level (including the territorial self-government units) were carried out to a limited extent. In 2021, work was begun to update the SPA 2020. The new document will be an important signal for both national and European partners about the importance of adaptation issues in national policy, including a high priority for adaptation policy. This work will contribute to the achievement of several sustainable development objectives. The new strategic document will implement the new EU Strategy on Adaptation to Climate Change adopted on 24 February 2021.

The PEP2030, adopted on 16 July 2019, played an important role in updating and complementing the SPA 2020. This policy covers adaptation to climate change, including the issues of the adaptation of urban areas to climate change. In order to accelerate the implementation of the PEP2030, a set of indicators was introduced. The values defined in 2020 were compared with the values from 2019 in order to analyse the possible changes and trends. It is planned that in 2023 the evaluation of the first four years of the implementation of the PEP2030 will be carried out.

In 2015, at the Ministry of the Environment, the Working Group on Adaptation to Climate Change was established as part of the operation of the national network Partnership: the Environment for Development. Many different issues related to adaptation to climate change were addressed by the group over several years, including the issues of the verification of legal gaps in the area of adaption to climate change, related, among others, to the Act on Spatial Planning and Development and on Construction Law, the climate issues in environmental impact assessments, an adaptation manual for cities, as well as technical tools, documents and solutions applied in the area of climate change in other EU Member States.

6.4.2. Water management policy

The Polish Waters State Water Holding (Polish Waters) is responsible for water management policy, with its competence including, among others, the preparation of the preliminary flood risk assessment (WORP), flood risk maps (MRP) and flood hazard maps (MZP), flood risk management plans (PZRP) and the drought effects prevention plan (PPSS). These planning documents are elements of Poland's policy on adaptation to climate change-related risks.

An update of the flood management plans adopted in 2016 is now being prepared. This is the last stage of the 6-year planning cycle which ends in 2022. The work in the second planning cycle was started by preparing a review and update of the WORP and review and update of the MZP and MRP so as to prepare the PZRP on their basis. The most important aim of the update of the PZRP is to limit

the potential adverse flood effects on human life and health, the environment, the cultural heritage and economic activities. This done by recommending the implementation of measures to minimise the risks identified and to diminish the flood related losses. They include both technical measures e.g. the construction of retention reservoirs and embankments non-technical ones (e.g. in the scope of natural retention and legal instruments), including the correct spatial planning at the self-government level.

The updates of the flood risk management plans which are coordinated at the river basin district level are prepared for 6 river basin districts. The plans cover all the aspects of flood risk management, in particular the measures to prevent, protect and properly prepare for floods, including flood prediction and early warning systems, taking into account the specific circumstances of the particular river basin districts. In the course of the work to prepare a draft PZRP, a complete set of analyses was carried out, including: analyses of the flood risk distribution to identify problematic sites, hydraulic modelling to determine the effectiveness and efficiency of the proposed measures, a cost-benefit analysis, an analysis and assessment of the compliance of the finally adopted options of measures with the legal requirements, as well as a multi-criteria analysis (with a selection of objective flood related, environmental or economic criteria). The analyses used different climate change scenarios so as to predict as well as possible the possibilities and conditions of the occurrence of the abovementioned extreme phenomena.

The prevention of the effects of both droughts and floods is the duty of the Government and self-government administrations and Polish Waters. In light of this, Polish Waters has prepared the Drought Effects Prevention Plan (PPSS), which is the main strategic planning document to guide the prevention of drought effects. The PPSS was adopted in September 2021 by a Regulation of the Minister responsible for water management[64]. The aim of the PPSS is to reduce the scale of hazards and risks caused by drought to ensure access to water of an adequate quantity and quality. The drought hazard analysis was indicated in the drought effects prevention plan. The deliverables of the drought hazard analysis include the range maps of the hierarchy-based areas at risk of any type of drought and a map showing the summary risk of drought events and the areas under the highest risk of drought in 4 types as a total. In accordance with the methodology for preparing water management plans, the prevention of the effects of the extreme phenomena should focus on proactive measures, those that prevent the occurrence and reduce the probability of the occurrence of the adverse effects of drought which are implemented irrespective of the actual occurrence of the phenomenon of drought. In consequence, the aim of the adaptation-oriented (proactive) approach is primarily to promote the measures to strengthen the properties and processes shaping the water resources in catchments in order to reduce the losses in the event of a drought. Therefore, there is a need for the complementary implementation at the scale of a catchment and a river basin district of both technical and non-technical measures to develop the water resources, supported by the instruments for spatial planning, land and water management, the protection of water and water dependent ecosystems and wetlands, as well as instruments to achieve environmental objectives. The measures to strengthen natural retention, including the application of technical solutions also contribute to improving and restoring the natural water cycle conditions.

In order to support the implementation of the objectives listed in the PZRP and the PPSS, work is underway on the Multiannual Programme called the Management of Water Resources in Poland. The main aim of the Programme is to improve flood safety and to achieve a positive water balance (the

[64] Regulation of the Minister of Infrastructure of 15 July 2021 adopting the Drought Effects Prevention Plan (Official Journal of the Laws of 2021, Item 1615

protection against drought and water retention). An additional effect will be the higher production of "*green energy*" due the increased potential for the use of hydropower plants. Investments will be carried out in two areas: the construction of water reservoirs and the restoration and construction of flood protection infrastructure. The Programme will be implemented by the Polish Waters State Water Holding, while the Minister responsible for water management will be entrusted with the supervision over its implementation. In January 2022, the Programme was entered in the list of the legislative and programming works of the Council of Ministers. At present, work is under way to reconcile the comments from interministerial and public consultations and to prepare for the implementation of a strategic environmental impact assessment of the Programme, along with a prognosis of its environmental impact.

6.4.3. Urban policy

The National Urban Policy 2030 (KPM 2030) adopted on 14 June 2022 is the most important document shaping the policy of cities on spatial management and their most important challenges, such as demographic problems, climate change, development problems and functional areas. In accordance with the principles of sustainable development, the solutions and measures defined in the KPM 2030 for the Government administration concern the legal, financial and organisational aspects. At the same time, the document provides support for local governments and communities by giving them tools and opportunities for development-oriented actions.

The preparation of urban adaptation plans was recognised to be a priority of the implementation of the SPA 2020. The organisational and financial support granted to the largest cities in Poland under the project "*Development of Urban Adaptation Plans for cities with more than 100,000 inhabitants*" (MPA44) contributed to the preparation in the period from 2017 to 2019 of local adaptation plans for 44 cities, most of them with more than 100,000 inhabitants, with the plans covering more than 30% of Poland's population. The main measures concern the blue-green infrastructure. At the same time, several other projects were launched to deal with these issues. The document entitled "*The Strategy for adaptation to climate change of the City of Warsaw until 2030 with an Outlook until 2050*" was prepared under the LIFE_AdaptCity_PL (2017-2019) project. In the Polish-Norwegian CLIMCITIES project targeting small and medium-sized cities, adaptation strategies were prepared for 5 cities with more than 50,000 inhabitants. An additional effect of the initiatives launched was the significantly improved awareness of the staff of the self-government administration and inhabitants of largest cities concerning climate change and the actions which can contribute to mitigate its adverse effects.

According to the data from October 2022, more than 75 cities with more than 20,000 inhabitants have adopted their climate change adaptation plans. At the Ministry of Climate and Environment, work is underway on the draft Act Amending Certain Acts to Strengthen the Climate Dimension of Urban Policy (UD246), providing, among others, for:

- the obligation to prepare urban climate change adaptation plans for cities with 20,000 or more inhabitants;
- the imposition of the obligation to separate within the citizens' budgets of municipalities a pool of resources for the dedicated implementation of projects the delivery of which is expected to increase the biologically active area and the retention of rainwater and meltwater;
- the exemption from the obligation to obtain a permit for the construction of drainless tanks for rainwater and meltwater with a capacity of up to 15 m^3. This amendment will contribute to dispelling an ambiguity of the law, thus supporting small retention measures, including the implementation of the My Water Programme by the NFOŚiGW.

6.4.4. Agricultural policy

The adaptation problems are also addressed by the institutions responsible for the agriculture sector. As part of the future agriculture policy, different types of actions are planned to protect the environment and to tackle climate change. The objectives of the new Common Agricultural Policy (CAP) primarily include the improvement of the profitability and incomes of agricultural holdings, the more effective implementation of environmental protection and climate policies, as well as sustainable rural development.

The new Eco-schemes project provides for the establishment of "*10% for nature*". This measure consists in increasing the share of the elements of the environment fostering biodiversity in the agricultural landscape to the level of 10% of the area of the agricultural holding (with the area including arable land, orchards and permanent grassland). The proposed intervention will have the form of an annual payment per hectare of agricultural land where the farmer undertakes to carry out at least one eco-scheme from the list of the proposed practices. The aim of the eco-schemes is to encourage farmers to implement practices which are favourable for the environment and climate and, at the same time, to create opportunities for supporting the shift to more sustainable and environmentally friendly agriculture.

The purpose of the eco-schemes is to achieve the environmental and climate objectives of the CAP, including climate change mitigation, support for sustainable development, the protection of natural resources, such as water, soil and air, and biodiversity conservation. When designing the eco-schemes an attempt was taken to ensure their availability to all the farmers and, thus, their general use at agricultural holdings. This would enable the highest effectiveness to be achieved in the scope of a positive impact on the environment and climate. In turn, a diverse set of practices, reflecting the diversity of Polish agriculture in terms of agro-techniques, technologies, the structure and size of agricultural holdings, production types (plant and animal production), will allow farmers to choose the best option for their agricultural holdings.

6.4.5. Forest policy

Some of the key measures to combat drought and forest fires include the comprehensive projects to adapt forests to climate change, implemented under the Operational Programme Infrastructure and Environment 2014-2020:

- Adaptation of forests and forestry to climate change – small retention and the prevention of water erosion in lowland areas (MRN2); the project includes the measures carried out in 113 Forest Districts in the areas of 17 Regional Directorates of State Forests (RDLPs);
- Adaptation of forests and forestry to climate change – small retention and the prevention of water erosion in mountain areas (MRG2); the measures are carried out in 47 Forest Districts in the areas of 4 RDLPs (in the South of Poland);
- Adaptation of forests and forestry to climate change – the prevention, counteracting and limitation of the effects of hazards related to forest fires (PPOŻ); the measures are carried out in 135 Forest Districts in the areas of 17 RDLPs.

The first two projects include the measures related to small retention and the prevention of water erosion and are carried out following the pattern of the earlier projects under the POIiŚ 2007-2013 in a breakdown into lowland and mountain areas in light of the specificity of these areas. It is planned that as part of the two projects a total of about 2,260 structures will be built by the end of 2022 to dam up water or slow down its flow and to retain a total of about 2.5 million m^3 of water in reservoirs.

The main aim of the PPOŻ project is to reduce the adverse effects caused by fires in forests, to efficiently locate the source of danger and to minimise losses; then, in the longer term, to reduce the average fire area and to expand the observations of forest areas, particularly in the Forest Districts qualified as falling within Category I of Fire Risk. The most important investments carried out in the project include:

- the development and modernisation of early warning and hazard prediction systems, including the construction and modernisation of fire protection look-out points (70 items), the purchase of advanced equipment enabling the location and detection of fires (114 items), the provision of additional equipment for Alarm and Dispatch Points (PADs) (16 items) and the construction of weather stations (11 items);
- technical support for a fire-fighting and rescue system to respond in case of forest fires, including the purchase of fire-fighting and patrol appliances (67 items).

The implementation of the project will contribute, among others, to strengthening the resilience of forests to natural disasters (such as fires, which – as the climate warms up – pose an increasingly high risk), improving the effectiveness of the forest fire early warning system and reducing the extent of fires and the associated adverse effects.

As part of the preparation of forest ecosystems for the increased pressure exerted by the intensification of the extreme weather phenomena, the following measures were also carried out:

- the reconstruction of monocultures,
- the growing of mixed forest stands,
- the promotion of species which are better prepared for climate change and more tolerant of it,
- the anticipatory signalling of hazards and the promotion of effective pest control measures.

Work is underway to prepare "*The comprehensive programme to prevent the forest dieback processes in Poland and mitigation measures until 2030*". Its aim is to prevent the emergence or to minimise the adverse effects of natural phenomena (droughts and fires), the destructive impact of high waters, floods and inundations by developing small retention systems, preventing excessive soil erosion and strengthening the resilience of forest ecosystems threatened by progressing climate change.

6.4.6. Crisis management

The updated National Crisis Management Plan adopted in 2022 addressed the climate-related factors and climate change. It is one of the most important planning documents concerned with crisis management, including preventive and preparatory measures in case of a flood, a strong wind, severe frost, heavy snowfalls, drought and heat.

6.4.7. Seashore protection

In 2016, the Act of 28 March 2003 Establishing a Multiannual Programme for Seashore Protection was amended.[65] The amendment set out new objectives of the Programme, among others, to build, expand and maintain the system for the protection of the seashore against sea erosion and coastal flooding, while resigning, at the same time, from the objectives of stabilising the coastline and preventing the erosion and waning of beaches and the degradation of cliffs.

[65] Official Journal of 2016, Item 678

6.4.8. Other initiatives

As part of its financial offer, the National Fund for Environmental Protection and Water Management proposes support in the period from 2022 to 2027 for adaptation measures under the Climate Change Adaptation Priority Programme. Its aims include strengthening the level of protection against climate change and natural hazards, as well as major accidents, improving the response to their effects, strengthening selected elements of environmental management and disseminating modern, efficient and effective solutions to improve the inhabitants' quality of life, to strengthen the resilience of cities to the effects of climate change and to enhance the adaptation to climate change in rural areas. The budget of the Programme is up to PLN 1.15 billion.

6.5. Monitoring and assessment of adaptation

The monitoring, reporting and evaluation (MRE) of the adaptation process in Poland is an element of the evaluation of progress in enhancing the resilience of the population, environment and economy to climate change. This process includes the regular monitoring at the national level of the implementation of adaptation policies and measures. The indicator-based approach adopted for this purpose is used to evaluate the effects of their implementation in terms of their contribution to adaptation to climate change.

The basic national strategic documents on adaptation, i.e. the SPA 2020 and the PEP2030, contain a list of performance indicators which are measured and reported annually. In turn, the Strategy for Responsible Development and the PEP2030 indicated the strategic projects including different minor adaptation measures and initiatives. Their implementation is monitored and reported every quarter of the year. Both the Ministry of Climate and Environment, other public institutions, including those subordinated to the Ministry, and external entities selected by way of public procurement are involved in the implementation of the projects.

The evaluation of progress in the implementation of adaptation policy also draws on the system for monitoring the implementation of projects carried out with the EU funds by means of selected performance, result and environmental effect indicators (the SL 2014 system). The rules of the evaluation of projects financed by the national funds are similar to those applied by the NFOŚiGW and the Voivodeship Funds. The monitoring covers the achievement of specific indicators dedicated to climate change adaptation projects. The NFOŚiGW and the WFOŚiGW present the reports on the implementation of indicators and priority objectives of programmes for approval by the Minister of Climate and Environment, as a rule at annual intervals.

The monitoring of the status of implementation of the measures envisaged in the plans drawn up as part of the MPA 44 project has been entrusted to the city mayors. At present, the cities which have adopted the urban adaptation plans (42) are preparing the reports on the implementation of the plans on their own. The reports have been prepared, among others, by: Szczecin, Rzeszów, Jaworzno, Kielce, Bydgoszcz, Elbląg and Lublin. The Ministry of Climate and Environment takes part in this process, also as part of the control of the sustainability of the MPA 44 project.

It is planned that a uniform system for the monitoring and evaluation of the implemented urban strategies and adaptation plans will be introduced in 2023. In accordance with the draft Act Amending Certain Acts to Strengthen the Climate Dimension of Urban Policy, every two years, by 30 June of the reporting year, the city mayor will be obliged to submit a report from the monitoring of the adaptation measures contained in the plan. The draft Act provides that the reports will be submitted to the Institute of Environmental Protection – National Research Institute for verification,

analysis and conclusion and subsequently forwarded to the Ministry of Climate and Environment by 30 November of the reporting year.

6.6. Selected adaptation measures

The regional and local character of adaptation to climate change conditions the initiatives which need to be undertaken in order to protect the local communities that are the most vulnerable to climate change and areas or sectors that are particularly vulnerable to extreme events. Several selected examples of measures in Poland demonstrate the complexity and diversity of the adaptation process which involves different entities, both Government bodies, EU funds, self-government authorities, nongovernmental organisations and residents.

6.6.1. Blue-green infrastructure

The introduction and strengthening of the blue-green infrastructure have become a significant direction of many urban strategies for adaptation to climate change. The idea of using natural values to support adaptation and to reduce the risk of climate hazards involves different approaches and measures, depending on the problem. At the scale of buildings, a street or a parking lot, the choice includes such structures as green roofs and walls, rain gardens, green streets, green tramway tracks, green stops, green playgrounds, school grounds, green parking lots, pocket parks and flower meadows. The adaptation of a city district to climate change includes the creation of tree corridors, the restoration of a stream in a central place, the creation of small canals connected to a river, the greening of river banks and the redesign and transformation of brownfields into districts resilient to climate change.

In the period from 2014 to 2020, as part of the Norway and EEA Grants, more than PLN 100 million was allocated to co-finance blue-green infrastructure in cities and to raise the awareness of adaptation in schools. The measures in this scope will continue to be funded in the third edition of the "*Environment, Energy, Climate Change*" Programme. In 2021, the NFOŚiGW launched its Priority Programme "Climate Health Resorts. Part 1) Adaptation to Climate Change" to support such measures at health resort localities. The Grow Green Project under the Horizon 2020 Programme in the space of Wrocław introduces demonstrative solutions – pocket parks, green walls and streets. In many cities, as part of citizens' budgets, inhabitants build a community garden, i.e. a common green public space, which is set up and cultivated by residents. At the initiative of the city authorities and inhabitants, rain gardens are set up (Gdańsk, Gdynia and Kraków) and so are pocket parks (15 parks in Cracow). The greening of tramway tracks is a solution which is increasingly often applied when the tracks are modernised and new ones are built (Warsaw and Cracow). In the city centre and at the busiest routes, green places are set up to allow people to wait for means of public transport – green stops. Additional greenery also appears on the roofs and walls of buildings.

6.6.2. No more concrete in the city centre

Over the last several dozen years, in cities many impermeable surfaces have arisen, i.e. concrete squares and parking lots, compact buildings and large-area service facilities. A response to the challenges of climate and nature policy on adaptation to climate change faced by self-government units is a new initiative aimed at limiting the sealing of surfaces, reducing the urban heat island effect, increasing the level of micro and small retention and green areas in cities, and creating financial and legal solutions supporting the implementation of the objectives set out. Among others, the following is envisaged:

- the implementation of the Project *Strengthening the coordination of climate change adaptation policy among local, regional and national authorities* as part of the support under the European Commission Technical Assistance Facility;
- the performance of the study *An assessment of the status of greening of selected Polish cities, with an indication of its effects on their climate and hydrological situation and the inhabitants' quality of life. Recommendations: towards green compact cities;*
- an update of *The guide to the investment preparation for the beneficiaries of European Funds*, with consideration given to climate change, along with a handbook on good practices on adaptation, including concrete removal and greening of city spaces.

6.6.3. Sustainable rainwater management

Its idea is to make the city resilient to climate change so that it functions like a sponge, accumulating rainwater and enabling its use in drought periods. This is a complete change of the approach to the issues of rainwater and water in the cities – moving away from the traditional ways of draining rainwater in favour of methods designed to retain it and use it in situ. An example of a comprehensive solution to rainwater management in the whole city area, taking into account the changes in the rainwater conditions until 2050, is the project "*Construction and reconstruction of the rainwater collection system and the adaptation of the rainwater collection system to climate change in the City of Bydgoszcz*". This is the first so large an initiative to be carried out in Poland with EU support, aimed at adapting the rainwater collection system in the City of Bydgoszcz to the present and future land uses and safeguarding the city against the effects of heavy rains and large quantities of rainwater and meltwater, to minimise inundations of buildings and flooding of streets, and to enable retention of water and its use in dry periods. The volume of the water retained is 36,900 m^3.

Urban projects on sustainable development and adaptation in rainwater management in the period from 2014 to 2020 were funded with grants from the Operational Programme Infrastructure and Environment in an amount of about PLN 1.1 billion. Similar resources will finance the continuation of this Programme under the new EU financial perspective 2021-2027.

In 2020, the NFOŚiGW launched its My Water Priority Programme, aimed at protecting water resources and minimising the phenomenon of drought in Poland by increasing the level of retention on the properties at single-family buildings and using the collected rainwater and meltwater, among others, due to the development of blue-green infrastructure. In turn, the strategic goal of the Programme is to increase the level of protection against the effects of climate change and natural hazards (among others, in accordance with the directions of actions set out in the Strategic Adaptation Plan for Sectors and Areas Vulnerable to Climate Change until 2020 with an Outlook until 2030 and the National Environmental Policy 2030 – the Strategy for the Development in the Areas of Environment and Water Management). The support can be obtained until 2024 for projects which will retain rainwater within the property covered by the project, as a result of which rainwater or meltwater will not be drained outside the property (e.g. into the domestic wastewater collection system, the rainwater collection system, the combined collection system, drainage ditches draining outside the property, to the adjacent sites, to streets, squares, etc.).

6.6.4. Local systems informing and warning about risks, especially flood risks

The effects of climate change include the increased risk of the extreme phenomena involving heavy rains, particularly in cities, as a result of a substantial share of impermeable surfaces and their large population density. The measures needed to ensure safety for the inhabitants of urban areas also include the construction of local systems for monitoring and warning the population about

hydrological and meteorological risks. Quite often, these systems are an important element of the water management systems in cities. An example of a measure in this area are the Local Monitoring and Flood Response Support Systems set up for Elbląg, Gdańsk and Sopot. These systems make it possible to determine the risk of a flood event and to monitor flood risk in order to enable the inhabitants to be effectively informed about the risk.

6.6.5. Agroforestry

An advantage of this land use is the protection of an agricultural site against both excessive quantities of water and drought, as well as from other extreme phenomena (among others, the air temperature and the wind). A combination of agricultural and forestry production enables more effective adaptation to climate change, among others, by slowing down water runoff, limiting soil erosion, increasing the availability of water or mitigating the extreme air temperatures. In Poland, in the past this system was generally applied in the form of tree planting on boundaries separating agricultural fields. For several dozen years, the tree strip plantings which create a windbreak and reduce wind erosion, protecting a hilly area against surface runoff, have been applied in the Kietrz Agricultural Complex. Windbreak strips and other midfield tree plantings are also the sites of many herbal plants and refuges of many animal species. An example of an agroforestry project is the innovative model of the cultivation, processing and distribution of herbs in the Zielawa River valley. The aim of the project is to develop and implement a new model of the alley cropping of black lilac and fruit rose (*Rosa rugosa* and a wild rose) with wild, shade-loving plants which are endangered and/or protected species, such as lungwort, cloudberry and common speedwell, and also to introduce wild plants in cultivation, such as common nettle, common agrimony or cabbage thistle.

Since 2022 as part of sub-measure 8.1 "*Support for afforestation and creation of woodland*" included in the Rural Development Programme for 2014-2020, assistance has been awarded for the planting of midfield tree clusters. The assistance is awarded for the planting of tree clusters in arable land with an area of at least 0.1 ha. The species composition of the planted trees can only include native tree or shrub species and the share of broadleaved species should be at least 90%. This support will contribute to enhancing water retention, thus constituting an important measure to prevent the drought effects and to reduce the quantities of pollutants released into waters. The midfield tree clusters prevent water and wind erosion and enhance carbon dioxide removals.

In addition, the Strategic Plan for the Common Agricultural Policy for 2023–2027 provides for the launch from 2023 of agroforestry systems, a support instrument promoted in the European Green Deal and the related strategies. The establishment of agroforestry systems consists in the use of agricultural land where trees or shrubs are integrated with agricultural crops in the same area. This multipurpose land use brings environmental and climate benefits by increasing infiltration and protecting surface waters. Agroforestry systems prevent erosion and increase the organic matter content in soil.

6.6.6. Prevention of the spread of invasive species

The adverse effects of climate change include the expansion of invasive species, including quarantine pests, to new areas. In order to prioritise the operations of the Main Inspectorate of Plant Health and Seed Inspection intended to reduce the risk of introduction of new pests posing a danger to agricultural and forest plantations in the territory of the country, the Institute of Plant Protection – National Research Institute in Poznań carries out a project consisting in an ongoing analysis of the phytosanitary risk posed by pests. As part of the project, pest risk analyses (PRAs) are carried out and

updated for selected pests, taking into account their capacity to expand and establish and their harmfulness in the Polish conditions.

For many years measures have been taken to reduce the adverse impacts of invasive alien species, including in protected areas. Under the Operational Programme Infrastructure and Environment 2014-2020, co-financing was provided, among others, for the Project *The development of the principles of the control and combating of invasive alien species, along with pilot measures and public education*, implemented by the GDOŚ. The aim of the project was, among others, to analyse the degree of invasiveness of alien species in Poland, with an indication of the species posing the greatest danger to the native nature and, and to develop methods for combating or controlling them. As part of the project, among others, an analysis of the degree of invasiveness of alien species in Poland was carried out and the species posing the greatest danger to the native nature were indicated. The pathways of unintended introduction or spread of invasive alien species were also analysed, the priority pathways were indicated and the concepts of the plans of measures for them were elaborated. The project provided, among others, for the preparation of studies on the methods for combating or controlling the most invasive alien species (at least 10 species). Subsequently, the principles of the control and combating of invasive species were verified in pilot actions.

As part of the monitoring and preventing of the spread of alien species, the following projects under the EEA FM were also carried out:

- *Environment without Sosnowsky's hogweed* (*Heracleum sosnowskyi Manden)* (2014-2016) – An inventory, monitoring, destruction and elimination of *Heracleum sosnowskyi Manden* in the areas of 30 municipalities in Małopolskie Voivodeship and several other selected areas;
- *Restoration of alluvial meadows (…)* (2014-2016) – the restoration of the favourable status of natural habitats and refuges of species in selected fragments of the Warsaw section of the Special Protection Area (SPA) of Natura 2000 Dolina Środkowej Wisły (PLB 140004); the measures undertaken consisted in reducing the presence of invasive alien species: Canada goldenrod (*Solidago canadensis*), tall goldenrod *(S. gigantea)* and box elder *(Acer negundo)* in more than 60 ha of the areas on the Vistula River*;*
- *The programme protecting domestic flora of the Sanok County against invasive species, their spread and infiltration into the area of the International Biosphere Reserve Eastern Carpathians* (2014-2017) – increasing the resilience of the native ecosystems in the Sanok County against the pressure from invasive alien species and raising the residents' knowledge of the impacts of invasive species on the native plant species;
- *Biodiversity conservation on the Natura 2000 sites Dolna Odra (PLB320003 and PLH320037) and Ujście Warty* (PLC 080001) by creating breeding grounds and protecting these breeding grounds against the predation by invasive alien species (2014-2016) – the conservation of endangered bird species in the flooded gravel pit in Kaleńsko; the project consisted in protecting the bird breeding grounds against the destructive effect of water table variations (the nests are usually flooded or after a flash flood invasive alien species reach the nests, mainly American mink); the implementation of the project involved large involvement in promotion and the education of children and youth.

On the basis of the initiative mentioned earlier, the Project *The protection of breeding birds in the Lower Odra by creating breeding grounds ensuring safe incubation and rearing of brood* (2017-2019). The project responded to an important problem of annual, almost complete losses of breeding species considered endangered and inscribed into the national and European red lists and protected by the Birds Directive.

The aim of the Project *Jewelweed – an invasive alien species – an inventory, spreading and combating methods* (2014-2016), was to identify the sites of jewelweed *(Impatiens glandulifera),* its spreading pathways and the most effective methods for reducing its population.

6.6.7. Protection of the Baltic Coast

In recent years, as part of the *Programme for Seashore Protection*, projects were carried out to implement artificial beach nourishment, to build, repair and maintain permanent shore reinforcements and to monitor the seashore. The performance indicator for the Programme in a given year is the length of the seashore protected against erosion and coastal flooding, expressed in km.

The scope of the measures carried out by the Maritime Office in Gdynia included:

- the reinforcement of the shore of the Vistula Lagoon at Piaski – a wooden palisade with stone rip-rap facing the water with the crown elevation of +1.2 m a.s.l., the length of the reinforcement 372 m, the reinforcement is an extension of the existing palisade to the west; the existing palisade was extended, the shore was reinforced, thus, securing the regional road No. 501 nearby from Krynica to Nowa Karczma;
- the flood protection of Kąty Rybackie – a ferroconcrete retaining wall on a vinyl sheet piling with the crown elevation of +2.30 m a.s.l., length 109.09 m, the protection structure is an extension of the existing flood protection of the port; by filling in a gap, a comprehensive flood protection structure was built for Kąty Rybackie facing the Vistula Lagoon;
- the repair and restoration of the shore reinforcements in the area of Gdynia Oksywie: a ferroconcrete retaining wall with stone rip-rap facing the water and a service road from concrete cubes, with the crown elevation of +3.00 m a.s.l., length 1,600 running metres;
- the flood protection of Krynica Morska – a flood protection earth wall with an anti-filtration diaphragm from vinyl sheet piling and a system of mobile flood protection barriers at the fishing and passenger ports, with the crown elevation of +2.50 m a.s.l., length about 4 km;
- the protection of the seashore in the area of the Hel Peninsula: the removal of old spurs and the construction of new spurs in the terrestrial part from plastic and in the water part from wood over about 12 km.

The seashore protection was implemented over 61.16 km. The total implementation cost of these projects was PLN 110.6 million[66].

In the period from 2014 to 2021, the Maritime Office in Szczecin, together with the Maritime Office in Słupsk (on 1 April 2020 its jurisdiction fell within the competence of the Maritime Office in Szczecin) initiated or implemented the measures to stabilise the seashore and to prevent erosion, the waning of beaches and the degradation of cliffs in the form of artificial beach nourishment at different sections of the shore:

- The artificial beach nourishment at Niechorze (km 368.15-368.85), Międzywodzie (km 391.80-392.80), Rewal (km: 369.70-370.20) and Wicie (km: 260.00 – 261.19);
- The artificial beach nourishment at Mrzeżyno (km 351.60 – 352.20 and km 350.95 – 351.60) and Niechorze (km: 366.00 – 367.00);
- The artificial nourishment: the shore reinforcements between Niechorze and Rewal (km: 368.55-369.70);
- The artificial beach nourishment at Międzywodzie (km 392.80 – 394.00);
- The artificial beach nourishment at Darłówko (km 268.30-270.20), Kołobrzeg (km 333.30- 334.00), Ustronie Morskie (km 321.60-323.00), Jarosławiec (km 255.32-255.56 and km 255.485-255.73), Wicie (km 260.65-261.15).

[66] Funded from the Programme for Seashore Protection, with PLN 91 million from the POIiŚ 2014-2020

As a result of the measures, 33.685 km of the seashore were secured and 1,425,101 m³ of material was dredged and delivered. The total cost was PLN 182,805,043 (funded from the Programme for Seashore Protection, with PLN 174,488,351 from the POIŚ 2014-2020).

The adaptation measures in the Polish Baltic zone aim at the protection of vulnerable coastal areas against the flood risks related to the rise of the Baltic waters and ensuring the stabilisation of the coastline: beaches, cliffs and dunes against sea erosion.

The moderately erosion prone dune shore can be protected by using erosion fences or fascine bundles on dunes which better capture the wind-borne sand on beaches, thus fostering the dune restoration after the storm season (in the autumn and winter). The additional protection is provided by the plantings of special grass species on the crown of the dunes. An example of such shore protection applying the principle of cooperation with nature is the model shore section between Lubiatowo and Białogóra, administered by the Maritime Office in Gdynia.

The dunes with a gabion core are restored on a strongly erosion prone shore after their almost complete destruction, from the sand delivered to the shore in the process of artificial beach nourishment. In order to ensure better protection for the hinterland, baskets of zinc coated wire, additionally covered by PVC, and densely filled with stones with a diameter from several to a dozen or so cm, are built into newly shaped dunes. The cores serve as the last line of defence of the shore against rupture and can withstand the wave pressure for a long time during a storm when the dune material is washed away. An example of the application of this solution are the dunes at the base of the Hel Peninsula which is strongly and very strongly erosion prone (the area is administered by the Maritime Office in Gdynia).

6.6.8. Renaturalisation of water ecosystems

The aim of the measures to restore the original water regime is to improve the ecological status of rivers. The renaturalisation measures improve water quality and create favourable living conditions for fauna and flora. Quite often, the enhanced retention capacity improves safety in areas previously at risk of flooding. Through the gradual restoration of the natural water system, the measures under the Project "*Renaturalisation of the hydrographic network in the Central Basin of the Biebrza valley*" made it possible to halt the process of degradation of peat soil and to restore the specific habitat conditions preferred by the breeding bird populations characteristic of open grassy floodplains. The restoration of the natural hydrological regime as a result of the implementation of the Project "*Renaturalisation of the inland delta of the Nida River*" created the conditions for the restoration of the unique natural values within the middle Nida delta.

As part of the Operational Programme Infrastructure and Environment 2014-2020, the Project "*Protection of habitats and species of non-forest water-dependent areas*" is carried out by the GDOŚ in cooperation with 11 Regional Directorates for Environmental Protection. The aim of the Project is to improve the conservation status of the habitat types and species covered by the Project measures in non-forest water-dependent areas the state preservation of which has been assessed as unsatisfactory or bad in the planning documents. The Project includes measures of key importance for restoring the favourable conservation status or halting a negative change trend.

6.6.9. Building the knowledge and raising the awareness of adaptation

Many initiatives were launched to build the knowledge of climate change and to disseminate it among the public, including the projects and measures presented in the National Communication.

Under the Project KLIMADA 2.0, i.e. the Knowledge base on climate change and adapting to climate change impacts, together with knowledge dissemination channels, to strengthen economic, environmental and societal resilience as well as to support the management of extraordinary risks associated with climate change, implemented by the IOŚ-PIB, a portal was launched to address climate change, also making available climate scenarios, the assessment of the climate change risks, the best adaptation practices, as well as the legal and economic aspects. The aim of the development of the knowledge of climate change and its effects is to improve the efficiency and effectiveness of adaptation measures in the sectors vulnerable to climate change.

As part of the initiative "*Climate-friendly Cities*" of the Ministry of Climate and Environment, city workshops were held in 2020 as a series of discussions with self-governments and nongovernmental organisations on the common vision of a climate friendly and neutral city and the tools to support the transition of cities. As a result of the analysis of the progress and potential of cities in the context of the climate and environmental transition as carried out in 2021, the title of Climate-friendly City was conferred to 5 cities. The cities thus distinguished were invited to cooperate in the programme for strategic guidance on the energy transition and adaptation to climate change to be provided by experts from institutes subordinated to the Ministry of Climate and Environment: the Institute of Environmental Protection - NRI, the Institute for Ecology of Industrial Areas, the Forest Research Institute and the National Centre for Nuclear Research. As a result, Climate Transition Roadmaps will be prepared for 15 cities. A series of meetings was devoted to the issues of indicators on urban greenery, nature compensation in cities, the green citizens' budget or the preparation of urban adaptation plans. A part of the budget of the Programme (more than PLN 157 million) was allocated to grants for the implementation of blue-green infrastructure projects, the removal of impermeable surfaces and the sustainable management of rainwater systems, including retention in urban ecosystems.

