Realization of investments in district heating companies with renewable energy sources and heat storage - the Danish example

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PlanEnergi:
Consultant Engineers
33 years with
renewable energy

- biomass
- biogas
- solar thermal
- heat storages
- heat pumps
- district heating
- energy planning

Agenda

- **The development of district heating in Denmark**
- **The legal framework**
- **Examples of ownership and organisation**
- **Financing of district heating in Denmark**
- **Development trends**

Realization of investments in district heating companies with renewable energy sources and heat storage - the Danish example

The historie

1898 Waste to heat

1903 Heat from power plants. Fuel: coal

1960 Change from individual coal and coke to individual oil or district heating. Fuel: Oil in district heating. From 1972 change to coal.

1979 Natural gas introduced. Law of heat supply and division in individual gas and district heating areas. Fuel: Coal and straw in district heating.

1990 Natural gas fired CHP-plants. Fuel: Natural gas (and still coal in power plants)

2010 Individual gas conversion to district heating. Fuel: Natural gas and renewable energy (and still coal in power plants, but power plants start to convert to biomass)

2017.. Conversion to renewable energy and excess heat in hybrid plants

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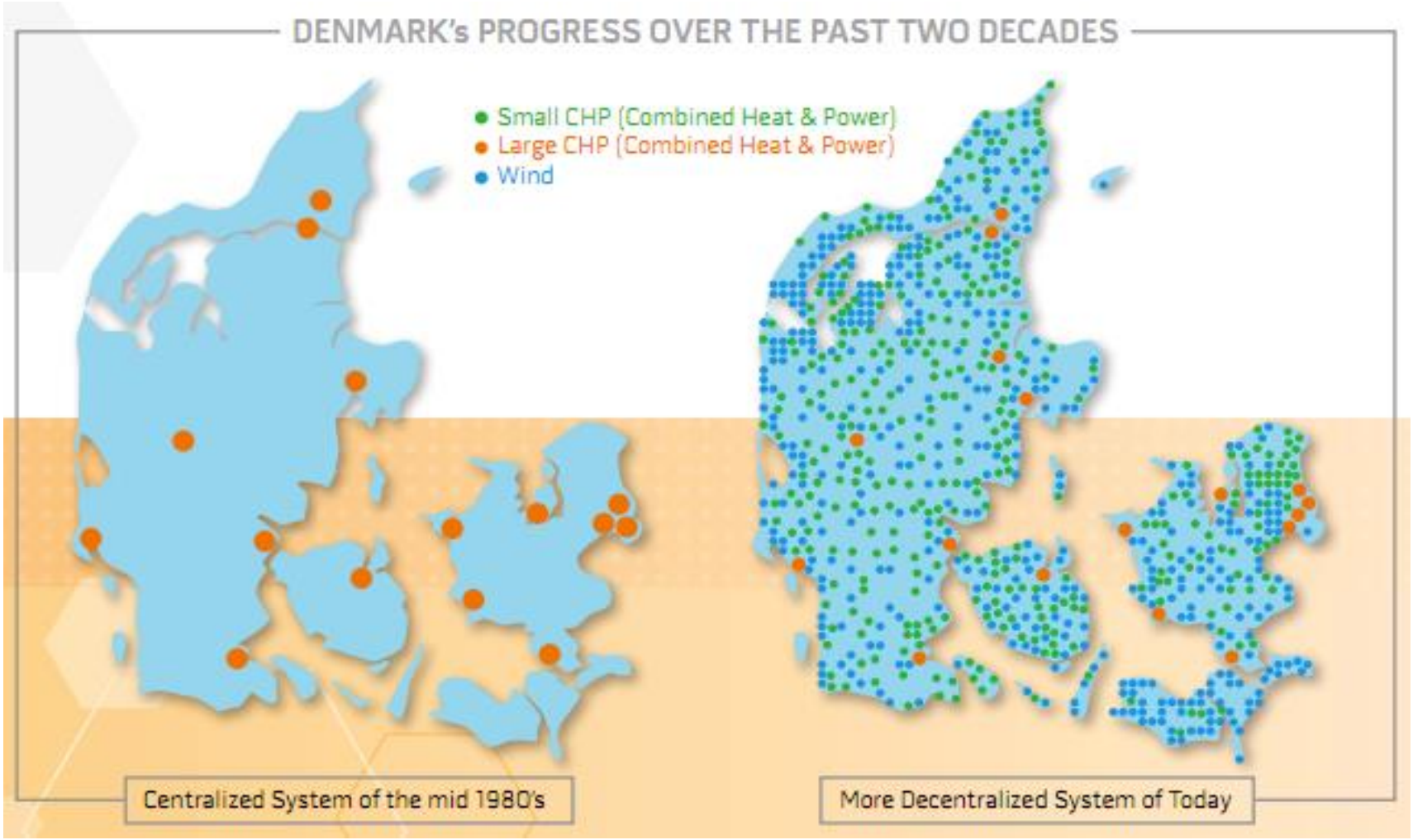

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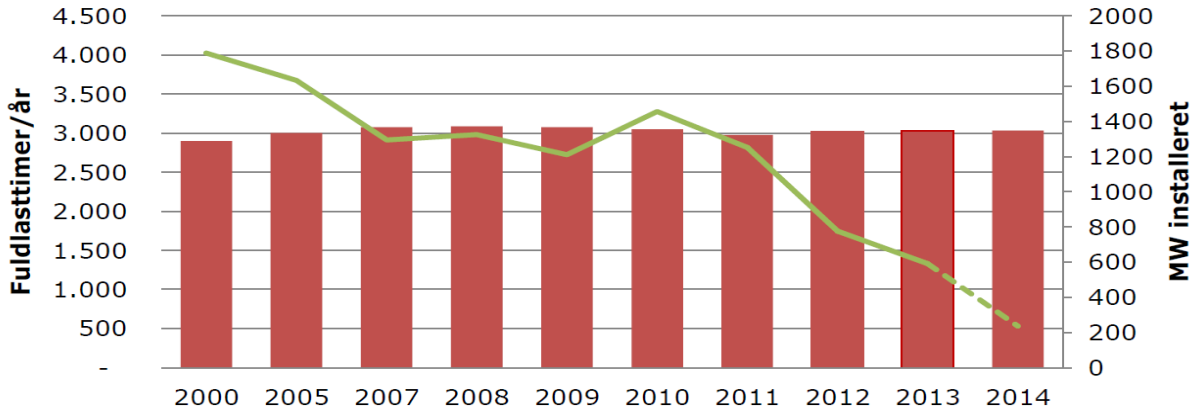
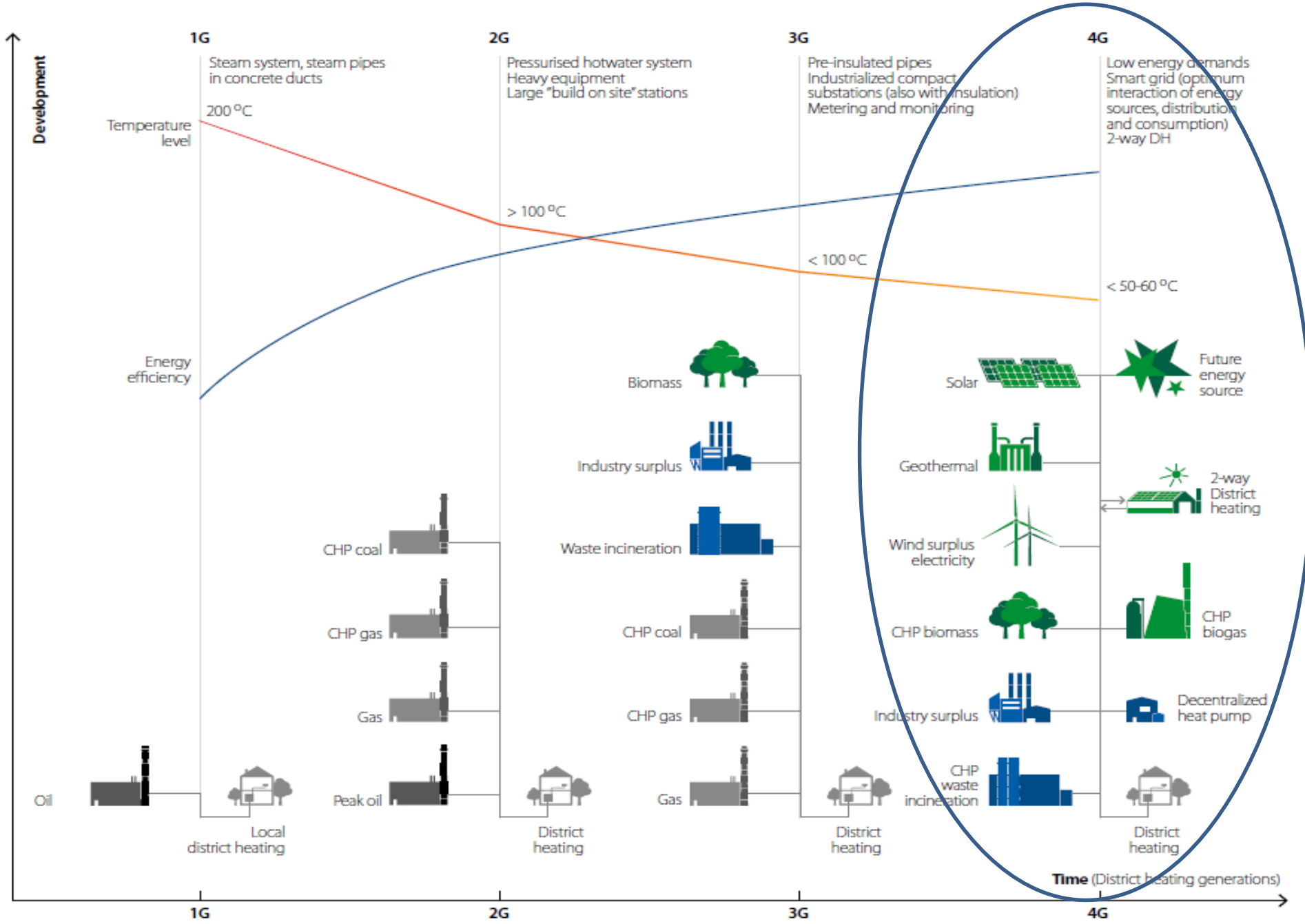
District heating status in Denmark today

- 65% of all Danish houses have district heating
- 54% of the heat demand is covered by district heating
- 50 municipal owned district heating companies deliver 70% of the heat
- 340 cooperatives deliver 30% of the heat
- 250 utilities have CHP with gas engines or gas turbines, but full load hours have been reduced from 4,000 in year 2000 to 500 in year 2014. No new gas engine capacity installed since 2007



District heating from 1G to 4G



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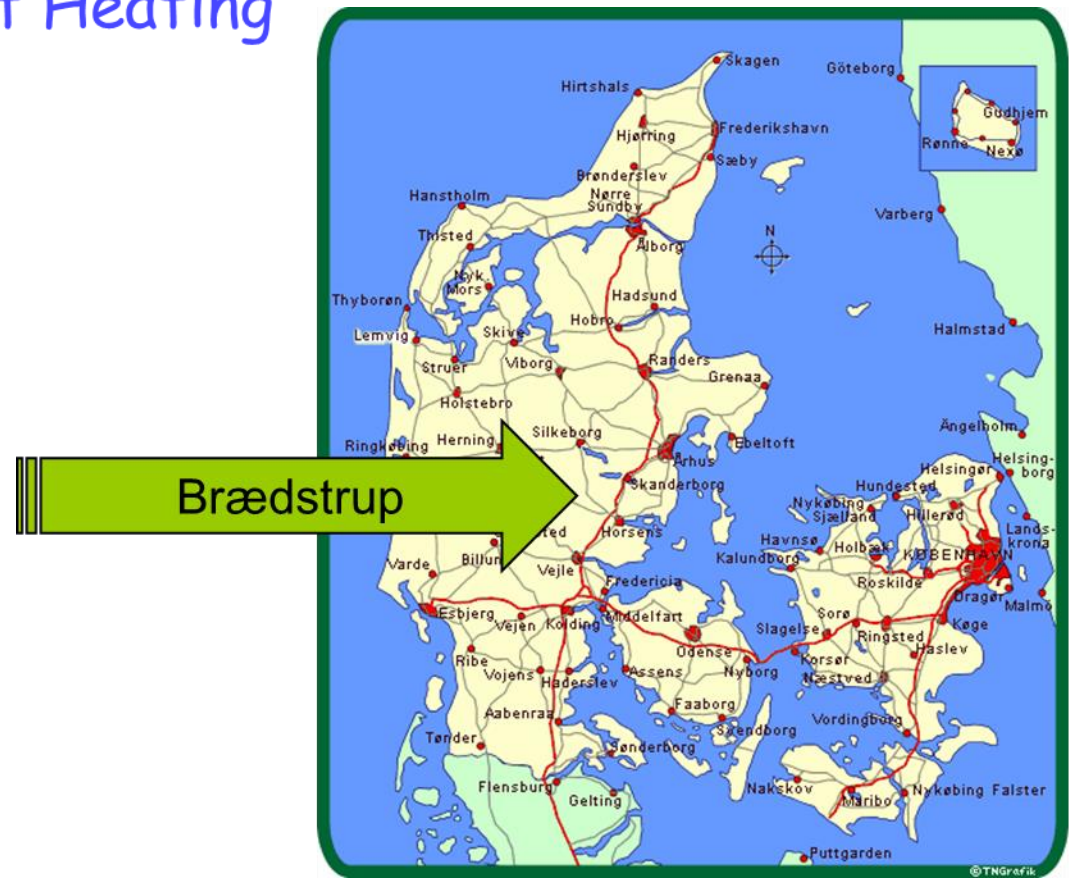
An example from Denmark: Braedstrup District Heating



