

Methodology and results of the district heating analysis for the Danish Energy Agency

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The DH analysis

- In march 2012 the Danish Parliament agreed on ***Accelerating green energy towards 2020.***
- As part of the agreement it was decided to carry out in-depth analysis of the electricity sector, the gas sector and the DH sector.
- The main focus in the DH analysis was to analyse:
 - How will DH be produced in the future?
 - Should DH further expand or rather decrease its share of the Danish heating market from a socio-economic perspective?
- The analysis should focus on the period towards 2035 with perspectives towards 2050
- The DH analysis was carried out by Ea Energy Analyses and COWI and published in May 2014. DTU contributed in the initial phase of the project with dividing consumers on district heating networks.

The DH analysis

Four types of DH systems

- Centralised:
 - 6 named cities/areas where DH today is produced on so-called centralised DH plants
- Large decentralised:
 - Non centralised DH areas with offtake above 1 PJ
- Other (waste)
 - 14 cities below 1 PJ with production today mainly based on waste incineration
- Small areas:
 - Aggregated into 13 areas subdivided based on existing production technologies

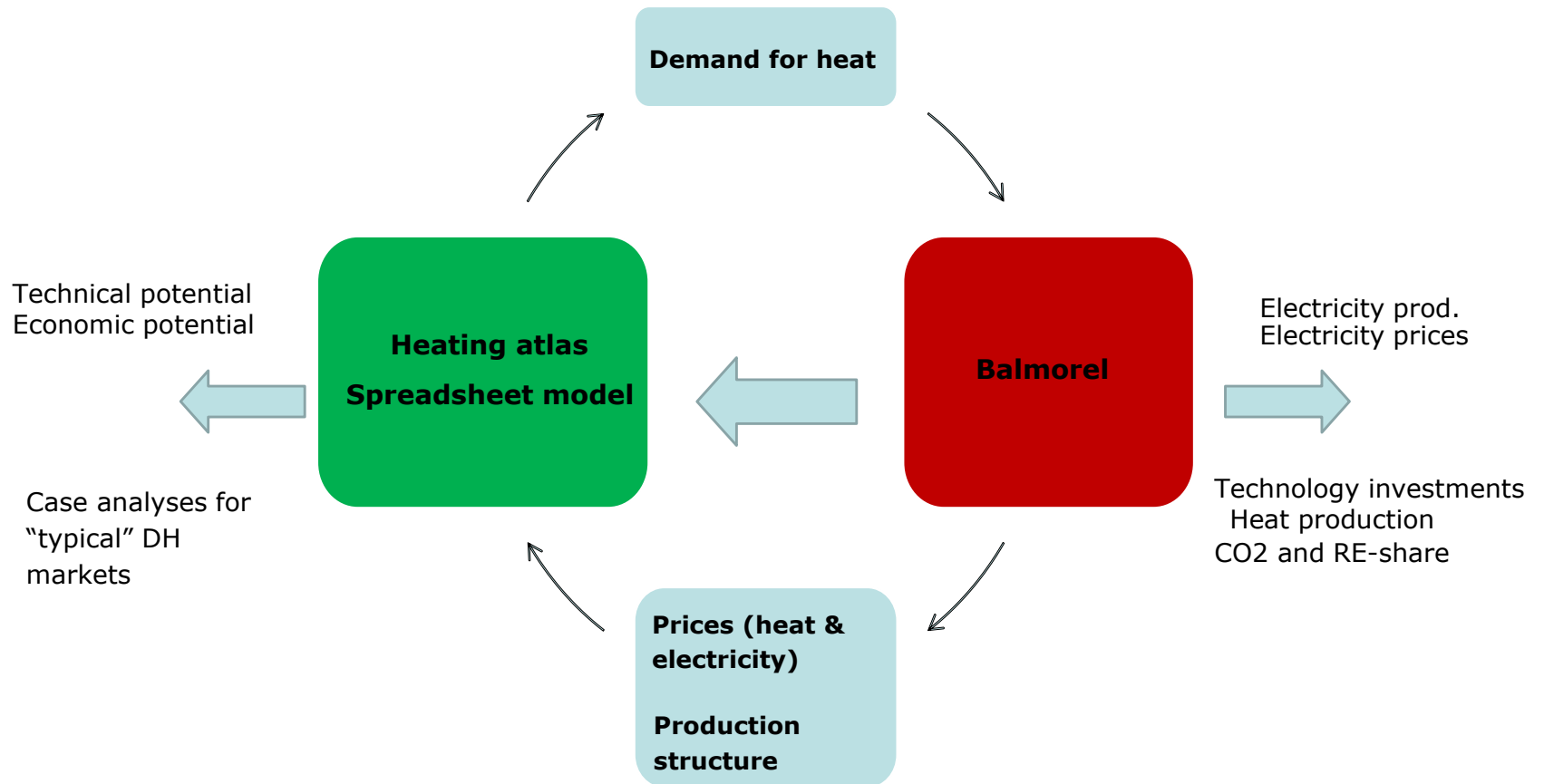
Four types of DH areas

Statistics 2011

	DH (PJ)	DH (%)
Centralised	81,3	62%
Large decentralised	12,2	9%
Other (waste)	6,9	5%
Small areas	31,1	24%
SUM	131,5	100%