Self-governments and nongovernmental organisations play a large role in the dissemination of the knowledge of adaptation to climate change. Guides to blue-green infrastructure are prepared, containing guidance and examples of solutions to be followed by the persons and institutions responsible for space development. There are many examples of publications promoting the application in practice of measures to make use of the values of the environment to mitigate the problems of excess rainwater, a water shortage or an urban heat island; among others, it is important to mention "*The catalogue of blue-green infrastructure. Part II. Guidelines and solutions*" of the Bydgoszcz Municipal Water and Wastewater Company, the practical guide "*The catalogue of good practices, Part II. The principles of the sustainable rainwater management in a built-up area*" from Wrocław, "*The valuable rainwater – a short guide to how to retain it in an allotment garden*" prepared by the Łódź Infrastructural Company or "*Addressing Climate Change in Cities. Catalogue of Urban Nature-Based Solutions*" published by the Ecologic Institute and the Sendzimir Foundation.

CHAPTER 7. FINANCIAL, TECHNOLOGICAL AND CAPACITY-BUILDING SUPPORTSUPPORT

7.1. Commitments under Articles 4.3, 4.4 and 4.5 of the UNFCCC

In accordance with their commitments under the UNFCCC, developed countries (listed in Annex II to the Convention) are obliged to provide financial support to developing countries (in accordance with Article 4.3 of the Convention). In the case of developing countries which are particularly vulnerable to the adverse effects of climate change, funding should also be provided for adaptation to these effects (Article 4.4 of the Convention). At the same time, all developed countries should take action to promote, facilitate and finance the transfer of, or access to, mitigation and adaptation technologies and know-how to implement the provisions of the Convention and the Kyoto Protocol (Article 4.5 of the Convention). Poland is not listed in Annex II to the UNFCCC; therefore, it is not obliged to fulfil the commitments under Articles 4.3, 4.4 and 4.5 of the Convention. Since it acceded to the European Union in 2004, Poland has implemented a substantial number of assistance programmes and actions voluntarily, making its contribution in accordance with the provisions of Article 9.2 of the Paris Agreement.

7.2. Development cooperation

Fulfilling its international commitments and fully understanding the need to support sustainable development at the global level, Poland takes action to provide assistance to developing countries or their societies, in accordance with the principle of international solidarity. Poland carries out many assistance projects in developing countries and those with economies in transition by making financial assistance available through bilateral and multilateral channels as part of official development assistance (ODA). This assistance is provided under the Act of 16 September 2011 on Development Assistance[67], on the basis of the framework laid down in "*The multiannual development assistance programme for the period from 2016 to 2020*" (WPWR 2016-2020) and annual development assistance plans. These programmes include development and humanitarian assistance with their thematic scope and geographical range specified each time for a given programming period. A successive multiannual development assistance programme for the period from 2021 to 2030 was prepared and adopted in January 2021.

Table 7.1. Poland's total official development assistance (grant equivalent) in the period from 2016 to 2021 (in constant 2020 prices)

Year	Net ODA (in PLN)	Net ODA (in USD)	ODA grant equivalent (in PLN)	ODA grant equivalent (in USD)
2016	2 927 823 970	742 578 014		
2017	2 705 836 595	715 956 121		
2018	2 728 083 175	755 342 452	2 752 734 313	762 167 776
2019	2 995 064 406	780 091 657	3 056 183 347	796 010 639
2020	3 166 395 517	811 950 000	3 233 861 054	829 250 000
2021	3 459 319 734	895 751 963	3 504 546 574	907 462 945

USD/PLN exchange rate according to the OECD (2022), Exchange rates (indicator). doi: 10.1787/037ed317-en (access on 2 July 2022)
Source: OECD Report

Table 7.1 shows the values of the Polish official development assistance in the particular years covered by the Communication. The data on the particular years indicate a growing trend (Fig. 7.1).

[67] Official Journal of the Laws of 2019, Item 291, as amended

The average rate of ODA as a percentage of the Gross National Income (ODA/GNI) in the period from 2016 to 2020 was about 0.14% (Fig. 7.2).

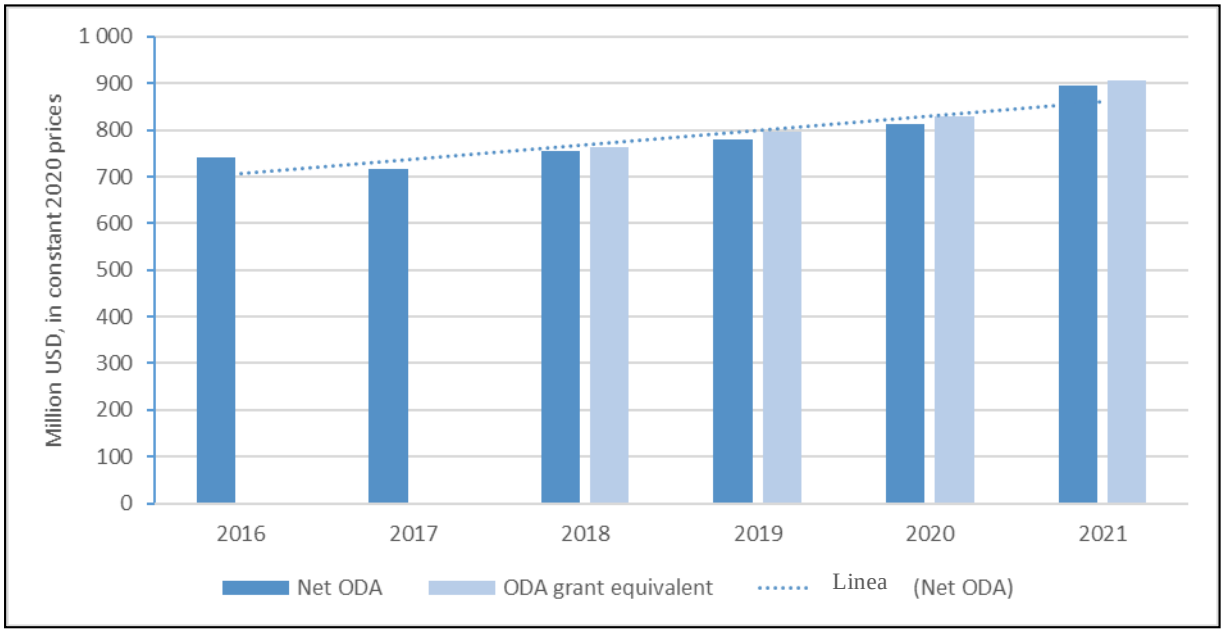


Fig. 7.1. Poland's total official development assistance (grant equivalent) in the period from 2016 to 2021
Source: OECD Report[68]

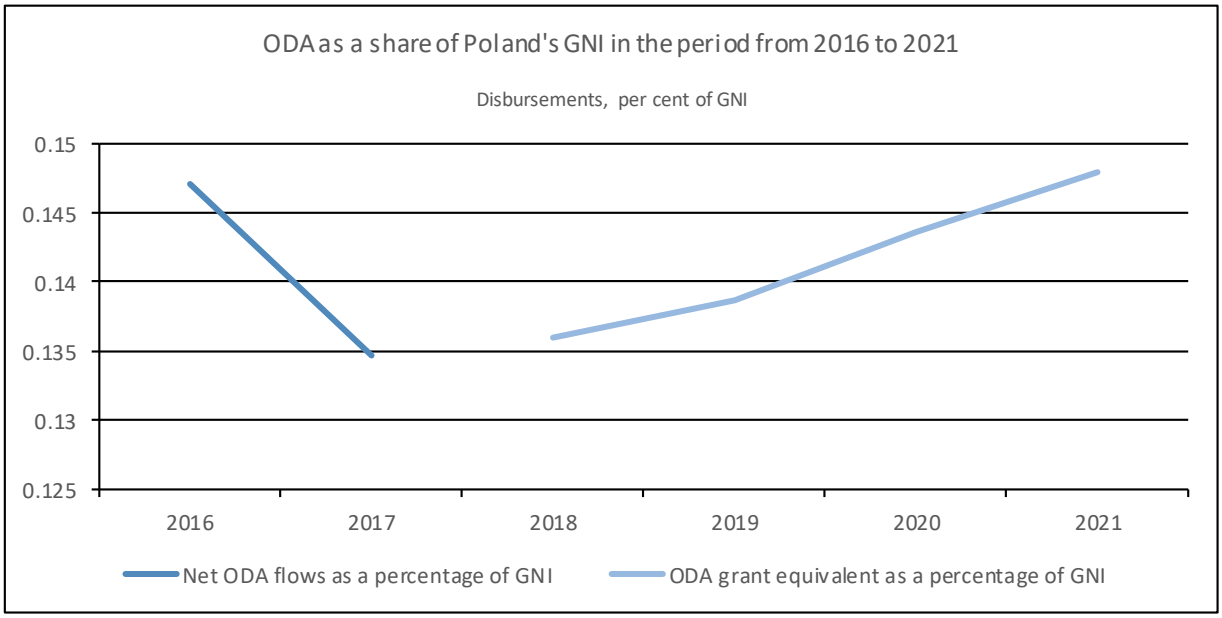


Fig. 7.2. Total official development assistance as a percentage of Poland's GNI in the period from 2016 to 2021
Source: OECD Report

The Polish institutions involved in the provision of financial support to developing countries for climate change mitigation and adaptation include, among others: the Ministry of Foreign Affairs (MSZ), the Ministry of Climate and Environment (MKiŚ), the Ministry of Finance (MF), the Ministry of Agriculture and Rural Development (MRiRW), the Ministry of Health (MZ), the Ministry of Family and Social Policy (MRiPS), the Ministry of Economic Development (MR), the Ministry of the Interior and Administration (MSWiA), the Ministry of Digitisation (MC), the Ministry of Infrastructure (MI), the

[68] Development Co-operation Profiles – Poland (oecd-ilibrary.org): https://www.oecd-ilibrary.org/sites/e3ce3d47-en/index.html?itemId=/content/component/5e331623-en&_csp_=b14d4f60505d057b456dd1730d8fcea3&itemIGO=oecd&itemContentType=chapter

Ministry of Maritime Economy and Inland Navigation (MGMiŻŚ), and the Ministry of Culture and National Heritage (MKiDN).

Table 7.2 Bilateral and multilateral assistance provided in the period from 2016 to 2020

Bilateral and multilateral assistance provided in the period from 2016 to 2020											
In million		2016		2017		2018		2019		2020	
Bilateral assistance	PLN	589.84	*22.54%*	839.42	*32.69%*	884.55	*31.97%*	857.00	*28.75%*	877.00	*27,13%*
	USD	149.59		222.20		244.80		223.21		224.91	
Multilateral assistance	PLN	2 027.11	*77.46%*	1 728.47	*67.31%*	1 881.95	*68.03%*	2 124.00	*71.25%*	2 356.00	*72,87%*
	USD	514.09		457.55		520.83		553.20		604.21	

USD/PLN exchange rate according to the NBP, annual weighted averages of foreign currencies in PLN (Table A)
Source: Ministry of Foreign Affairs

Bilateral ODA

In accordance with the WPWR 2016-2020, Poland implements its bilateral development cooperation within the framework of its geographical and thematic priorities[69]. The thematic priorities of the WPWR 2016-2020 include, among others, sustainable development and rural development, in particular food security, productivity and competitiveness of agricultural production, access to sales markets, the use of advanced technologies in agriculture, modernisation of local infrastructure and environmental protection, in particular renewable energy sources, energy efficiency, water management, waste management, prevention of the effects of natural disasters and human-induced catastrophes, the promotion of sustainable development, the tackling of climate change and its effects, and the conservation of natural resources.

Within the scope of the geographical priorities set out in the WPWR 2016-2020, Poland's bilateral development cooperation focuses on the partner countries in Eastern Europe and the selected partner countries in Africa and Near East. Table 7.3 presents the main directions of Poland's development assistance in the period from 2016 to 2020, including the priority countries and the countries from the TOP 10 group[70]. In accordance with the programme, the climate-related bilateral assistance is provided primarily to African countries (Ethiopia, Kenya, Senegal and Tanzania).

Table 7.3. Directions of Poland's development assistance in the period from 2016 to 2020

Year	Directions of Poland's development assistance in the period from 2016 to 2020	
	Priority countries	Other countries from the TOP 10 group
2016	4 Eastern Partnership countries (Belarus, Georgia, Moldova and Ukraine), 4 African countries (Ethiopia, Kenya, Senegal and Tanzania), Myanmar and Palestine	Syria, China, Angola, Serbia
2017		Turkey*, China, Syria, Lebanon, Serbia, Iraq
2018		Turkey*, Lebanon, Syria, Iraq, Jordan
2019		Turkey*, India, Mongolia, China, Iraq
2020		Turkey*, India, Mongolia, China, Lebanon, Albania, Nigeria

* including the contribution to the EU Facility for Refugees in Turkey
Source: Ministry of Foreign Affairs

[69] The programme for the period from 2016 to 2020 is a continuation of the previous multiannual development cooperation programme for the period from 2012 to 2015. The programme is prepared for periods of at least 4 years. It was last updated in 2018

[70] The countries other than the priority ones which are included in the top ten in terms of the value of the bilateral development assistance in a given year

Multilateral ODA

In the period from 2016 to 2020, the multilateral cooperation within the framework of which development projects and programmes were implemented represented about 75% of the official development assistance provided by Poland to developing countries. Fig. 7.3 shows the changes in the proportions between Poland's bilateral and multilateral assistance in the particular years covered by the Communication.

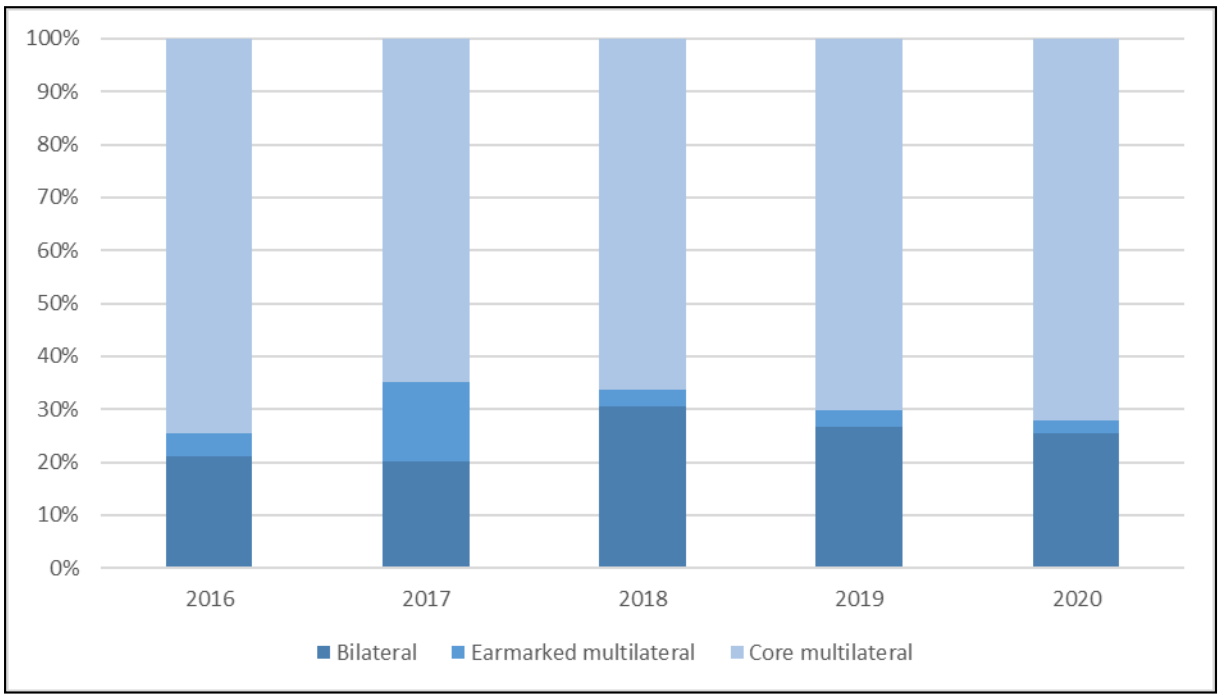


Fig. 7.3. Percentage shares of the particular types of Poland's official development assistance in the period from 2016 to 2020
Source: OECD Report

The most important channel, representing about 90% of the value of the assistance, which Poland uses to provide multilateral assistance is the European Union, by way of a contribution to the EU budget (a part of which is earmarked for external EU development assistance) and by way of contributions to the European Development Fund (EDF), which is the main extra-budgetary EU facility for funding its cooperation with the countries in Africa, the Caribbean and Asia-Pacific (APAC) regions, and the overseas countries and territories (OCT). In addition, the multilateral cooperation is implemented by way of contributions to the core budgets of international organisations, primarily the institutions of the United Nations System, the Organisation for Security and Cooperation in Europe (OSCE), the World Bank Group and other multilateral development finance institutions.

As part of one of the selected directions of its development assistance which is environmental protection, including the tackling of climate change and its effects, Poland provides financial assistance to organisations taking climate action, such as: the UNFCCC, UNCCD, UNEP, IAEA-TCF, UNECE-LRTAP, CITES, WMO, IRENA, EPPO, IUCN, World Bank, AIIB and BRRE.

7.3. Information concerning the minimisation of the adverse impacts of climate change in accordance with Article 3.14 of the Kyoto Protocol

In general, the Polish assistance provided for actions to minimise the adverse impacts of climate change in the period covered by the Communication systematically grew[71]. The contributions to international organisations dealing with the issues related to climate protection, environmental protection and the energy sector were included in the category of climate action.

Table 7.4. Poland's climate-related assistance in the period from 2016 to 2020

Year	Climate-related assistance		Including	PLN	USD
	PLN	USD			
2016	23 465 950	5 951 143	Multilateral	14 217 145	3 605 576
			Bilateral	9 248 805	2 345 567
2017	18 219 685	4 822 957	Multilateral	10 352 982	2 740 552
			Bilateral	7 866 703	2 082 405
2018	210 926 077	58 373 298	Multilateral	12 848 910	3 555 906
			Bilateral	198 077 166	54 817 393
2019	55 374 714	14 422 376	Multilateral	27 144 642	7 512 216
			Bilateral	28 230 072	7 812 606
2020	80 199 003	20 567 539	Multilateral	32 049 645	8 219 333
			Bilateral	48 149 358	12 348 206

USD/PLN exchange rate according to the NBP, the annual weighted averages of foreign currencies in PLN (Table A)
Source: Poland's reports submitted to the EC under Article 16 of MMR, EIONET

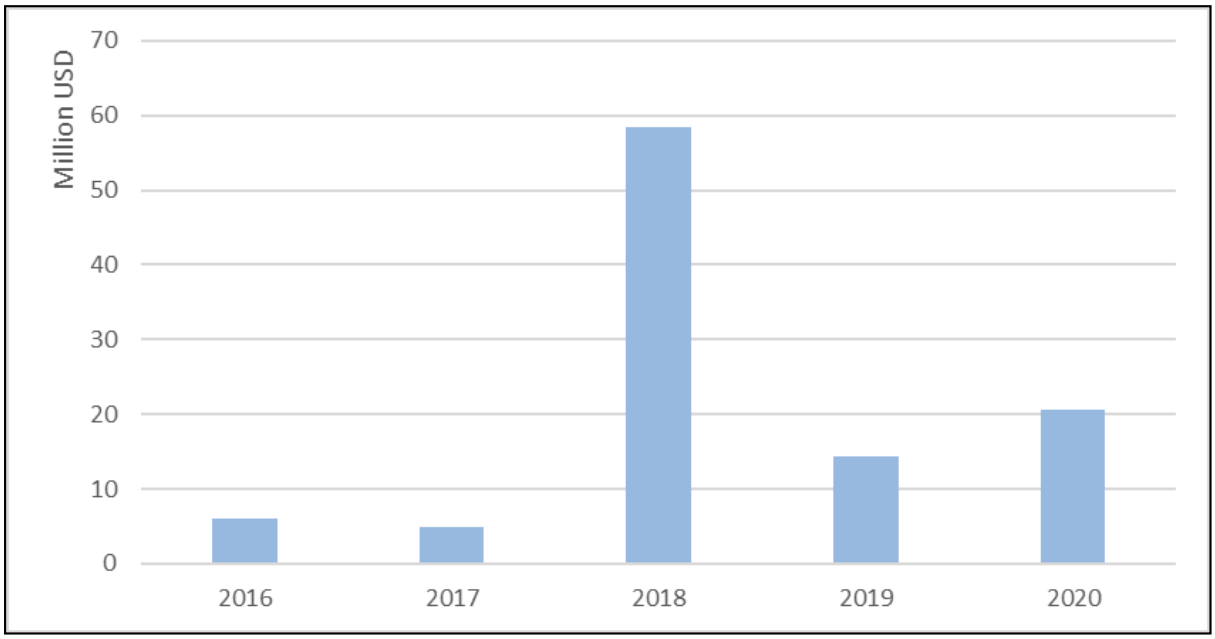


Fig. 7.4. Amounts disbursed by Poland on the climate-related official development assistance
Source: KOBiZE IOŚ-PIB on the basis of Poland's reports submitted to the EC under Article 16 of MMR, EIONET

As a total, in the period covered by the Communication Poland provided more than PLN 289 million (USD 78 million) for the climate-related development assistance[72]. Most of the resources were allocated to adaptation to climate change (82%), with only a relatively small part of them earmarked

[71] The substantial difference found in 2018 resulted from Poland's funding in the form of a preferential loan for Myanmar in an amount of PLN 181.4 million (USD 50.2 million)

[72] The financial data on the Polish climate-related development assistance in the period from 2016 to 2020 were defined in a foreign currency, with USD/PLN conversion according to the NBP, the annual weighted averages of foreign currencies in PLN (Table A)

for climate change mitigation (6%). The other part of Poland's climate-related support was provided for cross-cutting issues (11%). All the flows in the particular years covered by the Communication were classified as ODA. The categorisation of climate support between adaptation and mitigation was based on a description of Rio markers; however, the Rio coefficients were not applied. The short OECD DAC purpose codes were used for the sector classification. The data were given as "*disbursed*", since all the reported flows were implemented during a given calendar year. In the reporting period, all the reported revenues came from public sources. Table 7.5 shows specific information on the funding of climate action by particular climate action type.

Table 7.5. Funding of climate action provided by Poland as part of its official development assistance in the period from 2016 to 2020 by climate action type.

Funding of climate action provided by Poland as part of its official development assistance in the period from 2016 to 2020 by climate action type											
	Year	PLN	USD		Year	PLN	USD		Year	PLN	USD
Adaptation to climate change	2016	4 543 189,41	1 152 187,22	Mitigation	2016	4 521 036,16	1 146 568,98	Cross-cutting issues	2016	184 579,56	46 810,77
	2017	6 302 262,89	1 668 280,41		2017	1 264 847,96	334 819,59		2017	299 591,76	79 305,33
	2018	195 288 889,95	54 045 743,61		2018	1 720 176,13	476 054,72		2018	1 068 100,32	295 594,27
	2019	10 530 124,50	2 742 577,03		2019	7 971 222,56	2 076 109,54		2019	8 643 295,19	2 251 151,24
	2020	21 234 820,90	5 445 803,32		2020	2 806 580,79	719 765,29		2020	23 075 609,29	5 917 885,08
Total		**237 899 287,65**	**65 054 591,59**	*Total*		**18 283 863,60**	**4 753 318,12**	*Total*		**33 271 176,12**	**8 590 746,69**
Share		*82,19%*		*Share*		*6,32%*		*Share*		*11,49%*	

USD/PLN exchange rate according to the NBP, the annual weighted averages of foreign currencies in PLN (Table A)
Source: Poland's reports submitted to the EC under Article 16 of MMR, EIONET

In 2016, the value of the climate-related development assistance provided by Poland was almost PLN 23.5 million (USD 6 million). This assistance, provided in the form of grants, covered the issues of both adaptation to climate change, amounting to PLN 4.5 million (USD 1.15 million), and mitigation, amounting to PLN 4.5 million (USD 1.15 million). The other assistance covered cross-cutting issues: PLN 185,000 (USD 47,000). Its main beneficiaries included: Ethiopia, Ukraine, Tanzania, West Bank and Gaza Strip, Georgia, Moldova, Kenya, Myanmar, Nigeria, Iraq and Indonesia.

In 2017, Poland provided in the form of grants the climate-related development assistance of more than PLN 18 million (USD 4.8 million). Most of the bilateral assistance was provided for the issues of adaptation to climate change, amounting to PLN 6.3 million (USD 1.67 million), whereas the other assistance was allocated to mitigation, amounting to PLN 1.3 million (USD 335,000) and cross-cutting issues, amounting to PLN 300,000 (USD 79,000). This assistance went to: Ukraine, West Bank and Gaza Strip, Kenya, Georgia, Ethiopia, Tanzania, Moldova, Togo, Kyrgyzstan, Pakistan, Macedonia, Morocco, Armenia, Papua New Guinea, Zimbabwe, Indonesia, Nicaragua, Iran and Serbia.

In turn, in 2018 Poland provided the climate-related development assistance amounting to almost PLN 211 million (USD 58.4 million), including bilateral assistance amounting to PLN 29.5 million (USD 8.2 million) in the form of grants and PLN 181.4 million (USD 50.2 million) in the form of preferential loans. Most of the funding was allocated to adaptation to climate change, amounting to PLN 195.3 million (USD 54 million), with its other part provided for mitigation, amounting to PLN 1.7 million (USD 476,000) and cross-cutting issues, amounting to PLN 1.1 million (USD 296,000). Myanmar was the beneficiary of a preferential loan, while the assistance in the form of grants was provided to: Kenya, Jordan, Ukraine, Palestine, Belarus, Iraq, Tanzania, Georgia, Senegal, Somalia, Philippines, Kyrgyzstan, Moldova, Lebanon, Angola, Zimbabwe, Macedonia, India and Serbia.

In 2019, Poland's climate-related development assistance amounted to PLN 55.4 million (USD 14.4 million). The bilateral assistance was given only in the form of grants. In thematic terms, it was allocated for the purposes of adaptation to climate change, amounting to PLN 10.5 million (USD 2.7 million), cross-cutting issues, amounting to PLN 8.6 million (USD 2.3 million) and mitigation of climate

change, amounting to PLN 8 million (USD 2.1 million). The countries awarded the assistance included: Ukraine, Georgia, Moldova, Palestine, Kenya, Myanmar, Iraq, Lebanon, Jordan, Uganda, Tanzania, Kyrgyzstan, Cambodia, Papua New Guinea, Republic of South Africa and Belarus.

In 2020, Poland provided the climate-related development assistance amounting to PLN 80.2 million (USD 20.6 million). In this case, too, the bilateral assistance was given only in the form of grants. The assistance was allocated mainly to cross-cutting issues, amounting to PLN 23.1 million (USD 5.9 million), followed by adaptation to climate change, amounting to PLN 21.2 million (USD 5.4 million) and mitigation, amounting to PLN 2.8 million (USD 720,000). The beneficiaries of the Polish assistance in 2020 included: Albania, Georgia, Ukraine, Sudan, Lebanon, Moldova, Belarus, Myanmar, Senegal, Republic of South Africa and Uganda.

Fig. 7.5 shows Poland's climate-related development assistance in the period from 2016 to 2020 by geographical region. Poland's bilateral assistance went mainly to developing countries in Europe, Asia and Africa, as well as to other developing countries.

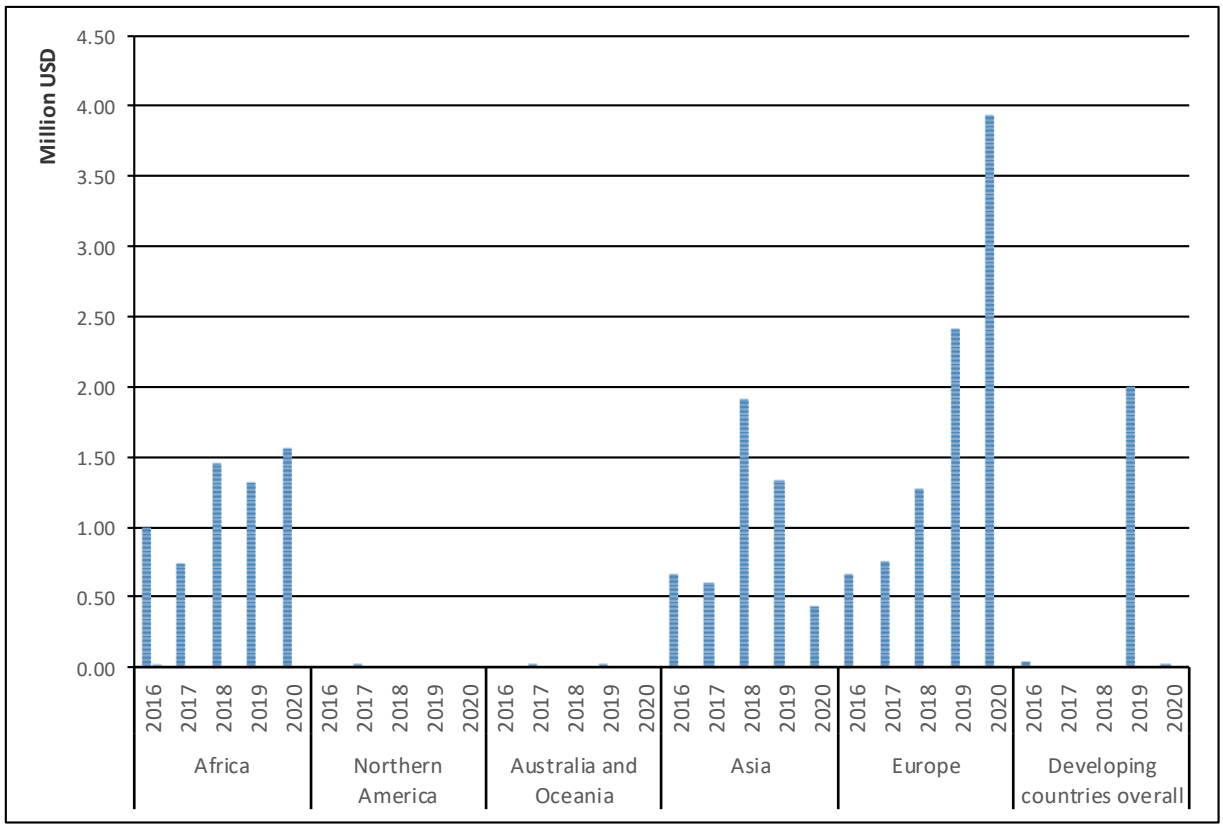
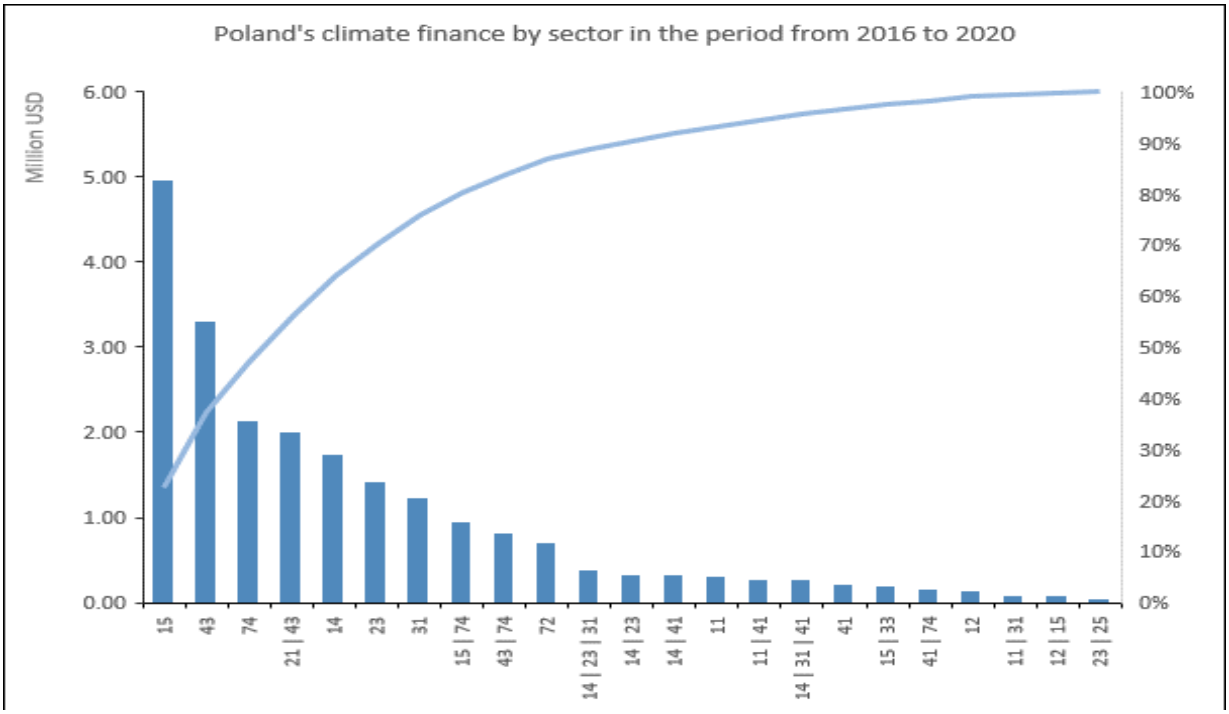


Fig. 7.5. Poland's climate finance in the period from 2016 to 2020 by geographical region[73].
Source: IOŚ-PIB on the basis of data from the Ministry of Foreign Affairs

In general, the support areas covered a wide range of actions, including, among others, basic water supply and management, fire and rescue services, disaster prevention, an exchange of experiences related to climate policy, promotion of awareness, waste management/disposal, environmental policy and administrative management and solar energy production. Fig. 7.6 shows by sector the climate finance provided by Poland in the period from 2016 to 2020[74].

[73] This diagram does not take into account the funding for Myanmar (Asia) in the form of a preferential loan amounting to PLN 181.4 million (USD 50.2 million) in 2018

[74] The OECD DAC purpose codes were used for the sector classification
See http://www.oecd.org/dac/stats/purposecodessectorclassification.htm



OECD DAC purpose codes	Sector	PLN	USD
11	Education	1 258 817.26	319 423.32
12	Health	567 345.30	145 499.27
14	Water supply and sanitation	6 470 197.31	1 736 544.87
15	Fire and rescue services	19 154 707.40	4 974 129.39
23	Energy	5 462 971.24	1 429 370.98
31	Forestry	4 717 499.38	1 237 921.77
41	General environmental protection	858 836.90	217 839.26
43	Other multisector	12 578 269.77	3 316 324.43
72	Emergency response	2 740 276.34	710 111.70
74	Disaster prevention and preparedness	8 210 002.61	2 148 463.31
11 | 31	Education / Agriculture	369 009.99	94 634.93
11 | 41	Education / General environmental protection	1 091 937.76	280 034.30
12 | 15	Health / Fire and rescue services	300 144.17	76 973.86
14 | 23	Water supply and sanitation / Energy	1 299 468.59	339 723.83
14 | 23 | 31	Water supply and sanitation / Energy / Agriculture	1 480 594.31	379 707.72
14 | 31 | 41	Water supply and sanitation / Forestry	1 084 853.83	278 217.59
14 | 41	Water supply and sanitation / General environmental protection	1 193 620.21	330 331.60
15 | 33	Fire and rescue services / Tourism	764 632.92	196 094.92
15 | 74	Fire and rescue services / Disaster prevention and preparedness	3 568 705.41	945 907.99
21 | 43	Transport and storage / Other multisector	7 678 806.80	1 999 949.68
23 | 25	Energy / Business and other services	220 639.16	57 465.60
41 | 74	Water supply and sanitation / Disaster prevention and preparedness	644 685.30	167 908.66
43 | 74	Other multisector / Disaster prevention and preparedness	2 946 170.14	815 345,70
TOTAL		**84 662 192,11**	**22 197 924.67**

Fig. 7.6. Climate finance provided by Poland in the period from 2016 to 2020 by sector
Source: KOBiZE IOŚ-PIB on the basis of data from the Ministry of Foreign Affairs

Poland also allocated resources to promote technological development in developing countries. In the period from 2016 to 2020, the resources were provided for the transfer of technology as part of the GreenEvo – Green Technology Accelerator (AZT) Programme. It was an innovative programme of the Ministry of Climate and Environment, designed to create favourable conditions for the dissemination of environmental protection technologies offered by Polish entrepreneurs in Poland and abroad.