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An example from Denmark: Braedstrup District Heating

- A cooperative owned by 1.550 consumers
- The consumer, the customer and the owner is one and the same person
- Annual production:
  Approx. 50.000 MWh heat – 22.000 MWh electricity
- Administration of approx. 5.000 water consumers

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All costumers

The General Assembly

All costumers have access

The Board

(4 members are elected by the General Assembly 1 from the mucipality)

Management and staff

An example from Denmark: Braedstrup District Heating

- The highest authority: The General Meeting (all consumers have access and the right to vote)
- A General Meeting at least once a year
- Information meetings through the introduction of new technologies
- Example:
  The approval of the first solar plant from 2007 (the first in the world with solar/CHP!!):
  122 votes for the proposal - 5 against
- The approval of the next solar plant from 2010 (Braedstrup SolarPark):
  199 votes for the proposal - 0 against

Braedstrup District Heating

199 votes for the proposal - 0 against!!!

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Braedstrup 2007

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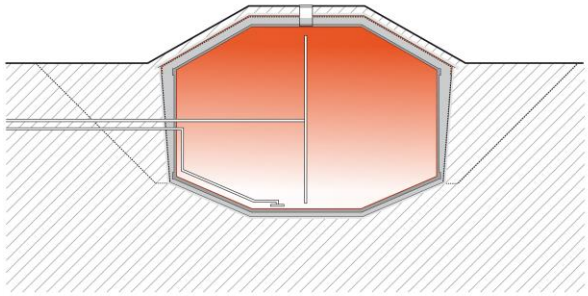
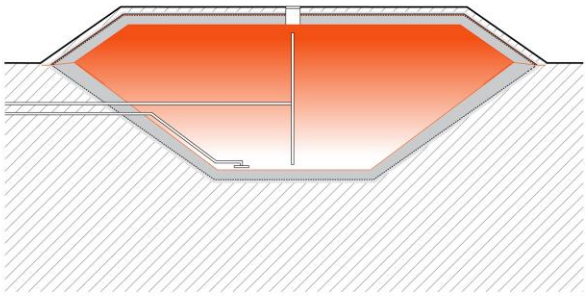
Braedstrup ”in bricks”
Legoland

Seasonal thermal energy storage concepts

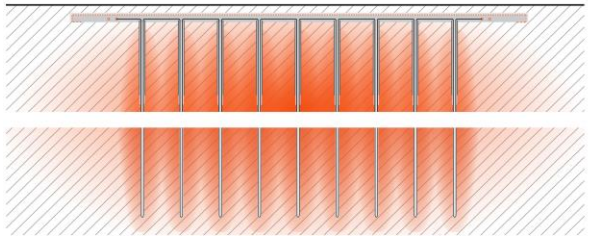
Tank thermal energy storage (TTES)
(60 to 80 kWh/m³)



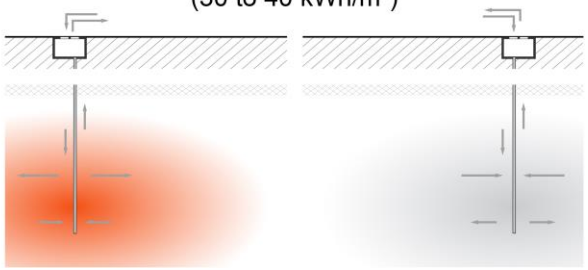
Pit thermal energy storage (PTES)
(30 to 80 kWh/m³)



Borehole thermal energy storage (BTES)
(15 to 30 kWh/m³)



Aquifer thermal energy storage (ATES)
(30 to 40 kWh/m³)



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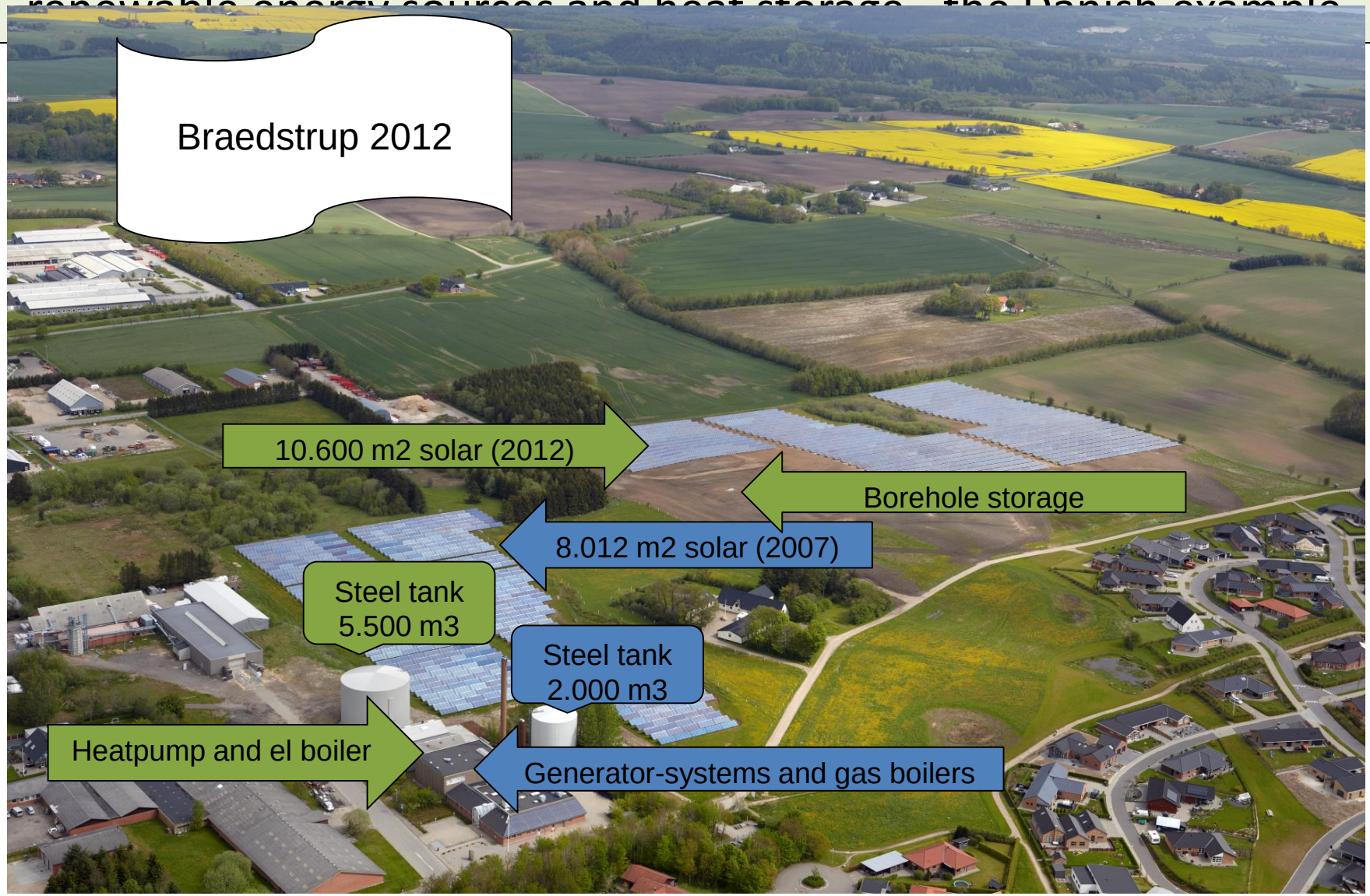
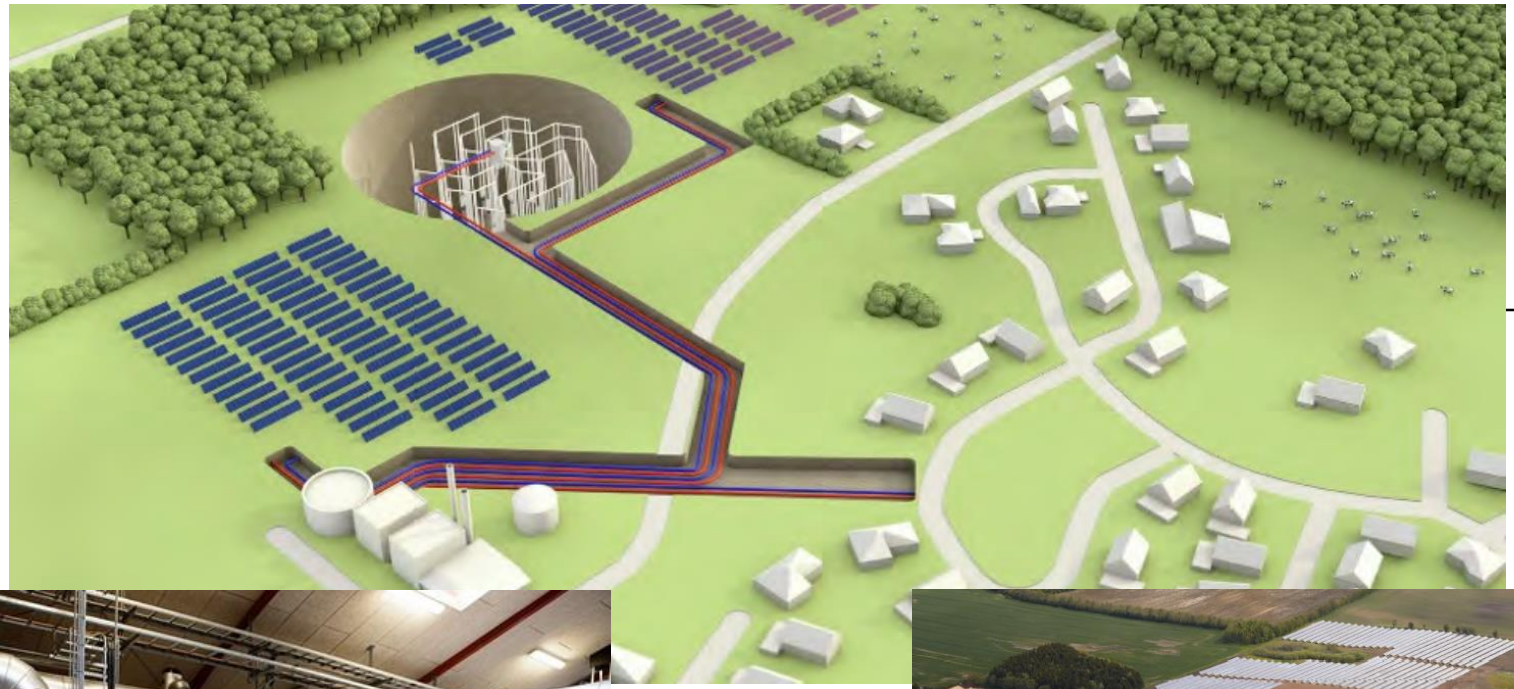
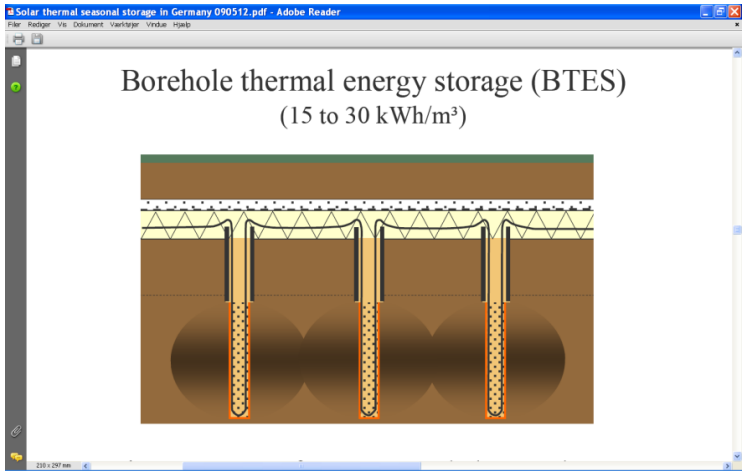