Analytical approach

Economic optimisation



Scenarios 2015-2050

All scenarios have EU-wide ambitious goals: 95 % CO₂ reduction by 2050

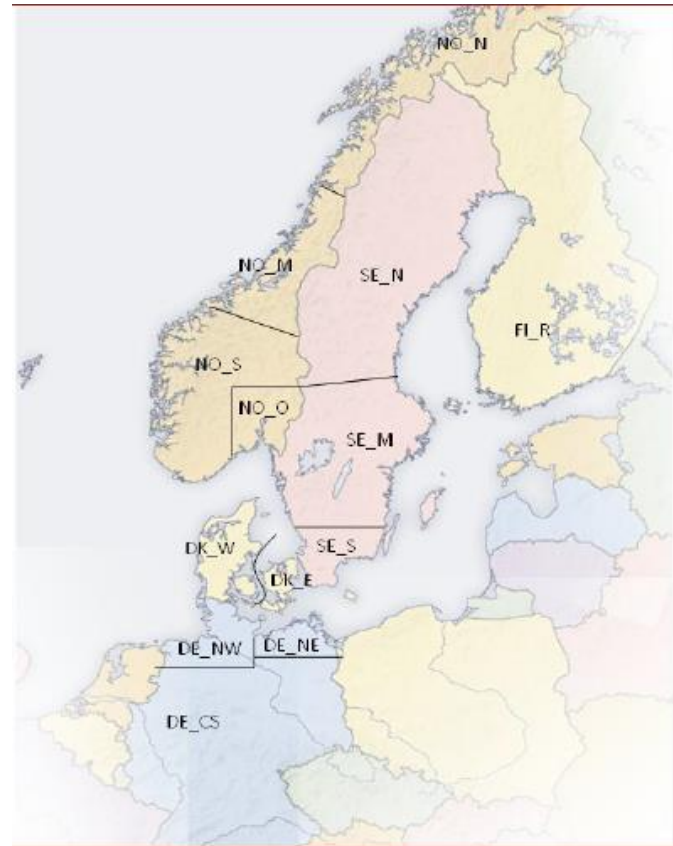
- A. Wind dominated system (limited biomass resources in the long term)
- B. Wind dominated system, no taxes no subsidies (limited biomass resources in the long term)
- C. Base case (Frozen policy in Denmark beyond 2020)



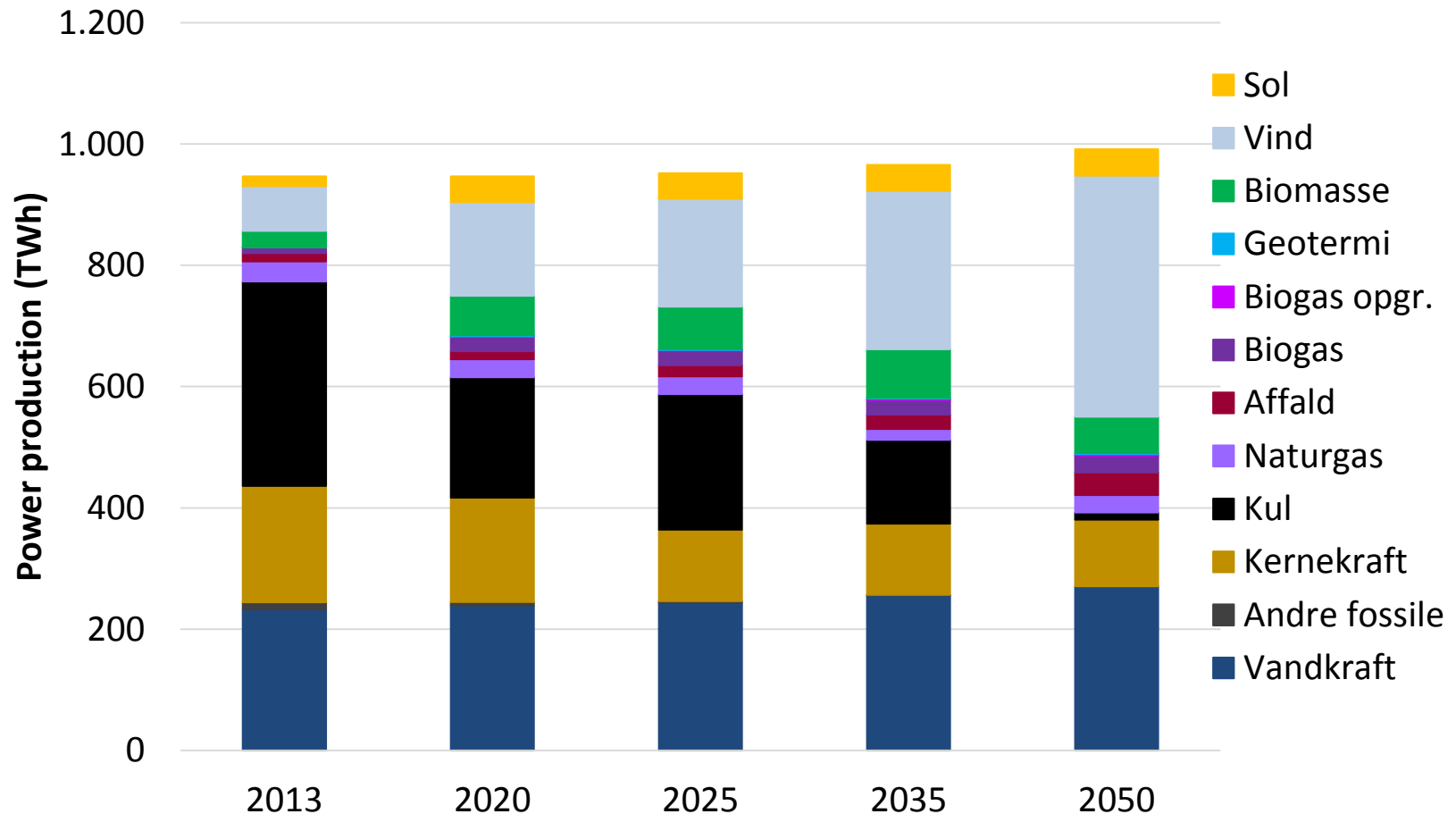
PRODUCTION OF DISTRICT HEATING IN THE FUTURE