The GreenEvo AZT Programme was launched in 2009 as a result of the findings at the 14th United Nations Conference on Climate Change (December 2008). Its main purpose was to assist Polish small and medium-sized enterprises (SMEs) in entering into international contacts and to provide them with indispensable tools to enable their dynamic development. The actions taken as part of the Programme comprehensively stimulated the development and strengthened the position of advanced green technologies in the process of building the circular economy.

Discerning the potential of Polish companies on the market of environmentally friendly technologies, the Ministry of Climate and Environment tried to support as effectively as possible the development and promotion of green entrepreneurs. During the implementation of the GreenEvo AZT Programme, companies had an opportunity to participate in meetings with potential partners from such countries as Argentina, Bosnia and Herzegovina, Botswana, Chile, China, Cyprus, Egypt, Georgia, India, Iran, Canada, Kazakhstan, Costa Rica, Cuba, Morocco, Mexico, Moldova, Mongolia, Nigeria, RSA, Senegal, Serbia, Tajikistan, Thailand, Ukraine, USA, Great Britain, Vietnam, and United Arab Emirates. In the last three years (2019-2021), the present winners of the Programme signed more than 100 sales contracts with Polish entrepreneurs and more than 90 sales contracts with foreign trade partners. The entrepreneurs declared that in most cases the fact that they had participated in the GreenEvo AZT Programme contributed to the conclusion of specific contracts. The most frequently concluded contracts concerned the sales of technologies responding to the request of a specific customer and including a price quotation. In addition to the conclusion of contracts, the Programme also enabled the launch of pilot projects to implement technologies in the country of the interested trade partner.

Moreover, just as in the case of financial assistance, Poland participated in the funding of EU projects and programmes intended to support the development and transfer of technology by way of contributions to the EU assistance budget, i.e. to the European Development Fund (EDF). In the period from 2014 to 2020, the 11th edition of the EDF was implemented. Examples of projects included the support for the Climate Technology Centre & Network (CTCN) and the flagship EU initiative Switch to Green, including Switch Asia, Switch Africa Green and SwitchMed.

CHAPTER 8. RESEARCH AND SYSTEMATIC OBSERVATIONS

8.1. Research and systematic observation policy and the funding system

8.1.1. Climate research in the national science policy

On 30 October 2008, the National Research and Development Programme was adopted as an instrument to facilitate the implementation of the national science and technology policy aligned with the levels of European and world standards. The issues of climate change mitigation and adaptation were included in two of the five priority research areas:

- Energy and infrastructure. Research directions: the efficient use of domestic fossil raw materials resources ensuring environmental security; the development of alternative energy sources, such as renewable, nuclear and hydrogen-based sources, and new technologies leading to increased reliability and efficiency of energy generation, processing, storage and transmission;
- Environment and agriculture. Research directions: the methods for environmental diagnoses and technologies for mitigating threats to climate, atmosphere and land surface; the development of technologies for acquiring satellite information on the environment and precise positioning.

On 1 October 2010, a package of 6 laws came into effect to reform the science system in Poland, including the Act of 30 April 2010 on the Principles of the Financing of Science. As a result of the reform of science, the Ministry of Science and Higher Education assumed the role of a leading centre for scientific policy development and coordination of activities in this field in Poland. The National Science Centre (NCN) and the National Centre for Research and Development (NCBiR) took over the tasks of creating programmes and funding research projects in the areas of fundamental research (NCN) and applied research (NCBiR).

The National Research Programme - The Assumptions of the National Science, Technology and Innovation Policies adopted in 2011 set out seven strategic directions of research and development:

1) New technologies in the field of energy;
2) Civilisation diseases, new pharmaceuticals and regenerative medicine;
3) Advanced information, telecommunications and mechatronic technologies;
4) Modern material technologies;
5) Environment, agriculture and forestry;
6) Social and economic development of Poland in the conditions of globalising markets;
7) State security and defence.

The issues of climate change and adaptation to climate change were addressed in three of the seven strategic, interdisciplinary directions of research and development:

- Environment, agriculture and forestry;
- New technologies in the field of energy;
- Modern material technologies.

On the basis of the strategic interdisciplinary directions of research set out, the NCBiR prepared five strategic programmes of research and development:

- Prevention and treatment of civilisation diseases – STRATEGMED;
- Environment, agriculture and forestry – BIOSTRATEG;
- Modern material technologies – TECHMATSTRATEG;
- Social and economic development of Poland in the conditions of globalising markets – GOSPOSTRATEG;
- Advanced information, telecommunications and mechatronic technologies – INFOSTRATEG.

The Act on Higher Education and Science adopted on 20 July 2018 significantly reorganised the higher education and science system in Poland. By creating the conditions for pursuing the research and didactic excellence, it was expected to ensure the sustainable development of research centres and to provide university-level schools with effective management tools. An important aspect of the Act was the introduction of an integrated system for the evaluation of the scientific achievements of institutions. Given the pivotal importance of its provisions, this Act was also called the Constitution of Science. This document contains the detailed guidelines defining the basis for the higher education and science system and sets out the scope of research activity. The activity includes:

- fundamental research understood to mean empirical or theoretical work, primarily intended to acquire new knowledge of the fundamentals of phenomena and observable facts, without the intent to use then for direct commercial purposes;
- applied research understood to mean the work for the purposes of acquiring new knowledge and competences with the intent to develop new products, processes or services, or to significantly improve them;
- development is the activity consisting of the acquisition, combination, shaping and use of the currently available knowledge and competences, including in the scope of IT tools or software, for production planning and the design and creation of changed, improved or new products, processes or services, excluding the activities including routine or periodical changes made to them, even if such changes have the nature of improvements.

In 2017, documents were adopted on the national environmental policy, including those on the protection of air and water resources, and climate change mitigation. On 14 February 2017, the Strategy for Responsible Development until 2020 (with an Outlook until 2030) was adopted and on 16 July 2019 so was the National Environmental Policy, setting out the development strategy in the areas of the environment and water management.

On 30 December 2019, the Minister of State Assets submitted the National Energy and Climate Plan for 2021-2030 (NECP) to the European Commission. This fulfilled the obligation imposed on Poland by the provisions of Regulation (EU) 2018/1999 of the European Parliament and of the Council. This Plan presented the assumptions and objectives as well as policies and measures designed to implement the five dimensions of the Energy Union, i.e. (1) energy security; (2) the internal energy market; (3) energy efficiency; (4) decarbonisation; and (5) research, innovation and competitiveness.

The NECP was prepared taking into account the conclusions from interministerial and public consultations, as well as the conclusions from the regional consultations and the Commission Recommendation C(2019) 4421 of 18 June 2019. The document was prepared on the basis of the national development strategies approved at the Government level (among others, the Sustainable Transport Development Strategy until 2030, the 2030 National Environmental Policy and the Strategy for the Sustainable Development of Rural Areas, Agriculture and Fisheries 2030) and taking into account the draft Energy Policy of Poland until 2040.

On 2 February 2021, the Government adopted the new strategic document called the Energy Policy of Poland until 2040, which replaced the Energy Policy of Poland until 2030 previously in effect. Its provisions primarily set out the directions of the development of the Polish fuel and energy sector. Their aim is the energy security of the country, while ensuring the competitiveness of the economy, energy efficiency and a decreased impact of the energy sector on the environment, along with the optimum use of the own energy resources. The Strategy is based on 3 pillars: (I) just transition, (II) the building of a parallel, zero-carbon energy generation system, and (III) good air quality.

As part of its operations, the NFOŚiGW implements its priority programmes, including those

related to adaptation to climate change, among others:

1) Adaptation to climate change and protection of waters against pollution. Water and wastewater management in agglomerations (since 2017);
2) Adaptation to climate change and protection of waters against pollution. Water and wastewater management in industrial plants (since 2021);
3) Good air quality. Clean Air (since 2018);
4) Support of the Minister of Climate and Environment in the implementation of climate and environmental policy. Part 1) Expert analyses, studies and the implementation of international commitments (since 2019);
5) Climate-friendly Resorts. Part 1) Adaptation to climate change (since 2021);
6) Environment, Energy and Climate Change (since 2020).

As part of the existing programmes, among others, the NCBiR launched strategic research and development programmes. One of them was the BIOSTRATEG, the scope of which clearly includes analyses on climate change and its impacts on the environment and economy.

Environment, agriculture and forestry – BIOSTRATEG

The aim of the Programme implemented in the period from 2014 to 2019 was to stimulate the improvement of the innovativeness and competitiveness of the economy, to ensure the sustainable development of the agri-food sector and wood-based industry, with consideration given to environmentally friendly solutions, and to reduce the adverse impacts of civilisation phenomena and climate change.

The Programme consists of 5 research tasks, with Task 3 (see Section 8.2.5) directly addressing climate change mitigation and adaptation:

1) Food security and safety;
2) Rational management of natural resources with particular emphasis on water management;
3) Climate change mitigation and adaptation to climate change, with particular emphasis on agriculture;
4) Biodiversity conservation and the sustainable development of the agricultural production space;
5) Forestry and wood-based industry.

Other major projects related to the climate change issues include:

Generator of Ecological Concepts GEKON

It was implemented in the period from 2013 to 2018, as a joint project of the NCBiR and the NFOŚiGW to develop low-carbon environmental technologies (including the co-financing of research, development and implementation). Funds were received by research and industrial consortia. PLN 400 million was allocated to the implementation of the whole programme (with PLN 200 million from the NFOŚiGW and the NCBiR each). The projects were implemented in 5 areas:

1) Environmental aspects of the supply of non-conventional gas;
2) Energy efficiency and energy storage;
3) Protection and rational use of water;
4) Energy supply from clean sources;
5) Novel technologies for the production of fuels, energy and materials from waste and recycled waste.

Moreover, as part of the Smart Growth Operational Programme (POIR), on the entrepreneurs' initiative, sectoral programmes were carried out to enable the implementation of large R&D projects in selected sectors. The sectoral programmes which were thematically related to broadly understood climate change mitigation included, among others: PBSE and IUSER (energy, including renewable

energy and energy efficiency), WOOD-INN (wood-based industry and furniture-making) and INNOVATIVE RECYCLING.

Table 8.1 shows the funding of the science budget (GERD) in the period from 2015 to 2020. At present, the science budget consists, among others, of the statutory activities of research units (including the grants for entities to maintain their research capacity, research fellowships, the Minister's programmes and target grants), the NCBiR, the NCN, the international research cooperation, the activity to disseminate science and EU resources (including, among others, the POIR, the POWER and Horizon 2020).

Table 8.1. Gross domestic expenditure on R&D (GERD)

Statistical data	2015	2016	2017	2018	2019	2020
Gross domestic expenditure on R&D (GERD) in PLN million	18 061	17 943	20 578	25 648	30 285	32 402
GERD as a percentage of the GDP	1.00	0.96	1.03	1.21	1.32	1.39

Source: GUS

8.1.2. Directions of the national research on climate change

The directions of climate research launched in the past were based on the documents and strategies mentioned earlier. A new document setting out the assumptions of the national science policy was submitted by the Minister of Education and Science and adopted by the Council of Ministers in July 2022. This document does not provide for completely new climate-related challenges, although its Section 4.3 entitled "*Natural resources and the environment*" includes to a substantial extent measures on weather, climate and broadly conceived environment. This is the case in particular with the last Section "*Energy and climate*" which provides for the launch of measures to limit the global air temperature rise in accordance with the Paris Agreement. It follows up on it by providing for the implementation of the European Green Deal (EGD), which will make Europe climate neutral by 2050. In order to achieve the decarbonisation target, the emissions need to be reduced in all the sectors, from industry and energy to transport and agriculture. In parallel to climate mitigation measures, action needs to be taken to adapt to the change underway.

The research now carried out corresponds with the assumptions. However, it is implemented and first of all financed in different ways at the particular institutions. In addition to the funding by the institutions established at the central level (NCN, NCBiR and NAWA), the individual units do their research works within the limits of resources earmarked for their statutory activities. This is the case, in particular, with university-level schools (especially, the research ones), research institutes (e.g. the IMGW and the IOŚ-PIB) and the units of the Polish Academy of Sciences. However, the levels of the funding of climate research at these institutions are diversified and often do not enable the launch of strategic research programmes.

In Poland, research in the field of climatology covers a wide range of issues. The major directions of the research include: physical climatology, climatology of areas exposed to large anthropogenic pressures, dynamic climatology, regional climatology, applied climatology and research on climate change and the factors which trigger and strengthen it.

In the scope of climate change research, the following categories can be distinguished:

- research on climate change in the past,
- modelling of climate processes,
- impacts of observed and predicted climate change on the natural environment, the economy and society,

- analyses of the occurrence variability of extreme events (heat waves, droughts and high wind speeds),
- impacts of human activities on climate,
- social and political aspects of climate change.

The research on climate change is described in detail in Section 8.2.

8.1.3. Participation in international programmes

In July 2013, as a follow-up and extension of the tasks under the Seventh EU Framework Programme 2007-2013, the Horizon 2020 – EU Framework Programme for Research and Innovation 2014–2020 was adopted. The key objective of this Programme was to integrate research and innovation by creating a single and coherent funding system, from the concept stage to the placing on the market. The third pillar of the Programme called "*Societal Challenges*" addressed the issues of adaptation to climate change:

- Health, demographic change and wellbeing;
- Food security, sustainable agriculture and forestry, marine/maritime/inland water research and the bioeconomy;
- Secure, clean and efficient energy;
- Smart, green and integrated transport;
- Climate action, environment, resource efficiency and raw materials.

The international programme Future Earth

The international programme Future Earth, which was launched in 2015, is a continuation and expansion of the International Geosphere-Biosphere Programme (IGBP), which had been implemented in the period from 1986 to 2015. The Future Earth Programme brings together international efforts to promote sustainable development at the interface among many disciplines, as well as social and political activities.

Biospheric Aspects of the Hydrological Cycle (BAHC)

The research related to this project in Poland focuses on the issues of the impact of the non-stationarity of geophysical processes on the national water resources, with particular attention paid to the extreme hydrological events (floods and droughts).

Global Land Project, Global Change and Terrestrial Ecosystems (GCTE)

Research on the impact of climate change on the carbon cycle in selected water and forest ecosystems.

International Global Atmospheric Chemistry (IGAC)

The Programme continues the monitoring of greenhouse gas concentrations in the atmosphere, the isotopic composition of carbon (stable isotopes 12C, 13C and 14C radiocarbon) in atmospheric carbon dioxide and methane, including its changes due to the anthropogenic emissions of these gases into the atmosphere. The concentrations and chemical compositions of aerosols are also in monitored in the sea areas, the coastal zone and urban agglomerations. Research is also carried out on the height of the atmosphere boundary layer in cities (with sodar and remote sensing methods) and the variability of the atmospheric ozone content and UV-B radiation. The aim of some of this research is to assess the effects of the particular sectors of the anthroposphere on climate, to establish the factors and standards for greenhouse gas emissions and also to work out climate change mitigation methods.

Past Global Changes (PAGES)

The research on environmental variability in the past focuses on the exploration of its mechanisms, especially during the last glacial period and the Holocene.

Surface Ocean-Lower Atmosphere Study (SOLAS)

As part of the continuation of the IGBP "*Marine Biosphere-Atmosphere Interactions*" Programme concluded in 2003, research was carried out on the optical properties of aerosols in the North Atlantic areas. Polish polar research makes an important contribution to the understanding of the impact of global warming on oceanic ecosystems.

Future Earth Coasts, formerly Land-Ocean Interactions in the Coastal Zone (LOICZ)

Particular attention was paid to the coastal zone in light of global warming, causing the sea level rise, increased storm frequency and intensity, and the associated more frequent flooding of coastal areas.

World Climate Programme (WCP)

Polish scientists and experts took an active part in the work of the World Meteorological Organization (WMO) in both its Commissions and Programmes. Research was continued as part of the World Climate Programme – Water on marine climatology. A programme for the recovery of historical observation data from Poland, conducted since 2005 by the Institute of Meteorology and Water Management (IMGW–PIB), was continued. Research on climate change in Poland was continuously carried out on the basis of long-term climate data series. The activities covered by the agenda and time schedule of the Global Climate Observing System (GCOS), established under the WMO, were continued.

Global Framework for Climate Services (GFCS)

The aim of the operation of the Programme is to enable better management of the risks of climate variability and change, and adaptation to climate change, through the development and incorporation of science-based climate information into planning and policy strategy on the global, regional and national scale. The Global Framework for Climate Services (GFCS) accelerates and coordinates the scientifically sound implementation of measures to improve climate-related outcomes at national, regional and global levels. As a framework with broad participation and reach, the GFCS enables the development and application of climate services to assist decision-making at all levels in support of addressing climate-related risks. The implementation of the Framework is based on five components: (1) observation and monitoring; (2) a climate services information system, (3) research and modelling and prediction, 4) a user interface programme and 5) capacity development. The GFCS focuses on developing and delivering services in five priority areas, which address issues basic to the human condition and present the most immediate opportunities for bringing benefits to human safety and wellbeing: agriculture and food security, disaster risk reduction, energy, health and water resources.

Intergovernmental Panel on Climate Change (IPCC)

Poland's Focal Point for the Intergovernmental Panel on Climate Change (IPCC), which was appointed by the Minister of the Environment in 1990, is located at the IMGW-PIB. Its activity consists in coordinating the work for the IPCC in Poland, the provision of opinions on the IPCC documents and the assignment of experts to participate in the sessions of working groups and experts' meetings. Polish scientists took part in the preparation and review of documents, including the periodic IPPC Assessment Reports.

European Global Ocean Observing System (EuroGOOS)

Polish research institutes (the Institute of Oceanology of the Polish Academy of Sciences (IO PAN), the Maritime Institute (IM) and the Institute of Meteorology and Water Management – National Research Institute (IMGW-PIB) are the members of the EuroGOOS. They take part in the development of European operational oceanography, which is expected to make an important contribution to the Global Ocean Observing System (GOOS). The key elements of the work as part of the EuroGOOS include

the construction and development of a stable surveillance system and oceanographic measurements within the Baltic Sea.

Global Flux Monitoring Network (FLUXNET)

Seven research stations in Poland, associated in the FLUXNET network, observe the exchange of open and latent heat and greenhouse gases (CO_2 and CH_4) between the atmosphere and natural ecosystems: forests, marshes and agriculture. Particular attention is paid to changes in the characteristics of greenhouse gas fluxes (temporal and spatial variability and the absolute values of the fluxes) under the influence of external stimuli: agricultural activity and deforestation as a result of the passage of tornadoes.

Aerosol Robotic Network (AERONET)

The AERONET is a network for the measurement of the quantity and types of suspended particulates (aerosols) and the amount of water vapour in the air. It consists of more than 600 solar photometers distributed all over the world. Four of them are located in Poland. The optical properties of aerosols were also measured during voyages in the Baltic, Norwegian and Greenland Seas (by the Institute of Oceanology of the Polish Academy of Sciences).

Earth System Science for the Baltic Sea Region (Baltic Earth)

Polish scientific institutions (the Institute of Oceanology of the Polish Academy of Sciences, the University of Szczecin and the University of Łódź) take part in the Baltic Earth (formerly BALTEX) subprogrammes on biogeochemical interactions between the land and the sea and the dynamics of sea level changes at different time and space scales (for meteorological, hydrological and geological reasons).

Joint International Programme Science for a Better Future of the Baltic Sea Region (BONUS)

The Joint International Programme Science for a Better Future of the Baltic Sea Region (BONUS) is a continuation and development of the previous activities to address the nature-related problems, to protect the marine ecosystem and to ensure the sustainable management of the Baltic Sea. All the Baltic Sea region countries participate in the Programme. The Programme includes, among others, the evaluation of the extent of retention of nutrient elements (nitrogen and phosphorus) between the sources of pollutants and their receiving waters, i.e. the Baltic Sea; the development of the radar methods for the detection of events on the surface of the sea, such as ice, oil slicks and waves, and the research on changes in the biodiversity of marine ecosystems.

International Network for Terrestrial Research and Monitoring in the Arctic (INTERACT)

The INTERACT (International Network for Terrestrial Research and Monitoring in the Arctic) Programme is based on a network of 79 field research stations located in the Arctic and Alpine regions of the northern hemisphere, including Polish polar stations (in Svalbard, of the Institute of Oceanology of the Polish Academy of Sciences) and alpine stations (in the Tatra Mountains, of the Institute of Geography and Spatial Organisation of the Polish Academy of Sciences). The network constitutes a platform for coordinating research, monitoring and logistics, through sharing experiences and creating networks of infrastructures for researchers on the natural environment. As part of the Programme, observation and research activities are continued, focusing on environmental research to identify, understand, predict and respond to the impacts of diverse changes on the environmental conditions.

Understanding and modelling of compound climate and weather events
COST Action DAMOCLES CA17109

The aim of the Project is to identify key processes and variables underpinning compound extreme events (which result from combinations and interactions of environmental processes), to analyse the available statistical methods for modelling these dependences in time and space, using multiple variables, and to identify the data needed to understand, and simulate compound extreme events. DAMOCLES is based on the cooperation of climate scientists, impact modellers and statisticians, to better understand and project compound events, and to improve the assessment of the risk of their occurrence in the future.

COSMO Consortium

The general goal of the COSMO Consortium is to develop, improve and maintain a high-resolution non-hydrostatic meteorological forecasting model to be used for both operational and research applications by consortium member countries.

ACCORD Consortium

It was established on 27 November 2020 by 26 National Meteorological Services to improve short-range (up to about 3 days ahead) weather predictions and to achieve as precise results as possible in order to predict the threats posed by the rapidly changing weather and climate, using high-resolution numerical models. In Poland, the IMGW-PIB is a member of the ACCORD Consortium.

RC-LACE Consortium

It was established in 1990. The organisation supports the development of numerical models, among others, cooperating with MeteoFrance to develop the ALADIN model. The RC LACE group consists of Central European countries, i.e. Austria, Croatia, the Czech Republic, Romania, Slovakia, Slovenia and Hungary. Poland joined the consortium in 2020. The main tasks of the consortium focus on the modernisation of the most advanced model products in the scope of data assimilation, model dynamics, ensemble forecasts, an exchange of measured data and model physics.

ACTRIS Consortium

ACTRIS is one of the projects of the European Strategy Forum on Research Infrastructures (ESFRI). Its aim is to develop infrastructure consisting of ground-based stations for analyses of historical and current data on aerosols, clouds and trace gases to predict the evolution of the atmosphere. The applicant is the Institute of Geophysics of the Polish Academy of Sciences in Warsaw. The involvement of the Institute of Geophysics of the Polish Academy of Sciences and the IMGW-PIB is the Polish research contribution to the European Project. At the same time, it has been put in the list of strategic research infrastructures included in the Polish Research Infrastructure Map in the category of Earth and Environment Science.

SatBaltic Consortium

The aim of the operation of the consortium is the Satellite Monitoring of the Baltic Sea Environment. SatBaltic enables the efficient and systematic determination of the condition of the Baltic Sea environment and the prediction of its changes in a wide range of environmental variables, including the atmospheric, hydrological, optical ones and those related to the energy balance, the chemical composition of seawater, phytoplankton, oxygen, nutrients, salinity and others. The members of the Consortium include the Institute of Oceanology of the Polish Academy of Sciences, the University of Gdańsk, the University of Szczecin and the Pomeranian Academy in Słupsk.

8.2. Research

8.2.1. Climate processes and research on the climate system

Research on climate change in the past

The research on past climate change in Poland mainly covers the period of instrumental measurements (since the turn of the 18th and 19th centuries) and is done at the levels of the whole country, selected regions or localities (depending on the availability of source materials). The scope of analyses includes the variability of thermal and pluvial characteristics. The oldest temperature and precipitation total records come from Gdańsk (systematic records since 1739), Warsaw (systematic records since 1779) and Cracow (systematic records since 1792). At present, the weather elements are recorded by the observation network run by the State Hydrological and Meteorological Service of the IMGW–PIB. As part of the ISOK Project, implemented in the period from 2012 to 2016, among others, by the IMGW-PIB, detailed weather risk maps were prepared. The IMGW-PIB implements its tasks to monitor and analyse the contemporary climate change in Poland in the period of instrumental observations. In 2011 (as part of the KLIMAT Project carried out at that time), the publication of monthly bulletins was initiated (Poland's Climate Monitoring Bulletin) and the reports on the status of Poland's climate (on 2020 and 2021) were issued, presenting the current conditions against the background of long-term variability of thermal, pluvial, anemological and solar conditions. In addition, since 2019 as part of the *klimat.imgw.pl* service, analyses on the extreme events (posing thermal and pluvial hazards) have been presented. Research is also done to reconstruct the climate conditions in Poland in the period before instrumental observations. It is mainly done with indirect methods using, among others, analyses of the structure of lake sediments, speleothems and peat bogs.

The aim of the work to reconstruct the climate conditions was to detect and analyse the observed trends or other features (e.g. periodicity) in the behaviour of climate characteristics. Research was continued to attribute the causes of the climate change observed in Poland's territory. Its aim was to relate the observed variability of the climate conditions to the processes unfolding at the global and regional scales. Examples of such processes include: the North Atlantic Oscillation, the Arctic Oscillation and the variability of the surface temperature change in the North Atlantic.

Selected research on climate change in the past, financed from the national resources (the NCN or the NCBiR) and international funds (the operational programmes of the European Union and other forms of international cooperation) is listed below:

- Devonian deep-water marine realm as a key to elucidate global ecosystem perturbations. University of Silesia in Katowice, MAESTRO 2013–2018;
- Reconstruction of palaeontological conditions based on cave infiltration for the northern and southern Carpathians for the Eemian interglacial and early Vistulian. Institute of Geological Sciences, Polish Academy of Sciences, SONATA 2016–2019;
- Recording the environmental response to climate change over the last 15 000 years on the European W–E transect line based on new, integrated high resolution analyses of sediments from Lake Gościąż. Institute of Geography and Spatial Organisation, Polish Academy of Sciences, OPUS 2016–2019;
- The occurrence of the heat waves in Europe and their circulation and synoptic conditions. Adam Mickiewicz University in Poznań, PRELUDIUM 2015–2018;

- The problem of synchronicity of droughts and fires along the continental gradient in northern Poland over the last 4000 years: high-resolution, multi-proxy studies of peatlands. Adam Mickiewicz University in Poznań, OPUS 2016–2019;
- Tracking climate signals preserved in lake sediments from integrated process studies and ultra high-resolution analysis of annually laminated sediments. University of Gdańsk, SONATA BIS, 2016–2021;
- Air temperature variability in northern Poland during the past two millennia – quantitative reconstruction based on annually laminated sediments of Lake Żabińskie, (CLIMPOL-2k). University of Gdańsk, OPUS 2015–2018;
- Reconstruction of climate change over the last 200,000 years and its impact on the aquatic ecosystem on the basis of subfossil Cladocera analysis deposited in the sediments of Lake Peten Itza (northern Guatemala). Institute of Geological Sciences, Polish Academy of Sciences, OPUS 2015–2018;
- Reconstruction of geomorphological processes in glacial environment after the end of the "*Little Ice Age*" – Sedimentological and morphological record of glacial systems reaction to changes in natural environment. Adam Mickiewicz University in Poznań, SONATA 2011–2017;
- Characteristics of the variability of thermodynamic, kinematic and composite parameters associated with the occurrence of extreme convective phenomena in Central Europe over the past 40 years. Adam Mickiewicz University in Poznań, PRELUDIUM 2015–2018;
- Precipitation extremes in different spatial and temporal scales – identification of factors favourable to the occurrence of precipitation extremes. University of Łódź, OPUS 2013–2017;
- Dust flux record and palaeohydrology of peatlands during the last 1000 years studied by nuclear and related analytical techniques. Adam Mickiewicz University in Poznań, Joint Institute for Nuclear Research, 2017–2018;
- Digitisation of the DWD archives (weather cards) from the former Prussia-occupied lands – a project implemented at the IMGW-PIB as part of the agreement with the DWD (*Deutscher Wetterdienst*);
- HISTKLIM – Digitisation of meteorological data archives collected in Małopolska region from the 19th to the mid-20th century. IMGW-PIB, 2018-2021;
- Reconstruction of climatic conditions in Gdańsk in the period of instrumental measurements, 1739–2010. University of Gdańsk, OPUS 2013-2016;
- Changes in hydrological and climatic characteristics and their impact on natural wetland ecosystems in the years 1900-2100. Gdańsk University of Technology, SONATA 2018-2022;
- Impact of climate and environmental changes on population dynamics, migration and extinction events of selected rodent species in Late Pleistocene and Holocene, Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, OPUS 2018-2022;
- Sea ice variability in the Nordic Seas since the end of the last glaciation. Paleogenetic evidence of climate change. Institute of Oceanology, Polish Academy of Sciences, OPUS 2019-2023;
- The Little Ice Age and the Polish economic crisis in the early modern period, University of Białystok, PRELUDIUM 2019-2023;
- Palaeoenvironmental records and causes of the global Kacak Episode in the late Eifelian (Middle Devonian), Polish Geological Institute – PIB, OPUS 2019-2023;
- Origin and transformation of chernozemic soils in Poland in relation to the climatic changes and influence of settlement and human activity since the beginning of the Neolithic period. Wrocław University of Environmental and Life Sciences, OPUS 2019-2023;

- Blue rings chronology and microanatomical parameters of tracheids – a new line of proxy evidence of environmental constraints in North American Bristlecone Pine. Nicolaus Copernicus University in Toruń, PRELUDIUM 2020-2022;
- Changes or resistance? Multi-proxy studies of the plant population shifts during the late Holocene in Arctic Alaska. University of Łódź, OPUS 2020-2023;
- Reconstruction of climatic conditions in the Arctic before the period of instrumental measurements on the basis of dendrochronological analysis of tundra dwarf shrubs and historical botanical collections. University of Katowice, SONATA 2020-2023;
- Pathways of permafrost thawing, fires, and decomposition processes recorded in the boreal peatlands on NW Siberia – PathThaw. S. Leszczycki Institute of Geography and Spatial Organisation, Polish Academy of Sciences, PRELUDIUM BIS 2020-2024;
- Sedimentary ancient DNA – a new proxy to investigate the impact of environmental changes on past and present biodiversity in Nordic Seas, Institute of Oceanology, Polish Academy of Sciences, GRIEG 2020-2023;
- Reconstructions of Climatic and Bioclimatic Conditions in Greenland and Labrador/ Nunatsiavut ca. 1770 to 1939 from Moravian Missionary Observations (MORCLIM). Nicolaus Copernicus University in Toruń, OPUS 2021-2025;
- Paleogenomic analysis of small mammals in the reconstruction of species responses to climate change. University of Warsaw, SONATA BIS 2021-2026;
- GLAVE – Paraglacial coasts transformed by tsunami waves – past, present and warmer future. University of Wrocław, SONATA BIS 2021-2026;
- The occurrence of extreme weather, climate and water events in Poland from the 11th to 18th centuries in the light of multiproxy data. Nicolaus Copernicus University in Toruń, OPUS 2021-2025;
- Reconstruction of the evolutionary history of the European snow vole (*Chionomys nivalis, Cricetidae, Mammalia*) based on ancient DNA and radiocarbon dating in the context of climate changes in the late Pleistocene and Holocene. University of Wrocław, PRELUDIUM 2021-2024;
- The influence of environmental and climate conditions in Eocene Europe on contemporary fauna of nematoceran Diptera. Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, OPUS 2021-2024;
- The fall, crisis or transformation? Correlation of the late antique settlement pattern changes with environment and climate fluctuations in the north-eastern Adriatic region based on results of geoarchaeological and palaeoclimatic research. Cardinal Stefan Wyszynski University in Warsaw, OPUS 2021-2024;
- What is the future of marine microplankton in the face of modern climate change – a story read from a Cretaceous fossil record. AGH University of Science and Technology in Cracow, OPUS 2022-2026;
- Reconstruction of glaciers extent and environment in southern Svalbard during the Holocene Climate Optimum as an analogue for modern climate warming effects. University of Silesia in Katowice, PRELUDIUM 2022-2025;
- Global climate change and its impact on brown bear populations: Predicting trends and identifying management priorities. Institute of Nature Conservation, Polish Academy of Sciences, Faculty of Economic Sciences, University of Warsaw, Norwegian University of Life Sciences, Department of Ecology and Natural Resource Management, Telemark University College, Department of Environmental and Health Studies, GLOBE;

- Variability of arctic river thermal regimes in a changing climate. Institute of Geophysics, Polish Academy of Sciences, VariaT.

Research in the climatology of air pollutants and greenhouse gases

The research in the climatology of air pollutants can be divided into two main areas:

- the impact of atmospheric aerosols on the weather conditions and climate change;
- the research on the air quality and the impact of the weather conditions on its variability at the regional and local scales, including the modelling and projection of shorter-term changes.

Significant progress compared with the past years was represented by an attempt to consolidate the implemented research work around large European programs (e.g. COPERNICUS, ACTRIS and AERONET). While the modelling and projection of the ambient pollutant quality fields at different temporal and spatial scales had been developed under the COPERNICUS Programme already in the previous reporting period (with the IOŚ-PIB playing a key role in this area in Poland), the research on atmospheric aerosols was done by particular research centres individually. The consolidation with the ACTRIS and AERONET Programmes and within the Aerosol Research Network (Poland-AOD) was stronger in recent years (and the Institute of Geophysics of the University of Warsaw (UW) and the Institute of Geophysics of the Polish Academy of Sciences (PAS) were the pioneers in research as part of this cooperation). This led to the unification of the measurement methods and the gradual incorporation of this research into the international structures. This results from the fact that the impact of aerosols on the weather conditions plays a significant role at the synoptic scale and in the global processes of climate change, as aerosols affect both the transfer of atmospheric radiation and the processes in the clouds in an extremely complex manner. Their knowledge contributes to the improvement of the numerical weather forecasting, while the estimation of the impact of aerosols on climate change is another field of research.

This area of research is developed in Poland, in addition to the Institutes of Geophysics of the UW and the PAS mentioned above, by the Institute of Environmental Engineering of the PAS, the Institute Oceanography of the PAS, the University of Wrocław, the University of Gdańsk, the Nicolaus Copernicus University, the Poznań University of Life Sciences, the Warsaw University of Technology and the IMGW-PIB. In accordance with the recommendations of the pan-European Aerosol, Clouds and Trace Gases Research Infrastructure (ACTRIS), these institutions carry out research projects based on comprehensive remote and in-situ measurements of aerosol particles. Poland is a member of the ACTRIS initiative, which associates 21 European countries and more than 100 institutions and organisations involved in high-quality observations of aerosols, clouds and trace gases (since May 2022 the European Research Infrastructure Consortium ACTRIS – ERIC).

