GOOD PRACTICES IN SME

Heat pumps

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What is a heat pump?

A compressor heat pump is a device which transfers heat from a low temperature source to a higher temperature source e.g.:

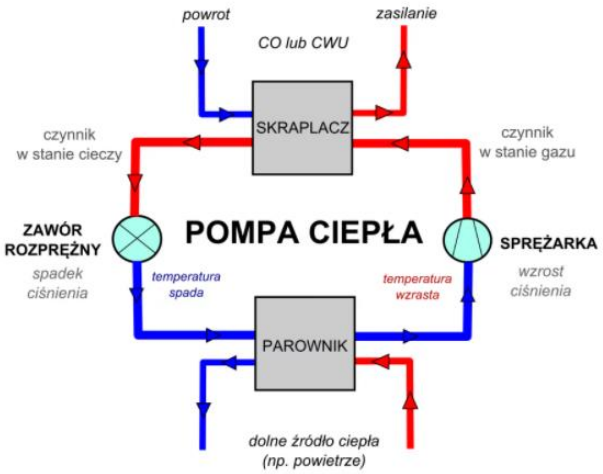
- from a 10°C ambient temperature environment to heat a room to 22°C,
- from an air-conditioned 20°C room to a 32 °C ambient temperature environment.

This means it can be used for both heating and cooling. A heat pump can also be used to supply hot or called water.

How does a heat pump work?

A heat pump uses electricity to power its compressor. The compressor heat pump functions using the following principles:

1. The working medium (with a low vaporization temperature) vaporises in the evaporator therefore absorbing heat from the lower heat source (e.g. outside air at 10°C)
2. The medium's vapour enters the electrically powered compressor. The compressor increases the temperature and pressure of the medium's vapour, which increases the medium's condensation temperature.
3. The medium enters the condenser where it condenses, releasing heat to the higher temperature heat source (e.g. underfloor heating installation at 35 °C)
4. The medium enters an expansion valve, which lowers its pressure and temperature.
5. The medium returns to the evaporator closing the thermodynamic cycle.



Pic. 1 Okiem Inżyniera: diagram of a heat pump

Top left to bottom right: return, central heating or hot water, supply, medium as liquid, CONDENSER, medium as gas, ***EXPANSION VALVE*** *(pressure and temperature decrease),* ***HEAT PUMP****,* ***COMPRESSOR*** *(temperature and pressure increase), EVAPORATOR, lower temperature heat source (e.g. air)*

What are the benefits of a heat pump installation?

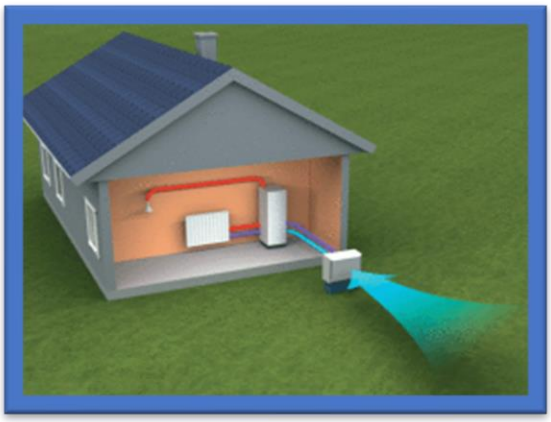
The per-unit cost of heating using heat pumps is lower than that of other heating sources (conventional heat boilers, district heating network). Moreover, a heat pump does not produce any pollutant or CO_2 emissions. It does involve a significant investment costs but replacing a conventional heat source with a heat pump can generate significant savings.

What types of heat pumps are available?

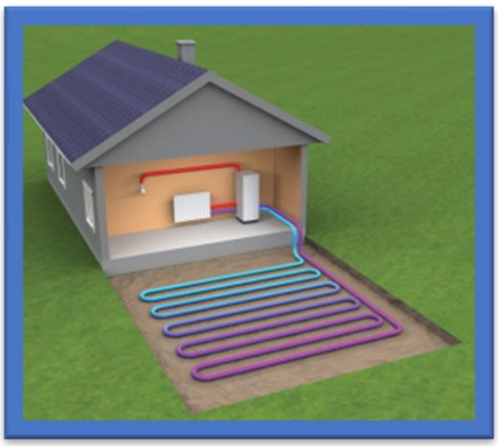
We distinguish heat pump types based on the lower temperature heat source they use. The commonly used lower temperature heat sources include air, ground, surface water, and ground water.