The Balmorel model

- The electricity & DH systems in the Nordic and Germany are represented
 - Technology catalogue
 - Demand for electricity & heat
 - Fuel & CO2 prices
 - National RE strategies
 - Production profiles for wind and PV
 - Limitations on certain fuels, eg. Waste and biomass
- Model optimisation of operations and investments in new production plants based on technology catalogue
- Denmark subdivided in 50 DH areas
- Flexible GAMS model

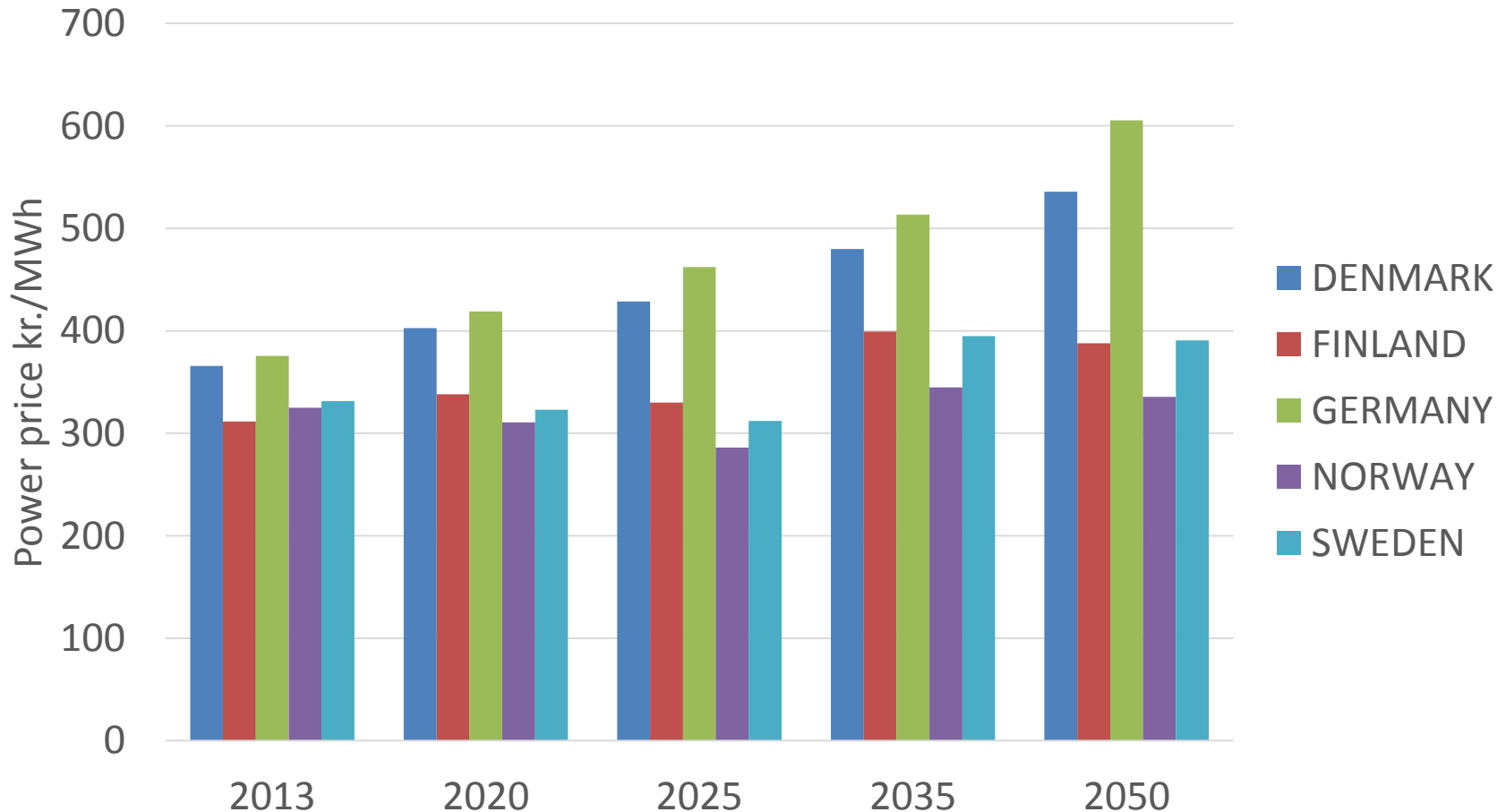


Development of the power system in Germany and the Nordic countries



Very large expansion of solar and wind power in Denmark and neighbouring countries => the power system changes dramatically towards 2050