In 2020, the Project ACTRIS - Poland: Infrastructure for research, implemented by the consortium of the University of Wrocław, the Institute of Geophysics of the PAS, the University of Warsaw, the Institute of Environmental Engineering of the PAS, the IMGW-PIB, the Poznań University of Life Sciences and the University of Silesia in Katowice, was included in the Polish Map of Research Infrastructure, financed from the resources of the European Regional Development Fund as part of the Smart Growth Operational Programme 2014-2020 (POIR), Axis IV: Increasing the research potential, Measure 4.2 Development of modern research infrastructure of the science sector. As part of this Project, unique test equipment is successively developed for aerosol measurements in Poland.

The research in the modelling of air pollutants at the national scale, in addition to the operational forecast modelling, is carried out by the IOŚ-PIB, the University of Wrocław and, at a lesser scale, by the AGH University of Science and Technology and the IMGW-PIB.

In turn, the research on air quality and the impact of the weather conditions on its variability at the regional and local scales enhances the knowledge of the mechanisms of the impact of the weather conditions on the pollutant concentrations in so-called hot spots and contributes to the development of advanced air quality management methods. The research is carried out in the largest agglomerations and cities in the country, as well as in the border areas (in the area of the so-called Moravian Gate). Moreover, research is done on atmospheric ozone and UV radiation (in Belsk and Legionowo) and on changes in the concentrations of greenhouse gases and halogens in Cracow and in the Tatra Mountains (Mount Kasprowy Wierch). Many centres also carry out dispersed fundamental research on the mutual interactions between the weather and air pollutants, including aerosols.

The research projects implemented in the climatology of pollutants and greenhouse gases are financed from the national sources (the NCN and the NCBiR) and international ones (the operational programmes of the European Union and other forms of international cooperation). The research projects implemented with the resources from the NCN are listed below:

- Importance of long range transport of BIOmass burning emissions to local Smog events in Urban Environments (BIOSURE). University of Warsaw, Faculty of Physics, DAINA 2 2021-2023, https://projekty.ncn.gov.pl/index.php?projekt_id=493506;
- Study of differences in optical and microphysical properties of local agricultural dust and long range transported desert dust. University of Warsaw, Faculty of Physics, PRELUDIUM 19 2021-2023, https://projekty.ncn.gov.pl/index.php?projekt_id=486968;
- Chemistry of the secondary organic aerosols (SOA) in the atmospheric aqueous phase. University of Warsaw, Faculty of Chemistry, OPUS 16 2019-2023, https://projekty.ncn.gov.pl/index.php?projekt_id=431079;
- Aerosol impact on microphysical, optical and radiation properties of fog. University of Warsaw, Faculty of Physics, OPUS 14 2018-2023 https://projekty.ncn.gov.pl/index.php?projekt_id=391223;
- Impact of absorbing aerosols on the planetary boundary layer height. Institute of Geophysics, Polish Academy of Sciences, SONATA 12 2017-2022 (until 16 August 2022), https://projekty.ncn.gov.pl/index.php?projekt_id=353348;
- Improving the modelled PM2.5 and PM10 concentrations through application of the Geographically Weighted Regression methods (AQ-GWR). University of Wrocław, Faculty of Earth Sciences and Environmental Management, OPUS 20 2021-2024, https://projekty.ncn.gov.pl/index.php?projekt_id=501851;
- Ecosystem connectivity effects on the metabolism and greenhouse gas fluxes in warming Arctic and Alpine lakes. Institute of Geophysics, Polish Academy of Sciences, OPUS LAP 20 2021-2025, https://projekty.ncn.gov.pl/index.php?projekt_id=498037;
- Spatial aspects of urban ventilation management and air quality monitoring: integrated assessment method. Case studies in Gdańsk, Poznań and Warsaw. Gdańsk University of Technology, PRELUDIUM 2020-2022, https://mostwiedzy.pl/pl/project/przestrzenne-aspekty-zarzadzania-przewietrzaniem-miasta-i-monitorowania-jakosci-powietrza-zintegrowa,725-1.

Selected completed projects implemented using different sources of financing:

- MONIT-AIR Integrated monitoring system of spatial data to improve air quality in Krakow, IMGW-PIB, EEA, 2014-2016;
- Influence of vertical profile of aerosol optical properties on surface UV radiation and photochemical smog. Institute of Geophysics, Polish Academy of Sciences, OPUS 13 2018-2022;

- Closing vertical profiles of atmospheric aerosols using in-situ measurements at the surface. Institute of Geophysics, Polish Academy of Sciences, PRELUDIUM 15 2019-2021;
- The influence of temperature inversion in boundary layer of the atmosphere on air pollution. University of Silesia in Katowice, Faculty of Earth Sciences, OPUS 13 2018-2022;
- AIR BORDER – Joint Czech - Polish measurements of cross-border transport of air pollutants, IMGW-PIB, INTERREG, 2017-2020;
- Impact of absorbing aerosols on the planetary boundary layer height. Institute of Geophysics, Polish Academy of Sciences, SONATA 12 2017-2022;
- Atmospheric water as a marker of particulate matter origin. Institute of Environmental Engineering, Polish Academy of Sciences, SONATA 12 2017-2020;
- Impact of air pollution on the health of the population in the Polish-Czech border area (HEALTHAIR) – IMGW-PIB, INTERREG, 2018-2020;
- Aerosol impact on microphysical, optical and radiation properties of fog. University of Warsaw, Faculty of Physics, OPUS 14 2018-2023;
- Distribution, transformation and transport of polycyclic aromatic hydrocarbons (PAHs) in the coastal atmosphere - source contribution and meteorological factors assessment using cluster-based approach and congener profiles. National Marine Fisheries Research Institute, OPUS 14 2018-2021;
- Identification of the sources of coal aerosols in the Krakow agglomeration based on an analysis of the chemical and isotopic composition of PM10 and PM1 fractions of suspended dust. AGH University of Science and Technology in Cracow, Faculty of Physics and Applied Computer Science, PRELUDIUM 2020-2022;
- Spatial representativeness of aerosol profiles, holistic multi-instrument approach. Institute of Geophysics, Polish Academy of Sciences, OPUS 21 2022-2025;
- Next Generation Earth Modelling Systems (NextGEMS), University of Warsaw, Faculty of Physics, EC, HORIZON 2020, 2021-2025;
- ACTRIS - Poland: Infrastructure for research on aerosols, clouds and trace gases. University of Warsaw, Faculty of Physics;
- ACTRIS-2: Aerosols, Clouds and Trace gases Research Infrastructure, IGF, HORIZON 2020, 2015-2019;
- HORIZON-CL5-2022-D1-02-02: Development of high-resolution Earth system models for global and regional climate change projections;
- LIFE Climate CAKE PL Project: it was implemented from September 2017 to November 2020. The concept of the LIFE Climate CAKE PL Project was developed at the National Centre for Emissions Management and the Centre was also responsible for its implementation. The "*System of providing and disseminating information in order to support the strategic implementation of climate* policy (LIFE Climate CAKE PL)" was co-financed from the EU resources under the LIFE Programme and the national resources from the NFOŚiGW (https://www.kobize.pl/pl/article/life-climate-cake-pl/id/962/opis-projektu);
- The Institute of Environmental Protection – National Research Institute (IOŚ-PIB) implements the Klimada 2.0 Project "*The knowledge base on climate change and adapting to climate change effects, together with knowledge dissemination channels, to strengthen economic, environmental and societal resilience as well as to support management of extraordinary risks associated with climate change*", co-financed from the EU resources. The Project envisages a number of measures to provide the necessary knowledge of climate change and the

assessment of its effects in order to improve the effectiveness and efficiency of adaptation actions in the sectors vulnerable to climate change. (https://klimada2.ios.gov.pl/);

- INTERREG CE Project "*Uniform approach to the air pollution management system for functional urban areas In Tritia region*", under Contract No. E1101 and with the acronym AIR TRITIA. The Project was carried out by the consortium of GIG, VSB TU Ostrava, TU Žilina, the City of Ostrava, the City of Opava, the City of Žilina, the City of Rybnik and the City of Opole. The aim of the Project was to develop air quality management methods for the cities in the TRITIA region, with consideration given to potential climate change and changes in the structure of pollutant emissions.

Research on high-latitude climate

For many years Poland has developed its research on high-latitude areas, i.e. polar areas. Given the location of the research area (the broadly conceived Arctic and Antarctica) and its wide international cooperation, it has made a significant contribution to global science. Although the beginnings of Polish polar research date back to the 1930s, its significant growth came in the last dozen years or so in relation to the Fourth International Polar Year. A very detailed description of Polish scientific achievements in polar research in the scope of meteorology and climatology can be found in the article of Przybylak et al., 2019 (http://ptgeof.imgw.pl/?strona=5,27,1). The Fourth Polar Year inspired the launch of many scientific initiatives and brought tangible scientific achievements. They produced several dozen scientific articles published in prestigious journals. Many research teams took part in the research, representing different research centres, but mainly the Universities in Toruń (UMK), Katowice (UŚ) and Poznań (UAM), as well as the Institute of Geophysics and the Institute of Oceanology of the Polish Academy of Sciences. The research concerned different regions in both hemispheres, still the studies on Svalbard dominated.

The list of research projects below includes a dozen or so of them dealing with climate variability and change in polar areas at different temporal and spatial scales. Some address the weather and climate variations and the climate change in the instrumental period, especially since the 1950s. Several studies in the scope of geology or geomorphology present the climate reconstructions going back to the past geological periods. It is important to note that in recent years many Polish studies already applied telemetry data, including in particular satellite data, and used climate models more widely.

The selected research projects implemented in the scope of high-latitude climate research were financed from the national sources (the NCN and the NCBiR) and international ones (the operational programmes of the European Union and other forms of international cooperation). The research projects implemented with the resources from the NCN are listed below.

- Interaction of glaciers and permafrost as an environmental continuum between the glacial and periglacial areas in Tarfala, Scandinavia and the Hornsund area, Spitsbergen. University of Silesia in Katowice, OPUS 2013-2017;
- Factors determining the process of calving of Spitsbergen glaciers on the example of Hansbreen. University of Silesia in Katowice, PRELUDIUM 2014-2017;
- Biodiversity, structure and functioning of benthic communities in the changing ecosystems of the northern Bering Sea and the Chukchi Sea. Institute of Oceanology, Polish Academy of Sciences, HARMONIA 2013–2017;
- The wind field of the Svalbard archipelago in the light of climate change projection using dynamic downscaling. University of Wrocław. OPUS 2015-2018;

- Detection, characterization and effects of icebergs in the Amundsen Sea, Antarctica. University of Gdańsk, ETIUDA 2016-2018;
- The impact of climate change on snow cover and hydrological regime of polar non-basin catchment. Institute of Geophysics, Polish Academy of Sciences, PRELUDIUM 2014-2017;
- Role of meltwater from snow cover for supplying drainage systems of the Spitsbergen glaciers. University of Silesia in Katowice, PRELUDIUM 2013-2017;
- Predictability of Eurasian winter climate fluctuations associated with oceanic heat anomalies in the Nordic Seas and North Atlantic. Institute of Oceanology, Polish Academy of Sciences, OPUS EURAKLIM 2015-2020;
- Integrated Arctic Observation System (INTAROS). Institute of Oceanology, Polish Academy of Sciences, Horizon 2020 2016-2021;
- Drifting fast or crawling slow? Advance of boreal species to Svalbard. Institute of Oceanology, Polish Academy of Sciences, Polish-Norwegian Research Programme 2017-2018;
- Future Arctic Algae Blooms and their role in the context of climate change. Institute of Oceanology, Polish Academy of Sciences, Norwegian Research Council 2015-2019;
- The changing ocean of the Polar North (POLNOR). Institute of Oceanology, Polish Academy of Sciences, Institute of Paleobiology, Polish Academy of Sciences, Polish-Norwegian Research Programme, 2014-2017;
- South Shetland neoglacial dynamics (Western Antarctica) from the perspective of microscale and isotopic studies. Polish Geological Institute – National Research Institute (PIG-NIB), PRELUDIUM 2015-2017;
- Causes of Arctic climate warming in the first half of the 20th century. Nicolaus Copernicus University, OPUS 2016–2019;
- Variability of the Russian Arctic and Subarctic climate in the last three hundred years. Nicolaus Copernicus University, OPUS 2013-2017;
- Response of fjord ecosystem in the South Shetlands on decadal to millennial (King George Island, South Shetlands) environmental changes: record from marine sediment cores (Admiralty Bay, King George Island). University of Warsaw, OPUS, 2013-2017;
- Aeolian and niveoaeolian accumulation in periglacial and glacial environments in central Spitsbergen, Adam Mickiewicz University in Poznań, PRELUDIUM, 2016-2018;
- Diversity and ecology of tardigrades (Tardigrada) of the Svalbard Archipelago with regard to the climate and theory of islands biogeography, PRELUDIUM, 2015-2018;
- Warm and cold periods of Late Holocene in European Arctic. Paleogenetic record in marine sediment of Hornsund (Spitsbergen, Svalbard), OPUS, 2014-2017;
- Reconstruction of glaciers extent and environment in southern Svalbard during the Holocene Climate Optimum as an analogue for modern climate warming effects. PRELUDIUM, 2022-2025;
- SVELTA - Svalbard delta systems under warming climate, POLS, 2021-2023;
- Impact of Atlantic Water variability and atmospheric circulation on the changing sea ice cover in the European Arctic (ATAC-ICE). Institute of Oceanography, Polish Academy of Sciences, 2019-2023;
- Changes of the north-west glaciers of Spitsbergen as an indicator of contemporary transformations taking place in the cryosphere, Nicolaus Copernicus University in Toruń, OPUS, 2018-2023;

- Applied remote sensing and geophysical imaging in recognition of the changes of the water balance in High Arctic catchments. Institute of Geophysics, Polish Academy of Sciences, SONATA BIS, 2021-2025;
- Hindcasting and projections of hydro-climatic conditions of Southern Spitsbergen. Institute of Geophysics, Polish Academy of Sciences, OPUS, 2018-2021;
- Determination of the evolution of slopes of southern Spitsbergen on the background of climate change, University of Silesia, PRELUDIUM, 2017-2019.

Oceanology research

In addition to the classic issues of water circulation, transport of energy and mass, and the optical conditions, in particular in the high-latitude areas in the northern hemisphere, the oceanology research focuses on analyses of the linkage between the variability of the climate conditions and the functioning of ecosystems, with the noteworthy wide range of biological indicators used. The spatial range of the analyses usually covers the Arctic Ocean, the Nordic Seas and the Baltic Sea. As part of the BONUS Programme, methods are applied to expand the ability of radar systems to detect and parametrise events on the sea surface (ice, oil slicks, algal blooms and waves). The research on the greenhouse gas concentrations in the atmosphere and the transport of the natural isotopes Be-7 and Pb-210 to the Earth surface has also an important position. Analyses are also carried out on the nutrient transport between the land and the sea and the biodiversity changes. It is important to note the operations of the SatBaltic Consortium intended to monitor the Baltic Sea environment. The tools applied enable the efficient and systematic determination of the state of the Baltic Sea environment and the projection of its changes in a wide range of environmental variables.

The selected research projects in the scope of oceanology in the context of climate change which were financed from the national sources (the NCN and the NCBiR) and international ones (the operational programmes of the European Union and other forms of international cooperation) are listed below:

- Structure and dynamics of the bottom layer in the region of Bornholm Basin, Słupsk Furrow and Gdansk Deep. Institute of Oceanology, Polish Academy of Sciences, PRELUDIUM 2014-2017;
- Mediating integrated actions for sustainable ecosystem services in a changing climate. IMGW-PIB, BONUS 2015-2018;
- Assessment of the groundwater discharge as a source of pharmaceuticals residues in the marine environment of the Bay of Puck (PharmSeepage). Institute of Oceanology, Polish Academy of Sciences, OPUS 2017-2020;
- Advanced research on the relationship between optical, biogeochemical and physical properties of suspended matter properties of seawater in the southern Baltic Sea (OPUS–OPTICS). Institute of Oceanology, Polish Academy of Sciences, OPUS 2017-2020;
- Holocene history of the Greenland Gyre WIR. Institute of Oceanology, Polish Academy of Sciences, OPUS 2017-2020;
- Development of a spectrophotometric pH-measurement system for monitoring in the Baltic Sea. Institute of Oceanology, Polish Academy of Sciences, BONUS 2014-2017;
- Harnessing coastal radars for environmental monitoring purpose, IMGW-PIB, BONUS-185, 2014-2017;

- Measurement, parameterization and analysis of the properties of sea spray aerosol stream fluxes in the boundary atmosphere layer in the southern Baltic and the European Arctic. Institute of Oceanology, Polish Academy of Sciences, PRELUDIUM 2016-2019;
- LARVAE – Linking annual cycle of reproduction and recruitment to environmental variables in Arctic epifauna. Institute of Oceanology, Polish Academy of Sciences, OPUS 2015-2019;
- SeaDataCloud Project - Further developing the pan-european infrastructure for marine and ocean data management, HORIZON 2020 2016-2020;
- Historical demography of *Salpa thompsoni* population as a response to the previous climate change episodes, University of Gdańsk, PRELUDIUM 2017-2022.
- Arctic benthos functioning response to climate warming induced changes in warm water advection and food supply (ABeFun). Instytut Oceanologii PAN, OPUS 2017-2022;
- Deep sea benthos response to climate warming induced environmental changes in Arctic (DeepClim). Institute of Oceanology, Polish Academy of Sciences, PRELUDIUM 2017-2021;
- Interannual variability of properties and distribution of deep and intermediate water in the Nordic Seas – DWINS. Institute of Oceanology, Polish Academy of Sciences, PRELUDIUM 2017-2021;
- Atmospheric conditions governing occurrence of coastal upwelling in the Baltic Sea. Adam Mickiewicz University in Poznań, OPUS 2017-2022;
- De-icing of Arctic coasts: Critical or new opportunities for marine biodiversity and ecosystem services. Institute of Oceanology, Polish Academy of Sciences, UNISONO 2018-2022;
- HIDEA – Hidden diversity of plankton in the European Arctic. University of Gdańsk, OPUS 2018-2023;
- Impact of Atlantic Water on zooplankton TAXonomical and FUNctional structure in Arctic fjords: spatial, seasonal and interannual assessment (Tax4Fun). Institute of Oceanology, Polish Academy of Sciences, OPUS 2018-2022;
- Gelatinous zooplankton in the Arctic Ocean – ecology, diversity and distribution in the climate change perspective. University of Gdańsk, ETIUDA 2019-2020;
- Sea ice variability in the Nordic Seas since the end of the last glaciation. Paleogenetic evidence of climate change. Institute of Oceanology, Polish Academy of Sciences, OPUS 2019-2023;
- Changes in the structure and functioning of pelagic ecosystems affected by water darkening due to glacier/river runoff in the fjords of European Arctic (CoastDark). Institute of Oceanology, Polish Academy of Sciences, OPUS 2019-2024;
- Newcomers/neo-natives in the High Arctic: sources, routes and dynamics of climate change driven colonisations by macroinvertebrate models with varied dispersal potential. Institute of Oceanology, Polish Academy of Sciences, PRELUDIUM 2020-2023;
- Climate change impacts on structure and functioning of benthic communities at the fjord-shelf boundary hotspots (CLIMB), Institute of Oceanology, Polish Academy of Sciences, SONATA 2020-2023;
- Sedimentary ancient DNA - a new proxy to investigate the impact of environmental change on past and present biodiversity in Nordic Seas. Institute of Oceanology, Polish Academy of Sciences, GRIEG 2020-2023;
- Responses of breeding seabirds to the warming Arctic. University of Gdańsk, SONATINA 2021-2024;
- Life at both edges of the globe – bipolarity concept tested on pelagic ostracods. Institute of Oceanology, Polish Academy of Sciences, PRELUDIUM BIS 2021-2025;

- Marine biocenosis succession on the hard bottom in rapidly changing Arctic environment. Institute of Oceanology, Polish Academy of Sciences, PRELUDIUM BIS 2021-2025;
- Benthic coastal buffers against climatic and eutrophication extremes. University of Gdańsk, POLS 2021-2023;
- Influence of rapidly progressing climate change on polar marine organisms – investigations along naturally occurring environmental analogues of future climate changes. Institute of Oceanology, Polish Academy of Sciences, OPUS 2021-2025;
- Improving coastal hazard assessment by the linkage between storm-induced landforms, sedimentary record and instrumental measurements – STORMLINK. University of Gdańsk, SONATA 2022-2025;
- Effect of organic matter SURface layer Enrichment on air-sea gas transfer velociTY (SURETY). Institute of Oceanology, Polish Academy of Sciences, OPUS 2022-2026;
- When co-existence means separation – ecological niche partitioning between sibling zooplankton species in warming Arctic (TWINS). Institute of Oceanology, Polish Academy of Sciences, OPUS 2022-2026;
- Impact of hydrological regimes on the quantitative and qualitative optical properties of dissolved organic matter in West Spitsbergen fjords. Institute of Oceanology, Polish Academy of Sciences, OPUS 2022-2025.

8.2.2. Modelling and forecasting

Research has intensified in the area of climate change modelling and forecasting. This has resulted from the availability of new datasets on the potential climate change scenarios (e.g. EURO-CORDEX) with high spatial and temporal resolution, as well as the development of forecasting models enabling the preparation of continuously improved forecasts, which is of particular importance for the development of systems against severe weather and hydrological events (e.g. the RCB alerts, the development of mobile applications, e.g. Meteo IMGW). Here, a case in point is the meteo.imgw.pl service which provides clear forecasts of selected weather elements, both in cartographic form and as meteograms. The service uses a wide set of forecasting models with different spatial resolutions and lead times:

- nowcasting: ALARO (4 km, 8 h);
- short-term:
  - AROME (2 km, 30 h);
  - WRF METEOPG (2.5 km, 60 h);
  - COSMO (2.8 km, 48 h);
  - ALARO (4.0 km, 72 h);
  - COSMO (7 km, 84 h);
- medium-term:
  - GFS (27 km, 10 days).

In addition, the service presents forecasts of aerosanitary conditions (using the CAMS model, 10 km, 4 days) and forest fire risks (using the WRF-FWI model, 2.5 km, 2 days).

In the scope of modelling the expected climate change in the 21st century, it is important to recall Klimada 2.0 Project "*The knowledge base on climate change and adapting to climate change effects, together with knowledge dissemination channels, to strengthen economic, environmental and societal resilience as well as to support management of extraordinary risks associated with climate change*", carried out by the IOŚ-PIB, with the main goal of providing the knowledge of climate change

and the assessment of its effects in order to improve the effectiveness and efficiency of adaptation actions in the sectors vulnerable to climate change.

The selected research projects in the scope of area of modelling and forecasting in the context of climate change which were financed from the national sources (the NCN and the NCBiR) and international ones (the operational programmes of the European Union and other forms of international cooperation) are listed below:

- Numerical weather prediction for sustainable Europe. IMGW-PIB, First Team Programme 2016-2019;
- Improvement potential of short-term weather forecast over Poland by the means of MOS and parameterization settings available in WRF model. 2018-2022;
- Development and implementation of an effective forecasting and monitoring of air pollution, based on AI techniques using data from an extensive metering network. AIRLY Sp. z o.o. 2017-2020, NCBiR under the Smart Growth Operational Programme 2014-2020;
- Modelling the influence of oil-in-water emulsions on the upwelling light field of seawater. Gdynia Maritime Academy, PRELUDIUM 2013-2017;
- Modelling of concentrations of suspended particulate matter and ozone for Poland using high-resolution spatial and temporal surveys. University of Wrocław, OPUS 2014-2017;
- Cloud microdynamics, University of Warsaw, MAESTRO 2013-2018;
- Analysis of geophysical surficial fluids models and CMIP climate models for verification of polar motion excitation functions. Space Research Centre of the Polish Academy of Sciences, OPUS 2015-2018;
- Prognostic troposphere model based on meteorological data, GNSS products and Numerical Weather Prediction Models. Wrocław University of Environmental and Life Sciences, PRELUDIUM 2015-2017;
- Precipitable water content (PWAT) as a predictor of extremal weather events in Poland in the light of multi-sources and high resolution measurements. University of Wrocław, OPUS 2016-2019;
- Analysis of the possibility of estimating the type of precipitation based on radar, satellite and numerical data. IMGW-PIB, OPUS 2016-2019;
- Numerical modelling of cloud microphysics and microphysics-dynamics interactions in shallow boundary-layer clouds. University of Warsaw, POLONEZ 2016-2017;
- Utilisation of time series of tropospheric parameters received from GNSS observation to validate climate models over Europe. University of Warmia and Mazury in Olsztyn, OPUS 2016-2019;
- GNSS observations as a numerical weather prediction data source, a way forward to enhanced forecasts quality. Wrocław University of Environmental and Life Sciences, SONATA 2014-2017;
- Development and implementation of the Polish IDF Atlas. IMGW–PIB, Smart Growth Operational Programme 2016-2019;
- SeaDataCloud – Further developing the pan-European infrastructure for marine and ocean data management. Institute of Oceanology, Polish Academy of Sciences, Horizon 2020 2016-2020;
- Optimising North Atlantic models to improve Arctic climate prediction. Institute of Oceanology, ERA.Net Plus 2016-2018;

- Modelling of concentrations and deposition of atmospheric pollutants and exposure of human populations and ecosystems to their detrimental effects – present condition and forecast. University of Wroclaw, OPUS 2013-2017;
- Use of artificial neural networks and methods in the field of pattern recognition for a complex catchment analysis of the impact of anthropogenic chemical and microbiological pollution on water resources. European Regional Centre for Ecohydrology, Polish Academy of Sciences, OPUS 2016-2019;
- Discrete-element sea ice modelling – development of theoretical and numerical methods. University of Gdańsk, OPUS 2016-2019;
- Aerosol processing through clouds – the construction of a comprehensive object-oriented programming tool for numerical simulations. University of Warsaw, HARMONIA 2013-2017;
- Improving the modelled PM2.5 and PM10 concentrations through application of the Geographically Weighted Regression methods (AQ-GWR). University of Wrocław, Faculty of Earth Sciences and Environmental Management, 2021-2024;
- Data assimilation and the quality of air pollution modelling. University of Wrocław, Faculty of Earth Sciences and Environmental Management, 2017-2021;
- Modelling of land surface movements due to rock mass drainage. Stanisław Staszic AGH University of Science and Technology in Cracow, Faculty of Geo-Data Science, Geodesy and Environmental Engineering, 2020-2023;
- Analysis of the possibility of estimating the type of precipitation based on radar, satellite and numerical data. A project implemented in a consortium with the Adam Mickiewicz University in Poznań, OPUS, 2016-2020;
- Analysis of turbulent flows with dispersed phase: impact of two-way momentum coupling and gravity on particle statistics, OPUS, 2018-2022;
- Numerical modelling of dispersed turbulent flows considering particle-scale interaction. A project implemented as part of international cooperation with Shenzhen University (China) on the modelling of the movements and interactions of particles in turbulent flows, NCN SHENG, 2018-2022;
- Numerical weather prediction for sustainable Europe. The aim of this Project was in particular to develop and implement operationally the most recent version of the COSMO-EULAG model, FNP PROPOZE 2017-2021;
- An automatic/semi-automatic high-resolution nowcasting system warning against severe weather events, IMGW-PIB.

8.2.3. Research on the climate change impacts on the natural environment

Research on the climate change impacts on the natural environment focuses on diverse ecosystems – from natural ones (peat bogs, forests, costs and waters) to agricultural and urbanised ones.

The Laboratory of Wetland Ecology and Monitoring (of the Adam Mickiewicz University in Poznań) continues its long-term activities by carrying out analyses on the paleohydrology of wetlands and peat bogs, including their responses to global warming are carried out by. Other research projects implemented in this scope include: biodiversity, eutrophication, anthropopressure, the climate change impacts on the occurrence of drought events and the climate change impacts on the hydrological system of rivers.

The Geological Institute – National Research Institute continues its activities (risk analyses) related to the evaluation of the vulnerability of the natural environment to climate change. They include: groundwater monitoring; forecasting threats due to prolonged droughts/excessive rainwater supply; documentation of areas with soil erosion and steppe formation; studies on the Baltic Sea coast erosion; and monitoring of landslide hazards, which now grow due to prolonged, intense rainfalls.

In 2020, in cooperation with Polish Waters, the MGW-PIB launched the Stop Drought platform dedicated to analyses of the hydrological conditions, providing access to a wide range of information: from the evaporation levels, though the analysis of the pluvial characteristics, water levels and soil moisture, to hydrological forecasts.

In light of the increasingly frequent heat waves, the research carried out by the Institute of Geography and Spatial Organisation on the impact of the observed climate change on urban ecosystems, e.g. the Warsaw Agglomeration and health resorts, is important. Research is continued on the urban heat island effect and its effect on city inhabitants (by the Jagiellonian University, IMGW-PIB and UŁ). The "*Climate and Bioclimate of Cities*" conferences are organized periodically by the University of Łódź, bringing together the researchers working in the climate in urban ecosystems. The IMGW-PIB carried out the research on the climate change impacts on the river catchment ecosystems, using for this purpose the digital platform: the Macromodel DNS. Since 2020 the weather module has been continuously developed to enable the analysis of the effect of changes in such parameters as precipitation or temperature on the processes unfolding in the land and bed phases of river catchments and thereby on the transport of pollutants (suspensions, nutrients, heavy metals, chlorophyll a or the eutrophication potential of rivers). To date, the research has focused on the catchments of the Raba, Wełna and Nurzec Rivers. The other aspect of the research for the Nielba River on the climate change impacts on the natural environment included the analyses of changes in the water eutrophication potential using data from EURO-CORDEX scenarios.

The selected research projects on the climate change impacts on the natural environment which were financed from the national sources (the NCN and the NCBiR) and international ones (the operational programmes of the European Union and other forms of international cooperation) are listed below:

- Trees as bioindicators of industrial air pollution during implementation of pro-environmental policy in Silesia region. Silesian University of Technology, SONATA 2012-2017;
- Study on the modification of the water chemistry of the Revelva river basin (Hornsund fjord area, Spitsbergen) by anthropogenic contamination with differentiated supply by atmospheric water. Gdańsk University of Technology, PRELUDIUM 2014-2017;
- Dendroclimatic and dendroecological studies of larch (*Larix decidua Mill*.) in the Carpathians and Sudetes. Stanisław Staszic AGH University of Science and Technology in Cracow, OPUS 2015-2017;
- The impact of catastrophic deforestation on the lakes and peatlands ecosystem in Tuchola Pinewoods. Institute of Geography and Spatial Organisation, Polish Academy of Sciences, OPUS 2016-2019;
- Evolutionary history of two species of Microtus in the late pleistocene and holocene. Reconstruction of population response to climate change using antique DNA and radiocarbon dating. University of Warsaw, SONATA 2016-2019;
- Shaping the cliff seashores under the influence of local and global causal processes in different time scales. University of Szczecin, SONATA 2016-2019;

- PANDa – Polish Atlas of Rains Intensities, retencja.pl, IMGW-PIB, POIR.01.01.01-00-1428/15, 2014-2020;
- The impact of climate change (warming and drought) on the diversity of eukaryotic microorganisms in peat bogs – next generation sequencing and field experiment. Adam Mickiewicz University in Poznań, PRELUDIUM 2016-2018;
- Reaction of the landscape to climate change and direct human impact: Quantitative analysis of gravity threats of mass processes in tropical mountain areas. Adam Mickiewicz University in Poznań, SONATA 2016-2019;
- The impact of climatic factors on reproductive strategies of birds. Jagiellonian University, SONATA 2016-2019;
- Cryosphere reactions in contrasting high-altitude conditions of Svalbard against environmental changes. Adam Mickiewicz University in Poznań, OPUS 2012-2017;
- Predicting annual dynamics of reflected radiation as consequence of smoothing of previously harrowed soils in a global scale. Adam Mickiewicz University in Poznań, OPUS 2015-2018;
- The response of the South Shetlands Antarctic fjord ecosystem to climate change in the last millennium: a record of marine sediments (Admiralty Bay, King George Island). University of Warsaw, OPUS 2013-2017;
- Eutrophication of shelf waters as a mechanism decreasing the efficiency of the biological pump. University of Gdańsk and IMGW–PIB, OPUS 2014-2017;
- Determination of the effect of climate change on the composition of phytoplankton in Western Spitsbergen fjords based on pigment in sediments (CLIP). Institute of Oceanology, Polish Academy of Sciences, PRELUDIUM 2017-2019;
- Investigation of the impact of environmental factors on phytoplankton blooms in the Baltic Sea on the basis of numerical models and existing databases. Institute of Oceanology, Polish Academy of Sciences, PRELUDIUM 2013-2017;
- Is size so crucial? Complex examination of plankton size structure in the warming European Arctic**.** Institute of Oceanology, Polish Academy of Sciences, OPUS 2014-2017;
- Assessment of the effect of dissolved organic matter on the acid-base system in the Baltic Sea. Institute of Oceanology, Polish Academy of Sciences, SONATA 2015-2018;
- Climate change impact on ecosystem health – marine sediment indicators. Institute of Oceanology, Polish Academy of Sciences, Polish-Norwegian Research Programme 2014-2017;
- Impact of climate change on development of *Cladium mariscus* (Great Fen sedge) population in Central-East Europe in the last 2000 years. Adam Mickiewicz University in Poznań, OPUS 2014-2017;
- Impact of potential leakage from the sub-seabed CO_2 storage site on marine environment at relevant hydrostatic pressure (CO_2Marine). University of Gdańsk, Polish-Norwegian Research Programme, 2014-2016;
- Declining size – a general response to climate warming in Arctic fauna? (DWARF). Institute of Oceanology, Polish-Norwegian Research Programme, 2014-2017;
- Climate Change Manipulation Experiments in Terrestrial Ecosystems: Networking and Outreach (ClimMani). Poznań University of Life Sciences, COST Action 1308, 2013-2018;
- Rethinking the peatland carbon cycle – identifying the role of mixotrophs in the biological carbon pump (MIXOPEAT). Adam Mickiewicz University in Poznań, Agence Nationale de la Recherche, 2017-2019;
- Long-term changes in the climate system in areas with varying levels of anthropopressure Institute of Geography and Spatial Organisation, Polish Academy of Sciences, 2012-2017;

- FORECOM – Forest cover changes in mountainous regions: drivers, trajectories and implications. Jagiellonian University, financed under the Swiss Programme of Cooperation with new Member States of the European Union, since 2012;
- Application of objective local classification of weather types in environmental studies and climate change detection. Jagiellonian University, Polish-Hungarian Executive Programme, since 2010;
- Unfavourable biometeorological conditions in the urban areas of central Europe in the context of climate change. Jagiellonian University, since 2009
- The impact of climate change on snow cover and hydrological regime of polar non-basin catchment. Institute of Geophysics, Polish Academy of Sciences, 2014-2017;
- The impact of climate change and the construction of dam reservoirs on the ice cover formation on the Carpathian rivers. S. Leszczycki Institute of Geography and Spatial Organisation, Polish Academy of Sciences, 2021-2025;
- Influence of rapidly progressing climate change on polar marine organisms – investigations along naturally occurring environmental analogues of future climate changes. Institute of Oceanology, Polish Academy of Sciences, 2021-2025;
- Climate change impacts on structure and functioning of benthic communities at the fjord-shelf boundary hotspots (CLIMB), Institute of Oceanology, Polish Academy of Sciences, 2020-2023;
- Human and climate impacts on drought dynamics and vulnerability. Institute of Geophysics, Polish Academy of Sciences, 2019-2023;
- Projection of climate change impacts on the hydrology of rivers and the functioning of river and valley habitats, Warsaw School of Life Sciences (SGGW), Faculty of Construction and Environmental Engineering, 2018-2019.