Brædstrup 450 MWh BTES





Brædstrup 450 MWh BTES

Bore hole – seasonal storage:
48 bore holes
Probes lowered to a depth of 45 meters
5 x 60 meters deep holes for temperature sensors
19,000 m³ soil is heated
4.750 m3 water

Short time storage:
Steel-tank, in total 7,500 m3
2,500 m3 in connection to CHP
5,500 m3 in connection to solar collectors, electric boiler

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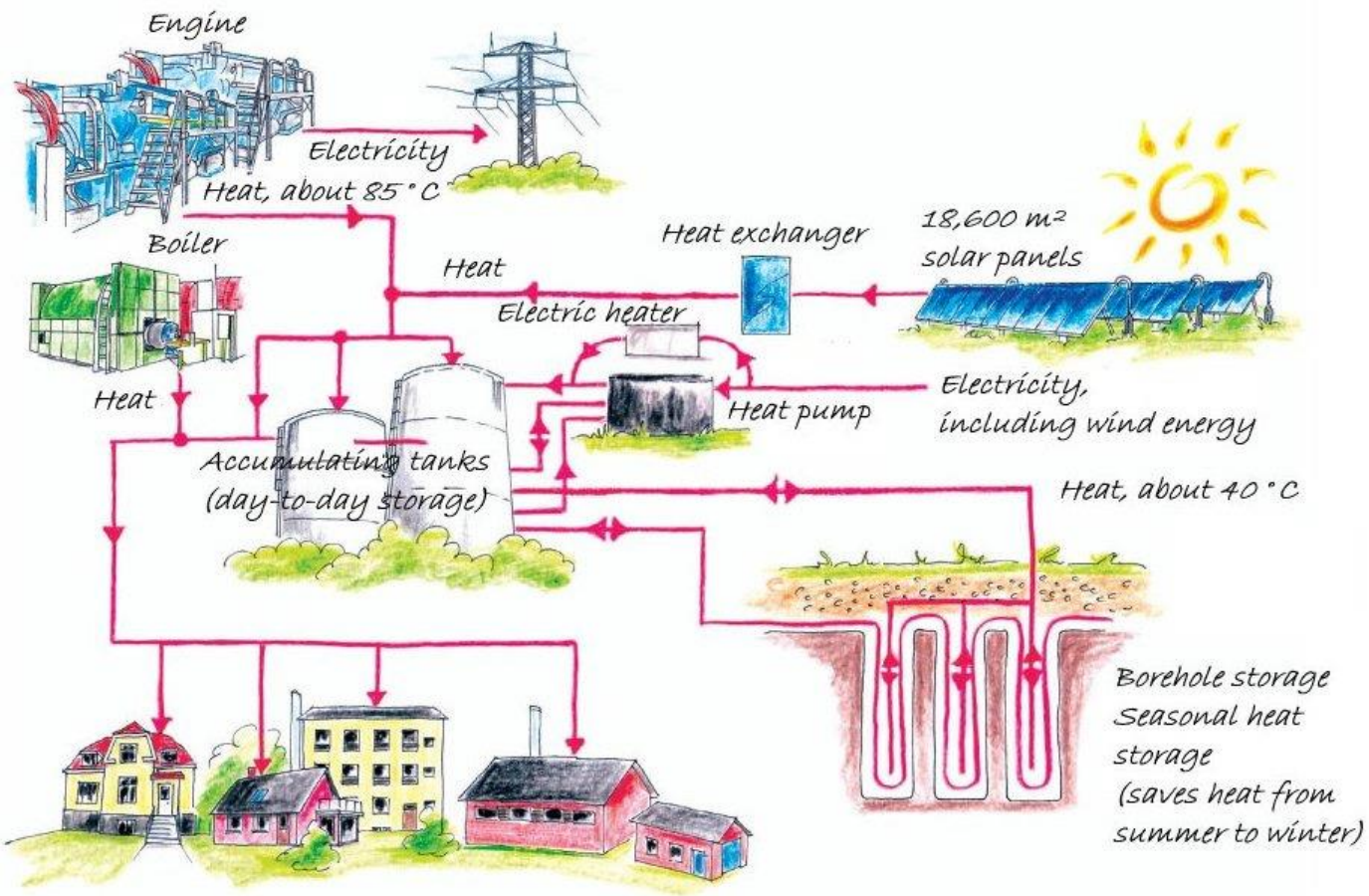
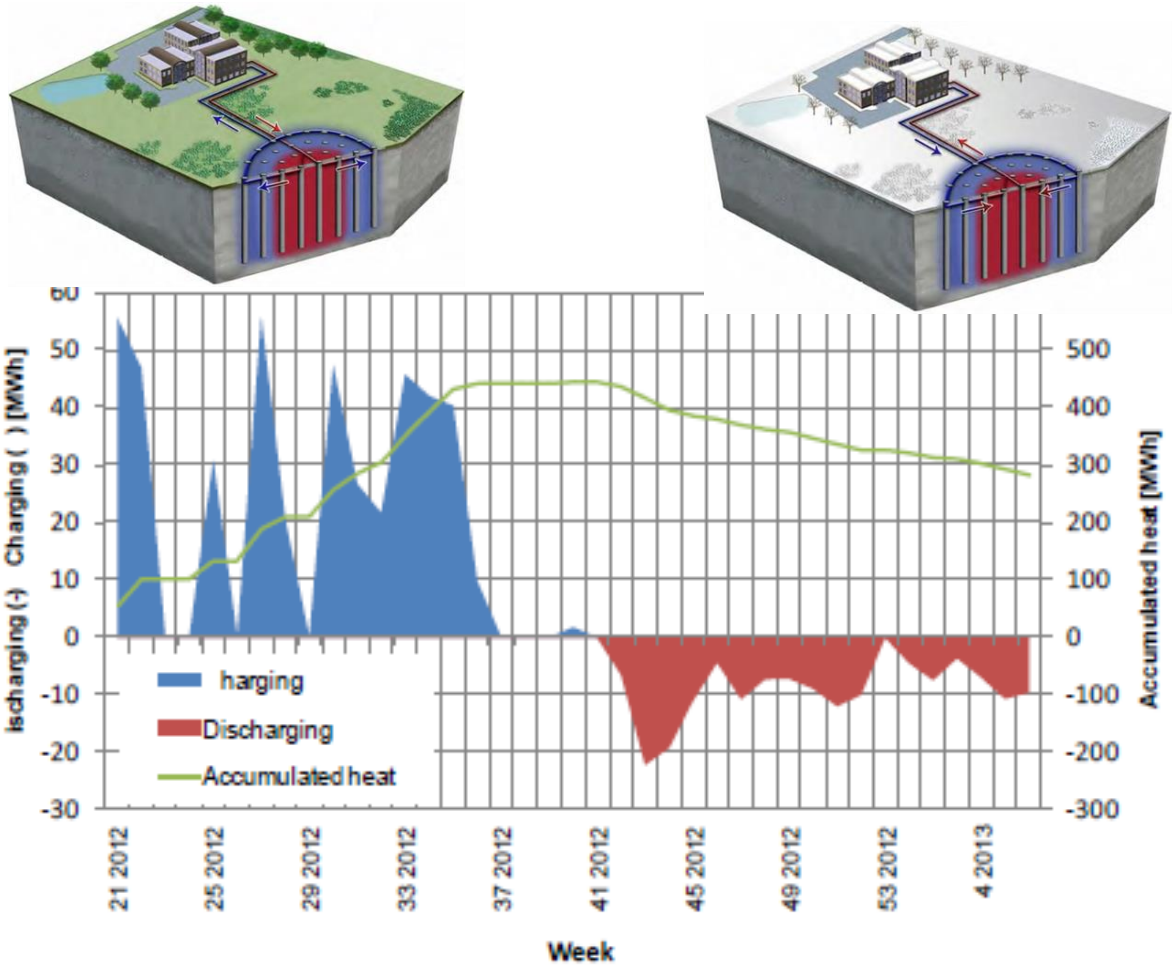
Braedstrup District Heating 2012



Borehole-storage system



Data for the borehole storage in Brædstrup

- Built 2011-12
- Size: 19.000 m^3 soil
- Price 260.000 € excl. transmission pipe and buffer tank or 0.41 €/MWh
- Temperatures 10-70^o C
- Capacity (calculated) 630 MWh
- Charge and discharge capacity 300 – 600 kW

Data – the 2007-project

Production: 3.600 MWh heat/year
(9 % of the production demand)

Invest: 1,6 mill. Euro
Grants: 0,4 mill. Euro
Nt. invest: 1,1 mill. Euro

Pay back time: 6,5 years

Data – the 2012-project

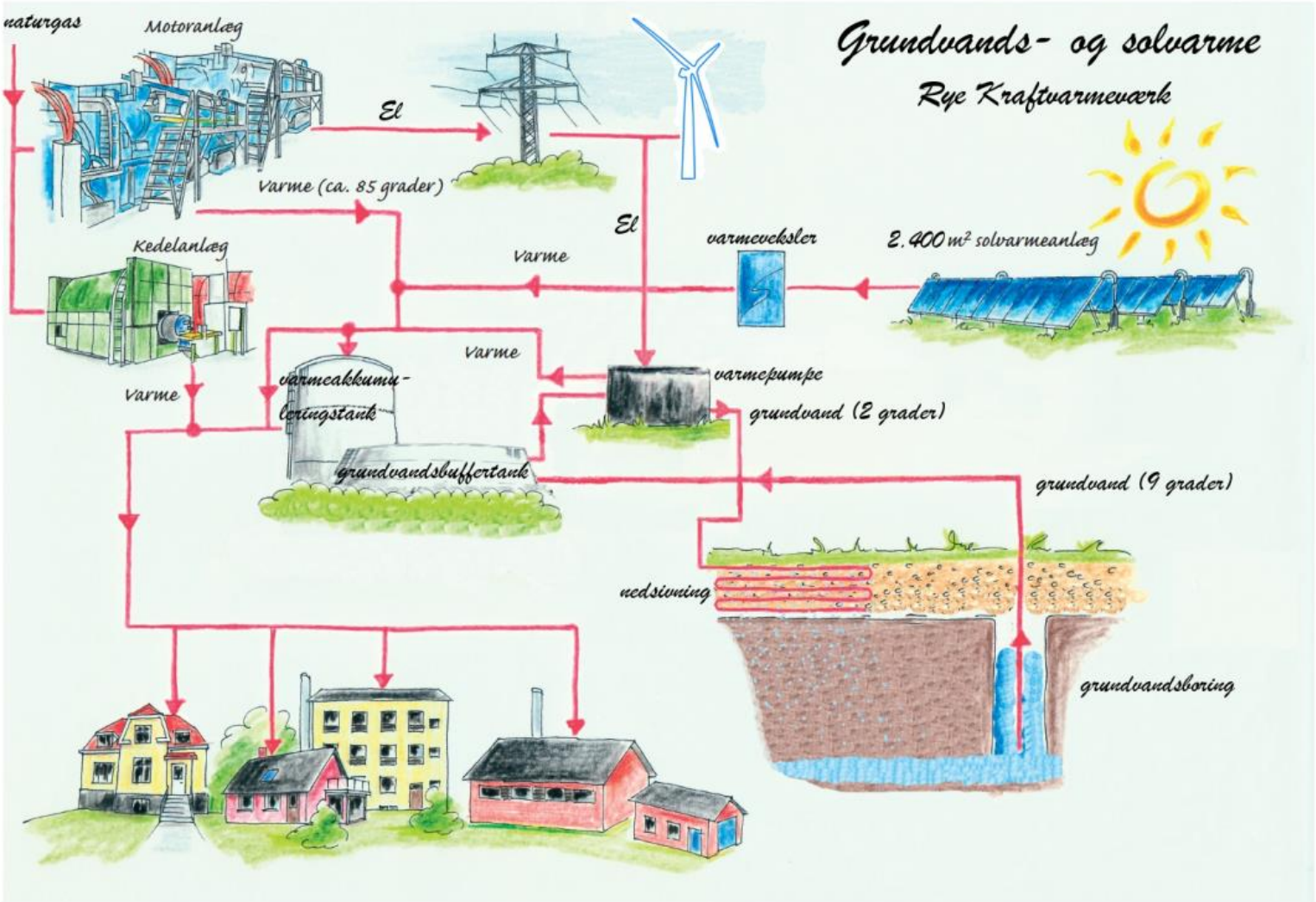
Production: 4.800 MWh heat/year
(Total: 20 % of the production demand)