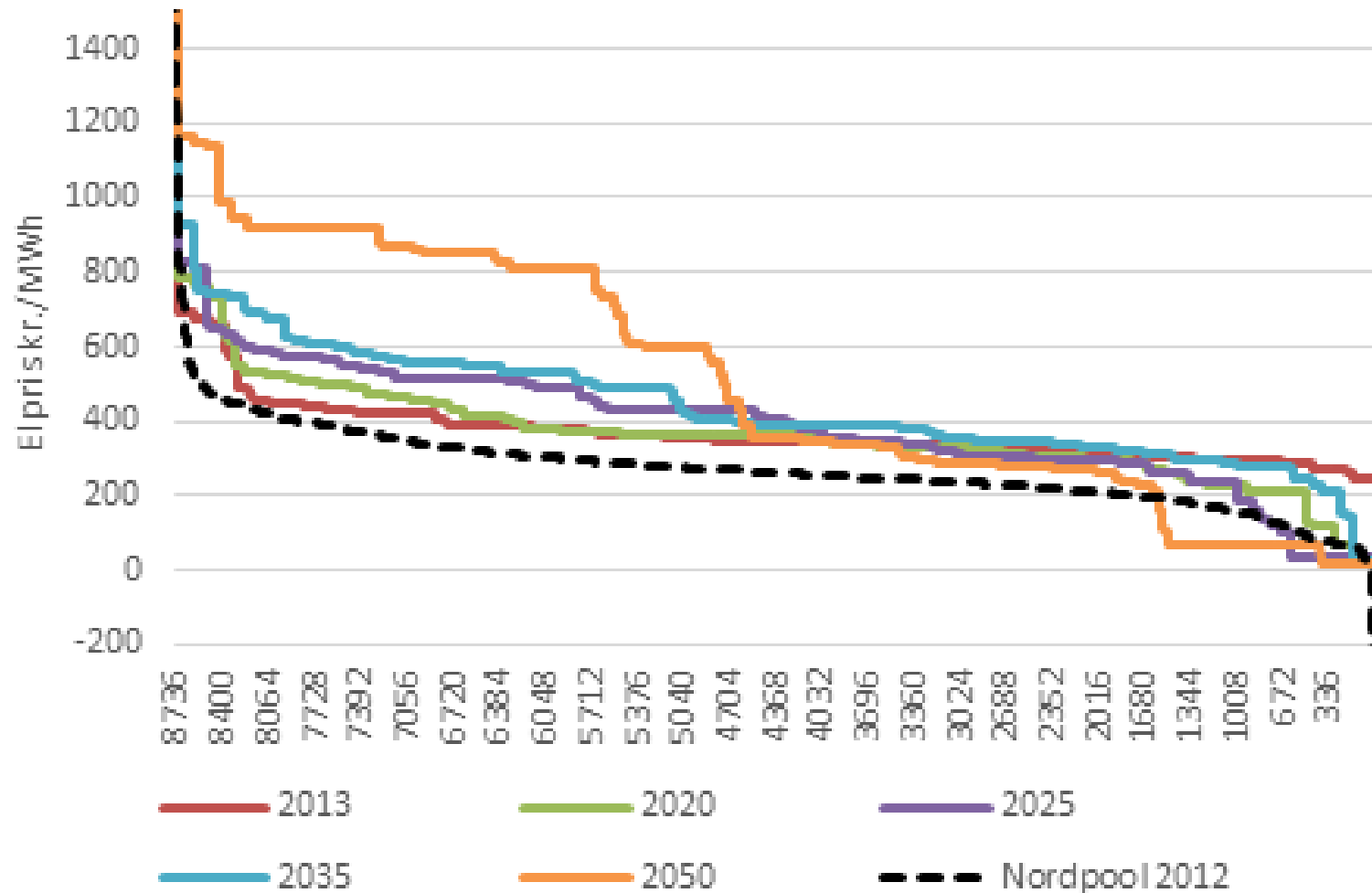
Power price development: Increasing prices