8.2.4. Socio-economic analyses

The analyses which are now carried out and continued mostly focus on the climate change impacts on water management and public health, with particular consideration given to rural areas, and on the extreme weather events and their effects on the economy. As part of the MPA Project (2017-2019), the vulnerability of the largest cities in Poland to climate change was analysed for different sectors and areas of a city and its adaptation potential was assessed, taking into account, among others, its financial capacity, the social capital, the preparedness of services and innovativeness. Subsequently, the vulnerability was assessed for the city which had answered the question as to whether it was able to cope with the climate change effects, in terms of both damage control and the use of opportunities; and, thus, as to whether adaptation measures had to be taken in this scope. After climate hazards and city documents, including socio-economic analyses, had been taken into account and analysed, adaptation measures were proposed to reduce the risk of adverse effects of climate events. In addition to research on the adaptation of urban areas to climate change, analyses are also carried out to project economic changes resulting from climate change (among others, by sector). Research is also done on the socio-economic vulnerability, resilience and competitiveness of regions. Analyses are carried out as well on the climate change impacts on the conditions of water management in agriculture in the context of adaptation to climate change.

Examples of the implemented research projects on socio-economic issues in the context of climatology which were financed from the national sources (NCN and NCBiR) and international ones (the operational programmes of the European Union and other forms of international cooperation) are listed below:

- Impact of climate change and adaptation of some sectors of national economy in Poland and Bulgaria. Institute of Geography and Spatial Organisation, 2015-2018;
- The role of man and extreme events in the transformation of environment at the margin of the Eastern Himalaya and their piedmont. Institute of Geography and Spatial Organisation, Polish Academy of Sciences, 2015-2017;
- Projection of economic impacts of climate change in sectors of the EU based on bottom-up analysis (PESETAIII). Institute of Fundamental Technological Research, Polish Academy of Sciences, Horizon 2020 2014-2020;
- Socioeconomic sensitivity and resilience of regions in Poland and Slovakia. Institute of Geography and Spatial Organisation, Polish Academy of Sciences, 2016-2018;
- RAINMAN – Integrated Heavy Rain Risk Management, No. CE968, INTERREG, 2017-2020;
- Economic, social and institutional conditions of water management in Polish agriculture in the context of adaptation to climate change, Wrocław University of Economics and Business, OPUS 2022-2025;
- Travel behaviour in Polish cities: causality, behavioural changes, and climate impacts. Adam Mickiewicz University in Poznań, OPUS 2021-2024;
- Vulnerability to extreme weather events: mapping natural hazards and related activities. Analysis of selected sectors and infrastructures at risk due to extreme meteorological events in Wielkopolska region. Institute of Agricultural and Forest Environment, Polish Academy of Sciences, OPUS, 2019-2023;
- Climatic conditions in South Baltic Areas in the second half of the 15th and 16th centuries and their consequences for social, economic and cultural life. Nicolaus Copernicus University in Toruń, OPUS, 2014-2018;
- Modelling of climate change impacts on regional competitiveness, Maria Curie-Skłodowska University in Lublin, OPUS, 2020-2024;
- Embodying Climate Change: Transdisciplinary Research on Urban Overheating. Adam Mickiewicz University in Poznań, IDEALAB, 2020-2023;
- The Little Ice Age and the Polish economic crisis in the early modern period. University of Białystok, PRELUDIUM, 2019-2023;
- The mortality of kuyavian villagers in 1815-1914 against socio-economic transformation and change of chosen climatic elements. The case of Kowal Parish. An attempt of an interdisciplinary analysis based on historical and climate data. Nicolaus Copernicus University in Toruń, OPUS, 2018-2021;
- Analysis of factors influencing beliefs, attitudes and support level for solutions reducing negative effect of Anthropogenic Climate Change. University of Warsaw, PRELUDIUM, 2018-2021.

8.2.5. Research and development programmes on approaches to mitigation and adaptation

In 2013, the Strategic Adaptation Plan for Sectors and Areas Vulnerable to Climate Change (SPA2020) was adopted. The aim of the SPA2020 was to ensure the sustainable development and effective functioning of the economy and society in the changing climate conditions. One of the partial objectives of the SPA2020 was to define necessary adaptation measures to be undertaken in various areas of the economy and social life and to estimate the necessary costs.

In 2017, the CLIMCITIES Project ("C*LIMate change adaptation in small and medium size CITIES*") was completed. It addressed adaptation to climate change in small and medium-sized cities with the number of inhabitants between about 50,000 and 99,000. In 2019, the project involving the

preparation of Urban Adaptation Plans for 44 cities with the number of inhabitants exceeding 100, 000 (MPA) was completed. In the same year, the ADAPTCITY Project "*Preparation of a strategy for adaptation to climate change of the city of Warsaw*" was also completed. In turn, in the period from 2017 to 2022 the IOŚ-PIB implemented the KLIMADA 2.0 Project "*The knowledge base on climate change and adapting to climate change effects, together with knowledge dissemination channels, to strengthen economic, environmental and societal resilience as well as to support management of extraordinary risks associated with climate change*", co-financed from the EU resources. The Project envisaged a number of measures with the main goal of providing the knowledge of climate change and the assessment of its effects in order to improve the effectiveness and efficiency of adaptation actions in the sectors vulnerable to climate change.

Polish research institutions can seek co-financing under the interregional Interreg Europe Programme 2021-2027, which is a continuation of the Interreg Europe Programme 2014-2020. Polish institutions took part in the Interreg Central Europe Programme 2014-2020, the aim of which was, among others, to increase the capacity of the region to reduce CO_2 emissions (e.g. they took an active part in a dozen or so projects, among others, on energy management, the revitalisation of green areas in cities and post-industrial areas, the adaptation of forest trees to the changing climate, air quality and groundwater pollution). It is envisaged that these entities will continue to take an active part in efforts to seek the financial resources available in the transnational Interreg Central Europe Programme 2021-2027. As the members of international partner consortiums, Polish institutions also take an active part in the transnational Interreg Baltic Sea Region Programme 2021-2027 (a continuation of the Interreg Baltic Sea Region Programme 2014-2020), the aims of which include, among others, measures to ensure sustainable use of waters, to adapt water management to the changing climate conditions in urban, rural and coastal areas, such as storms, floods or droughts, and to mitigate climate change as part of plans to develop the blue economy. One of the priorities of the Programme is climate-neutral societies. In addition to the three Interreg Programmes mentioned above, co-financing is available for climate change projects from all the Interreg programmes for cross-border cooperation for the period from 2021-2027 in which Poland participates: on the border with Germany, the Czech Republic, Slovakia, Ukraine and Southern Baltic States.

The Strategic Government Programme HYDROSTRATEG "*Innovations for water management and inland navigation*" was approved in December 2021 by the Ministry of Education and Science. The main objective of the Programme is to implement new solutions to improve the efficiency of the use and management of water resources in Poland. The main problems of the Polish water management include an insufficient or excessive quantity of water and its very poor quality. The Hydrostrateg Programme was launched to respond to the need to improve the efficiency of the management of water resources in Poland. The Programme covers three research areas: water in the environment – biodiversity/bioproductivity; water in the city; and inland navigation. Its range of possible topics includes a large number of specific objectives corresponding with the issues of adaptation and mitigation, including, among others, the shaping of cities as Blue-Green Networks, which are resilient to climate change, improve their inhabitants' quality of life and health, constrain suburbanisation and turn hazards into the potential for sustainable development by using stormwater to enhance adaptation to climate change. In July 2022, the NCBiR announced the first competition for projects as part of the Hydrostrateg Programme.

The research in Poland corresponds with the international efforts to develop the science-based foundations for adaptation to climate change. Intensive work is underway on the methods for the sustainable management of surface waters and groundwater, the development of the methods for soil

cleaning and preventing soil erosion, the optimisation of production to improve energy efficiency and resource use, and the reduction of pollutant emissions. The research on innovative techniques to reduce CO_2 emissions in agricultural production has become particularly important in light of the prospect that this sector of the economy can be included in the emissions trading system. As part of the Smart Growth Operational Programme, research and development work on infrastructure is carried out by enterprises focusing on the low-emission economy and resilience to climate change. As part of the Operational Programme Infrastructure and Environment, among others, programmes are developed to improve the quality of the measures to address water shortages, to review and update flood hazard maps and food risk management plans.

The selected implemented research projects on approaches to climate change mitigation and adaptation which were financed from the national sources (the NCN and the NCBiR) and international ones (the operational programmes of the European Union and other forms of international cooperation) are listed below:

- Economic, social and institutional conditions of water management in Polish agriculture in the context of adaptation to climate change, Wrocław University of Economic and Business, OPUS 22, 2022-2025;
- Knowing about climate change adaptation at the local level. A collective case study of urban adaptation plans in Poland. Warsaw School of Life Sciences (SGGW), SONATINA 5, 2021-2024;
- Paleogenomic analysis of small mammals in the reconstruction of species responses to climate change. University of Warsaw, SONATA BIS 10, 2021-2026;
- The adaptation of the regional security complex in the face of climate change: the example of the Arctic. Maria Curie-Skłodowska University in Lublin, PRELUDIUM 18, 2020-2022;
- Hybridization as an evolutionary process which reinforces the adaptive potential of tree species in the face of climate changes. Institute of Dendrology, Polish Academy of Sciences, SONATA 16, 2021-2024;
- Global warming effects: Adaptive capability of *Daphnia longispina* complex to elevated temperature. Adam Mickiewicz University in Poznań, PRELUDIUM, 2016-2019;
- A Systems Approach Framework for Coastal Research and Management in the Baltic – BaltCoast. Institute of Hydroengineering, Polish Academy of Sciences, BONUS, 2015-2018;
- Mediating integrated actions for sustainable ecosystem services in a changing climate – MIRACLE. IMGW-PIB, BONUS, 2015-2018;
- Towards sustainable governance of Baltic Marine Space – BaltSpace. Maritime Institute, BONUS, 2015-2018;
- Coherent policies and governance of the Baltic Sea Ecosystems – GO4BALTIC. University of Warsaw, BONUS, 2015–2018;
- Biodiversity changes - causes, consequences and management implications– BIO-C3. National Marine Fisheries Research Institute, BONUS 2014-2017;
- A platform to analyse and foster the use of Green Travelling Options – GREEN TRAVELLING. Silesian University of Technology, ERA-NET 2014–2017;
- Harnessing coastal radars for environmental monitoring purposes. IMGW-PIB, BONUS, 2014-2017;
- Information system on the impact of climate change on agriculture and adaptation methods. Multiannual program. Institute of Soil Science and Plant Cultivation – State Research Institute;
- Support for low carbon agriculture able to adapt to observed climate change in the perspective of 2030 and 2050 (LCAgri). Institute of Soil Science and Plant Cultivation – State Research

Institute, Polish Academy of Sciences, Institute of Environmental Protection – National Research Institute, Azoty Group; NCBiR Biostrateg 1 Programme 2015-2018;

- Development of Urban Adaptation Plans for cities with more than 100,000 inhabitants in Poland. Institute of Environmental Protection – National Research Institute. Ministry of the Environment, 2017–2019;
- Climate change adaptation in small and medium size cities. Institute of Environmental Protection – National Research Institute, Polish-Norwegian Project, 2017;
- A pan-European framework for strengthening Critical Infrastructure resilience to climate change (EU–CIRCLE). The Maritime University of Gdynia participated in the project, 2015-2018;
- A Comparative Study on Institutional Capacity, Governance, and Climate Change Adaptation in Poland and Norway (PolCitClim). University of Warsaw, Polish-Norwegian Research Programme, 2014-2017;
- Resource Management in peri-urban areas: going beyond urban metabolism *(REPAiR)*. Institute of Geography and Spatial Organisation, Polish Academy of Sciences, Horizon 2020, 2016-2020;
- Shaping the profile of the demand for electric power, while saving energy and its cost without interfering with the profile of the demand for usable energy. Euros Energy Sp. z o.o. IUSER NCBiR Programme as part of the Smart Growth Operational Programme 2014-2020;
- Modular power management system for sustainable energy management from renewable sources with storage function for household and industrial applications. ZE Twerd Company 2017–2020. NCBiR as part of the Smart Growth Operational Programme 2014-2020;
- Area forecasting of electricity production from Renewable Energy Sources, taking into account its impact on network node loads. GLOBEMA Sp. z o.o. 2016–2019. NCBiR as part of the Smart Growth Operational Programme 2014-2020;
- Smart Sensor Networks in Air Protection (ISSOP). Atmoterm S.A. 2016–2020. NCBiR as part of the Smart Growth Development Operational Programme 2014-2020;
- Development of an integrated system for precise control of microclimate in large facilities to meet almost zero energy requirements (nZEB). FRAPOL Sp. o. o. 2017–2019. NCBiR as part of the Smart Growth Operational Programme 2014-2020;
- Innovative medium-voltage energy storage system with the lowest carbon footprint on the market, including a testing technology in the automatic production process. NORTHVOLT POLAND Sp. z o. o., 2021-2023. NCBiR as part of the Smart Growth Operational Programme 2014-2020;
- Ecological asphalts. LOTOS ASFALT Sp. z o. o., 2020-2023, NCBiR as part of the Smart Growth Operational Programme 2014-2020;
- Water purification by evaporation. Miejskie Przedsiębiorstwo Wodociągów i Kanalizacji S.A., 2021-2023, NCBiR as part of the Smart Growth Operational Programme 2014-2020;
- Prediction of stormwater network performance as a SaaS based on data acquired by machine learning. CARL DATA SOLUTIONS PL Sp. z o.o., 2017-2018, NCBiR as part of the Smart Growth Operational 2014-2020;
- Development and putting into operation of a novel industrial method and equipment for effective flue gas cleaning from dust and toxic gases in small- and medium-capacity heating boilers used in heating plant, PONER Sp. z o. o., 2019-2022, NCBiR as part of the Smart Growth Operational Programme 2014-2020;
- Reduction of air pollution as a result of the production of pro-ecological elastomeric materials. Jan Kochanowski University in Kielce, 2020-2023, NCBiR as part of the Smart Growth Operational Programme 2014-2020;

- Obtaining a new generation of Polish varieties of rapeseed, cereals and Fabaceae resistant to new breeds of pests, with better ability to mitigate and adapt to climate change, with appropriate technological features required by consumers and industry. Hodowla Roślin Strzelce Sp. o. o. 2017–2023. NCBiR as part of the Smart Growth Operational Programme 2014-2020;
- CLIMATIC TOWN – Energetic Revitalization of Cities. Marshal Office of the Dolnośląskie Voivodeship 2016–2018. NCBiR, Co-operation Programme INTERREG V-A Poland – Saxony;
- Friendly house – cross border network of energy-efficient demonstration buildings. Koszalin University of Technology 2016-2017. South Baltic Cross-border Co-operation Programme 2014-2020;
- Research on a modern, backup source of electricity. Energia OZE Sp. z o.o., 2017–2019. NCBiR, Regional Operational Programme for Śląskie Voivodship 2014-2020;
- Comprehensive adaptation of forests and forestry to climate changes – small retention and protection against water erosion in mountain areas. State Forests National Forest Holding 2016–2022. NCBiR as part of the Infrastructure and Environment Operational Programme 2014-2020;
- Comprehensive adaptation of forests and forestry to climate change – prevention, counteracting and reduction of the effects of threats related to forest fire. State Forests National Forest Holding 2016–2022. NCBiR as part of the Infrastructure and Environment Operational Programme 2014-2020;
- The knowledge base on climate change and adapting to climate change effects, together with knowledge dissemination channels, to strengthen economic, environmental and societal resilience as well as to support management of extraordinary risks associated with climate change. IOŚ – PIB 2017-2021. NCBiR as part of the Infrastructure and Environment Operational Programme 2014-2020;
- The cooperation for adaptation to climate change through small retention and protection of biodiversity. "*Green Action*" Ecological Foundation 2017–2019. NCBiR as part of the Infrastructure and Environment Operational Programme 2014-2020;
- Modernization and development of the calibration infrastructure of the National Reference and Calibration Laboratory for Atmospheric Air Research and the additional equipment of a network of air quality monitoring in Poland. Chief Inspectorate for Environmental Protection 2015–2020. NCBiR as part of the Infrastructure and Environment Operational Programme 2014-2020;
- NEYMO-NW – Lausitzer Neiße/Nysa Łużycka – climatic and hydrologic modelling, analysis and prognosis related to water resources under low water level conditions, INTERREG, 2014-2020;
- Strengthening of water monitoring in the scope of procedures for ensuring and controlling the quality of measurements and assessments of surface water status and research, measurement and IT infrastructure. Chief Inspectorate for Environmental Protection 2015–2021. NCBiR as part of the Infrastructure and Environment Operational Programme 2014-2021;
- Elaboration of plans to counteract the effects of drought in river basin districts. Polish Waters National Water Holding 2016–2020. NCBiR as part of the Infrastructure and Environment Operational Programme 2014-2020;
- TRANSGEA – Cross-border co-operation in local actions to adapt to climate changes, IMGW-PIB, INTERREG, 2018-2020;
- Preparation of the investment programme to improve the quality and to reduce the losses of water intended for human consumption, Ministry of Infrastructure, 2020-2021;

- Preparation of the programme to prevent water shortages, Ministry of Maritime Economy and Inland Navigation, 2014-2022;
- Programme for testing new groundwater pollutants for the purposes of monitoring the substances in the watch list, Polish Geological Institute – NRI, 2020-2022;
- Review and update of flood hazard maps and coastal flood risk maps, including risks posed by internal sea waters within the competence of the Maritime Office in Gdynia, Maritime Office in Gdynia, 2017-2020;
- Review and update of flood hazard maps and coastal flood risk maps, including risks posed by internal sea waters within the competence of the Maritime Office in Słupsk, Maritime Office in Gdynia, 2017-2020;
- Review and update of flood hazard maps and coastal flood risk maps, including risks posed by internal sea waters within the competence of the Maritime Office in Szczecin, Maritime Office in Szczecin, 2017-2020;
- Review and update of coastal flood risk management maps, including risks posed by internal sea waters, Ministry of Infrastructure, 2018-2021;
- Review and update of flood risk management maps, Polish Waters National Water Holding, 2019-2022, as part of the Infrastructure and Environment Operational Programme 2014-2020;
- Mediating integrated actions for sustainable ecosystem services in a changing climate – MIRACLE. IMGW-PIB, BONUS 2015-2018;
- Review and update of flood hazard maps and flood risk maps, Polish Waters National Water Holding, 2017-2022, part of the Infrastructure and Environment Operational Programme 2014-2020;
- The role of urban parks in modifying city climate and bioclimate today and in the future CLIMPARK. Institute of Geography and Spatial Organisation, Polish Academy, OPUS, 2022-2025;
- Human and climate impacts on drought dynamics and vulnerability. Institute of Geophysics, Polish Academy of Sciences, SHENG 1, 2019-2023;
- Support for low carbon agriculture able to adapt to observed climate change in the perspective of 2030 and 2050 (LCAgri). Institute of Soil Science and Plant Cultivation – National Research Institute, Polish Academy of Sciences, Puławy Nitrogen Works of Azoty Group, Institute of Agrophysics, Polish Academy of Sciences, Institute of Environmental Protection – National Research Institute, 2018-2021;
- Innovation in Underground Thermal Energy Storages with Borehole Heat Exchangers. AGH University of Science and Technology, MuoviTech Polska Sp. z o.o., University of Stavanger;
- CO_2-Enhanced Geothermal Systems for Climate Neutral Energy Supply. AGH University of Science and Technology, Mineral and Energy Economy Research Institute, Polish Academy of Sciences, SINTEF Energi AS (also referred to as SINTEF Energy Research AS), Norwegian University of Science and Technology, EXERGON Sp. z o.o., BHEsINNO, 2020-2023;
- GReen And SuStainable – kNoewledge EXpanded freight Transport in cities. Maritime University of Szczecin, The Institute of Transport Economics – Transportøkonomisk institutt, VITRONIC Machine Vision Polska Sp. z .o.o., GRASS-NEXT;
- Tools for information to farmers on grasslands yields under stressed conditions to support management practices. Institute of Geodesy and Cartography, Poznań University of Life Sciences, Norwegian Institute of Bioeconomy Research, NORCE Norwegian Research Centre AS, GEOMATIC Michał Wyczałek Jagiełło, GrasSAT;
- Improved bio-inocula and living mulching technologies for integrated management of horticultural crops. National Institute of Horticultural Research in Skierniewice (Poland –

Coordinator), NIAB EMR (Great Britain), Max Plank Institute for Polymer Research (Germany), Research Group for Organic Farming GRAB (France), Creaciones Aromaticas Industriales S.A. CARINSA (Spain), Eurecat Chemical Technologies Unit (Spain), BioHotiTech, 2021-2023;

- Mod4GrIn – self-sustainable, smart module for city green infrastructure in climate change adaptation. Institute for Ecology of Industrial Areas, Norwegian Institute of Bioeconomy Research, CommLED Solutions Sp. z o. o., Mod4GrIn, 2020-2023.

8.3. Systematic observations

8.3.1. Meteorological observation systems

In Poland, observations and measurements as part of the global meteorological and climate observation system are carried out by the State Hydrological and Meteorological Service (PSHM) at the Institute of Meteorology and Water Management – National Research Institute (IMGW–PIB). These operations are performed at 923 points situated all over the country (Table 8.1). The whole network implements a measurement and observation programme in line with the WMO standards and the equipment installed in it is subject to continuous monitoring and periodic calibration at the IMGW–PIB Central Laboratory of Measuring Equipment.

The observation network is enhanced with an actinometric network. It was set up in the early 1060s and now consists of 25 stations. The data from four actinometric stations are forwarded to the World Radiation Data Centre (WRDC) in Sankt Petersburg in the Russian Federation.

Table 8.1. IMGW-PIB observation network (as of 1.01.2022)

Type of station	Number
First- to fourth-order meteorological stations	923
First-order synoptic stations, including 2 alpine meteorological observatories (WOM)	63
Second-order climatological stations	197
Third-order rain gauge stations	658
Fourth-order special stations	5
Aerological measurement stations (GUAN)	3
Meteorological radars of the POLRAD system of meteorological radars	8
Stations of the PERUN atmospheric discharge detection and location system	12
Satellite data receiving station	1

Source: IMGW-PIB

After verification and control, data obtained from the IMGW–PIB network of measurement and observation stations and points are collected and stored in the national database of historical data of the IMGW–PIB, without specifying the validity period, in hard copy (the oldest date back to the end of the 18th century), microfilms and electronic carriers (digital data covers the period since 1951, and the data for a greater measurement range – since 1966).

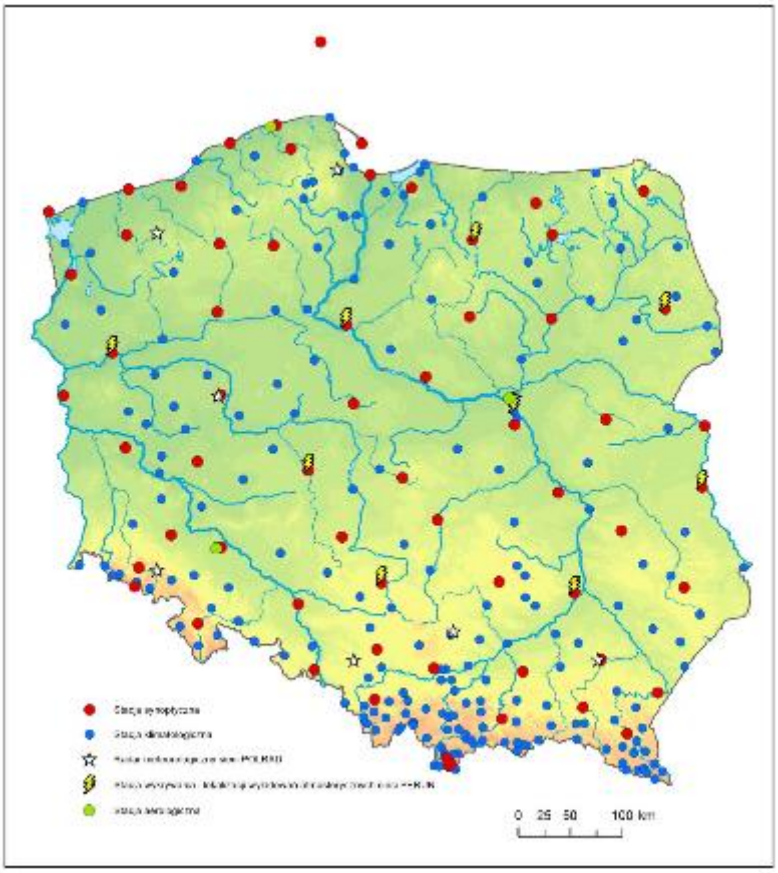


Fig. 8.1. IMGW-PIB observation network (as of 1.01.2022)

8.3.2. Oceanic observation systems

Research on the marine environment of the Polish zone of the Baltic Sea is carried out by numerous scientific and administrative institutions, including the Institute of Oceanology of the Polish Academy of Sciences (IO PAN), the University of Gdańsk (UG) and the Maritime University of Gdynia (UMG), while the coastal zone, bays and lagoons of the Baltic Sea, including coastal and transitional bodies of water, are monitored by the Regional Environmental Monitoring Departments. The fish stocks and the state of the environment in this respect are monitored by the National Marine Fisheries Research Institute – National Research Institute (MIR-PIB) both in coastal areas and in open seas. The Polish sea areas are monitored by the Department of Oceanography and Baltic Monitoring at the Institute of Meteorology and Water Management – National Research Institute. The monitoring of the sea areas is an element of the State Environmental Monitoring System, which is implemented under the supervision of the Chief Inspectorate for Environmental Protection. In addition to meteorological observations, the monitoring of the deep-sea zone includes the measurements of the physical parameters (sea water temperature, salinity, sea currents), chemical parameters (oxygen concentration and contents of nutrients, heavy metals and organic compounds) and biological ones as well as the contents of radionuclides of anthropogenic origin (^{137}Cs and ^{90}Sr). The observation programme complies with the requirements of the Marine Strategy Framework Directive (MSFD). The observations are carried out from RV Baltica, a research vessel equipped with advanced equipment for measurements of physical water features and a chemical laboratory, and the vessel MY Littorina, which is used in shallow-water research. The Baltic Sea monitoring data are collected in the oceanographic database and then forwarded to the European Environment Agency (EEA), the Helsinki Commission (HELCOM) and the International Council for the Exploration of the Sea (ICES).

The oceanographic research carried out outside the Baltic Sea is done by the Institute of Oceanology of the Polish Academy of Sciences in cooperation with the National Marine Fisheries Research Institute (MIR–PIB) from the deck of the ship SY Oceania. In addition to the research voyages in the Baltic Sea, the vessel carries out research in the Northern European Seas – the North Atlantic and the Arctic. During its voyages, it performs measurements in the fields of physics, hydrodynamics, chemistry, biochemistry, the ecology and genetics of marine organisms.

Since December 2008, an automatic meteorological station has operated on the Petrobaltic Beta offshore platform in the Baltic Sea in the vicinity of Cape Rozewie about 70 km from the shore. The results of the measurements, among others, of pressure, wind velocity and direction, temperature and humidity are sent to the IMGW–PIB with a 10-minute time step.

In 2015, as part of the routine operations of the Polish programme for monitoring the Baltic Sea, the FerryBox automatic meteorological and oceanographic measurement system was installed on board MF Stena Spirit ferry. The measurements taken on the Gdynia – Karlskrona route include, among others, continuous measurements of temperature and salinity.

The Republic of Poland participates in the global maritime observation system under the VOS (Voluntary Observing Ships) and SOOP (Ship Of Opportunity) Programmes. 82 ships from the Polish merchant fleet are included in the VOS Programme (as of 2014). Most of them send data to data collection centres. Two vessels sailing in the Baltic Sea participate in the SOOP Programme. Sea level data from the Władysławowo station are transferred on an operational basis to the European Sea Level Network (ESEAS).

In Poland, the analyses of satellite images are carried out for the purposes of oceanology by the IMGW-PIB, the University of Gdańsk, the University of Silesia in Katowice and the Institute of Oceanology, Polish Academy of Sciences. They cover, among others, the wind fields over sea areas, sea surface temperatures, ice and the colour of seawater.

The IO PAN participates in the measurements taken by the ARGO network carrying out in-situ global ocean observations. The network consists of 4,000 floats measuring the depth profiles of seawater temperature and salinity. The data are transmitted in real time to database management centres where they are then processed and prepared for publication. Since 2009 the IO PAN has launched 34 floats. 20 of them were launched within the Nordic Seas from RV Oceania, a research vessel of the IO PAN, while another 3 were deployed in the same region from Horyzont II, a training ship of the AMG. Since November 2016, the IO PAN has launched 11 ARGO floats from RV Oceania in the Baltic Sea.

8.3.3. Earth surface observation systems

The system of observations on the terrestrial essential climate variables includes:

- hydrology (GTN-H);
- river discharge (GTN-R);
- lakes (GTN-L);
- glaciers (GTN-G);
- permafrost (GTN-P).

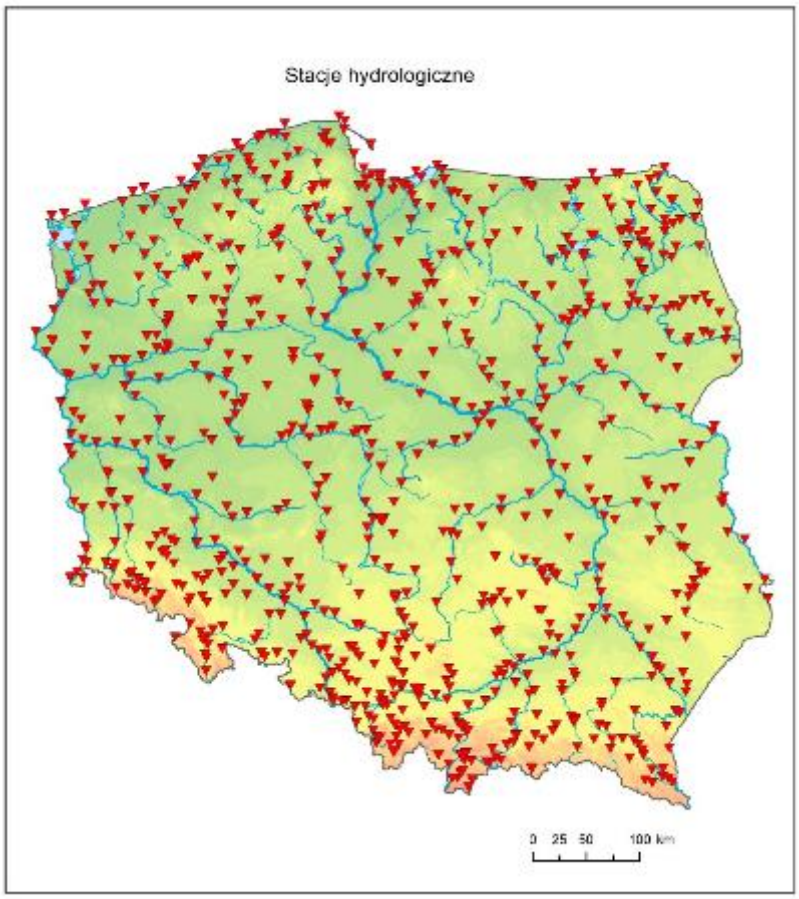


Fig. 8.2. Hydrological stations of the IMGW-PIB (as of 01.01.2022)

As part of the GTN–H component, the IMGW–PIB carries out water level measurements at 863 inland sites (01.01.2022). The basic measuring range includes observations of water levels, ice events, ice cover thickness, plant overgrowth of the river bed and, if possible, daily variations of the water level and water temperature measurements (at almost 120 sites). The density of the hydrological measurement network depends on the flood risk in a given area. For this reason, the number of stations is far greater in the south of the country. The thickness of the snow cover is determined at 690 sites in Poland and 1 station in southwestern Spitsbergen, i.e. the Hornsund Station (of the Institute of Geophysics, Polish Academy of Sciences). At many stations, in addition to daily measurements of snow cover thickness, snow cover density is determined as snow water equivalent (mm of water/cm of snow cover thickness). At hydrological stations (previously there were water gauge posts here), hydrometric measurements are carried out as part of the GTN-R component to determine the water level – discharge ratio.

The inland hydrological measurement network is supplemented by limnological measurements (as part of the GTN–L component) carried out in 15 lakes in the northern and western parts of the country. They cover the water balance of the lakes monitored. In all the lakes included in the limnological network, the inflow and outflow are measured and, in addition, three of the stations measure the evaporation from the surface of the lake. For some lakes, the components of the water balance have been systematically determined since the early 1960. Moreover, in some lakes the water temperatures are measured on the surface or in a vertical cross; water transparency and quality are also determined periodically.

At high latitudes, Polish research units monitor inland glaciers under the GTN–G component. In the case of the Norwegian Arctic (south-western Spitsbergen), the glacier monitoring programme

has been carried out for many years by the University of Silesia and the IGF PAN, covering many parameters. In Antarctica, ice surveys have been conducted by the Polish Academy of Sciences in the vicinity of the Henryk Arctowski Station, periodically and to a limited extent, still their results have made it possible to determine the rate of glacier retreat (since the 1950s) and the intensity of the summer outflow. Regular summer thaw depth measurements and systematic ground temperature measurements have been taken (doe to 1.0 m depth) since 1977 by the IGF PAN in the area of the Hornsund Station (south-western Spitsbergen) as part of the GTN-P component.

The Republic of Poland is a member of the International Permafrost Association (IPA) and participates in the Circumpolar Active Layer Monitoring (CALM) Programme which is part of the global observing programme GTN-P (the UMK and the UMSC). The measurement results are forwarded to the CALM data centre at the University of Cincinnati (USA) and to the National Snow and Ice Data Center w Boulder (Colorado, USA).

The tradition of phenological observations in Poland dates back to the end of the 19th century. These observations were resumed by the IMGW–PIB (formerly the PIM) after World War Two, interrupted in 1992 and relaunched in 2005. The network of phenological observations under the supervision of the IMGW–PIB has now 50 sites. Some universities and agricultural advisory centres also operate their own networks of phenological observations. In agriculture, the observations focus on the assessment of climate change impacts on plant production, agriculture, the extent of ecotones, i.e. the limits of climate and plant zones, and ecosystems in Poland. This work was done primarily at the Institute of Soil Science and Plant Cultivation – National Research Institute (IUNG) and the Poznan University of Life Sciences.

8.3.4. Satellite climate observing systems

Data from satellite meteorological systems are used in Poland on a routine basis for the meteorological, hydrological, sea and air aviation-related protection of the country. Poland is a member of the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) and the European Space Agency (ESA), which ensure its quick access to data from meteorological and environmental satellites, and participates in the operations of these agencies to maintain and develop satellite systems.