Invest: 3,6 mill. Euro
Grants: 0,9 mill. Euro
Nt. invest: 2,7 mill. Euro

Pay back time: 10 years

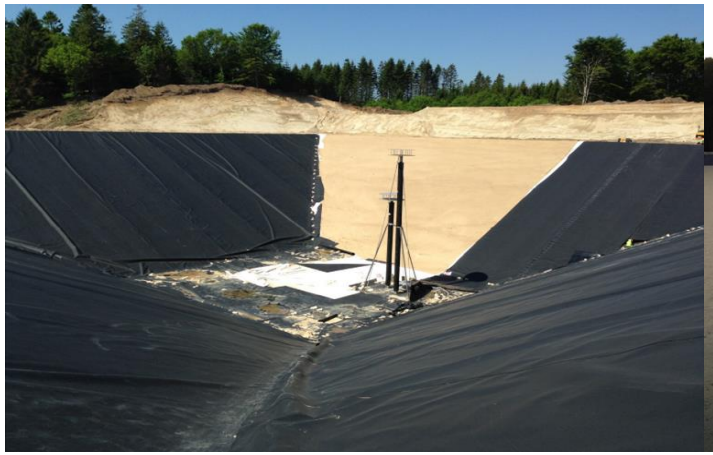
Operations and administration of Rye Kraftvarmeværk

Operations and administration of Rye Kraftvarmeværk



Dronninglund






Dronninglund

Data for the pit heat storage in Dronninglund

Built 2013

Size: 60,000 m^3 water

Price 2.3 mio. € or 38 €/m^3 or 0.416 €/kWh

Temperatures 10 – 90^o C

Capacity: 5,570 MWh

Charge and discharge capacity: 27 MW

Calculated heat loss: 1,602 MWh/year

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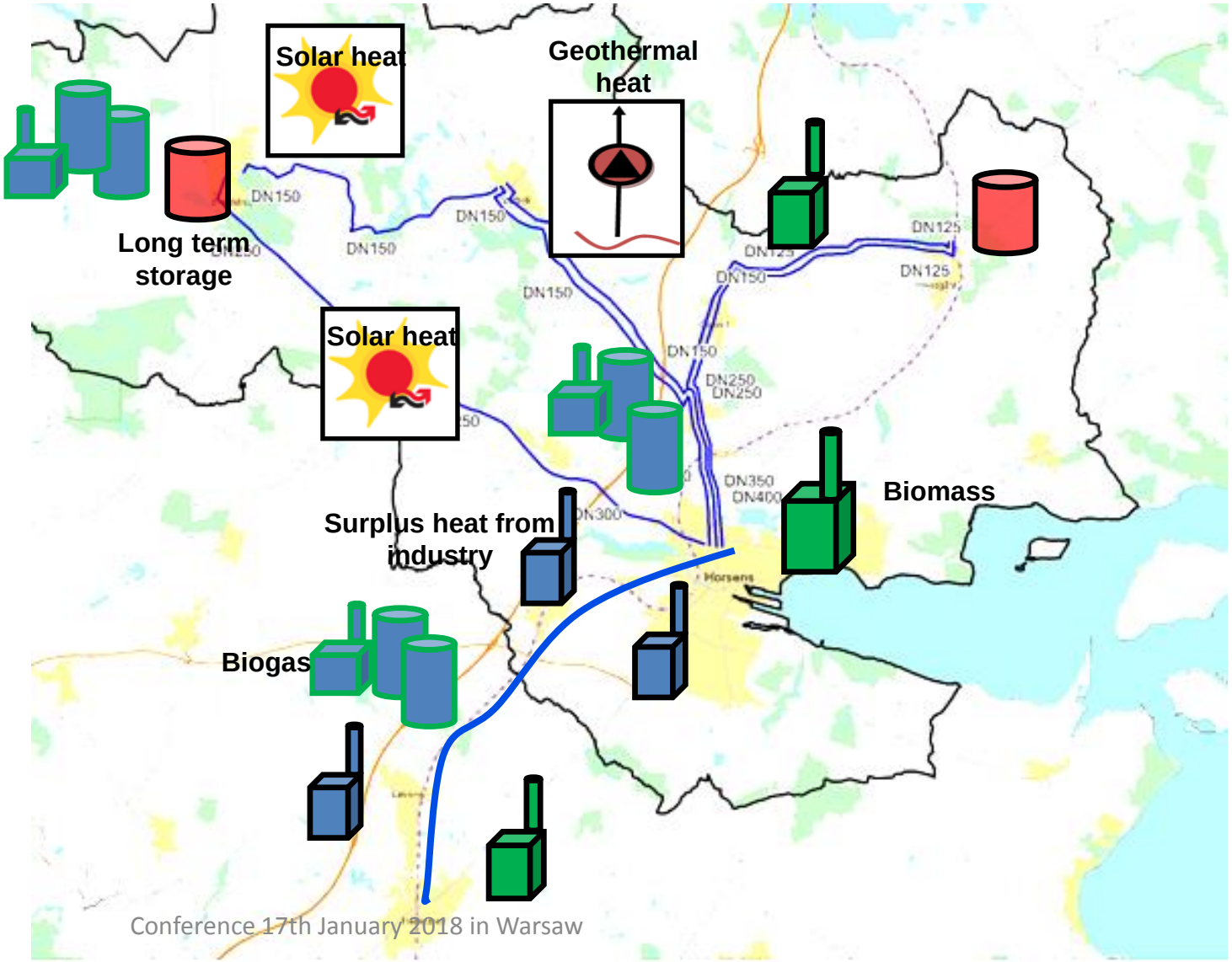
Future development

- To increase efficiency: Small DH utilities will be administrated by the larger ones
- To reduce losses: Monitoring of consumption flow and return temperatures from buildings will be online (this is already realised for several utilities)
- Bench marking will be obligatory for the larger plants
- More transmission lines connecting utilities

The Flex Cities project



THE COPENHAGEN DISTRICT HEATING NETWORK

Vestforbrænding

Lynetten

Amagerværket

ARC

HCV

KARA/NOVEREN

SCA

Avedøreværket

Copenhagen Airport

Køge Kraftvarmeværk

Heat supply areas:

- CTR + HOFOR
- VEKS
- Vestforbrænding
- Other

- Waste-to-energy plant
- CHP station
- Peak load plant
- Transmission pipeline

10 km

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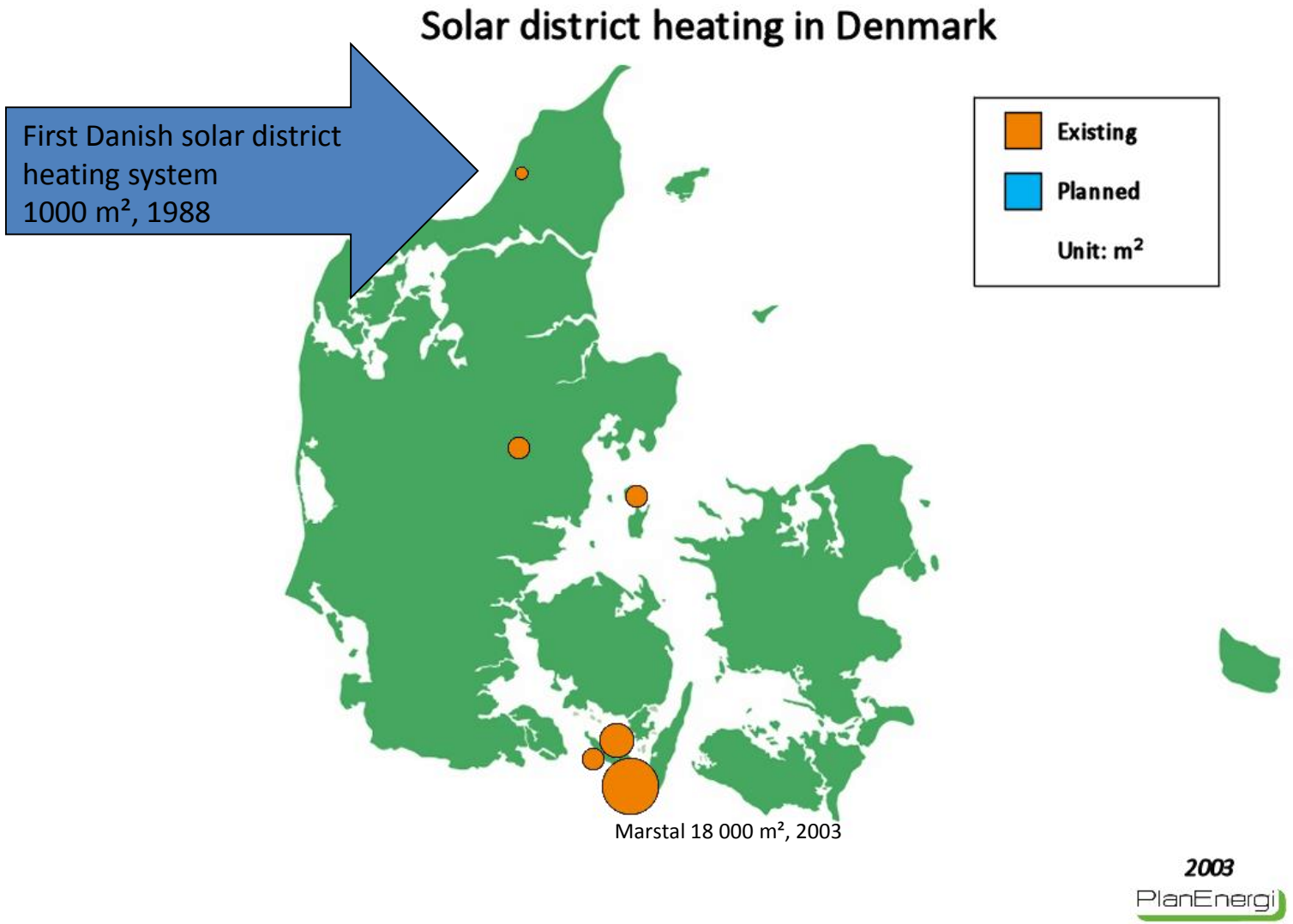