A well functioning "energy-only" power market has been assumed

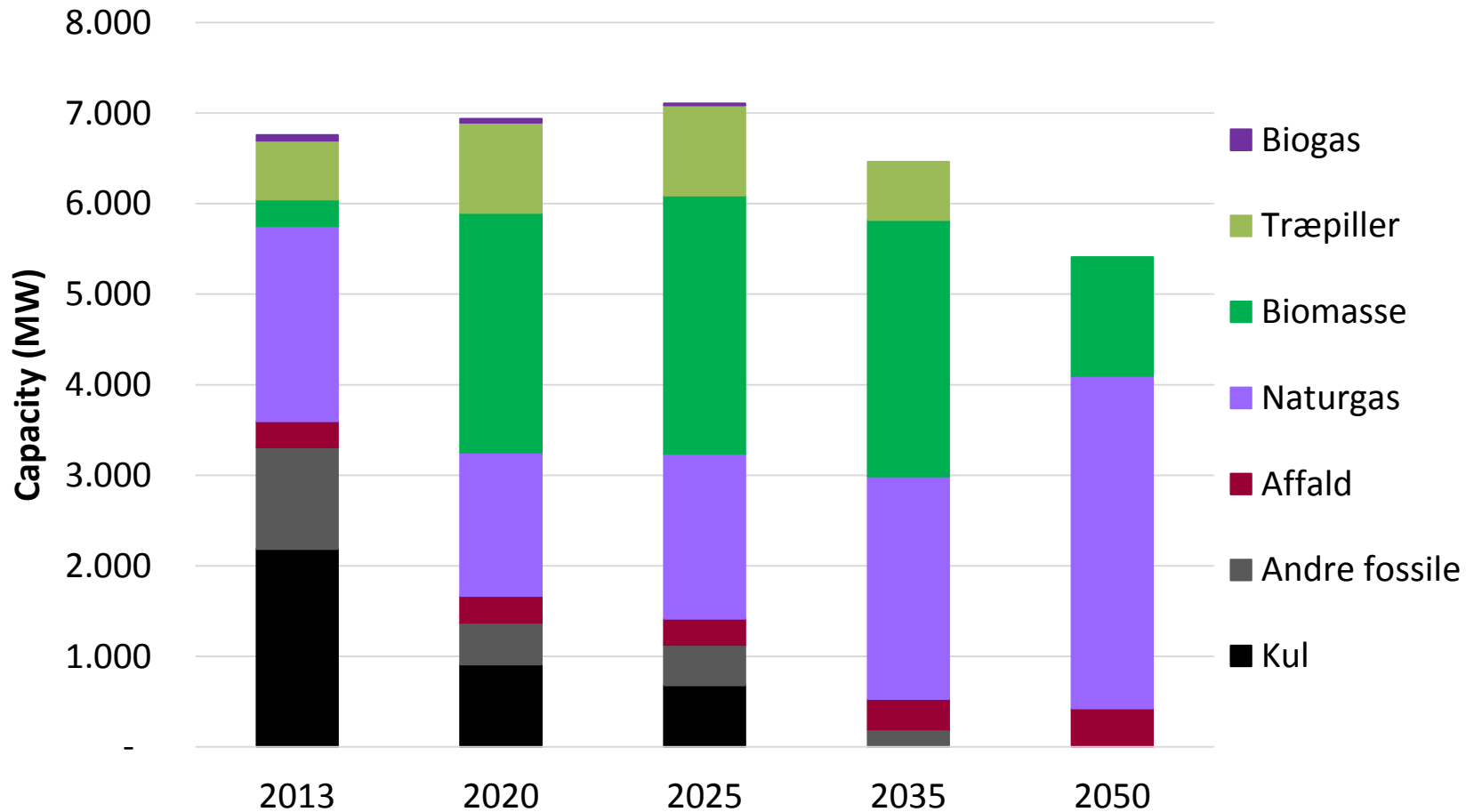
Power price development: Increasing fluctuation

Western Denmark



Power production capacity in Denmark

The wind scenario with subsidies and taxes



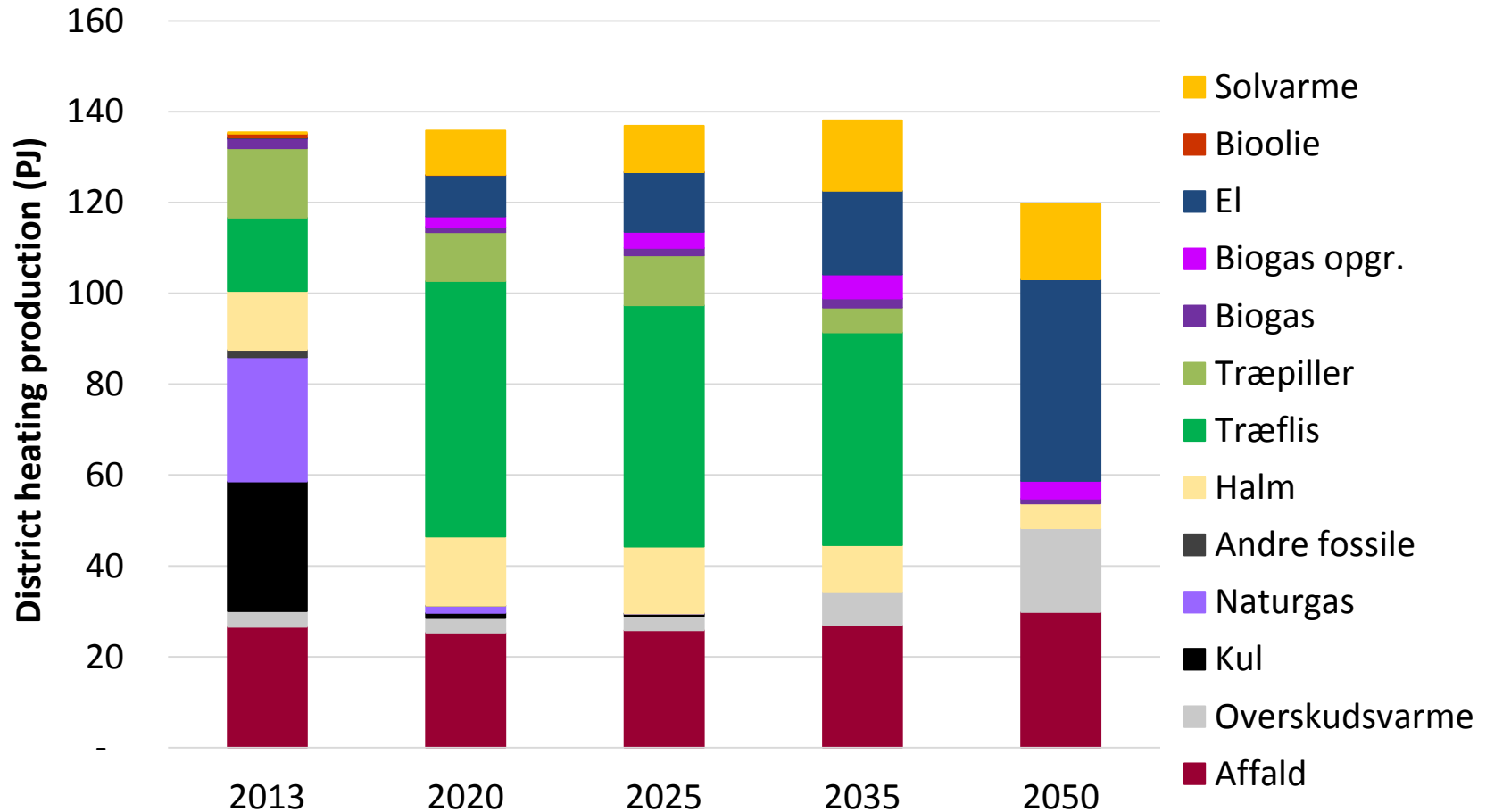
”Natural gas”: Plants using natural gas, biogas or other green gas