The operational reception, processing and provision of data from meteorological and environmental satellite systems for the purposes of monitoring the environment and weather (and hence indirectly climatology, too) are carried out at the Satellite Remote Sensing Centre of the IMGW–PIB in Cracow. Since the 1960s, the IMGW–PIB has had a ground-based station in Cracow for the reception and processing of satellite data. It enables the collection of satellite data from all the meteorological and environmental satellites directly from a satellite, which are made available by means of the EUMETcast satellite system (as part of the EUMETSAT) or from dedicated ESA hubs. These systems include:

- systems of geostationary satellites: METEOSAT-8, 9, 10 and 11 (EUMETSAT), GOES-E (USA), GOES-W (USA), Himawari (Japan) and Fengyun (China);
- systems of polar satellites: a series of US NOAA satellites (15, 18, 19 and 20) and Suomi NPP, European satellites METOP - B and C, the oceanographic satellite Jason-3 and environmental satellites TERRA and AQUA;
- satellites of the EU Copernicus Programme: Sentinel-1, Sentinel-2, Sentinel-3, Sentinel-5P.

Since Poland has also acceded to the Collaborative Ground Segment Programme (ESA), the ground-based station also receives operationally satellite data directly from the Sentinel-1 satellite.

Data from circumpolar satellites are received by means of 3 tracking antennas, including an antenna with a diameter of 3.8 m, which is part of the system for direct data reception from the Sentinel-1 satellite. Fig. 8.3 shows a block diagram of the satellite data reception system.

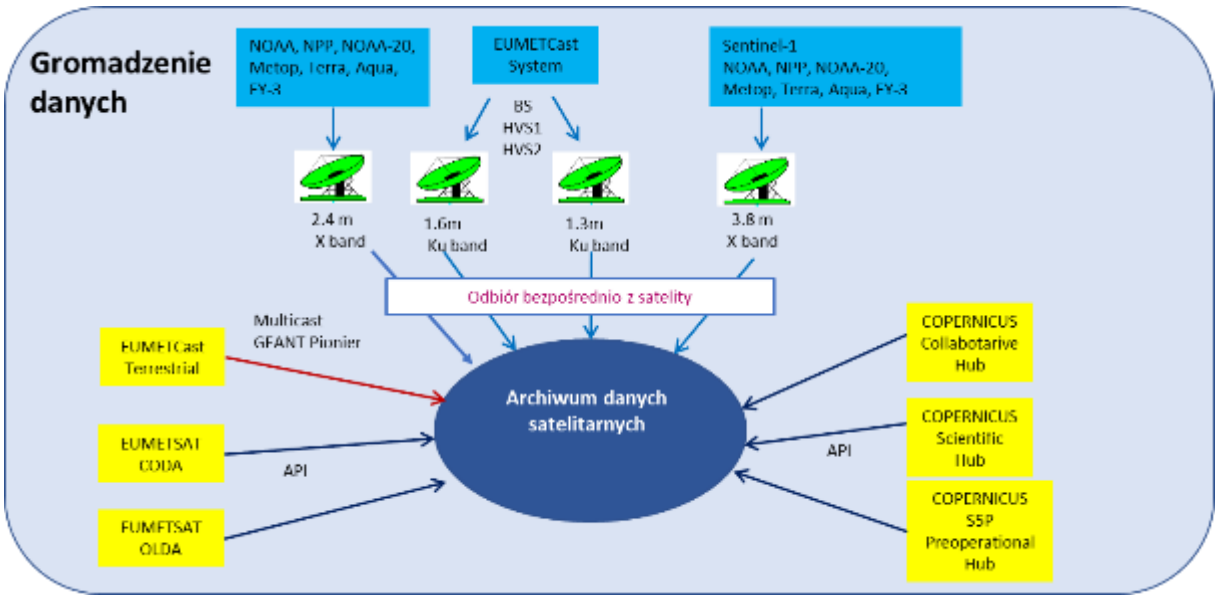


Fig. 8.3. System for data reception from meteorological and environmental satellites, including the Copernicus satellites

Satellite data are made operationally available to the entities and users which are involved by statute in the meteorological, hydrological and sea protection of the country, using both the internal and external IMGW-PIB data distribution systems and the service established as part of the Project "*Operating system for gathering, sharing and promotion of digital information about the environment (Sat4Envi)*", financed from the resources of the European Union and the state budget under the Digital Poland Operational Programme. As a result of the implementation of this Project, a backup archive of level 1 data from the Copernicus satellites has also been made. This archive also collects data from the meteorological satellites which are received by the IMGW-PIB station. The service and archive are available on the website https://dane.sat4envi.imgw.pl.

Research in the field of satellite observing systems focuses on the use of satellite information for meteorology and hydrology in the operational mode. In addition, work is done on the use of satellite data in climatology, oceanology, agriculture and surveys on the natural environment.

As part of research projects implemented, a system for satellite monitoring of the total ozone content has been developed as a component of the environmental monitoring carried out by the Chief Inspectorate for Environmental Protection (GIOŚ). From 1993 the total ozone content over the area of Central Europe was operationally determined from satellite data using different types of satellite sensors available over that period. Since 2017 the total ozone content has been monitored on the basis of the data from the Ozone Mapping and Profiler Suite (OMPS) sensor on board the NOAA-20 and Suomi NPP satellites. On the basis of these data, the daily and monthly total ozone content distributions over Central Europe are determined. The accuracy of the estimation of the total ozone content from satellite data is determined by a comparison with the measurements of ground-based stations.

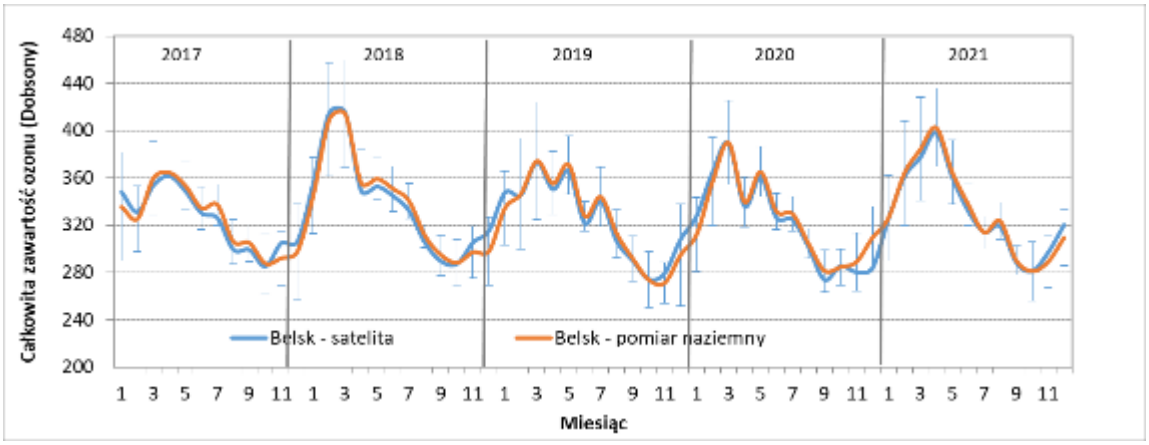


Fig. 8.4. Mean monthly values of the total ozone content determined from OMPS satellite data and measured by the Dobson spectrophotometer (the data source: WOUDC) at the Belsk Station in the period from 2017 to 2021. The vertical bars correspond to the interval of ± standard deviation of the mean calculated from the satellite data. [Total ozone content (Dobson units)]

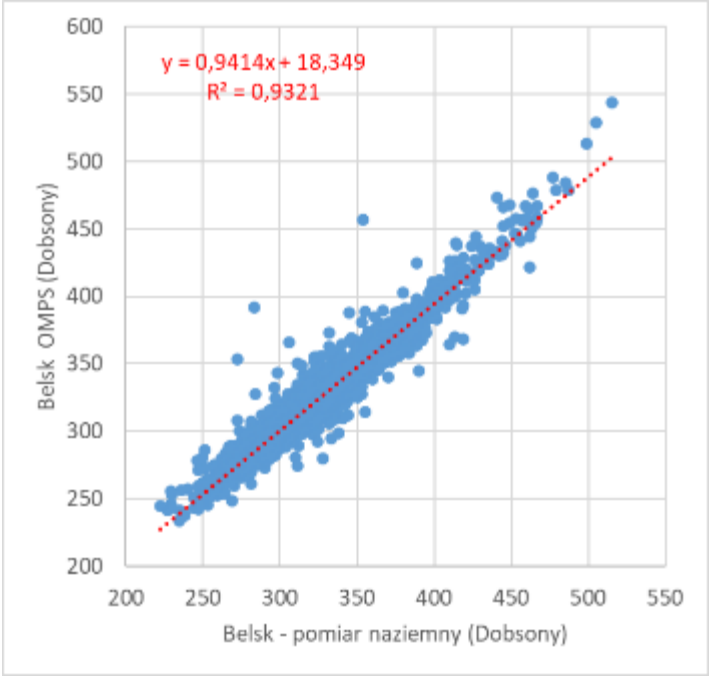


Fig. 8.5. Comparison of the the total ozone content determined from OMPS satellite data with the one measured by the Dobson spectrophotometer (the data source: WOUDC) at the Belsk Station in the period from 2017 to 2021 [Dobson units]

Work is also carried out to use satellite data to calculate NO_2 emissions from Sentinel-5P/TROPOMI satellite data for point emitters and heating systems.

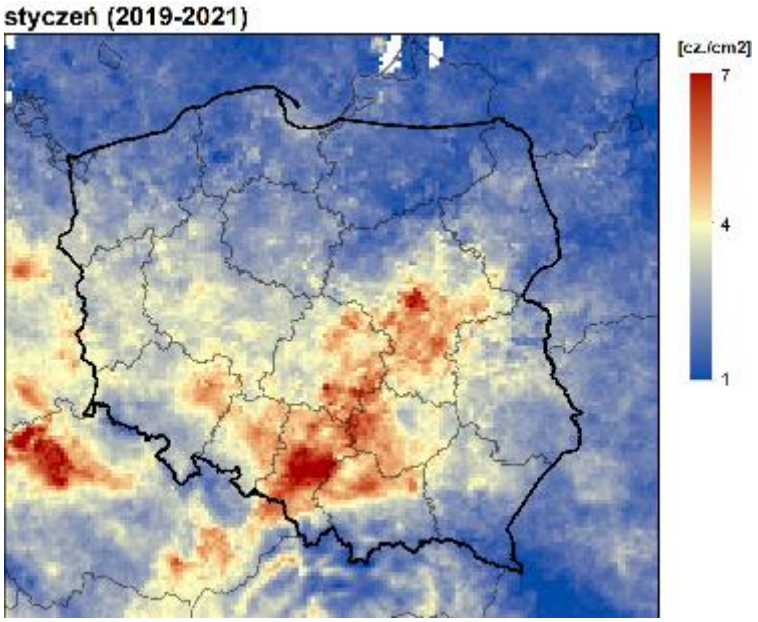


Fig. 8.6. Distribution of the multiannual mean monthly NO_2 content in the troposphere over Poland's territory in January. Based on the Sentinel-5P/TROPOMI data from the period from 2019 to 2021 [Mol/cm^2]

Satellite data are used in research on the variability of sea surface temperature carried out as part of the Project "*The climate conditions of changes in the marine environment (in the case of Southern Baltic. Sea surface temperature data series*".

The environment is also monitored using medium-resolution data from Sentinel-1 and -2 satellites. Operational ice detection has been launched in the Szczecin and Vistula Lagoons and so has the pilot monitoring of ice jams on the main Polish rivers.

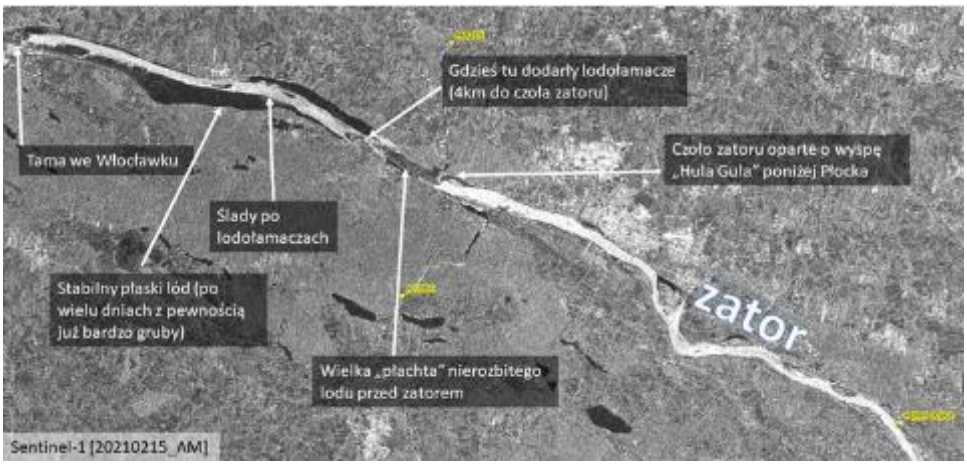


Fig. 8.7. An example of the analysis of an image from Sentinel-1/SAR (VV polarisation) to detect an ice jam on a river. An ice jam on the Vistula Rive near Płock on 15.02.2022.

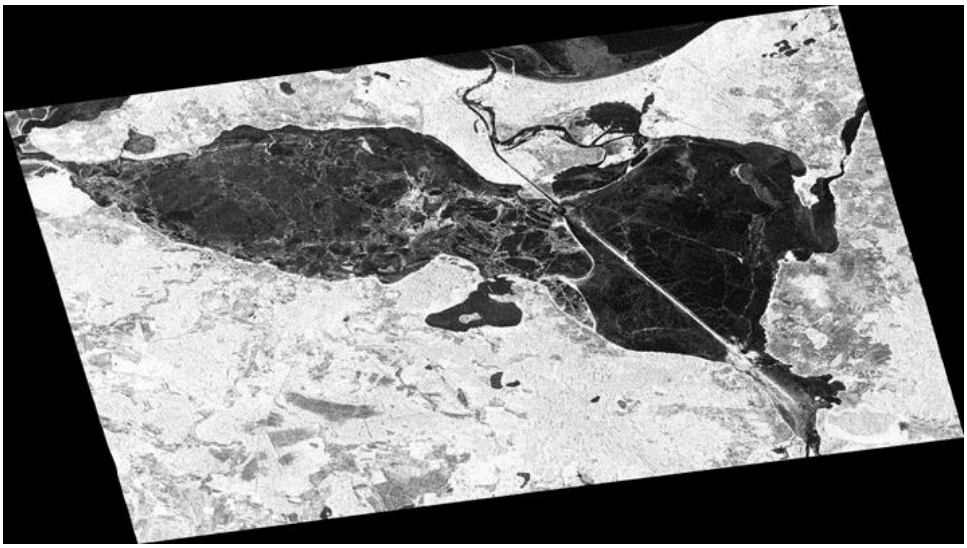


Fig. 8.8. Ice in the Szczecin Lagoon on 14.02.2017. An image from Sentinel-1/SAR (VV polarisation)
Source: Copernicus Sentinel [2022].

Since Poland is a member of the EUMETSAT, the IMGW-PIB actively participates in the work of the Satellite Application Facilities in the field of operational hydrology – H-SAF. As part of the H-SAF Consortium, work is carried out to develop and validate the algorithms for using satellite data to determine precipitation intensity, the parameters characterising snow cover and soil moisture. The results of this work are used, among others, to monitor the precipitation in areas uncovered by the radar system and to detect snow cover in Poland's territory. The satellite data on soil moisture are used to monitor the spatial and temporal variability of this parameter in Poland's territory and enable the detection of drought-affected areas.

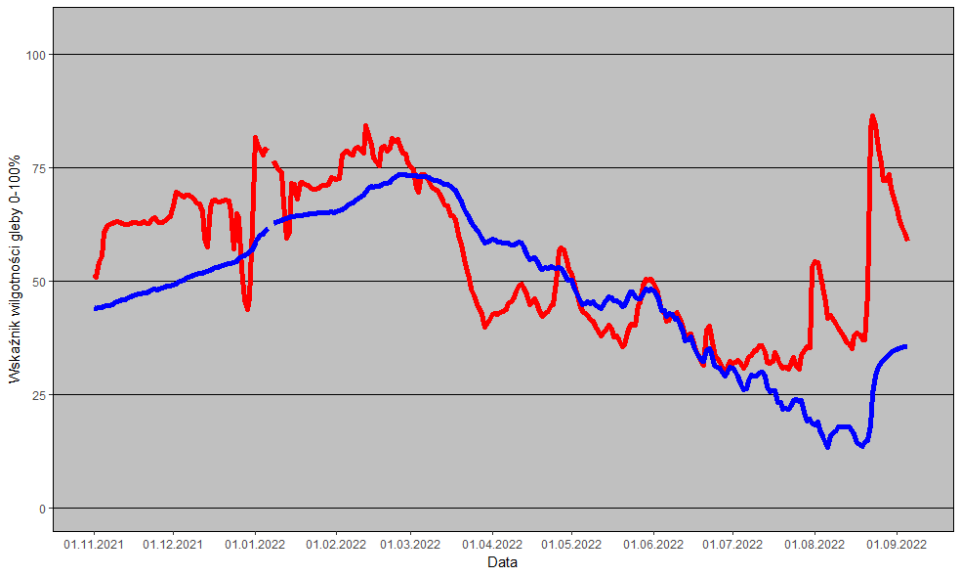


Fig. 8.9. Variations in the mean soil moisture index in the County of Wołów (Dolnośląskie Voivodeship) in 7-28 cm (red line) and 28-100 cm (blue line) soil layers in the period from 01.11.2021 to 05.09.2022 [Soil moisture index]. A clearly visible drought in the spring and the most part of the summer of 2022.

The drought periods which regularly occurred in recent years pose a growing fire risk. In light of this, work has started to prepare fire detection products and to assess their range using both the data from meteorological satellites and the medium-resolution data from the Copernicus environmental satellites.

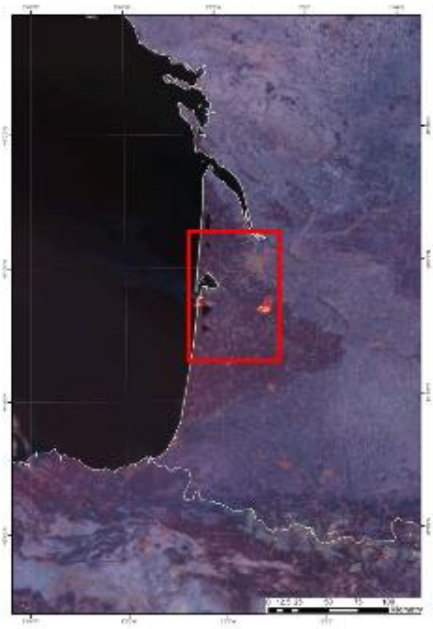


Fig. 8.10. True colour RGB composite of fire temperature (R=3.9 µm; G=2.2 µm; B=1.6µm), S-NPP/VIIRS of 18.07.2022, 11:43 UTC. A visible forest fire (bright orange and yellow colours) south of Bordeaux in France.

Fig. 8.11. True colour RGB composite, Sentinel-2 of 17.07.2022, with a close-up of the main forest fire outbreak point south of Bordeaux in France.

As part of its agrometeorological activity, the Unit of Specialised Forecasts of the IMGW-PIB has developed an online service covering a number of parameters characterising climate at the local scale, using satellite and ground-based data. Ongoing monitoring is carried out in the form of the maps of current values and anomalies from long-term values and the charts of the behaviour for 380 Counties and 16 Voivodeships of such parameters as:

- the solar radiation reaching the surface of the Earth;
- the current evapotranspiration;
- the reference evapotranspiration;

- the soil moisture indices for two layers;
- the general cloudiness of the sky;
- the hydro-thermal coefficient of Selyaninov;
- the climatic water balance;
- the degree to which the water needs of plants are satisfied;
- the gross primary production;
- the beginnings of the phonological seasons of the year;
- the beginning of the growing season;
- the occurrence of storms in Poland.

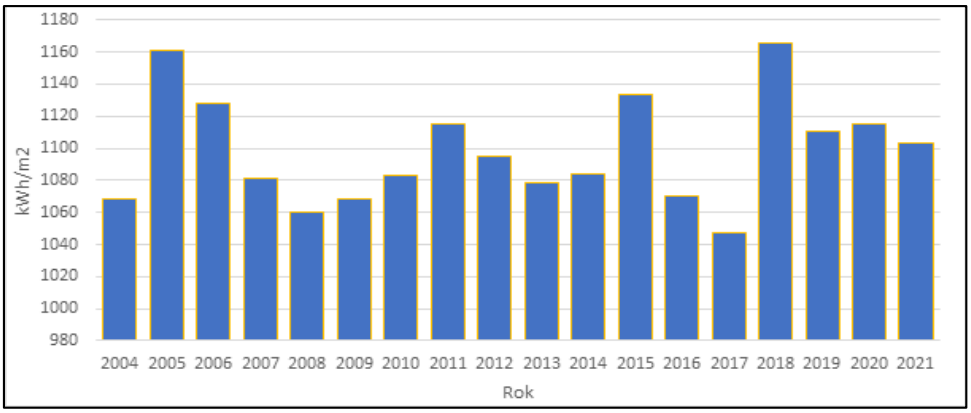


Fig. 8.12. Comparison of annual total insolation levels (averaged over Poland's territory) in the period from 2004 to 2021.

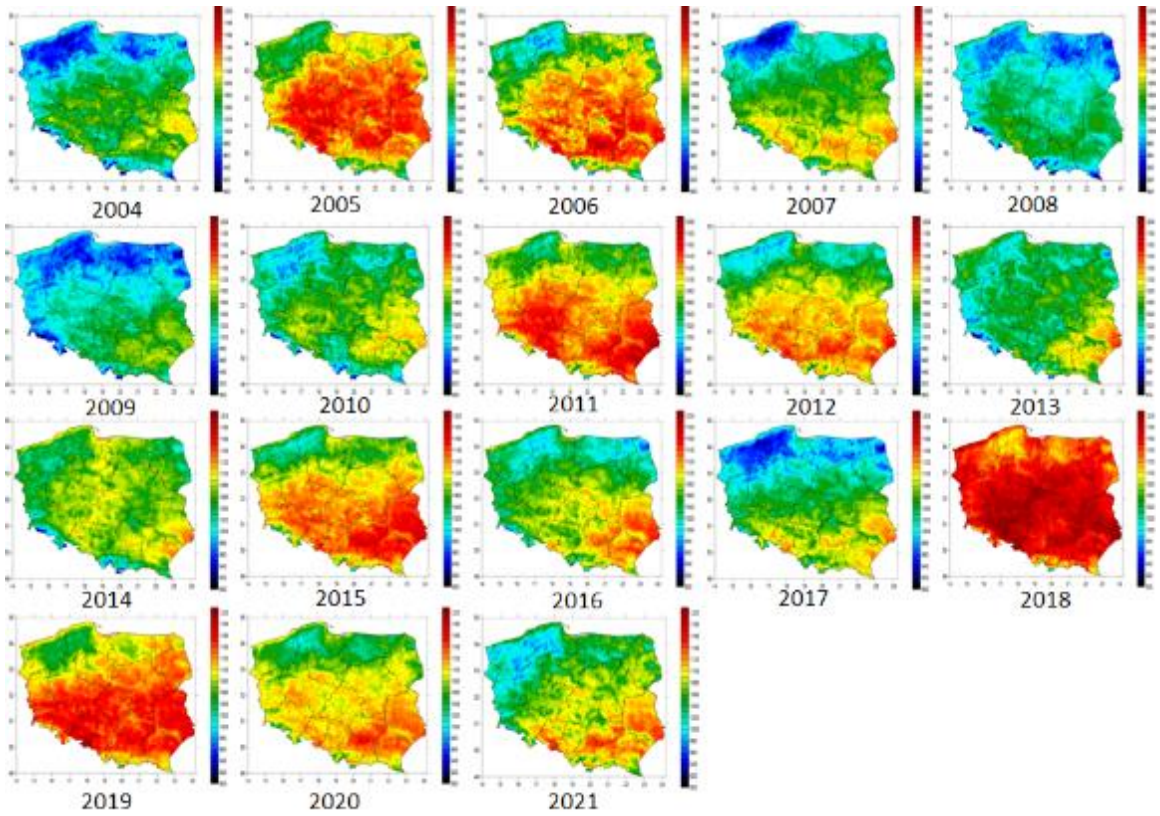


Fig. 8.13. Spatial insolation distribution in the period from 2004 to 2021 (annual totals in kWh/m^2)

Moreover, current data are presented in the form of the maps: of the surface temperature, the leaf area index (LAI), the active photosyntethic radiation absorbed by plants, soil moisture in 4 layers, the precipitation intensity and total, the surface albedo, the snow cover extent and the snow cover thickness on the basis of the data from microwave satellite sensors.

At present, the service contains more than 120,000 maps and charts covering the period since 2004 until the present. On the basis of these data, expert studies and analyses are prepared, including those to meet the needs of the Government. Monthly "*Agrometeorological Bulletins*" are published. Part of the service and bulletins are available to the public on the website: http://agrometeo.imgw.pl .

8.3.5. Monitoring of greenhouse gases

Research on the status of the ozone layer over Poland

The research on the status of the ozone layer over Poland and the UV radiation intensity measurements, carried out on commission from the Chief Inspectorate for Environmental Protection as part of the State Environmental Monitoring System, are coordinated by the IMGW–PIB and the Institute of Geophysics, Polish Academy of Sciences. Some stations have monitored ozone since the 1960s. The research on the ozone layer over Poland includes:

- the measurements of the total ozone content in the atmosphere and its vertical distribution,
- the measurements of the vertical ozone concentration profiles by the survey method,
- the determination of the field of the total ozone layer over Europe by satellite observations,
- the measurements of the UV radiation intensity at the stations in Łeba, Legionowo, Belsk and Zakopane.

The data are forwarded to the Norwegian Institute for Air Research in Oslo (NILU), the World Ozone and Ultraviolet Radiation Data Centre (WOUDC) in Toronto and the Laboratory of Atmospheric Physics of the University of Thessaloniki.

Analysing the long-term changes in the mean values of the total ozone content in Belsk (the red curves in the Fig. 8.14 represent the mean behaviour after smoothing by the local regression method), it can be seen that the trend in the mean annual value of the total ozone content has changed since the mid-1990s. A distinct falling trend which appeared at the end of the 1970s was halted in about 1996. Ever since the mean values of the total ozone content have grown. At the beginning of the 21st century, that trend was halted and the mean values of the total ozone content vary about a steady level without a distinct trend.

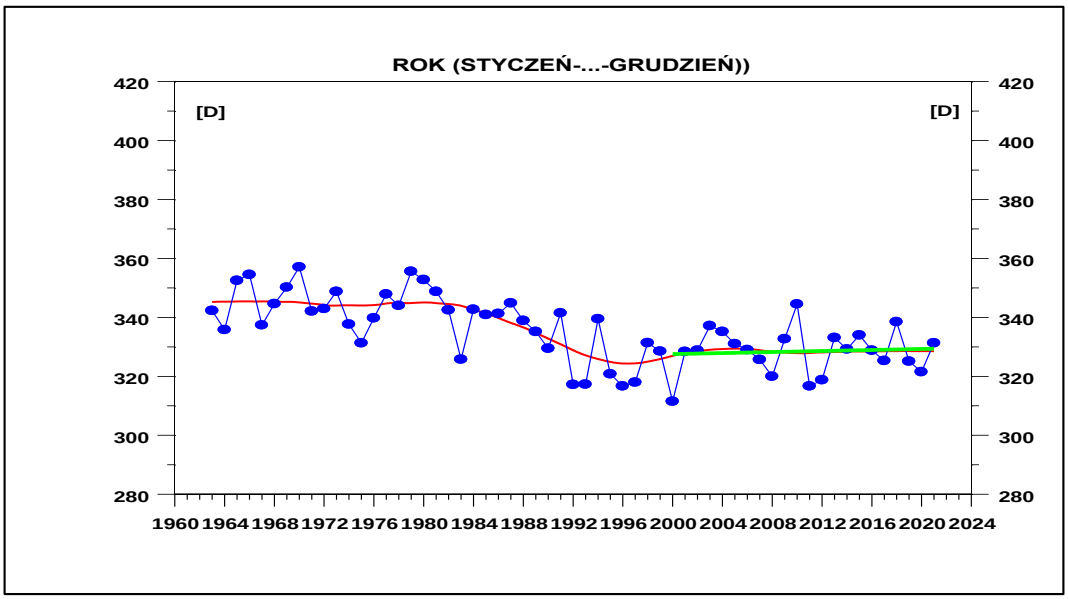


Fig. 8.14. Mean values of the total ozone content measured by the Dobson spectrophotometer at the Central Geophysical Observatory of the Institute of Geophysics, Polish Academy of Sciences, in Belsk, in the period from 1963 to 2021. The red curve represents the smoothed data, while the green curve shows a linear trend (statistically insignificant) in the period from 2000 to 2021

Research on the carbon dioxide and methane concentrations in the atmosphere

The measurements of the carbon dioxide concentration in the ground layer of the atmosphere are carried out at the background atmospheric pollution monitoring station in Borecka Forest (IOŚ-PIB) on commission from the GIOŚ as part of the State Environmental Monitoring System. Some universities, including the AGH University of Science and Technology in Cracow, the University of Łódź and the Poznan University of Life Sciences, carry out their own programmes of observations and research on greenhouse gases. Since 1994 the atmospheric concentrations of carbon dioxide and methane – the main anthropogenic greenhouse gases – have been measured by the AGH University of Science and Technology (the Environmental Physics Group of the Faculty of Physics and Applied Computer Science), in cooperation with the IMGW-PIB, at the Alpine Meteorological Observatory w on Mount Kasprowy Wierch, situated at an elevation of 1,987 m a.s.l. in the Tatra Mountains. The unique situation of the station qualifies it for inclusion in the network of the WMO reference climatological stations and it is also part of the network of European High Altitude Research Stations.

At present, two Picarro laser spectrometers are operated:

- G2101-i (measuring the concentrations of CH_4, $^{12}CO_2$ and $^{13}CO_2$), since 2015;
- G2401 (measuring the concentrations of CO_2, CH_4 and CO), since 2022.

They apply the method of Cavity Ring Down Spectroscopy (CRDS). It enables the measurements of the parameters listed above with 1 Hz resolution. This method has replaced the gas chromatography which is abandoned in this type of research. Moreover, averaged monthly air samples are collected on Mount Kasprowy Wierch and CO_2 is extracted from them to measure ^{14}C radiocarbon in atmospheric CO_2.

The location of the station enables the measurement of the concentrations of greenhouse gases (CO_2, CH_4) at least during the night hours, devoid of the influence of anthropogenic and biogenic emissions, which in turn enables monitoring of the so-called regional background concentration of these gases GHG (the concentration in the free troposphere). The obtained concentration values confirm the global growing trend of the CO_2 concentration: at the Kasprowy Wierch station, the rate of the CO_2 concentration increase is on average 2.16 ppm annually.

This seasonal variability of the CO_2 concentration in the atmosphere, with the maximum values observed in winter and the minimum values observed in summer, is associated with the biosphere activity. In the period analysed, the amplitude of this cycle for the Kasprowy Wierch station varied between 10 – 21 ppm.

The research on atmospheric CO_2 carried out in parallel in Cracow using isotopic methods enables the breakdown of the total CO_2 concentration in the atmosphere into individual components, i.e.: the regional background (for Cracow represented by Kasprowy Wierch), the biogenic component (CO_2 originating from the autotrophic and heterotrophic respiration of vegetation and other living organisms) and the anthropogenic component (CO_2 from fossil fuel combustion).

Research is done to specify the sources of anthropogenic CO_2 as those associated with the combustion of fossil fuels in street traffic, the combustion of coal in industry (the so-called high emission sources) and the combustion of coal and natural gas in urban buildings (the so-called low-emission sources). By using carbon isotopes in CO_2: ^{12}C, ^{13}C and ^{14}C, the amount of the particular types of CO_2 emissions in the Cracow atmosphere can be attributed to each of these sources.

The information collected at the Kasprowy Wierch Station is used at the national level for the education and research carried out by the Faculty of Physics and Applied Information Science of the

AGH University of Science and Technology (M.Sc. and D.Sc. theses, research grants, commissioned projects) and other national units, and at the international level by the participation in the European Union projects as part of the Fourth, Fifth, Sixth and Seventh Framework Programmes of the European Union and the Horizon 2020 Programme (with the completed projects including ESCOBA, METHMONITEUR, CARBOEUROPE-IP, IMECC, GHG-EUROPE, INGOS, EUROHYDROS and MEMO2). At present, 2 projects are implemented as part of the Horizon 2020 Programme; they are CoCO2 and CORSO. The stations are also used in the implementation of the projects funded by the United Nations Environment Programme (UNEP), a UN body, and the Climate & Clean Air Coalition (CCAC) supported by the Environmental Defense Fund (EDF). In the subsequent years, the greenhouse gas measuring station KASLAB plans to take an active part in successive research projects as part of the EU Horizon 2020 Programme, the MFF framework programmes which will replace the Horizon 2020 projects and also in other projects involving research on climate change and GHG cycle.

The data measured at the Kasprowy Wierch Station are forwarded to the European and global carbon cycle research databases. Moreover, the infrastructure and equipment of the Station is made available to European research groups (among others, as part of the CoMet Project implemented since 2018). The results of the measurements which are collected at the Kasprowy Wierch Station have been used in many scientific publications dealing with the carbon cycle issues at the regional and global levels. The data acquired at the Kasprowy Wierch Station were used in the successive editions of Poland's National Communication to the Conference of the Parties to the UNFCCC. The efficient operation of the Kasprowy Wierch Station has enabled the Faculty of Physics and Applied Information Science of the AGH University of Science and Technology to participate in the European projects involving carbon cycle and climate change research. The Kasprowy Wierch Station is committed to providing measured data to the emerging international research initiatives associating prestigious laboratories in the world, e.g. the Integrated Carbon Observation System, the Global Carbon Project or the Geo Carbon and GHG Initiative.

The satellite measurements and also other methods for the top-down determination of the methane emissions into the atmosphere indicate that the area of Upper Silesia is the source of this gas at the regional scale. At present, the multi-strand research on the atmosphere in this region is continued to identify the methane sources. The first results of the research indicate both the biogenic sources and the emissions from the many coal mines located in this area.

CHAPTER 9. EDUCATION, TRAINING AND PUBLIC AWARENESS OF GLOBAL CLIMATE CHANGE

9.1. Education policy

Both the UNFCCC and all the other final documents of the UN Conference on Environment and Development adopted in Rio de Janeiro in 1992 provide that education is the basis of the development and enhancement of the human capacity to face the challenges posed by the hazards related to climate change and enables the implementation of sustained and sustainable development. The UNFCCC emphasises the need to raise the public awareness, with particular consideration given to the climate-related areas. The relevant tasks are laid down in its Article 6, which recommends that the States Parties should implement relevant education programmes and ensure general access to information on the environment, personnel training and an exchange of experiences at the international level. The Kyoto Protocol also obliges its Signatories to cooperate at the international level and urges the use of organisations and institutions to implement education, training and public awareness raising and to facilitate access to information on climate change. One of the key goals under the 2030 Agenda for Sustainable Development, i.e. SDG 4, also places a strong emphasis on equal access to education and its quality.