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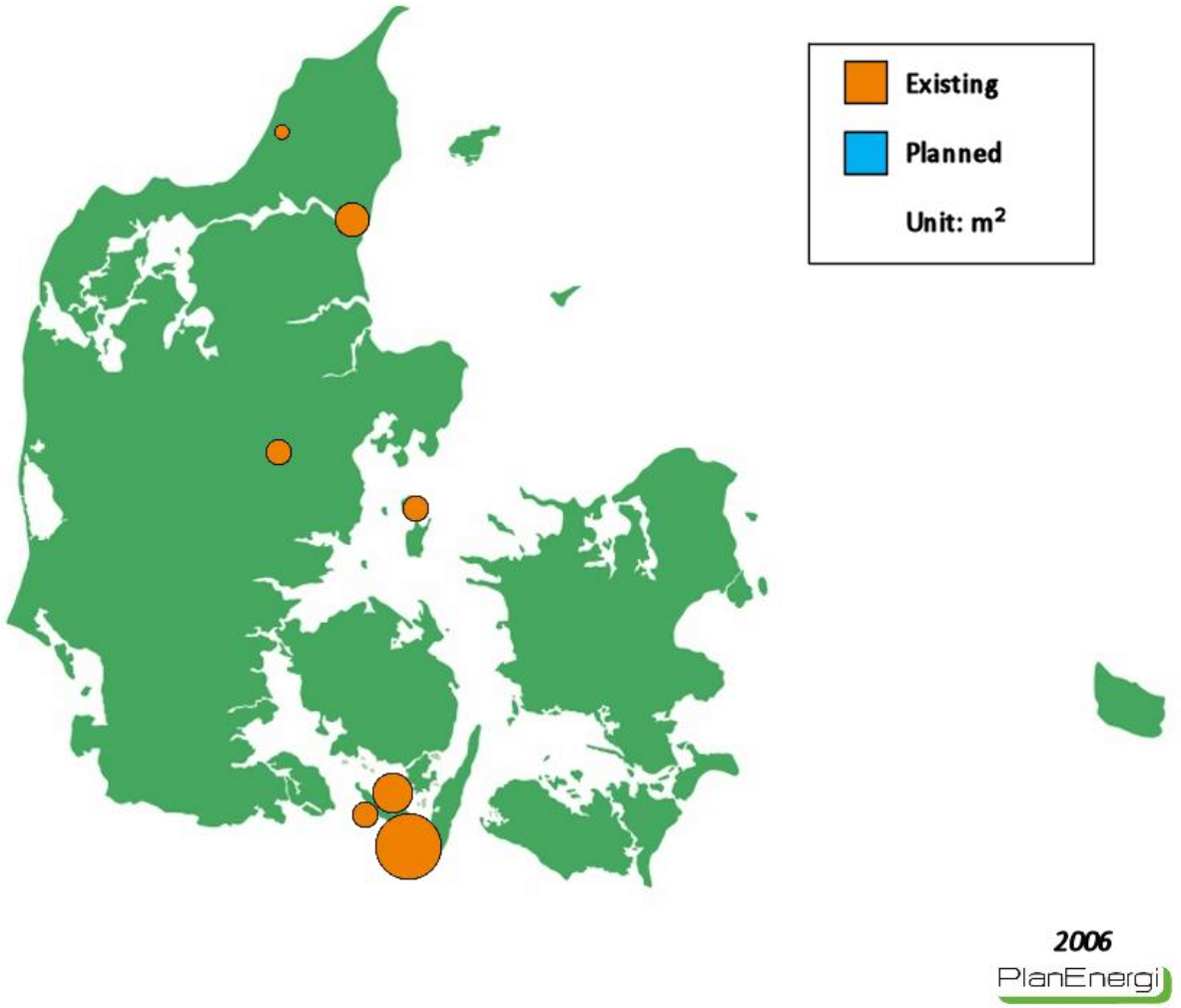
Solar district heating in Denmark



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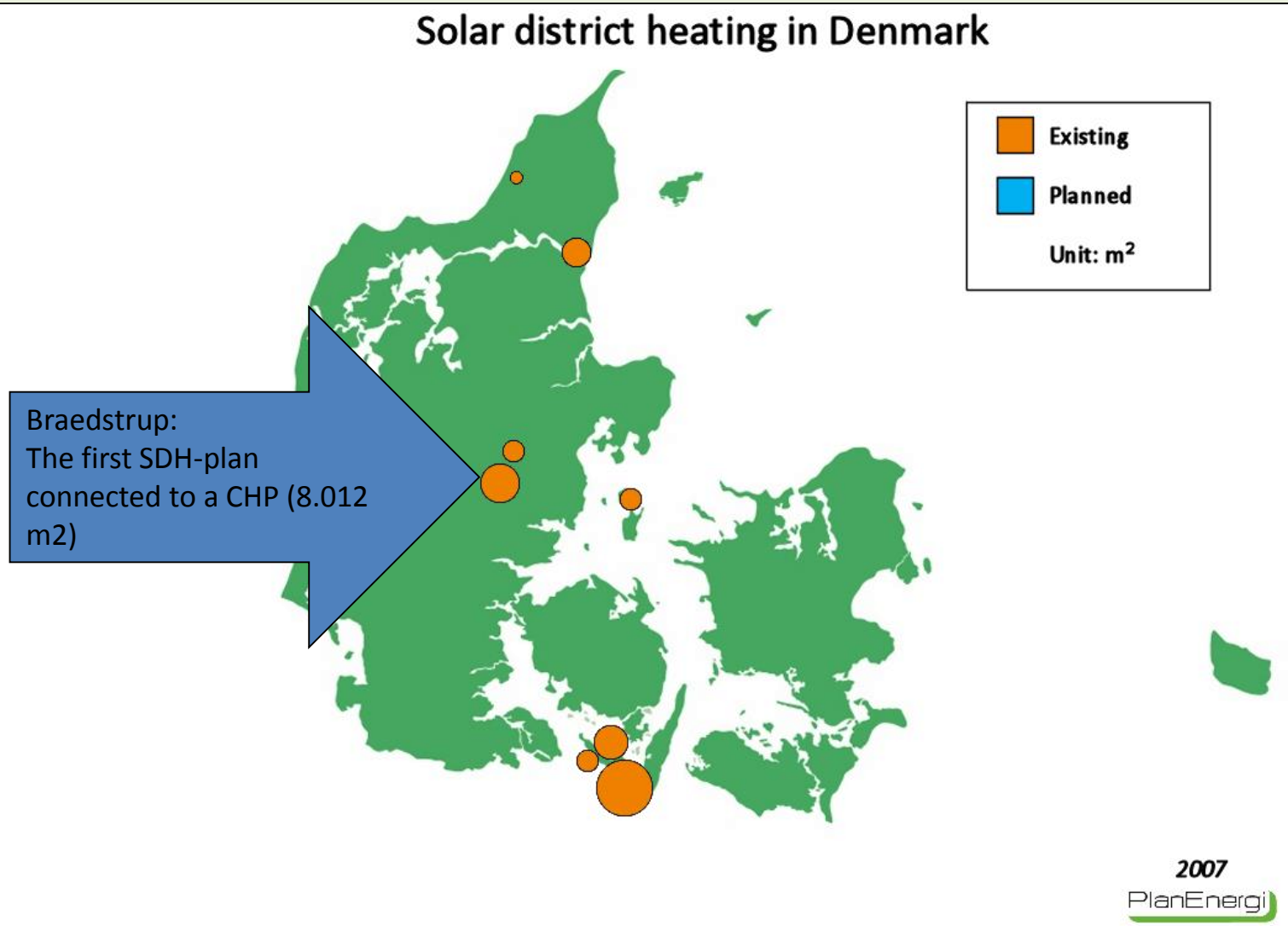

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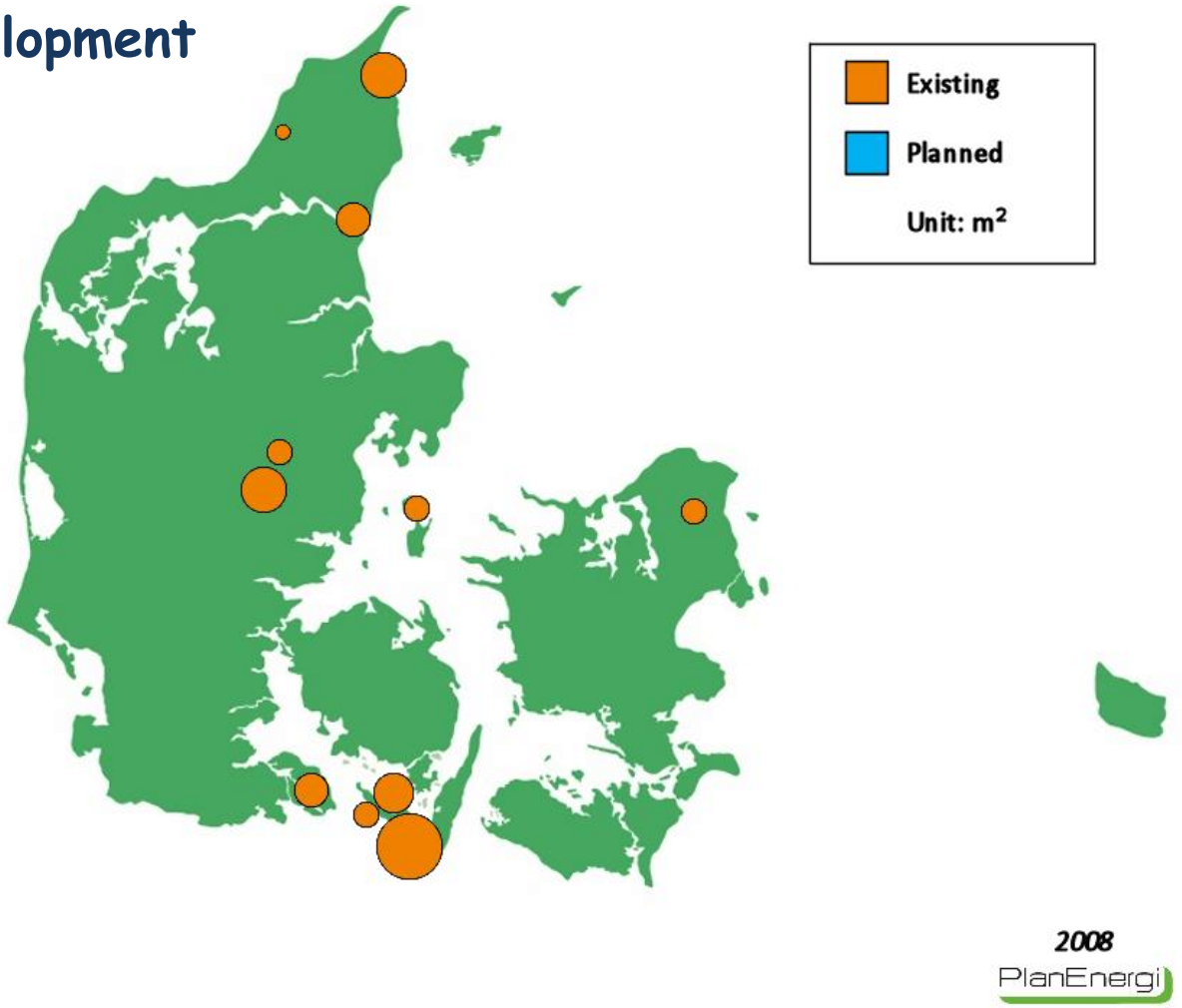
Solar district heating in Denmark