Increased capacity on biomass replacing coal, gas plants with few running hours



DH production in Denmark

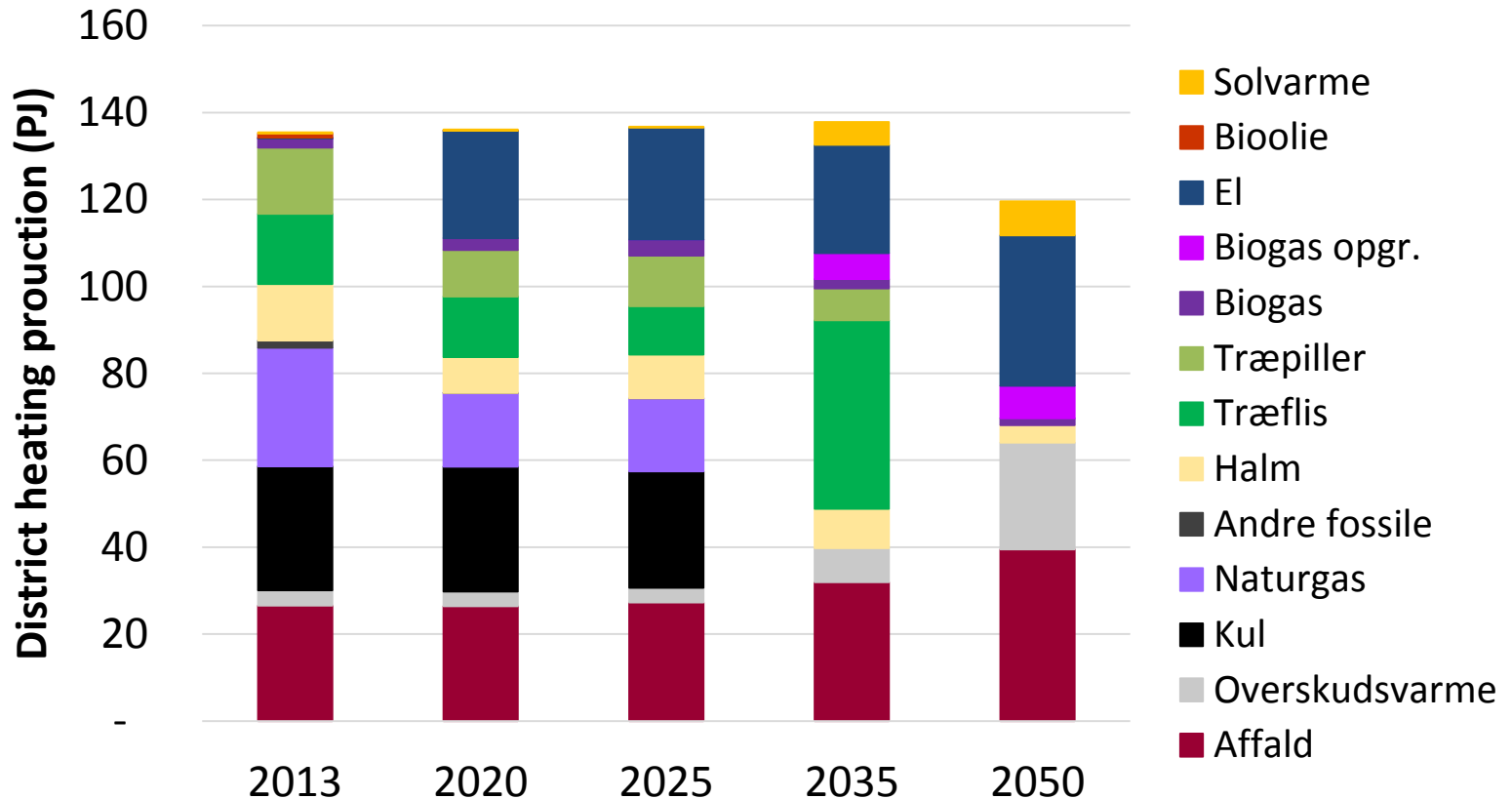
The wind scenario with subsidies and taxes



- Coal and natural gas replaced primarily by biomass and solar heating in 2020 og 2025
- Different solutions in small, medium and large systems
- 13 In the long term heat pumps will play an increasing role