Poland's response to these recommendations was laid down in its National Environmental Policy 2030 (PEP2030)[75]. The aim of the PEP2030 is to develop the potential of the environment for citizens and entrepreneurs, corresponding with the goal in the area of the environment in the Strategy for Responsible Development (SOR), specifying its provisions and presenting solutions for particular interventions. One of the horizontal objectives *Environment and education. Development of the environmental competences (knowledge, skills and attitudes) of the public* supports the climate-related objective, i.e. *Environment and climate. Climate change mitigation and adaptation and the management of the risk of natural disasters.* In addition to environmental education, the goal of actions in this area is to shape sustainable consumption patterns, which requires the preparation of a strategic plan. This plan is expected to present the implementation framework for environmental education, with consideration given to contents from each of the thematic environmental areas present in the PEP2030. Until such a plan is prepared, the 1994 National Strategy for Environmental Education – Through Education to Sustainable Development, which is still in effect, continues to play its role. This document was updated in 2001 and strengthened with an implementing programme[76]. The action plan laid down in it covered particular age and vocational groups, set out relevant tasks for the entities carrying out education and proposed the ways of financing them. In accordance with the National Strategy, the Ministries in the areas of the environment and education, with the participation of all the Ministries within the range of their competence, are responsible, as the leading entities, for environmental education, including education in the area of climate change mitigation. The Ministry of Foreign Affairs has a special role to play in the development of education which addresses climate issues at the global level, including Poland's responsibility for assistance in the process of adaptation to climate change in developing countries. The Strategy also emphasises the need to implement education activities within the framework of formal education and broad non-formal education contributing to raising the public awareness, including the understanding of the impact of the climate

[75] https://www.gov.pl/web/środowisko/polityka-ekologiczna-państwa-polityka-ekologiczna-państwa-2030
[76] www.mos.gov.pl/g2/big/2009_04/97b75873145cdf7e7695ed9573147c78.pdf

process on social and economic life. In Poland, the issue of access to information on the environment and its protection is regulated by the relevant Act[77].

The Ministry of Climate and Environment (MKiŚ) supports environmental education and the raising of the environmental awareness of the public, with their components including: knowledge of the environment, practical competences and the environmentally friendly motivation to change attitudes and everyday behaviour. In addition to the formal education pathway, which falls within the competence of the Ministry of Education and Science, the environmental education is delivered as part of extracurricular, non-formal education, provided, among others, by specialised environmental education centres, the education centres in national parks, units of State Forests, nongovernmental organisations, territorial self-governments, public environmental protection institutions and the mass media. The Ministry of Climate and Environment participates in the development of both modes of the teaching process, initiating or taking part in projects. The education projects under implementation are related to priority thematic areas, among others, of climate change mitigation and adaptation[78]. Since 2021 the interministerial cooperation for environmental education has been supported by the Team for Environmental Education, Including Climate Education and the Promotion of Environmentally Friendly Living Conditions. As part of its work, the Team has defined the concept of climate education and set out the objectives which it is expected to achieve, emphasising the human role in mitigating the adverse effects of climate change. The main aim of the activities of the Team and the working groups coordinated by the representatives of youth climate organisations is to prepare 40 class scenarios as part of the systematised division of contents. These activities are preliminary steps leading to the cooperation in the area of climate education, engaging in them the key administration authorities and youth communities.

In accordance with the recommendations of the COP25 decisions, the official participation of youth in the decision-making on climate was strengthened. In 2020, the Youth Climate Council (MRK) was appointed as a body to provide opinions to the Minister of Climate and Environment. The Council, consisting of youth aged 15 to 26 years, expresses the concerns of young people with hazards posed by climate change. The tasks of the MRK include the provision of opinions on Acts, the delivery of non-formal education, the creation of a platform for dialogue between decision-makers and youth, and public consultations, among others, on the climate education in schools[79].

9.2. Education in the formal education system

Since the previous Communication the formal education system in Poland has changed at the primary and post-primary stages. In 2017, the reform of the structure of the education system introduced an 8-form primary school (replacing a 6-year primary school and a 3-year gymnasium), a 4-year grammar school, a 5-year technical secondary school, a 3-year first-level sectoral school and a 2-year second-level sectoral school. The amendment to the Act on the Education System introduced the provision stipulating that "*The education system shall ensure in particular (…) the dissemination of*

[77] Act of 3 October 2008 on the Provision of Information on the Environment and Its Protection, Public Participation in Environmental Protection and Environmental Impact Assessments

[78] Examples of the activities of the MKiŚ: 2020 r. – a series of online workshops for school youth and the series of "*Climate Classes*" (www.lekcjezklimatem); 2021 – webinars on climate change mitigation for teachers; education packages for primary schools, including, among others, "*Friends of the Climate*" (www.gov.pl/web/klimat/materiały); information and education packages for self-governments (www.naszklimat.gov.pl); TV spots

[79] www.gov.pl/web/klimat/MRK

the knowledge of the principles of sustainable development among children and youth and the development of attitudes conducive to its implementation at the local, national and global systems"[80].

The main document defining the compulsory content of curriculum in educational institutions is the "*Core Curriculum for Upbringing at Kindergartens and General Education in the Individual School Types*"[81]. This document defines the sets of learning objectives and curricular contents which are included in the curricula and enable the establishment of the criteria for school assessments and examination requirements. The Core Curriculum indicates that schools are obliged, among others, to deliver environmental education at all the education stages, including the upbringing at kindergartens, placing an emphasis on the upbringing of pupils in harmony with nature and the development of attitudes conditioning their efficient and responsible functioning in the contemporary world.

The core curriculum for upbringing at kindergartens includes, among others, such concepts as heat or hurricanes, constituting the introduction to the conversation about what climate change and its effects are. In Form IV, the respect for nature is indicated as the objective of education as part of nature classes, encouraging pupils, among others, to take action to protect nature and the cultural heritage of their community, to separately collects waste, to indicate the possibilities of its reuse and to limit the waste generation in households. In all the types of schools, the expected achievements of their pupils/students include the assessment of the changes unfolding in the natural environment as a result of human impacts and their effect on the quality of life and the ability to find remedial measures, making it possible for the education to include the issues of adaptation to climate change.

As part of the health education and biology and geography courses delivered in Forms V to VII, pupils learn how to respond to situations posing a risk to health or life, improving their capacity to take care of their closest environment, and to build a sense of shared responsibility for the state of the environment, favourable for keeping good health. The core curriculum for grammar schools provides that as part of the biology course pupils should come to understand the justifiability of nature conservation, demonstrate the attitude of respect for all the living beings and the responsible use of natural resources, and explain the principles of sustainable development. Much more attention to climate education is paid as part of the geography course where pupils learn about the environmental problems of the contemporary world, discuss the impact of deforestation and other factors on the climate change on Earth and propose measures to mitigate climate change.

In vocational schools, i.e. a first-level sectoral school, a technical secondary school, a second-level sectoral school, environmental education is delivered as part of general education, in accordance with the core curriculum for general education as set out for these types of schools. Moreover, all the core curricula for sectoral vocational education take into account, among others, the education effects concerning compliance with occupational safety and health rules, including the knowledge and understanding of, as well as compliance with, the principles of environmental protection, and the prevention of threats to the environment at the workplace and during the execution of vocational tasks. In selected professions, specific education contents related to environmental and climate education have been defined (as suggested by specific vocational tasks carried out in a given profession), concerning, among others, renewable and alternative sources of energy and heat, as well as rational waste management, including the transfer of waste for recycling or disposal.

[80] Act on the Education System (Official Journal of the Laws of 2022, Item 2230)

[81] Core Curriculum for Upbringing at Kindergartens and General Education for Primary School … (Official Journal of the Laws of 2017, Item 356, as amended); Core Curriculum for General Education at Grammar Schools, Technical Secondary Schools, Second-level Sectoral Schools (Official Journal of the Laws of 2018, Item 467, as amended)

The preparation of good materials to assist in the teaching process is supported by university-level schools and scientific institutes, while the production of these materials is co-financed by grants from the NFOŚiGW and the Voivodeship Funds, as well as from business, companies and foundations. The materials prepared by the institutions working for environmental protection help teachers deliver their classes, among others, on climate change mitigation and adaptation[82].

Diverse forms of support for schools in their climate education (education materials, online portals, class scenarios, competitions and campaigns) are prepared on commission from the Department of Education and Communication of the Ministry of Climate and Environment. Large business institutions in the environmental protection sector also run websites offering the participation in activities which are useful for the work of teachers and pupils. Many schools benefit from supplementary education programmes and take part in knowledge competitions and actions organised by specialised nongovernmental organisations or institutions which, among others, introduce global issues by promoting the efforts to avoid food waste or the purchases of fair trade products or encourage youth with interesting competitions to gain knowledge of the environment and to share it with others[83]. The Ministry of Education and Science provides access to broad choice of educational materials which is available to all interested teachers, students and educators at the Integrated Educational Platform www.zpe.gov.pl .

University-level schools, representing the highest component of the formal education system, offer substantive and didactic support for lower-level schools, since they educate teachers as part of their teaching specialisations, additional courses and post-graduate studies which also include climate education. University-level schools also prepare staff and leaders who implement the principles of sustainable development in practice and carry out actions related to climate change mitigation in all the areas of the economy and social life. The environmental protection courses are delivered at most of the public higher education establishments, including humanities universities, polytechnics and schools of life sciences, as well as non-public higher education establishments, and many studies of this type have the inter-faculty or even inter-university character[84]. In order to improve the teaching process and to align the graduate's profile with the needs related to the contemporary challenges of environmental management, including climate change mitigation and adaptation, every year for 27 years now the methodological conferences "*Environmental Protection at Universities*" have been organised.

In addition to the major studies, increasingly often university-level schools also offer university-wide lectures on the most important civilizational challenges related to the environment[85].

[82] Examples: the methodological conferences and workshops for teachers delivered by the IOŚ – PIB in cooperation with the Mazovian Local Government Centre for Teacher Training; the substantive support from universities, such as the Cardinal Stefan Wyszyński University (UKSW) (the annual conferences on the issues of sustainable development) or the University of Warsaw (UW) – the University Centre for Environmental Studies and Sustainable Development (open semester lectures "*Selected issues of ecology and environmental protection*").

[83] The competition for youth "*Bet on the Sun*", consisting in the education of groups of pupils on renewable energy who subsequently share their knowledge with other pupils; in 2018, almost 8,000 participants from nearly 1,100 pupil teams from all over Poland took part, while the already 8th edition of this project was launched in 2022; https://fundacjabos.pl

[84] Inter-Faculty Studies on Environmental Protection (MSOŚ) at the University of Warsaw (UW); www.ucbs.uw.edu.pl

[85] For 30 years the education of this type has been delivered by the University Centre for Environmental Studies and Sustainable Development of the UW and the Centre for Studies on Man and the Environment of the University of Silesia

University-level schools also deliver post-graduate studies, enhancing the competences within a specific, specialised field related to environmental protection[86].

University-level schools, also including non-public ones which have introduced classes on environmental protection and adaptation, develop teaching activities addressed not only to students but also to the entire academic communities. In order to coordinate these activities at university-level schools, special teams and Climate Councils are established and they launch a variety of initiatives, including e.g. the following:

- At the Jagiellonian University (UJ): on the initiative of the Climate Council of the UJ, the online course "*The Climate and Environmental Crisis Voiced by Many Sciences*" (2022/23) is delivered; it is supported by the book "*At the Eleventh Hour to the End of the World. The Climate and Environmental Crisis Voiced by Many Sciences",* available on the Internet[87];
- At the University of Silesia (UŚ): research and education projects, preparing programmes and training courses on climate change and adaptation; the engineering studies at the Faculty of Earth Science on the possibilities of mitigating the adverse effects of climate change (including, among others, modelling and prediction of hazards, early warnings against floods and emergency response); the energy advisory programme "*Prosumer society – Prosumer energy*"[88];
- At the University of Warsaw (UW): support for and development of scientific research, teaching and popularisation in the scope of the issues of the climate and sustainable development; the activities of the Advisory Team for the Climate and Environmental Crisis, called "*The University of Warsaw for Climate*", for education and socially aware and responsible consumption, along with the working out of good practices at the University of Warsaw to diminish the adverse impacts on the environment; the establishment of the Green Dialogue Platform for the purposes of initiating interdisciplinary research on environmental changes, support for education addressing environmental changes and the associated social changes, and the external cooperation; the launch of inter-faculty studies in the English language on sustainable development, along with the seminar on climate change*;* the publication of the manual "*The Climate ABC. The interdisciplinary Fundamentals of the contemporary knowledge of climate change*" and the delivery on its basis of the university-wide online courses; the launch of the Smart Green University Programme to improve the space and infrastructure of the UW; the development and financing of classes on climate change and environmental protection; and the publication of information and scientific articles of the UW researchers on the website "*The UW for Climate*"[89].
- An important element of the development of didactics in the area of broadly understood climate education are the sustainable development-oriented specialisations on management studies; such activities are primarily undertaken by private university-level schools which adapt their curricula to the proposed and upcoming legislative amendments in the area of non-financial,

[86] Examples: the Post-graduate Studies on Biofuels and Renewable Energy Sources at the Faculty of Earth Sciences of the University of Szczecin; the Post-graduate Studies for the Environmental Protection Consultants at the Institute of European Education (launched in 2016; and the Post-graduate Studies on Air Quality Management at the Centre for Ecology and Ecophilosophy at the UKSW

[87] Jagiellonian University https://www.UJ.edu.pl/

[88] University of Silesia https://us.edu.pl/wp-content/uploads/dokumenty/us-dla-klimatu-for-climate-folder_cop-internet.pdf

[89] UW for Climate https://www.uw.edu.pl/uniwersytet/uw-dla-klimatu/

ESG-related reporting; as part of post-graduate studies, university-level schools also offer MBA courses in the area of climate change.

9.3. Training courses in the scope of environmental education and environmental protection

Specialised vocational training courses enabling the improvement of competences are available in all the aspects related to environmental protection. Some of them cover entire sectors, e.g. the chemical one, with several hundred companies from the sector taking part in the Responsible Care Programme. Many courses delivered by university-level schools, commercial companies and expert environmental nongovernmental organisations, such as e.g. training courses on sustainable development, particularly on energy conservation, are addressed to specific vocational groups. Academic centres and nongovernmental organisations deliver courses on environmental impact assessments, for both the institutions carrying out the assessments and the addressees of them. Training courses are also addressed to the representatives of local authorities and self-governments, including e.g. the training courses on the practical use of the access to information on the environment and its protection and those on air protection and adaptation to climate change.

A number of entities delivering training courses do not only work on a commercial basis, since some of them treat it as their mission, e.g. when they provide training courses to prepare specialists in the area of urban adaptation to climate change[90] and elaborate books and instruction brochures, e.g. on the low-emission economy at the local level in order to make the staff of territorial self-government units acquainted with the issues of climate change and its impact on energy management.

The training courses are often co-financed by the NFOŚiGW, which clearly reduces the participation cost. Using the NFOŚiGW resources, in the period from 2017 to 2019, economic advisors delivered more than 200 training courses for the social workers of social welfare centres on the rational energy use and co-financing of RES projects. The Fund also covers the participation in the training courses on the preparation of applications for project funding from the EU Funds and also co-finances some post-graduate studies delivered at university-level schools[91].

From the point of view of improving the formal education, diverse training courses supplementing the knowledge in the field of climate change mitigation and raising the methodological skills of both teachers and educators, i.e. the persons delivering education in non-school establishments, are of key importance. Such training courses are delivered, among others, by the Centre for Education Development, teacher training centres operated by Voivodes and the Centre for Citizenship Education[92]. The programmes addressed to science and nature teachers and the persons responsible for upbringing at primary and post-primary schools which develop their competences and knowledge enabling them to talk about climate change with their pupils correspond with the national education policy, recommending the development of the attitudes of responsibility and the strengthening of environmental education at schools. Other examples include the annual training courses for nature teachers organised by the Mazovian Local Government Centre for Teacher Training

[90] The Sendzimir Foundation, founded by Tadeusz Sendzimir (1894-1989), a Polish inventor in the field of metallurgy, delivers training courses, such as "*Blue-green infrastructure, with exercises in its planning*", "*Practical methods for improving energy efficiency in historic buildings*" and "Various aspects of urban green areas management"

[91] Two-year Post-graduate Studies on Air Quality Management delivered by the Centre for Ecology and Ecophilos ophy at the Cardinal Stefan Wyszyński University (UKSW) in Warsaw

[92] The Centre for Citizenship Education delivers an all year long, free of charge online programme "*The Environmentally Friendly School*"; www.globalna.ceo.org.pl/programy-edukacyjne/ekologiczna-szkoła

which include the methods and contents of teaching about the causes and consequences of climate change. Numerous training courses and post-graduate studies upgrading teachers' skills are also delivered by university-level schools.

One of the frequent topics of the training courses delivered by research institutes and international organisations are the issues related to the explanation of the causes and effects of climate change. The aim of these training courses is to disseminate the best practices in applying the attractive and effective methods for teaching nature courses, including the climate science. The programmes often have the cascade character, meaning that the persons trained are obliged to share the knowledge they have gained with the colleagues at their education establishments. Similarly, the methodology and contents of education for sustainable development (with particular consideration given to the role of forests in adaptation to climate change) are provided by the training courses organised for forest educators by State Forests.

In the agriculture sector, training courses are organised for farmers, also including examples of good practices minimising the adverse impact of agriculture on the greenhouse gas emissions and promoting the use of renewable energy sources. The Voivodeship Agricultural Advisory Centres are involved in the process of training farmers. Moreover, the Rural Development Programme for 2014-2020 provided resources to support the training of advisors in agricultural practices which are beneficial for climate and environment and the training of these advisors was fully free of charge.

Entrepreneurs can use sectoral training courses in the areas related to environmental protection, e.g. waste management, which are delivered by institutions and associations of entrepreneurs. The cooperation between companies and educational institutions also entails the recruitment and assignment of students or pupils to apprenticeships and internships and the arrangement of visits by students or pupils to workplaces in order to make them familiar with the specific conditions of their operation.

As part of the measure called the Energy Market Academy, the Ministry of Climate and Environment carried out webinars addressed primarily to older youth (the pupils and students of secondary schools and university-level ones), adult Internet users and territorial self-government units. Invited guests from the substantive departments of the Ministry of Climate and Environment, as well as, among others, the State Treasury units, university-level schools, research institutes, etc. took part in the webinars as lecturers. The Energy Market Academy was a series of about 20-30 minutes long webinars published in social media, dealing with the issues of energy policy, consumer rights on the energy market, RES and electromobility. The Energy Market Academy consisted of experts who provided guidance on climate change mitigation and on the ways of using this opportunity to take care of the household budget as well.

As part of the Project "*National Parks as Brands*" managed by Ministry of Climate and Environment and financed with EU resources under the Operational Programme Infrastructure and Environment and the NFOŚiGW, training courses were attended by 270 members of the park staff who were involved in environmental education. During a special course, they became acquainted with modern teaching methods and acquired competences in using social media in the communication with the local community and tourists.

9.4. Education outside formal education establishments delivered by public institutions and nongovernmental organisations

In addition to the establishments operating within the formal education system, knowledge can be drawn from diverse sources, constituting a variety of entities working independently as associations, foundations or environmental nongovernmental organisations (in many cases having the status of public benefit institutions) or within the organisational structures of nature conservation and forestry. Their operations, including the events which they organise, along with different forms of communication (e.g. the media and the Internet), influencing the environmental awareness of the public, are defined as the non-formal education system.

In a sense, the activities of the Department of Education and Communication (DEiK) at the MKiŚ are positioned between the formal and non-formal education systems. The Department has initiated the preparation of the Friends of the Climate package, i.e. class scenarios and other graphically attractive ancillary materials for pupils, while the "*Climate for Schools*" packages were provided for teachers to facilitate the implementation of scenarios. Moreover, the MKIŚ makes available the materials for post-primary schools, such as the series of lectures entitled "*The Energy Market Academy. Climate for the Curious*". The materials are substantively supervised by the team preparing the core curricula for schools; this indicates the indirect participation of the MKiŚ in the formal education system. At the same time, the DEiK runs the Our Climate education and information campaign which is typical of non-formal measures[93].

The Ministry of Development Funds and Regional Policy implements the project called the Partnership Initiative of Cities. The aim of the Project is to share and promote knowledge among cities and other entities involved in the shaping and implementation of urban policy in the scope of the pursuit of integrated urban policy by the cities. The Project is a response to the need voiced by self-governments for an exchange of knowledge and experiences among the cities and other entities involved in the shaping and implementation of urban policy and the acquisition of ideas on how the development potential of Polish cities can be strengthened. One of the topics of the present edition of this Project is green cities. The Project is expected to support the representatives of 10 Polish cities (Gdańsk, Lublin, Słupsk, Żory, Ruda Śląska, Racibórz, Kostrzyn, Uniejów, Żyrardów and Międzyrzec Podlaski) in the implementation of climate-friendly nature-based solutions, contribute to making the cities more resilient to extreme climate and weather phenomena and to respond to social and environmental challenges. The implemented solutions will contribute to the sustainable functioning and development of the cities, as they will foster the efficient use of available space and resources; limit the adverse impact of intensive urbanisation on the natural environment; restore degraded ecosystems; enhance and diversify ecosystems, mitigate climate change and limit the adverse impact of intensive (flash) weather events.

The largest number of non-formal education forms practised in organisational structures are delivered by the units of State Forests, the education centres at the national and landscape parks, the Regional Centres for Environmental Education, museums and botanical gardens. Increasingly often, business institutions and foundations set up by banks and media finance their education programmes, publications or knowledge competitions.

[93] Our Climate Campaign www.naszklimat.gov.pl, a part of which is the competition for the Rural Housewives' Circles consisting in the description of eco-practices in climate change mitigation to be implemented at one's own home

Locally, the Regional Centres for Environmental Education carry out education activities. The aim of these Centres is to raise the environmental awareness of the public, to develop the ability to understand and use the acquired knowledge in everyday life and to make the attendees sensitive to the issues of the environment. One of such establishments is the Włocławek Centre for Environmental Education (WCEE), which has operated since 1997 and addressed its educational offer to different groups of attendees – from kindergarten children to adults or even the senior citizens from the Universities of the Third Age. The WCEE implements the Programme "*I Am Aware. This Pays Off*", with its range covering four Voivodeships, and teaches their inhabitants and tourists about the importance of everyday choices in terms of their impact on the environment. Both this and other education programmes of the WCEE are supplemented with open-air educational paths where field classes and workshops can be held with children, youth and adults, and so can open-air events, walks, cycling excursions, etc. During the pandemic, as part of the Programme "*Learn. Get to Know and Explore the Environment around Us*", the WCEE created a virtual educational path in a city park.

The programmes of environmental nongovernmental organisations are much more individualised than those of the regional educations centres. Treating the climate mitigation issues as a priority, 27 of them established the Climate Coalition in 2002. The members of the Coalition include organisations[94] from all over Poland with different profiles: research, expert and advisory and educational ones. The Coalition organises workshops, conferences and thematic training courses on climate change and carries out information actions through its website, where the particular members of the Coalition also present their activities[95]. The Coalition also takes part in the consultations on many documents of the European Commission on climate policy. In addition to their joint education activities "*to tackle human-induced climate change for the benefit of man and the environment*", each of the organisation has its specificity expressed in the forms of the education delivered and the promotion campaigns addressed to their specific audience. There are also organisations which participate in climate education, although they are not involved in environmental protection, as they discern the need for climate change mitigation.

In cooperation with the Polish Athletic Association and the National Parks, the Ministry of Climate and Environment carried out the Project "*ECOathletes at the National Parks*" which promoted the active spending of time in the areas of the National Parks by pupils, teachers and families. As part of the Project, children, together with teachers and parents, had an opportunity, in the areas of 23 National Parks, to take part in sports activities led by licensed coaches associated in the Polish Athletic Association. The activities were complemented with the educational part carried out by the educators of the National Parks. The aim of these activities was to raise the environmental awareness of the participants, e.g. concerning the impact of the unfolding climate change on the native natural ecosystems and the role of individual actions to protect the environment and to mitigate climate change.

[94] Aeris Futuro Foundation, BoMiasto Association, ClientEarth Foundation, Compassion in World Farming Poland, Polish Foundation for Energy Efficiency, Arka Environmental Foundation, Green Action Ecological Foundation, Foundation for Sustainable Development, GAP Foundation Poland, Foundation for Sustainable Development, Open Plan Foundation, Greenpeace Poland, Institute for Sustainable Development, Gaia Club, Lower Silesian Ecological Club, Polish Ecological Club Tychy Circle, Polish Ecological Club Mazovian Branch, Polish Ecological Club Pomeranian Branch, Pracownia na rzecz Wszystkich Istot [A Lab for All Living Creatures], Eko-Unia Ecological Association, ProVeg Poland, Ecological - Cultural Association "*Common Earth*", Social Ecological Institute, WWF Poland, Union of Polish Green Network Associations, Green Mazovia, Centre for Clean Air Policy (a supporting member)

[95] Climate Coalition https://koalicjaklimatyczna.org

Given the role of forests in carbon dioxide sequestration, forest education is particularly important for education for climate. It is carried out on a large scale by State Forests and its education activities are very diversified[96]. Because of the COVID-19 pandemic, 2020 was very untypical; hence the total number of the participants in all the activities, apart from those online, was smaller than in the previous years (in 2019, it was about 1.2 million persons); still, it exceeded 376,000 (including the activities in 432 Forest Districts). A very popular form of education activities are classes indicating the role of forests and their importance in the time of climate change. In 2020, Forest Districts cooperated with nearly 3,000 schools all over the country, undertaking more than 1,700 joint projects and field activities. State Forests has also a very strong education infrastructure, consisting of 54 education centres, 212 forest chambers, 758 educational paths, museums and education materials published by the State Forests Information Centre (CILP). The Forest Districts which are part of the Forest Promotion Complexes with an especially rich education infrastructure play the largest role in the education. The educator staff consists of almost 5,000 employees of State Forests and, due to the continuous raising of their competences through the participation in different forms of professional improvement, the contents and forms of education to an increasingly large extent respond to the global challenges related to climate change.

University-level schools not only prepare teachers for work at the formal education institutions but also make a significant contribution to the non-formal education of the public by carrying out popularising activities, organising popular science sessions and open days and participating in the Science Festivals organised by the Copernicus Science Centre. In turn, Scientific Student Circles present scientific demonstrations, e.g. related to water and climate, to the participants in the Science Festivals.

Such events as the ToGetAir Climate Summits are also important in terms of education and information. During them university experts, the representatives of civil organisations, Ministries and regional self-governments, the representatives of the State Treasury companies, environmental nongovernmental organisations, international concerns and smaller companies involved in climate change mitigation and the media discuss the issues of the safe energy future of Europe, the eco-economy of the 21st century and transboundary cooperation.

9.5. Participation in the international activities

The event in the area of the international activities which attracted in Poland the largest attention of the media and public interest in the UNFCCC was the COP24 Climate Summit which took place in December 2018 in Katowice. The official sessions were accompanied by many events of an educational character. In turn, the largest international event in the area of education for climate was the World Conference on Education for Sustainable Development in Berlin in May 2021 organised by the UNESCO with the message "*Learn for our planet. Act for sustainability*" (in the online mode). The agenda of the sessions also included two contributions from Poland[97]. The Conference concluded with the adoption of the Berlin Declaration on Education for Sustainable Development[98], which obliged the States to intensify their actions in education for sustainable development and to develop international cooperation to ensure that society gains the competences to tackle the most important global challenges, including climate change.

[96] Report on the education activities of State Forests in 2019. State Forests Warsaw 2020, Report on the education activities of State Forests in 2020. State Forests Warsaw 2021

[97] Polish National Commission for UNESCO https://www.unesco.pl

[98] Berlin Declaration https://unescodoc.unesco.org

Under the patronage of the Polish National Commission for UNESCO, the school network called the UNESCO Associated Schools participates in international programmes and implements the Project "*Sustainable Development – Sustainable Lifestyle*". Another project of the Associated Schools, "*The Baltic Sea Project*", consists in direct contacts with schools in the Baltic Sea Area countries and focuses on an exchange of information and the cooperation among schools to enable them to become acquainted with different elements of the environment and to protect them, also including energy conservation.

The Polish National Commission for UNESCO also promotes a series of online seminars held in cooperation with the Climate Convention and devoted to education. The issues addressed at the seminars directly correspond with the UNESCO Framework for the Implementation of Education for Sustainable Development after 2019 and the decisions related to the Action for Climate Empowerment adopted at the UNFCCC COP26 in Glasgow in 2021. With the Polish National Commission for UNESCO there is also the committee which selects candidates from Poland for different global prizes and distinctions, including the UNESCO Japan Prize on ESD 2021, founded by Japan for an establishment with accomplishments in education for sustainable development. The Polish candidate submitted for this UNESCO competition was the Earth and People Foundation implementing the Project "*Green Knowledge for the Universities of the Third Age".*

The Environmental Information Centre UNEP/GRID, affiliated with the National Foundation for Environmental Protection, coordinates and exercises care over the Globe Programme (Global Learning and Observations to Benefit the Environment). The Programme has been implemented since 1997 under the agreement between the Polish Ministry of National Education and the United States National Oceanic and Atmospheric Administration. Polish schools are active in the Programme in which more than 20 000 schools participate globally. As the representation of the United Nations Environment Programme in Poland, the UNEP/GRID also promotes education materials representing the translation of the publication "*Kick the Habit – a UN Guide to Climate Neutrality*". Different international organisations, scientific institutions, cultural representations and embassies carry out their activities in the area of climate education.

Polish organisations participate as partners in many projects intended to disseminate the knowledge of climate change and lifestyle which are financed from the EU education programmes. Many such international partnerships are created due to the projects of the EU LIFE Programme, particularly when they have a transboundary character. Scientists from Poland also take part in different international climate actions, e.g. supporting with their authority such global initiatives as the signing of the World Scientists' Warning of a Climate Emergency, initiated at the University of Silesia and calling for scientists' warning of the effects of climate change to be treated with the utmost seriousness and for a responsible reaction to climate change[99]. The largest number of examples of international cooperation can be found in the academic community, among others, at the University of Warsaw, which has been since 2015 a member of the Copernicus Alliance – European Network on Higher Education for Sustainable Development and the Global Universities Partnership on Environment for Sustainability (GUPES), the UNEP-related network of universities[100].

[99] www.us.edu.pl/en/apel-naukowców-pt-worldscientists-warning-of-climate-emergency

[100] GUPES: www.unep.org/explore- topics/education-environment/ why-does-education-and-environment-matter/global-universities-partnership-on-environment-for-sustainabiity

The global network of the Regional Centres for Expertise on Education for Sustainable Development, established in 2003 at the United Nations University (UNU*)* and represented by the Institute for the Advanced Study on Sustainable Development, is involved in an equally wide range in the field of education[101]. In 2018, the UNU approved the RCE Warsaw Metropolitan, a consortium coordinated by the University Centre for Environmental Studies and Sustainable Development at the University of Warsaw. Its members include the Warsaw university-level schools, civic organisations, the Office of the Capital City of Warsaw and the Kampinoski National Park. The aim of the operation of the RCE Centre is to disseminate civic competences in the field of sustainable development among the inhabitants of the Warsaw Metropolitan Area[102]. The drawing on the achievements of the entire network of the Regional Centres enables the adaptation of global examples to local practices and the dissemination of Polish solutions in the world. This is evidenced by the use of the example of the cooperation between all the partners of the RCE Warsaw Metropolitan and the Kampinoski National Park in the manual on good practices in climate change mitigation and biodiversity conservation which has been prepared for the global RCE network.

In 2018, the Centre for Environmental Studies and Sustainable Development launched a new M.A. course called *Sustainable Development.* The course is delivered in the English language and is attended by students from a dozen or so countries, from both Europe, Asia and Africa. As the first university-level school in Poland, the University of Warsaw joined the UN-led Race to Zero initiative and thus pledged to take immediate actions to halve its greenhouse gas emissions by 2030. This is very important for raising the climate awareness of the whole academic community. The University of Gdańsk, the University of Warsaw, the Gdańsk University of Technology and the Łódź University of Technology were appreciated for their actions for sustainable development in the 2022 Times Higher Education (THE) ranking.

Polish experts provide advice in the work of international organisations on environmental education, including climate issues. Experts from the University of Warsaw participate in the work of the Programme Committee of the World Environmental Education Congress, the Informal Advisory Committee on Education, Communication and Public Awareness of the Convention on Biodiversity and the Commission on Education and Communication of the International Union for Conservation of Nature (IUCN).

Teachers and educators from Poland are active on the Internet, social media and different forums dedicated to education for climate. Paradoxically, the pandemic period made it easier for many persons from Poland to participate in international conferences and seminars due to the organisation of the meetings online. This type of Polish experts' activities coincides with the Strategy of the NFOŚiGW for 2021-2024[103], which provides that *"In light of the noticeable impact of social media on the shaping of the public opinion, the promotion of environmentally friendly activities needs to be intensified. It should be promoted not only domestically, but also internationally so as to show the specific efforts taken by this respect by Poland and its citizens".*

9.6. Education and the raising of the environmental awareness of the business sector

From year to year, even despite the pandemic, the private sector and different business institutions become increasingly involved in actions to raise the environmental awareness in their own

[101] RCE: www.rce.org

[102] https://www.rcenetwork.org

[103] www.gov.pl/web/nfosigw/strategia-narodowego-funduszu-ochrony-srodowiska-i-gospodarki-wodnej-na-lata-2021-2024

enterprises. This also entails the launching or sponsoring of external actions to strengthen the climate education of the public. These actions enable entrepreneurs to highlight their own achievements in the implementation of the Sustainable Development Goals under the 2030 Agenda for Sustainable Development, particularly energy conservation and greenhouse gas emission reductions, and to publicise their efforts to green their companies as examples of good practices.

During the POLECO International Trade Fair for Environmental Protection the MKiŚ organizes the *EcoSphere*, or the space for experts' debates which make a substantive contribution to the Fair at the Poznań Congress Centre and online on Facebook or the website of the event[104]. The *EcoSphere* Conference creates the space for a dialogue with business about the progressing climate change and the related need for energy transition in Poland. As part of the event, thematic sessions are held on the challenges related to the transition, the urban adaptation to climate changes, water resource management and ecodesign.

The importance of education in business and the importance of business in the dissemination of education for climate increase. The evidence to this involvement includes the work of the Roundtable for Climate and the signing of proposals for including the issues of education for climate in the core curriculum for schools by the representatives of several dozen enterprises. Business can not only lobby for the manner of delivering the education at schools but also supports it directly by proposing and financing different forms of the transfer of knowledge and the shaping of environmentally friendly habits, among others, by organising programmes, campaigns and competitions for schools (e. g. Top Marks for Nature[105]).

Enabling the public to acquire the knowledge and skills needed to improve the state of the environment is appreciated by both public institutions and private sector companies which take part in sectoral competitions. The winners are awarded distinctions, such as "*Eco-responsible Business*", conferred to enterprises launching initiatives for sustainable development and resource efficiency, while the title of "*Promoter of Clean Energy*" is given to institutions or persons for their consistent work on new renewable energy sources.

Organisations associating business institutions from different sectors play an extremely important role in raising the climate awareness of enterprises and their leaders. Some of them organise training courses and workshops, educate their member companies and take part in the climate transition.

The general level of the interest in climate policy clearly grows as it becomes more specific and extends to other sectors. Before 2017 the operational interest, rather than the declarative interest only, could mainly be seen among energy enterprises and those of the energy-intensive industry, i.e. large companies from several sectors. At present, the representatives of practically all the 60 sectoral unions participate in the work of the bodies of the Green Transition Council. The purpose of the actions taken by the owners of small and medium-sized enterprises associated in the Clean Business Clubs is to manage their companies in such a way or to shift them to such activities which minimise their adverse impact on the environment. The companies participating in the Clean Business Programme become involved in the development of localities and regions in which they operate, thus demonstrating that the development based on the environmental and social responsibility is possible and constitutes a condition for building a modern economy. Corporate employee volunteering, e.g.