The Development



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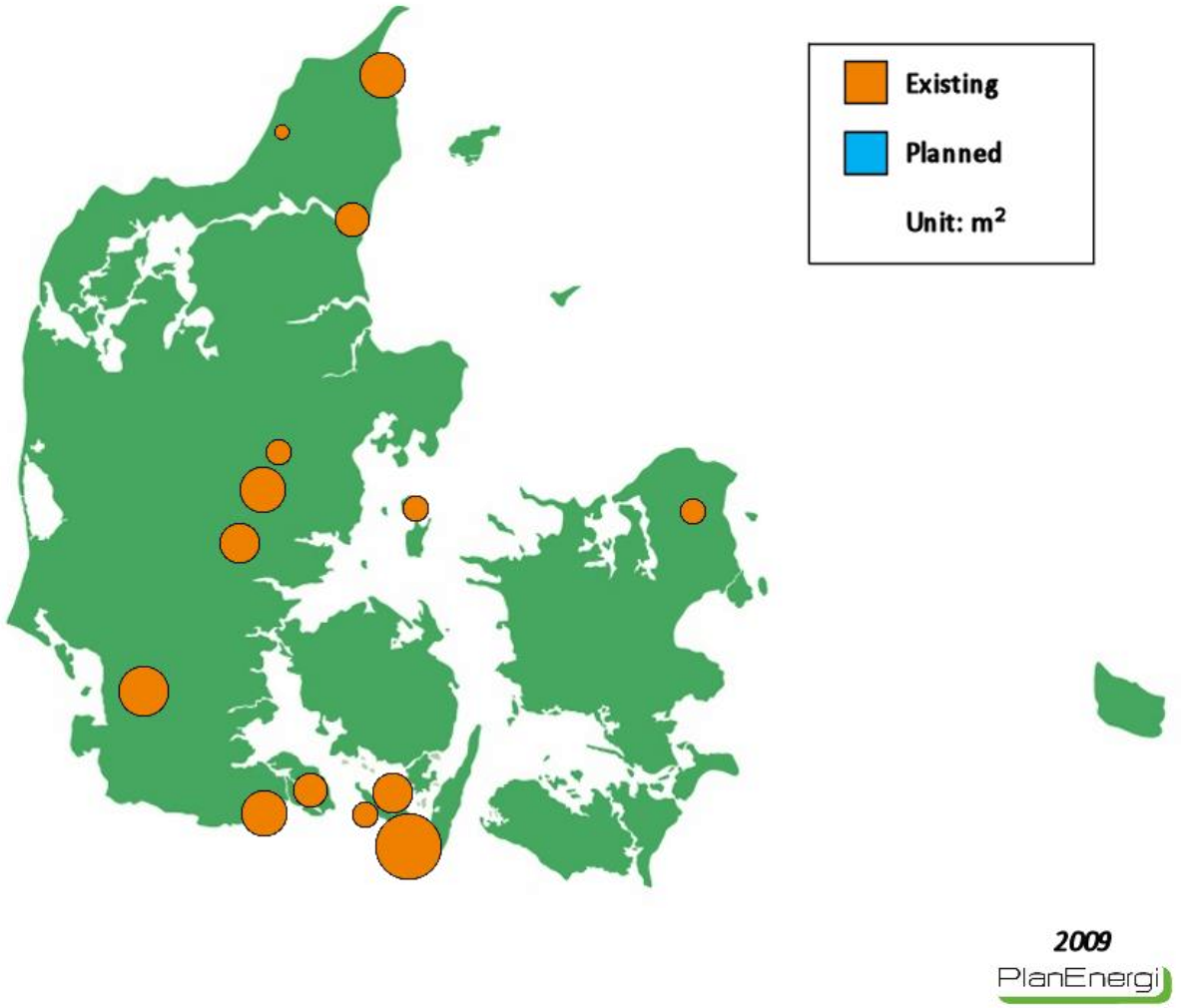

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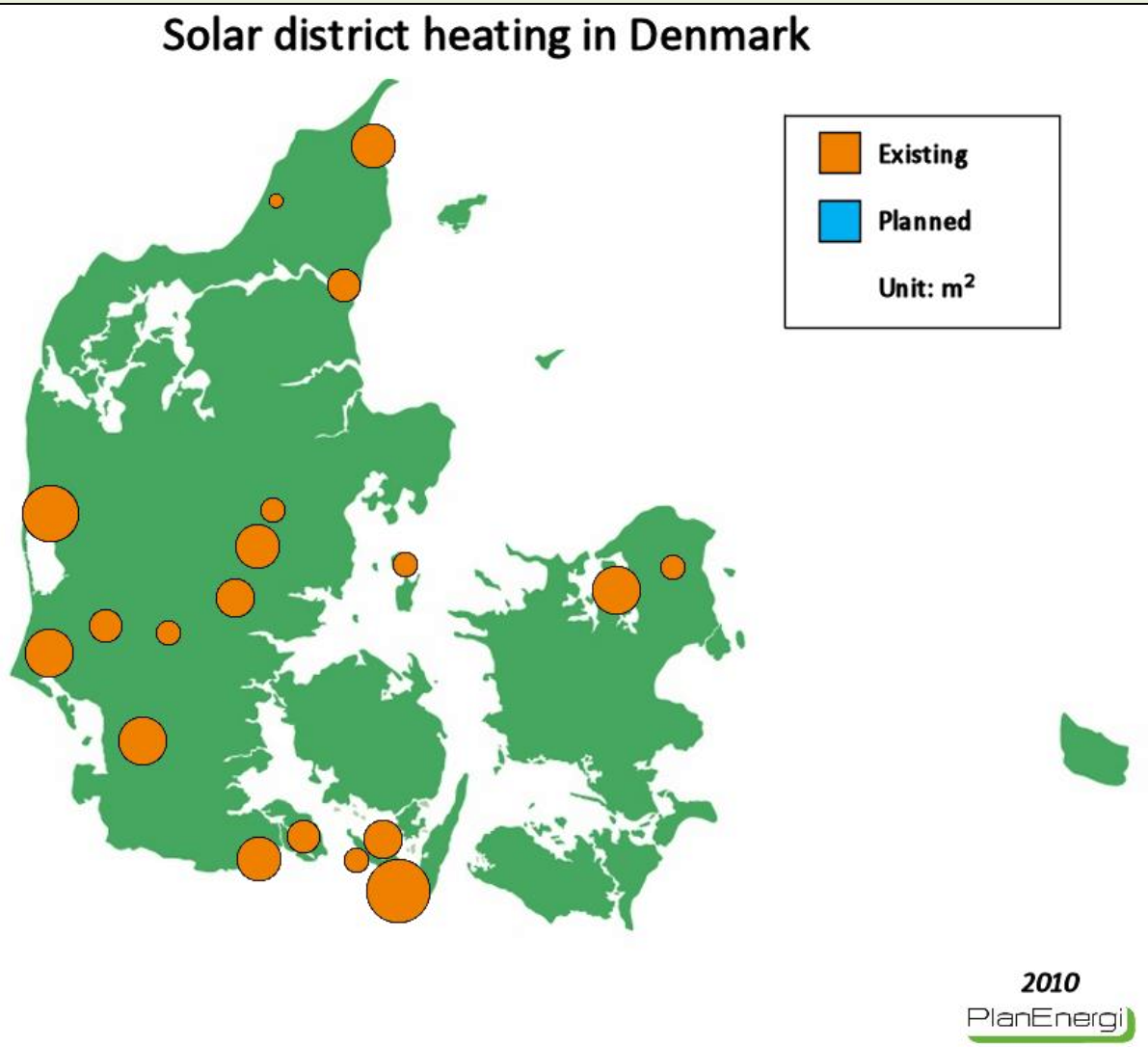

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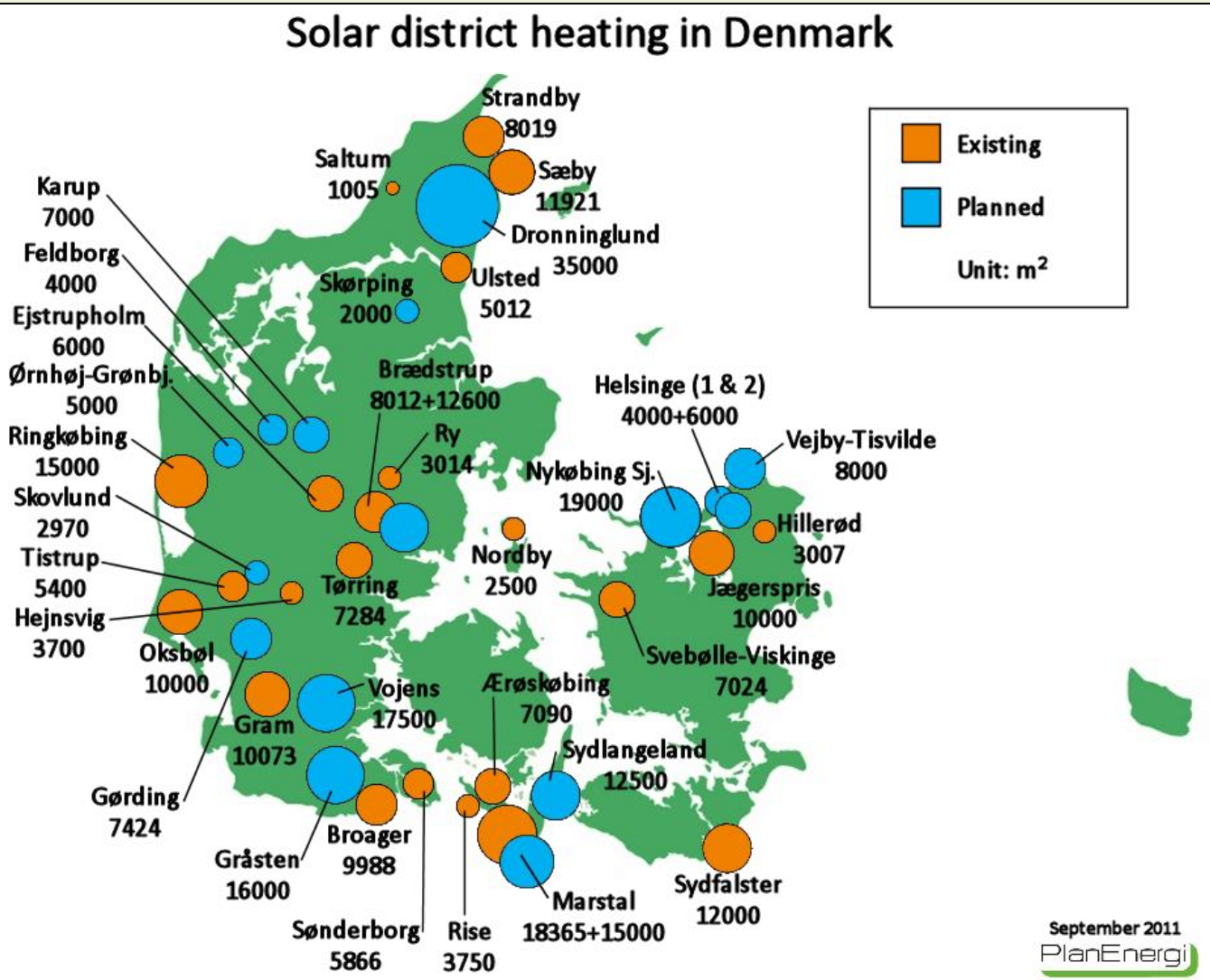

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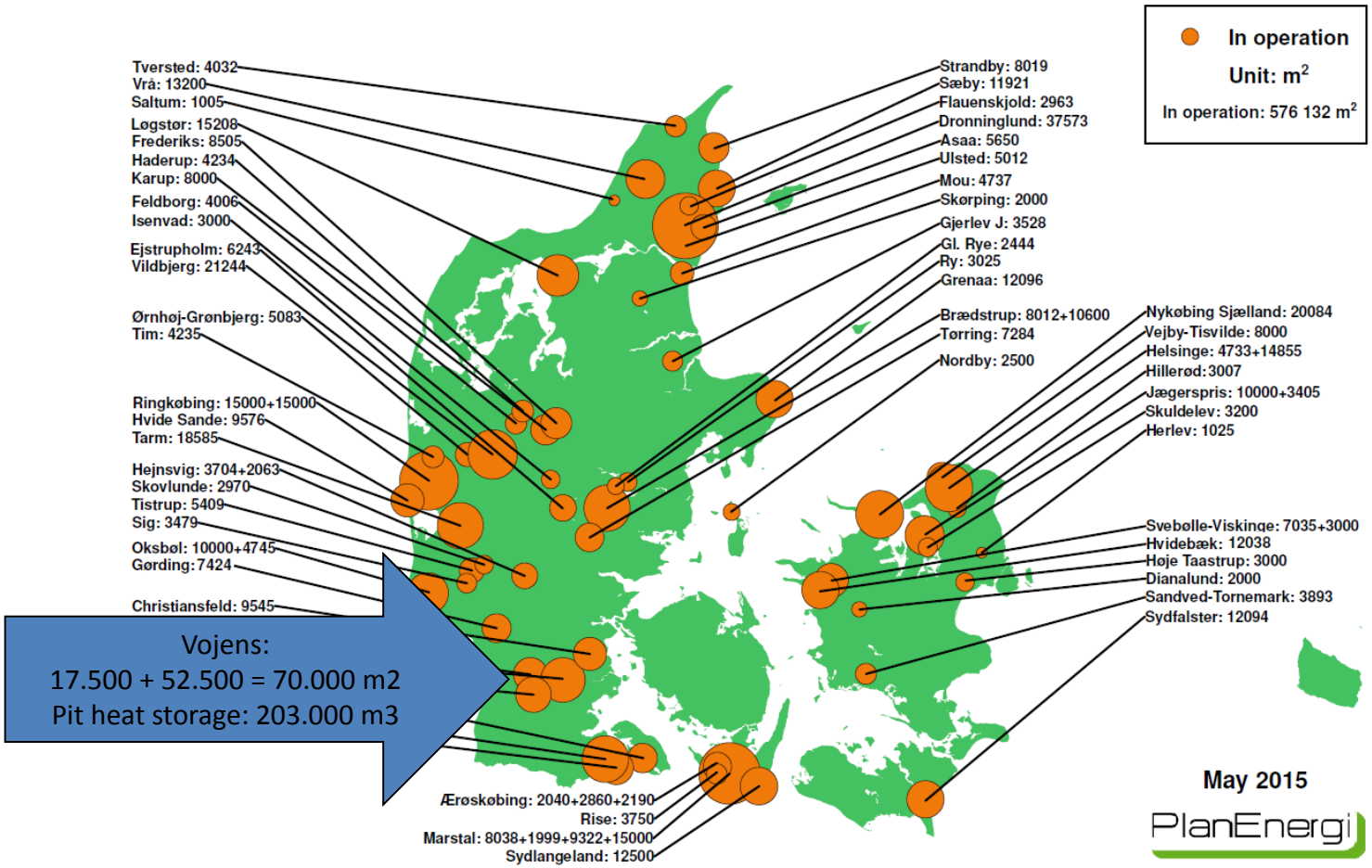