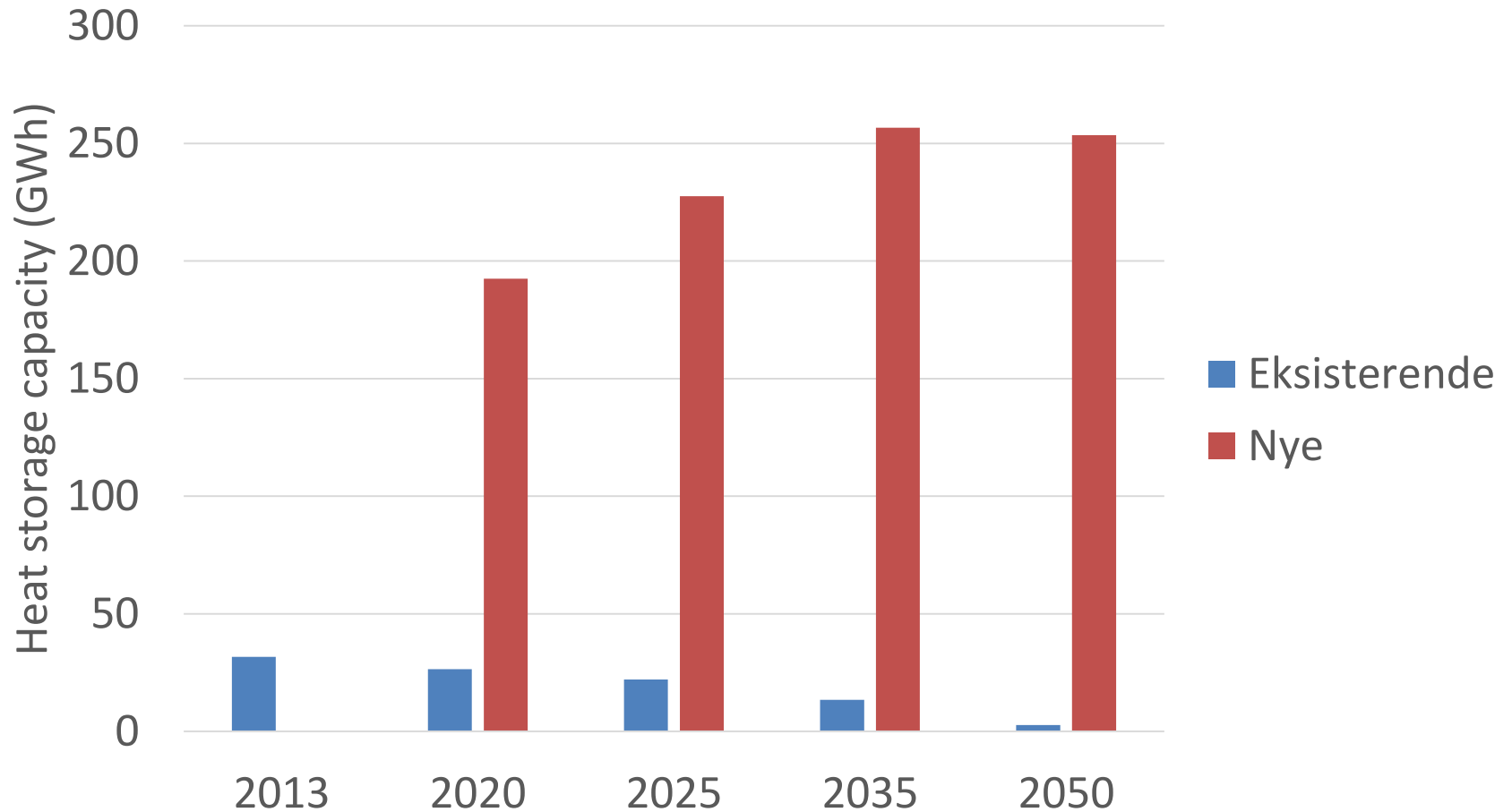
DH production in Denmark

The wind scenario without subsidies and taxes



- Coal continues as an important fuel in the large cities until it is forced out.
- Natural gas halved by 2020 and phased out by 2035. Slower phase out without taxes.
- Significant investments in heat pumps, solar heating has marginal influence

Investments in heat storages



Summing up

- The ambitious 95 % CO₂ reduction target together with the biomass ceiling imply massive changes of the energy system. Wind power is dominating in the whole system area (Germany and the Nordic countries).
- Still high CHP production in 2025. After 2025 significantly decreasing.
- The tax system motivates a large change of DH production towards biomass, solar heating and heat pumps in the short term.
- In the longer term the constraints on biomass use mean that new technologies like heat pumps and solar heating will play a dominating role together with MSW.
- Natural gas CHP as base load plant is phased out – even without taxes/subsidies.
- The number of full load hours for all thermal plant types decreases significantly from 2035 (except MSW). High value of peak load and new power transmission.
- Average power prices increase in all of the model area, heat prices show small increase from 2020.
 - With taxes the marginal heat costs are decreasing in large and middle sized areas but increasing in smaller areas.

DEVELOPMENT OF DISTRICT HEATING CONSUMPTION

Heat Atlas – methodology (1)

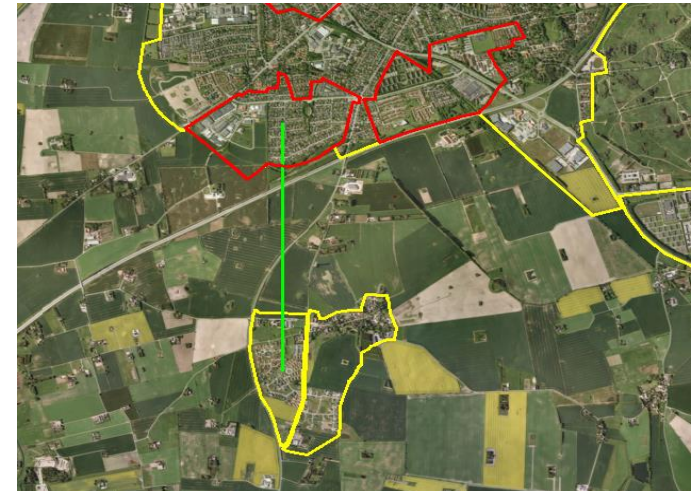
- All heated buildings in Denmark mapped using BBR and GIS-tool:
 - 4000 town areas (80 % af heating)
 - Residual group of buildings: DH not considered relevant
 - Heat consumption and installation type for alle buildings
 - Focus on existing houses in Denmark
- Town areas divided in 4 groups:
 - Existing DH consumers
 - Individual heating in DH areas
 - Individual heating in town areas with DH
 - Individual heating in town areas with no DH
- All existing consumers coupled to a district heating area in Balmorel