One of the most popular lower temperature sources is outside air – a water/air heat pump can be installed practically anywhere, while its investment costs are significantly lower than that of other types of pumps. However, if the air temperature outside falls below a set value, the water/air heat pump will require the support of a conventional heater (e.g. electric heater).

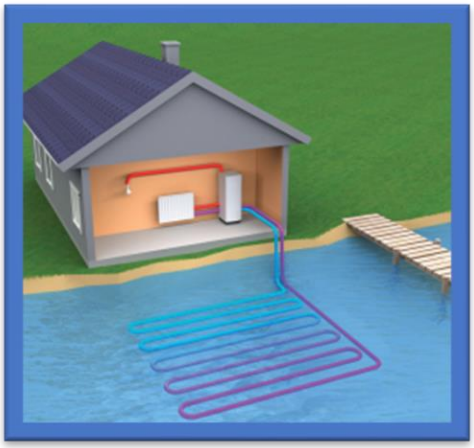
The second most popular heat pump type is the ground source heat pump. In this case higher investment costs must be considered, however, depending on the type of soil, this pump can operate monovalently, which means there is no need for conventional heater support.



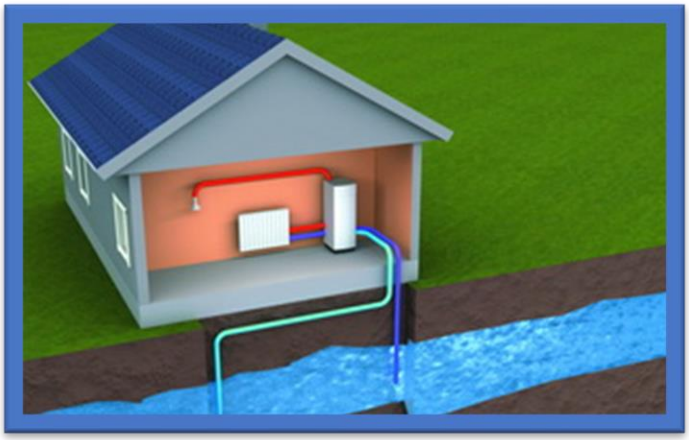
Pic. 3 air sourced heat pump



Pic. 2 ground sourced heat pump



Pic. 4 surface water sourced heat pump



Pic. 5 ground water sourced heat pump

Pic. 6 muratordom: heat pump installation

Example of replacing a coal boiler with a heat pump

A building uses an old coal boiler (P=30 kW) with an efficiency of η_s=60% to prepare hot water. The boiler is in operation for about t=4 700 hours annually and if fired with eco-pea coal with a calorific value of W_o =25MJ/kg and a price of k=800PLN/t. What are the potential savings of replacing the boiler with a COP=4 heat pump? The building's owners pay on average k_e=0,55 PLN/kWh for electricity.

The annual cost of feeding the solid fuel boiler can be calculated using the formula:

$$\boldsymbol{cost = \frac{0,36 \cdot P\,[kW] \cdot t[h] \cdot k\,[\frac{PLN}{t}]}{W_o[\frac{MJ}{kg}] \cdot \eta[\%]}}$$

Annual cost of fuel for the old boiler:

$$\frac{0{,}36 \cdot 30kW \cdot 4\,700\ h \cdot 800\ PLN/t}{29\ MJ/kg \cdot 60} = 23\,338\ PLN$$

The annual cost of powering a heat pump can be calculated using the formula:

$$\boldsymbol{cost = \frac{P\,[kW] \cdot t[h] \cdot\ k_e[\frac{PLN}{kWh}]}{COP}}$$

Annual cost of powering the heat pump

$$\frac{30\ kW \cdot 4\,700\ h \cdot\ 0{,}55\ PLN/kWh}{4} = 19\,388\ PLN$$

Annual savings generated by replacing the boiler with a heat pump:

$$23\,338\ PLN - 19\,388\ PLN = 3\,950\ PLN$$

Source: KAPE