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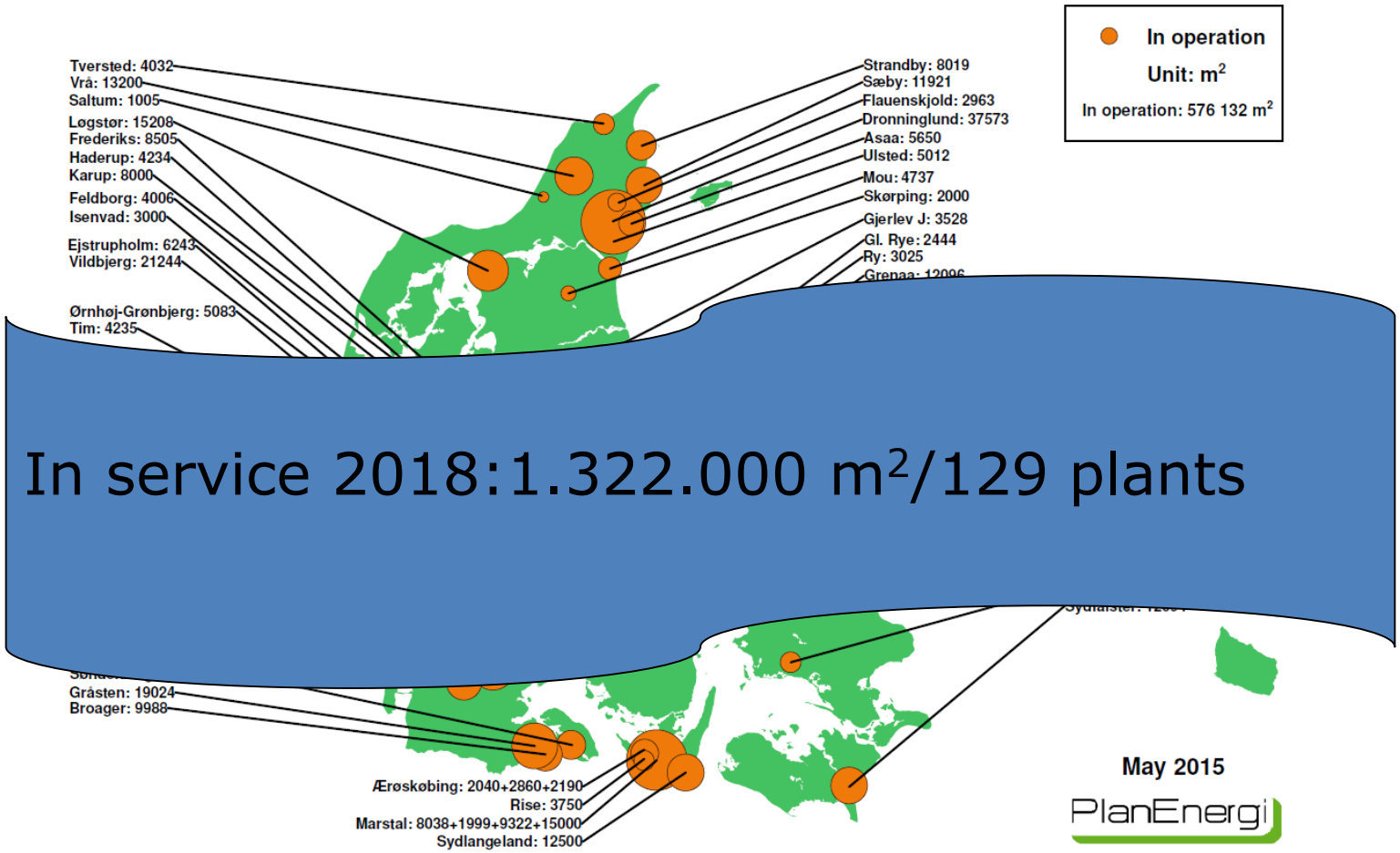

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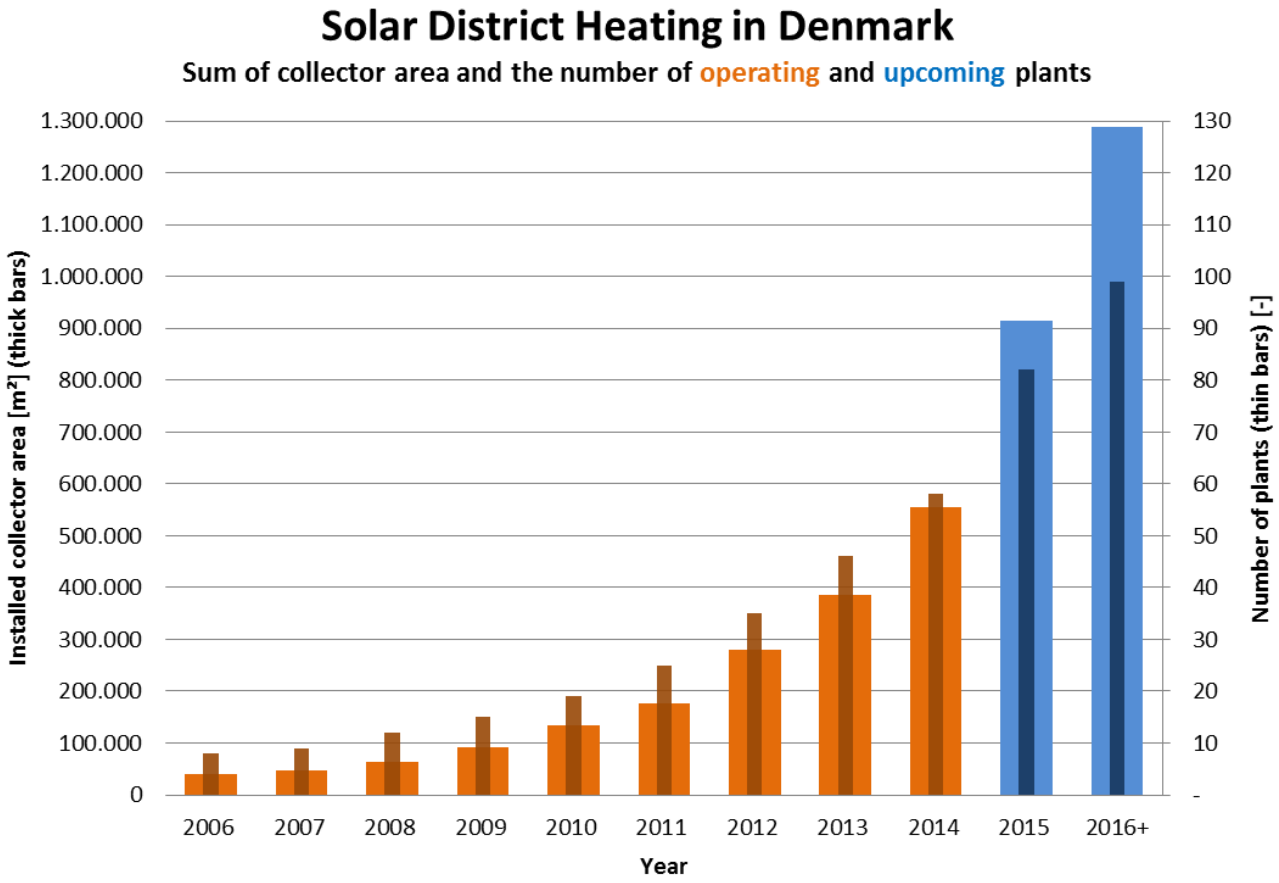
The Development



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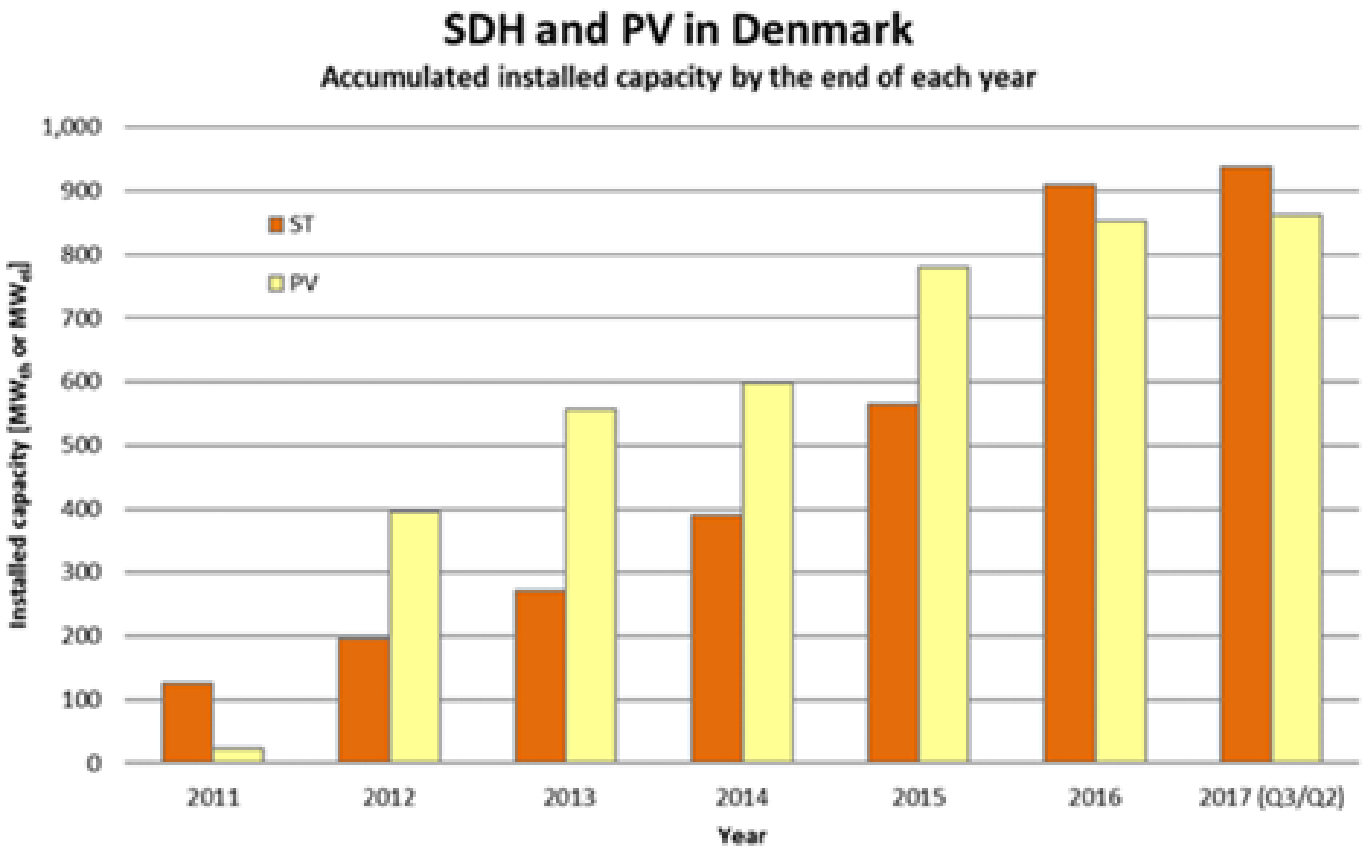
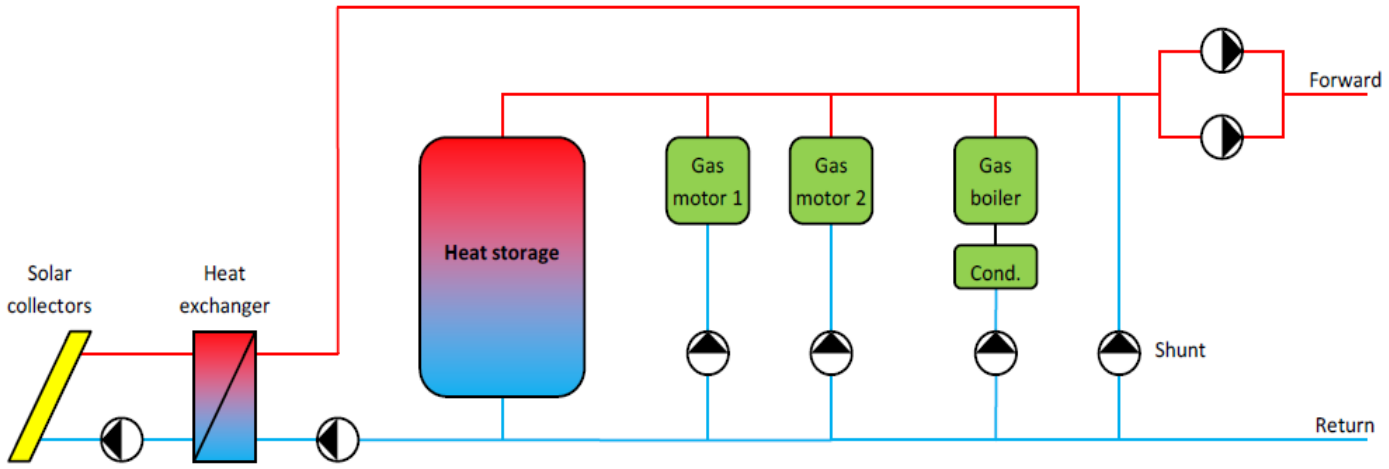