[104] www.poleco.pl
[105] http://piatkadlanatury.pl

employees' individual actions for the environment, plays an increasingly large role in raising the environmental awareness.

9.7. Role of the media in education and public campaigns

In the surveys on the sources of the knowledge about threats to the environment, the Poles very often indicate the media the importance of which in respect of information grows as the time passes from their completion of the formal education[106]. Among the different types of information carriers, the role of electronic media: television, the radio and digital press portals in the Internet, becomes increasingly strong at the expense of printed press. Gradually, too, television gives away its leading position to Internet-based portals and social media forums. While the surveys in 2014[107] indicated that television was the main source of information about the environment for 76% of the Poles, already in 2020[108] climate knowledge was drawn from television by barely 42% of respondents, on a par with social media. It can be seen that the role of the media from which the Polish society learns about environmental issues not only grows but also, irrespective of the type of surveys, they show a common tendency for the role of schools or universities to diminish as the main source of climate knowledge. This is why the provision of Article 6 of the UNFCCC, providing for the need to involve the media in the presentation of climate change-related problems, becomes so important for education.

The issues of environmental protection and climate change appear in the media increasingly often and their coverage intensifies with the weather events becoming more violent as experienced by the public domestically and abroad. However, the media cover these issues in different ways. As far as practical adaptation solutions are concerned, most attention is given to climate by the specialised press. It includes both sectoral and popular science journals which play an important role in the flow of information in the circles which are related to environmental protection by profession or hobby.

In turn, it is the nationwide press that plays the largest role in reaching the widest audience. It mostly consists of the main national dailies which increasingly often publish articles dealing with the causes and effects of global warming and their economic and social consequences. In spite of the falling numbers of copies of their printed editions, most of serious dailies and magazines have, in addition, their digital versions on their websites and their Facebook profiles on social media. Large opinion-forming magazines also affect with their articles the public awareness concerning the threats posed by global warming. Climate-related issues are also increasingly often addressed by so-called glossy magazines, which present the relations between climate change and everyday life and give guidance on lifestyles. The climate-related issues can also be seen more often in the so-called hobby press, addressed to specific special-interest groups, e.g. anglers and lovers of dogs or cars. In turn, In reaching out to the inhabitants of smaller towns, a few hundred local press titles play a large role, addressing the regional issues, e.g. those related to the thermal modernisation of buildings or giving practical advice on energy conservation and other environmentally friendly consumer actions.

The frequency of addressing the issues of climate change mitigation in the media changes depending not only on the weather conditions but also with reference to specific events, e.g. the Conferences of the Parties to the UNFCCC, the so-called Climate Summits (COPs). Especially as a result

[106] ungc.org.pl/wp-content/upload/2022/06/Edukacja -klimatyczna-w-Polsce.pdf

[107] The environmental awareness and behaviour of Poland's inhabitants. TNS Polska report for the MoE, Warsaw 2012, 2014

[108] CEO survey on the climate change awareness of youth and young adults in Poland ceo.org.pl/1planet4all./aktualności

of those that Poland organised (COP14 in Poznań in 2008, COP19 in Warsaw in 2013 and COP24 in Katowice in 2018), the frequency of information on climate change grew in the media, debates were held on television and related news and experts' publications and discussions appeared in the press.

Although the role of television becomes weaker, still, together with the radio, it continues to play an important role in the general transfer of information. In light of this, many radio and television programmes on environmental protection have the character of cyclical magazines with a permanent position on the air. Apart from the shows created at the initiative of the media themselves and funded from their internal budgets, most regular radio broadcasts (among others, the series on renewable energy sources) and TV programmes are subsidised by the NFOŚiGW.

The Ministry of Climate and Environment takes an active part in the events addressing the issues of climate change and environmental protection. An example of such an action is its participation in the Earth Festival in Uniejów at the invitation of the Clean Air Programme Association (SPCP) as part of the joint information and education actions of the Clean Air Programme, under the trilateral agreement between the MKiŚ, SPCP and NFOŚiGW. Together with the NFOŚiGW, the MKiŚ had a joint stand at the Eco Town event, including the meetings with experts on clean air, energy sector and nuclear energy, and workshops for children called "*A Training Course for a Little Radiological Protection Inspector*"[109]. As part of the Festival, the representatives of the MKiŚ and its subordinated and supervised bodies, as well as other institutions, frequently appeared on Polsat TV.

The Ministry of Climate and Environment used the traditional and social media to implement its education and information campaigns, such as the Campaign for the Green Investment Plan[110], the Top Marks for Selected Collection and Clean Air – A Healthy Choice. Your Choice, and the campaign for renewable energy sources. As part of the Clean Air Campaign, 12 lifestyle/popular science articles were prepared and published[111] to promote the use of the assistance under the Clean Air Programme, 24 entries into the Ministry's Facebook profile were prepared and published, an outreach campaign was carried out on the Internet and so was the mailing addressed to the staff of self-government units. As part of the Campaign for Renewable Energy Sources, air time at radio stations was bought for the broadcast of spots on renewable energy sources and a press campaign was commissioned in the printed press and the websites of press titles on the opportunities for using photovoltaic energy. As part of the Top Marks for Selected Collection Campaign, initiated in 2019, a number of communication measures were carried out for the purposes of promoting selected waste collection, with five fractions represented by brand heroes:

- an advertising campaign – on the Internet and in the social media;
- actions addressed to the local government administration[112];
- the website *naszesmieci.pl* [Our Waste], in particular enabling the operation of this website during the campaign and the provision of information and materials on the campaign[113].

[109] Radiation sources were searched for with a Geiger–Müller counter, experiments were carried out to determine air quality and a solar charger for cellular phones and environmentally friendly cycle stations could be used

[110] The production and broadcasting of TV spots promoting the programmes of the MKiŚ on green investments, addressed to different beneficiaries, including citizens, self-governments and entrepreneurs

[111] czystepowietrze.gov.pl

[112] The preparation of information materials in a section of the Campaign website (The Guide to Communication with Inhabitants on the Uniform Separate Waste Collection System (JSSO); Q&A – Updated for the purposes of the Campaign; a poster on the JSSO for the communication with self-governments with the message: *What Results from Waste Recycling?;* 8 infographics on the JSSO concerning what is derived from appropriately selectively collected waste of the particular fractions and the selective collection in numbers), as well the mailing of the materials on the JSSO to self-government units, three times during the Campaign;

[113] Including 5 articles, 5 infographics and 9 videoinfographics

In addition to the campaigns, a TV show of an educational character was implemented. It was called "*A Great Test on Climate*" and devoted to the issues of air protection and unfolding climate change. Among others, it included:

- a nationwide knowledge test, in particular in the scope of acquiring the knowledge, among others, of the nature of climate change, the origin of greenhouse gases (with a breakdown into natural and anthropogenic factors involved in so-called human activities), the factors affecting air pollution, the causes of smog (an indication of the differences between the issues of air pollution, smog and climate change);
- 5 publicist features broadcast in the form of video footage;
- a street survey;
- the website of the competition, including quizzes preparing for the test, an online test during the show and the presentation of 3 video footage items with the participation of an expert and the representatives of the MKiŚ.

As part of the actions on the radio, 8 radio shows were produced and broadcast on Polish Radio Channel 1 on: the Clean Air Programme, offshore wind energy, the My Power Programme, nuclear energy in Poland, the Youth Climate Council, the My Water Programme, electromobility and waste management.

9.8. Use of the Internet in the education

As the main contemporary medium used to disseminate and to enable multilateral communication, the Internet plays an enormous role in supporting education for climate. The Internet strengthened its importance in particular during the COVID-19 pandemic, enabling education through the remote education and the online organisation of any types of meetings, seminars and conferences. According to the GUS data, in 2017 the Internet was used by 59% of pupils and students, while in 2021 by already 92%[114]. Due to the use of the Internet, the knowledge of climate change is disseminated, to reach not only groups of specialists but also all those how are interested in environmental protection. The survey showed that the Internet was the main source of information on climate and environment for 27% of the Poles in 2012, more than 30% in 2014[115] and more than 54% of respondents in 2021, in particular those from younger age groups[116].

In line with the growing tendency for using the Internet to find information, many state and scientific institutions keep their own websites and portals on climate issues. The Ministry of Climate and Environment runs its information portal[117], providing information, among others, on current environmental policy and climate change-related issues. In parallel, the Department of Education and Communication of the MKiŚ runs its education website providing class scenarios and materials for teachers. The websites of research institutes (IOŚ-PIB, IMGW-PIB, IGPiM and others) are also sources of information and input data useful at the different stages of education and popularisation of the knowledge of climate issues.

The information and news provided on the effects of climate change are, in general, presented in the context of their impact on biodiversity. State Forests is very active in this respect, running

[114] The Information Society in Poland in 2021 GUS Warsaw 2022, Statistical Office in Szczecin. Szczecin 2021

[115] A study on the environmental awareness and behaviour of Poland's inhabitants. TNS Polska reports for the MoE, Warsaw 2012 and 2014; https//www.gov.pl>attachment

[116] CEO report 2021 http:// ceo.org.pl/1planet4all/aktualności/badanie-swiadomosci-młodzieży

[117] www.ekoportal.gov.pl

a special website[118], and so does the State Forests Information Centre (CILP)[119], making available education films, news, broadcasts, etc. and also publishing an electronic version of the popular science magazine on forests and nature conservation. In 2020, the website of State Forests and the CILP were accessed more than 4.5 million times[120].

Portals dealing with broadly conceived environmental education are increasingly often established. The websites of nongovernmental organisations and university-level schools pay much attention to climate change-related issues. The Internet also enables the communication among the participants in the diverse environmental projects and actions organised by national and international institutions and nongovernmental organisations. The Internet also enables the establishment of a network for cooperation among education institutions and establishments, e.g. university-level schools, for the implementation of climate policy and sustainable development. Moreover, the Internet facilitates access to information on the environment.

There is also a specific category of education tools on the Internet, consisting of interactive applications, such as quiz type educational games based on choice making, where during a game one can specify one's ecological footprint and the ways of reducing it and where a prize is given for a positive choice.

9.9. Financing of education and information centres

The need for financial resources for environmental education (including climate-specific education) continues to grow, given the increasingly large expectations as to its quality, scope and universality. At the same time, new funding sources emerge, although the National Fund for Environmental Protection and Water Management (NFOŚiGW) and 16 Voivodeship Funds (WFOŚiGW) unquestionably remain the main sponsors of environmental education in Poland. One of the horizontal environmental objectives implemented by all the Funds is "*the promotion of environmentally friendly behaviour, actions and projects for biodiversity preservation and adaptation to climate change*"[121].

Since it began to finance environmental protection in Poland the NFOŚiGW, which was established in 1989, has supported diverse forms of environmental education and since Poland's accession to the EU it has also become a partner of European institutions in the management of foreign resources from the European Union and the European Economic Area (EEA). It co-finances actions in the scope of active environmental education, media-based campaigns, workshops, training courses and projects intended to disseminate environmental knowledge, competitions designed to raise the environmental awareness of the public and post-graduate studies. It also provides co-financing for radio, film and TV productions, publications and websites, as well as for the construction, expansion and adaptation of infrastructure for environmental education. Moreover, the Fund implements education, information and promotion actions, training courses and webinars, i.e. measures with a nationwide range. The aim of the financing is to raise the level of environmental awareness and to shape environmentally friendly attitudes of the public by promoting the principles of sustainable development and upgrading the skills of vocational groups having the largest effect on the implementation of the national environmental, energy and climate policies. A new programme of the NFOŚiGW, i.e. the Programme for Regional Support for Environmental Education, came into effect in

[118] www.lasy.gov.pl
[119] www.cilp.lasy.gov.pl
[120] Reports on the education activities of State Forests in 2019 and 2020. State Forests Warsaw 2020 and 2021
[121] The Common Action Strategy of the NFOŚiGW and WFOŚiGW for 2013-2016 with an Outlook until 2020

2022. As part of funded projects with a local and regional scope, in 2022 the Fund provided more than PLN 60 million for education in regions. Grants were also awarded for the dissemination of good agricultural practices and the popularisation of the issues related to the use of renewable energies and a competition in innovative solutions in environmental protection. Grant support was also given for actions of civic organisations, environmental nongovernmental and religious organisations, cultural and educational projects, competitions and conferences, such as Environmental Protection in the Context of Progressing Climate Change.

In 2020, the NFOŚiGW awarded a grant of about PLN 42 million to nationwide projects and those with the range of at least three Voivodeships. Every four years the Common Action Strategy of the NFOŚiGW and the Voivodeship Funds is prepared; thus, the Strategy 2017-2020 is replaced by the Strategy 2021-2024[122], with the horizontal objective of the development of environmental competences. In this period, the Fund will have at its disposal PLN 20 billion for education, since, as pointed out in the Strategy: "*the support for environmental education and the promotion of environmentally friendly in the present situation take on special significance, especially in the scope of the provision of information and the promotion of the behaviour conducive to final energy conservation*".

The resources of the Operational Programme POIiŚ 2014–2020 were used to finance the Energy Consultancy Project called "*National consultancy support system for the public sector, the residential sector and enterprises in the scope of energy efficiency and RES*". This Project will be continued in an expanded formula as part of the FEnIKS Programme 2021–2027.

Education projects can also be financed from the European Economic Area (EEA) Financial Mechanism and the Financial Mechanism, which are sources of resources not only for large projects, but also for small local ones.

State Forests also allocates substantial resources for education, maintaining its own education infrastructure: 54 forest education centres, several hundred rooms of different types for delivering classes and many educational paths in the field. Moreover, State Forests finances classes for schools, competitions, exhibitions and festivals and is involved in publishing and media-based operations in which the State Forests Information Centre (CILP) specialises.

Substantial resources, though difficult to estimate, are provided for local education projects by self-governments which use directly the resources of the municipal budgets or those of the institutions of self-governments, such as community centres or libraries. It is exactly from the municipal budgets that civic organisations can be awarded grants for educational actions to raise the environmental awareness of the members of local communities. The own contributions of volunteer workers, e.g. teachers devoting their time to additional thematic classes, are also underestimated.

Enterprises and certain representatives of the business sector become increasingly active sponsors of education. Education financing also includes the expenditures of entrepreneurs on training courses to raise the environmental competences of their employees.

The list of entities financing environmental education becomes longer, since resources are provided from different, not necessarily environment-oriented funds which are relevant for a group of addressees of a given education programme, e.g. the inhabitants of rural areas or senior citizens.

[122] The NFOŚiGW Strategy 2021–2024

9.10. Monitoring, review and evaluation of the implementation of Article 6 of the UNFCCC

The cited examples of activities in the different areas of actions which are recommended by Article 6 of the UNFCCC indicate the existence of both numerous and diverse entities involved in education in Poland which are supported a well-developed infrastructure (centres, didactic teaching materials and differentiated methods of delivery). In particular, this is the case with education outside the formal education system. The results of sociological studies presented here demonstrate the growing climate awareness of the Polish public, especially in the case of the young generation whose consumption style not only becomes more environmentally friendly, but also manifests the need for high-quality climate education to become an important element of the education system. These changes can be attributed to the impact of the very diversified opportunities offered by non-formal education and climate-friendly activities at university-level-schools the graduates from which begin to join the teachers' community. Moreover, it should be noted that the bottom-up process of the so-called Roundtable of Education for Climate has started. The aim of this social dialogue is to agree with many communities the manner of expanding the school core curriculum with competently delivered education for climate. A very good signal in this case is the signing of a letter of intent on cooperation between the Minister of Education and Science and the Minister of Climate and Environment. As a result of the signing of the letter, the interministerial Team for Climate Education has been established. Its main task is to coordinate the process of preparing class scenarios and introducing them into the teaching process. These actions respond to the provisions of Article 6 of the UNFCCC, which were additionally strengthened by the COP25 recommendation to increase the participation of youth in education and in taking decisions related to climate change.

It is also important to note the growing awareness of business, especially the efforts taken by large organisations associating employers and enterprises to develop the climate competences in the associated companies and sectoral groupings. Business can also be monitored on the basis of the number and quality of the applications for prizes in the competitions for the achievements in the green transition and the market offer of products conducive to a change in the consumption pattern. In the area of education financing, the aim of the monitoring is to determine whether the funds are spent in the manner adequate to the needs.

It is also important to emphasise the quickly growing availability and role of the Internet in education for climate, especially the emergence of competent portals and websites, supervised by scientific councils, which popularise the knowledge of climate change and the ways to mitigate it and to adapt to it.

The comparison based on the cooperation and an exchange of experiences at the international level (enhanced by webinars and online conferences) shows that Poland effectively implements the recommendations of Article 6 of the UNFCCC, to a large extent due to the activity of civic organisations and university-level schools, the well-developed infrastructure of non-formal education and the system of funds financing education projects.

GLOSSARY

Abbreviation	Meaning
2020 CEP	Energy and climate package until 2020, also known as: climate package, "*3x20*" or "*20-20-20*" package
2030 CEP	Energy and climate package until 2030
a.s.l.	above sea level
AAUs	Assigned Amount Units
A-CDM	Airport Collaborative Decision Making Solution
AEAs	Annual Emission Allocations
AERONET	Aerosol Robotic Network
AIIB	Asian Infrastructure Investment Bank
AKPOŚK	Update of the National Municipal Wastewater Treatment Program
APAC	African, Caribbean and Pacific Group of States
approx.	approximately
AR4	Fourth Assessment Report of the IPCC
AR5	Fifth Assessment Report of the IPCC
ARE	Agency of Energy Market
ARMiR	Agency for Restructuring and Modernisation of Agriculture
ASF	African Swine Fever
ATM	Air Traffic Management
Atm	Asynchronous Transfer Mode
AZT	Green Technology Accelerator
BAHC	Biospheric Aspects of the Hydrological Cycle
BAT	Best Available Techniques
BDO	Database on products, packaging and on waste management
BDS	Reporting Database
BECCS	Bioenergy with Carbon Capture and Storage
bln	billion
BONUS	Joint International Programme Science for a Better Future of the Baltic Sea Region
BP	class with a selection structure
BR4	Fourth biennial report for the Conference of the Parties to the United Nations Framework Convention on Climate Change
BRRE	Council of Europe Development Bank
BRT ETS	Emission Trading System for the Buildings and Road Transport Sectors
BULGiL	Office for Forest Planning and Management
CAKE	Centre for Climate and Energy Analyses
CALM	Circumpolar Active Layer Monitoring
CaO	calcium oxide (quicklime or burnt lime)
CAP	Common Agricultural Policy
CBAM	Carbon Border Adjustment Mechanism
CBM-CFS	Carbon Budget Model of the Canadian Forestry Sector
CCAC	Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants
CCS	Carbon Capture and Storage
CCU	Carbon Capture and Utilization
CDA	Continuous Descent Approach

CDM	Clean Development Mechanism
CDR	Agricultural Advisory Centre in Brwinów
CE	circular economy
CEEB	Central Emission Register of Buildings
CEF	Connecting Europe Facility
CERs	Certified Emission Reductions
CETA	Comprehensive Economic and Trade Agreement
CH_4	methane
CHP	Combined Heat and Power
CILP	State Forests information Centre
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora, also known as the Washington Convention
CLEF	carbon leakage exposure factor
CNG	compressed natural gas
CO	carbon oxide
CO_2	carbon dioxide
$CO_{2\ eq.}$	carbon oxide equivalent
COP	Conference of Parties
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
COVID-19	coronavirus disease 2019
CPK	Central Transport Hub
CRDS	Cavity Ring Down Spectrometry
CRF	Common Reporting Format
CRO	Central Operator Registry
CTCN	Climate Technology Centre and Network
CTF	Common Tabular Format
CUPT	Centre for European Union Transport Projects
DAC	Development Assistance Committee
DEiK	Department of Education and Communication at the Ministry of Climate and Environment
DJF	meteorological winter – months: December, January and February
DNA	deoxyribonucleic acid
DSO	distribution system operator
DSRB	Long-Term Renovation Strategy
DSS	Decision Support System
EAFRD	European Agricultural Fund for Rural Development
EC	European Commission
EDF	European Development Fund
EEA	European Economic Area
EEDI	Energy Efficiency Design Index
EEX	European Energy Exchange
EFA	ecological focus area
EFTA	European Free Trade Association
EGD	European Green Deal
EIA Act	Act of 3 October 2008 on the provision of information about the environment and its protection, public participation in environmental protection, and environmental impact assessments

EIONET	European Environment Information and Observation Network
EMW	European Mobility Week
EP	European Parliament
EPC	Energy Performance Contract
EPPO	European and Mediterranean Plant Protection Organization
ERUs	Emission Reduction Units
ESA	European Space Agency
ESD	Effort Sharing Decision
ESEAS	European Sea Level Network
ESFRI	European Strategy Forum on Research Infrastructures
ESR	Effort Sharing Regulation
ESG	Environmental, Social, and Governance
ETF	Energy Transition Fund
EU	European Union
EU ETS	EU Emissions Trading System
EUAAs	European Aviation Allowances
EUAs	European Union Allowances
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EUR	euro
EUR10	value of the euro expressed at the market exchange rate in 2010
EuroGOOS	European Global Ocean Observing System
EUROSTAT	European Statistical Office
EUTL	European Union Transaction Log
FDPA	Foundation for the Development of Polish Agriculture
FEnIKS	European Funds for Infrastructure, Climate, Environment 2021-2027
FEWE	Polish Foundation for Energy Efficiency
F-gases	fluorinated greenhouse gases
FIP	feed in premium
FIT	feed in tariff
FK	Railway Fund
FLUXNET	Global Flux Monitoring Network
FM	Financial Mechanism
FPBŻ	Federation of Polish Food Banks
FTE	Energy Transition Fund
FTiR	Thermal modernisation and Renovation Fund
FŻŚ	Inland Navigation Fund
GAEC	good agricultural and environmental conditions
GCM	Global Climate Model / General Circulation Model
GCOS	Global Climate Observing System
GCTE	Global Change and Terrestrial Ecosystems
GDOŚ	General Directorate for Environmental Protection
GDP	Gross Domestic Product
GERD	Gross domestic expenditure on R&D

GFCS	Global Framework for Climate Services
GHG	greenhouse gas
GIS	Green Investment Scheme
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GLOBE	Global Learning and Observations to Benefit the Environment
GNI	gross national income
GT	gross tonnage
GUPES	Global Universities Partnership on Environment for Sustainability
GUS	Statistics Poland
GWP	Global Warming Potential
ha	hectare (unit of area)
HELCOM	Baltic Marine Environment Protection Commission, also known as the Helsinki Commission
HFC	fluorocarbons
hm^3	cubic hectometre (unit of volume)
IAEA	International Atomic Energy Agency
IAEA-TCF	Technical Cooperation Fund of the International Atomic Energy Agency
IBL	Forest Research Institute
ICAO	International Civil Aviation Organization
ICES	International Council for the Exploration of the Sea
IEA	International Energy Agency
IERiGŻ-PIB	Institute of Agricultural and Food Economics – National Research Institute
IGAC	International Global Atmospheric Chemistry
IGBP	International Geosphere-Biosphere Programme
IGF PAN	Institute of Geophysics of the Polish Academy of Sciences
IGPiM	Institute of Spatial Management and Housing
IHAR-PIB	Plant Breeding and Acclimatization Institute – National Research Institute
IIASA	International Institute for Applied Systems Analysis
INTERACT	International Network for Terrestrial Research and Monitoring in the Arctic
IM	Maritime Institute
IMGW-PIB	Institute of Meteorology and Water Management – National Research Institute
IMO	International Maritime Organization
IO PAN	Institute of Oceanology of the Polish Academy of Sciences
IOŚ-PIB	Institute of Environmental Protection –National Research Institute
IPA	International Permafrost Association
IPCC 2006 GL	2006 IPCC Guidelines for National Greenhouse Gas Inventories
IPPU	Industrial Processes and Product Use
IRENA	International Renewable Energy Agency
ITD	Wood Technology Institute
IT	Information Technology
ITP	Institute of Technology and Life Sciences
ITS	Intelligent Transport Systems
IUCN	International Union for Conservation of Nature
IUNG-PIB	Institute of Soil Cultivation and Soil Science - National Research Institute

IZ-PIB	National Research Institute of Animal Production
JI	Joint Implementation
JJA	meteorological summer – months: June, July and August
JSSO	Uniform Separate Waste Collection System
JTF	Just Transition Fund
KAPE	Polish National Energy Conservation Agency
KDO	class for restocking
kg	kilogram (unit of mass)
kgoe	kilogram of oil equivalent (energy unit)
km	kilometre (unit of length)
KO	restocking class
KOBiZE	National Centre for Emissions Management
KOWR	National Support Centre for Agriculture
KP	Kyoto Protocol to the United Nations Framework Convention on Climate Change
Kpgo 2022	National Waste Management Plan 2022
Kpgo 2028	National Waste Management Plan2028
KPI	National Investment Plan
KPK	National Railway Programme
KPM 2030	National Urban Policy 2030
KPO	National Recovery and Resilience Plan
KPOŚK	National Programme for Municipal Wastewater Treatment
KPZL	National Programme for the Augmentation of Forest Cover
KPŻ2030	National Navigation Programme until 2030
KSE	National Power System
kt	metric kiloton (unit of mass)
l	litre (unit of volume)
LAI	Leaf Area Index
lCERs	long-term CERs; units issued for an afforestation or reforestation project activity under the CDM
LFAs	areas facing natural or other specific constraints
LGW	Forest Carbon Farms
LOICZ	Land-Ocean Interactions in the Coastal Zone
LPG	liquefied petroleum gas
LRF	Linear Reduction Factor
LULUCF	Land use, land use change and forestry
m	meter (unit of length)
m^2	square meter (unit of area)
MARPOL	International Convention for the Prevention of Pollution from Ships
MBA	Master of Business and Administration
MC	Ministry of Digitization
MELS	Mitigating greenhouse emissions from livestock systems
MEPS	minimum energy performance standard
MESSAGE	Model for Energy Supply Strategy Alternatives and their General Environmental Impacts
MF	Ministry of Finance

MFiPR	Ministry of Development Funds and Regional Policy
Mg	Megagram (unit of mass)
MGMiŻŚ	Ministry of Marine Economy and Inland Navigation
MI	Ministry of Infrastructure
MIR-PIB	National Marine Fisheries Research Institute
MKiDN	Ministry of Culture and National Heritage
MKiŚ	Ministry of Climate and Environment
MMR	Monitoring Mechanism Regulation; Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC
MOST	Model of Reducing Losses and Food Waste for the Benefit of Society
MPA44	Development of Urban Adaptation Plans for cities with more than 100,000 inhabitants in Poland
MR	Ministry of Development
MRE	Monitoring, Reporting and Evaluation
MRG2	small retention and the prevention of water erosion in mountain areas
MRiPS	Ministry of Family and Social Policy
MRiRW	Ministry of Agriculture and Rural Development
MRK	Youth Climate Council
MRN2	small retention and the prevention of water erosion in lowland areas
MRP	flood risk map
MSFD	Marine Strategy Framework Directive
MSOŚ	Inter-Faculty Studies on Environmental Protection at the University of Warsaw
MSR	Market Stability Reserve
MSWiA	Ministry of the Interior and Administration
MSZ	Ministry of Foreign Affairs
Mtoe	megaton of oil equivalent (unit of energy)
MW	megawatt (unit of power and energy flux)
MWe	megawatt of electrical power (unit of power and energy flux)
MWth	megawatt of thermal power (unit of power and energy flux)
MZ	Ministry of Health
MZP	flood hazard map
N	nitrogen
N_2O	nitrous oxide
NAPCP	National Air Pollution Control Programme
NAWA	Polish National Agency for Academic Exchange
NBP	National Bank of Poland
NC7/BR3	Seventh National Communication and Third Biennial Report under the United Nations Framework Convention on Climate Change
NCBiR	National Centre for Research and Development
NCN	National Science Centre
NCP	National Contact Point
NDC	nationally determined contribution
NEC	Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC, also known as the National Emission Ceiling Directive

NECP	National Energy and Climate Plan for the years 2021-2030
NEU	climate neutrality scenario
NF_3	nitrogen trifluoride
NFOŚiGW	National Fund for Environmental Protection and Water Management
NH_3	ammonia
NILU	Norwegian Institute for Air Research
NIR	National Inventory Report
NIT	National Indicative Target
NMVOCs	non-methane volatile organic compounds
non-ETS	part of national greenhouse gas emissions that are not covered by the EU ETS
NO_X	nitrogen oxides
NPK	compound mineral fertilizers containing nitrogen (N), phosphorus (P) and potassium (K)
NPM	National Housing Programme
NRT	National Reduction Target
NTUA	National Technical University of Athens
OCT	overseas countries and territories
ODA	Official Development Assistance
ODEX	energy efficiency index
OECD	Organisation for Economic Co-operation and Development
OMPS	Ozone Mapping and Profiler Suite
OSCE	Organization for Security and Co-operation in Europe
p.e.	population equivalent
p.p.	percentage point
PA	Paris Agreement to the United Nations Framework Convention on Climate Change
PAD	Alarm and Dispatch Point
PAGES	Past Global Changes
PAHs	polycyclic aromatic hydrocarbons
PAN	Polish Academy of Sciences
PEK	Energy and Climate Scenario
PEP2030	National Environmental Policy 2030
PEP2040	National Environmental Policy 2040
PFC	perfluorocarbons
PGG S.A.	Polska Grupa Górnicza S.A.
PIT	Personal Income Tax
PJ	petajoule (unit of work and energy)
PL	Poland
PLN	Polish zloty
PLP	National Forest Policy
PM1	atmospheric aerosols (particulate matter) with a diameter of not more than 1 µm
PM10	atmospheric aerosols (particulate matter) with a diameter of not more than 10 µm
PM2,5	atmospheric aerosols (particulate matter) with a diameter of not more than 2.5 µm
PMRP	Maritime Policy of the Republic of Poland
POIiŚ	Operational Programme Infrastructure and Environment 2014-2020

POIR	Smart Growth Operational Programme
POWER	Operational Programme Knowledge, Education and Development
PPEJ	Polish Nuclear Energy Programme
ppm	parts per million
PPOŻ	counteracting and limitation of the effects of hazards related to fires
PPSS	drought effects prevention plan
PRA	Pest Risk Analysis
PROM	Program of reducing food losses and waste in Poland
PSHM	State Hydrological and Meteorological Service
PWKSD	Programme to Strengthen the National Road Network until 2030
PWR	pressurized water reactor
PV	photovoltaic
PZPM	Polish Association of the Automotive Industry
PZRP	flood risk management plan
QA/QC	Quality Assurance / Quality Control
R&D	research and development activities
RCE	Regional Centre for Expertise on Education for Sustainable Development
RCM	Regional Climate Model
RDF	Refuse Derived Fuel
RDLP	Regional Directorate of State Forests
RDP	Rural Development Programme
RED II	Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources
RES	renewable energy sources
RIS	River Information System
RPBDK	Government Programme for the Construction of National Roads until 2030 (with an Outlook until 2033)
RR	relative risk
RRF	Recovery and Resilience Facility
SCF	Social Climate Fund
SDG	Sustainable Development Goal
SEEMP	Ship Energy Efficiency Management Plan
SEF	Self-evaluation form
SESAR	Single European Sky ATM Research
SF_6	sulphur hexafluoride
SGGW	Warsaw School of Life Sciences
SI	spark ignition
SIR	Network for Innovation in Agriculture and Rural Areas
SMEs	small and medium enterprises
SMRs	Statutory Management Requirements
SO_2	sulphur dioxide
SOLAS	Surface Ocean-Lower Atmosphere Study
SOOP	Ship Of Opportunity Programme
SOR2020	Strategy for Responsible Development until 2020
SPA	Special Protection Area

SPA2020	Strategic Adaptation Plan for Sectors and Areas Vulnerable to Climate Change until 2020 with an Outlook until 2030
SPCP	Clean Air Programme Association
SRT2030	Sustainable Transport Development Strategy until 2030
STEAM-PL	Set of Tools for Energy Demand Analysis and Modelling
SUMP	Sustainable Urban Mobility Plan
SZRWRIR 2030	Strategy for the Sustainable Development of Rural Areas, Agriculture and Fisheries 2030
t	tonne (unit of mass)
TBE	tick-borne encephalitis
tCERs	temporary CERs
TEN-T	Trans-European Transport Network
TGE	Polish Power Exchange
THE	ranking of the best universities in the world prepared by the British magazine "*FTHE*"
thous.	thousand
TJ	terajoule (unit of work and energy)
t_{max}	maximum temperature
toe	tonne of oil equivalent (energy unit)
TSO	transmission system operator
TTIP	Transatlantic Trade and Investment Partnership
TWh	terawatt-hour (a unit of energy used for expressing the amount of produced energy, electricity and heat)
UAM	University of Adam Mickiewicz in Poznań
UAV	unmanned aerial vehicle
UG	University of Gdansk
UJ	Jagiellonian University
UKSW	Cardinal Stefan Wyszyński University in Warsaw
UŁ	University of Lodz
UMCS	Maria Curie-Skłodowska University in Lublin
UMG	Gdynia Maritime University
UMK	Nicolaus Copernicus University in Toruń
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNECE	United Nations Economic Commission for Europe
UNECE CLRTAP	Convention on Long-range Transboundary Air Pollution
UNEP	United Nations Environment Programme
UNEP/GRID	United Nations Environment Programme's Global Resource Information Database
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change, the so-called Climate Convention
UNU	United Nations University
URE	Energy Regulatory Office
URL	Uniform Resource Locator
USD	U.S. Dollar
USZE	Act of 17 July 2009 on the system for managing emissions of greenhouse gases and other substances
UŚ	University of Silesia in Katowice
UV	ultraviolet

UW	University of Warsaw
WAM	*„with additional measures*" scenario
WCEE	Włocławek Center for Ecological Education
WCP	World Climate Programme
WEM	*„with existing measures*" scenario
WFOŚiGW	Voivodeship Funds for Environmental Protection and Water Management
WISL	National Forest Inventory
WMO	World Meteorological Organization
WORP	Preliminary Flood Risk Assessment
WOUDC	World Ozone and Ultraviolet Radiation Data Centre
WPWR 2016-2020	The multiannual development assistance programme for the period from 2016 to 2020
WRDC	World Radiation Data Centre
WTO	World Trade Organization
VOD	Video on Demand
VOS	Voluntary Observing Ship Programme
VPN	Virtual Private Network

ANNEX 1. FIFTH BIENNIAL REPORT TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

In order to avoid duplication of information in the 8th National Communication and in the 5th Biennial Report, below the location is given in the 8th National Communication of the descriptive information required in biennial reports.

Information required in the 5th Biennial Report (BR5)	Chapter in the NC8
Information on greenhouse gas emissions and trends	3
Reduction target	4.1.2
Progress in achievement of reduction target – mitigation actions and their effects:	
Policies and measures related to GHG emission reduction by sectors and gases	4.2
National institutional system established for monitoring and progress evaluation of emission reduction target	4.1.5, 4.1.6
Assessment of economic and social adverse effects of measures aimed at reducing greenhouse gas emissions	4.3.4
Market mechanisms	4.1
Projections	5
Provision of financial, technological and capacity-building support to developing country Parties:	
Financial assistance	7.2
Technology transfer	7.3
Capacity building	9.5

Additional information required in the Biennial Report is also given in the Common Tabular Format (CTF) accompanying the NC8/BR5 report