Solvarmedata.dk

The technique for the simple system

Principe diagram for solar and naturel gas fired CHP



Business - models

Typical example (DK): Solar Area: 10.000 m2

Purchase of land (30.000 m2):	50.000 Euro
Solar modules. pipes, heat exchangers, pumps, heat transfer fluid, etc.:	1.850.000 Euro
Fencing, soil processing, etc.:	50.000 Euro
Transmission pipe (1.000 m):	300.000 Euro
Control-systems:	100.000 Euro
Counseling, case processing, etc.:	40.000 Euro
Total:	**2.390.000 Euro**

Calculated production: 5.000 MWh/year

Annual capital costs: 2.375.000 Euro x 5%/year: 119.000 Euro/year

Maintenance: 1,0 Euro/MWh: 5.000 Euro/year

Total production costs: $\frac{124.000 \text{ Euro/year}}{5.000 \text{ MWh/year}}$ = **24,8 Euro/MWh**

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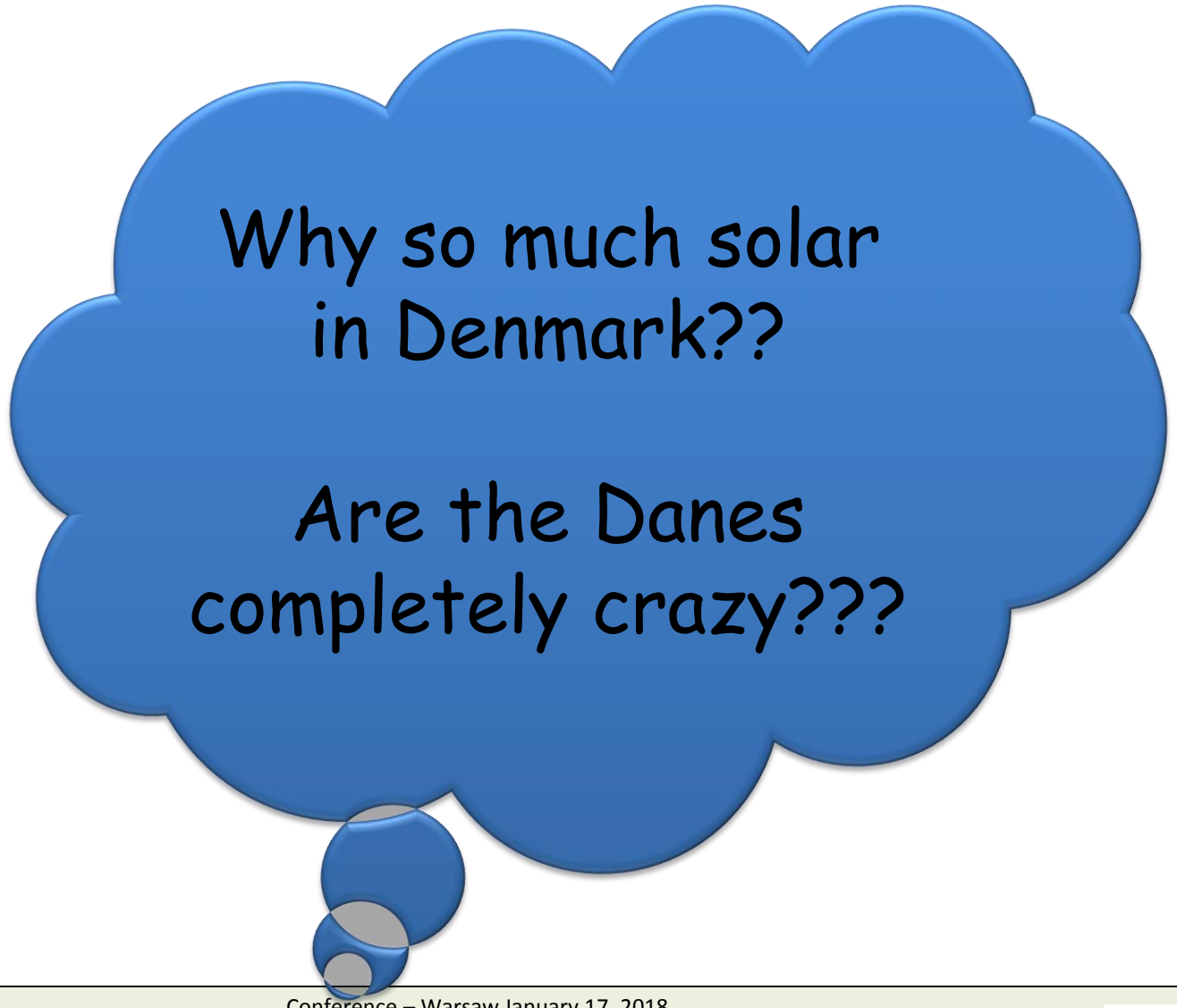
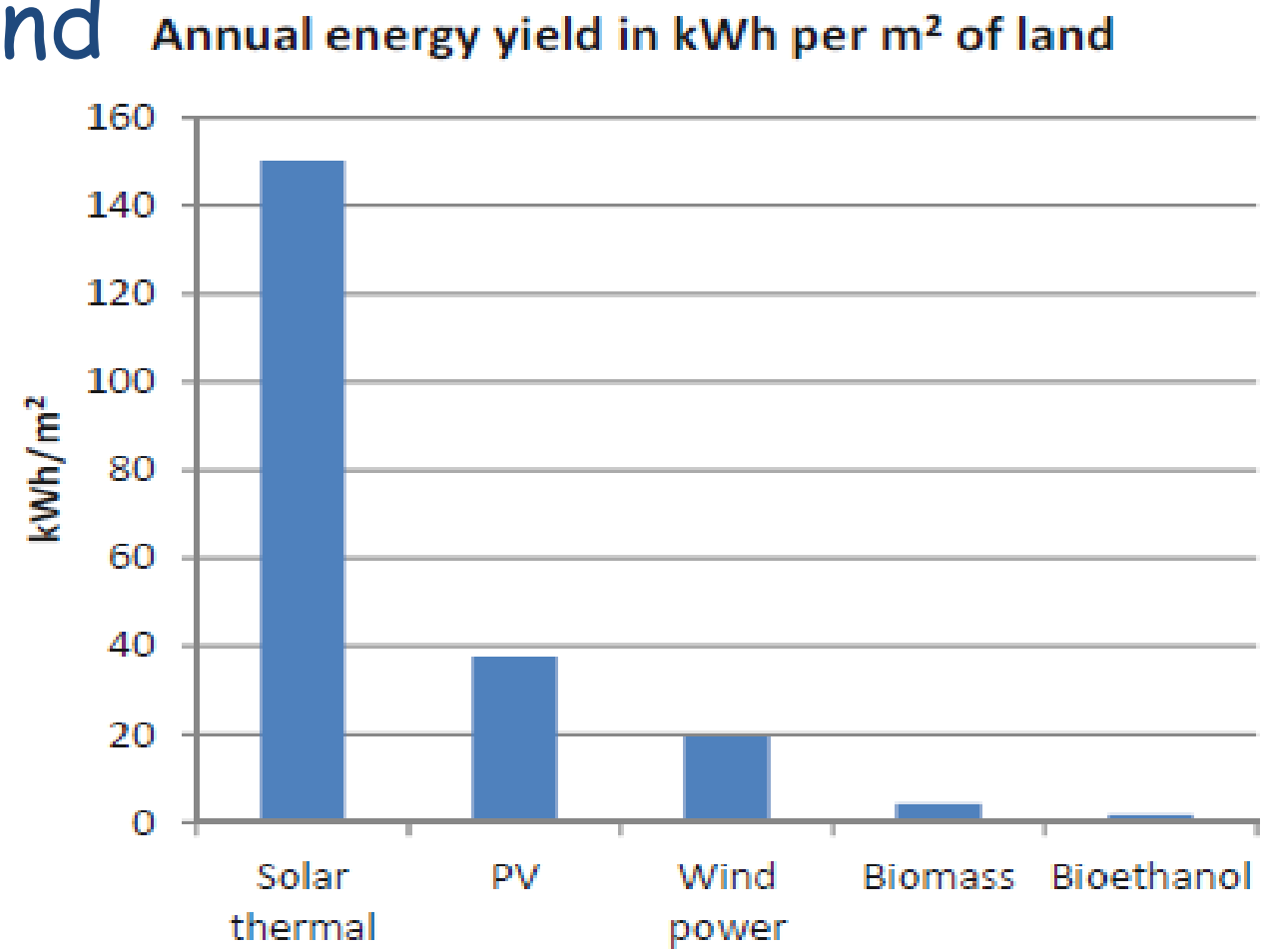


Reasons for solar in DK:

- The economy: High taxes on natural gas. App. same level as the gas price. No taxes on solar!!!!
- It is not allowed to use biomass at most of the natural gas fired plants (CHP)
- Saved CO_2 quotes can be sold
- Municipality guarantee for loans
- Available land for solar
- The solar group under Danish District Heating Association was started and arranged workshops and capacity building courses
- The structure for the District Heating sector and great decision ability in the individual boards
- The national plans for converting to renewable energy

The land


Annual energy yield in kWh per m² of land
kWh/m²
160
140
120
100
80
60
40
20
0
Solar thermal
PV
Wind power
Biomass
Bioethanol

New dokuments in Polish

Nowe dokumenty w języku polskim

SDHp2m – Implementation of SDH in existing biomass

Realizacja inwestycji słonecznych systemów ciepłowniczych wraz z instalacją na biomasę w istniejących systemach ciepłowniczych

SDHp2m – Implementation of SDH in Cities with DH

Realizacja inwestycji słonecznych systemów ciepłowniczych w istniejących systemach ciepłowniczych zlokalizowanych na terenach miejskich

SDHp2m – Implementation of new SDH and biomass

Realizacja inwestycji słonecznych systemów ciepłowniczych w połączeniu z kotłami na bio-masę na terenach wiejskich bez dostępu do sieci ciepłowniczej

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Thank you for your attention

Per Kristensen

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