Heat Atlas – methodology (2)

Individual heating in DH areas



Individual heating in town areas with DH



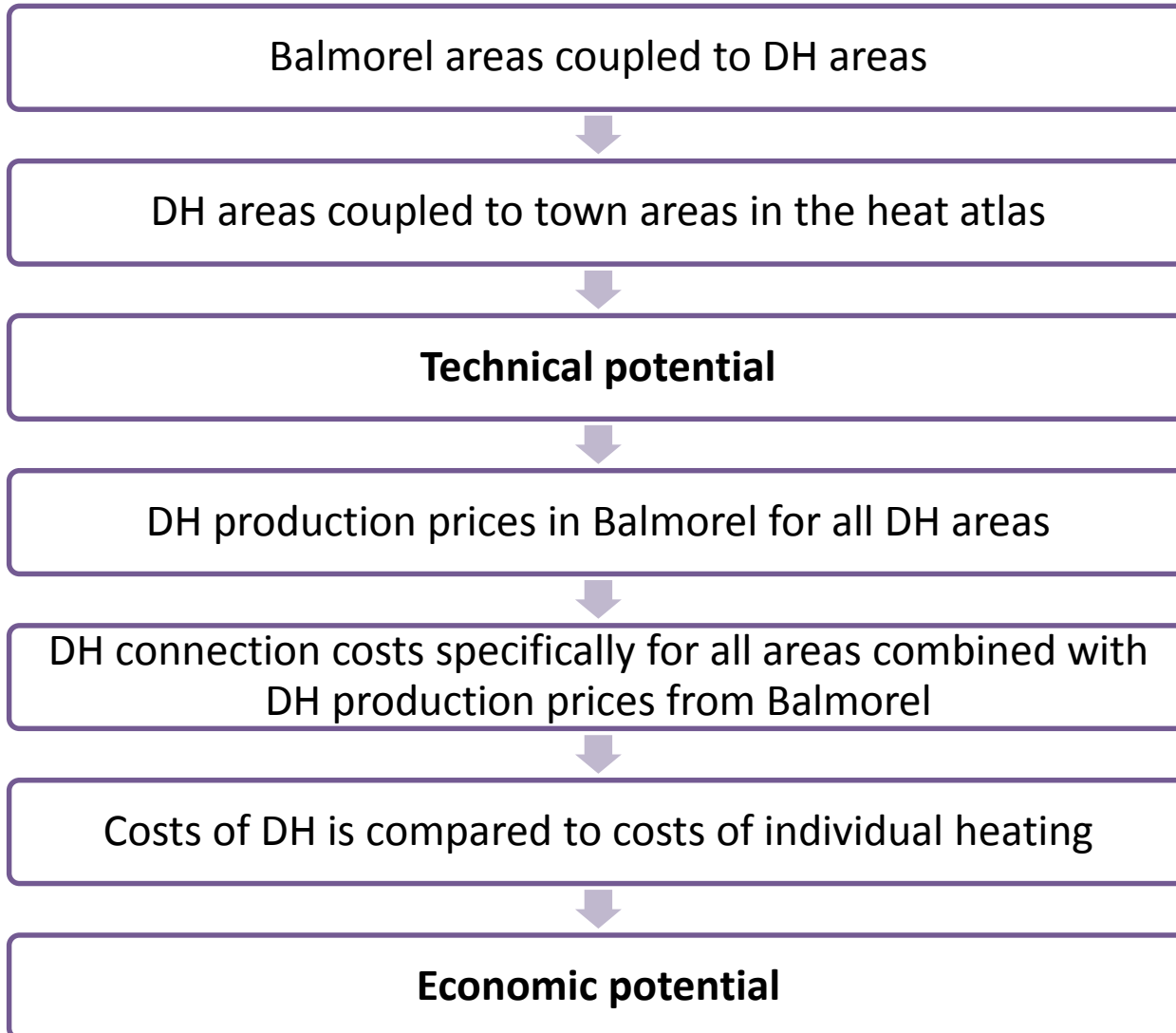
Individual heating in town areas with no DH



Heat Atlas – methodology (3)

- Individual heating:
 - Divided in three groups according to size: Small (0-50 MWh/year), Middle (50-350 MWh/year) and Large (>350 MWh/year)
 - Costs of heat production calculated using DEA prices for fuels and Technology Catalogue. Power price from Balmorel.
 - Assumption on division on technologies in 2020 and 2035. Natural gas, oil, wood pellets, different heat pumps.
 - Costs of connection to DH included: connection, street grid, transmission depending on type of consumer.
- District heating
 - Heat costs are calculated with Balmorel
- Costs calculated with and without taxes in 2020 and 2035
- 1 % yearly decrease in heat consumption assumed

Heat Atlas – methodology (4)



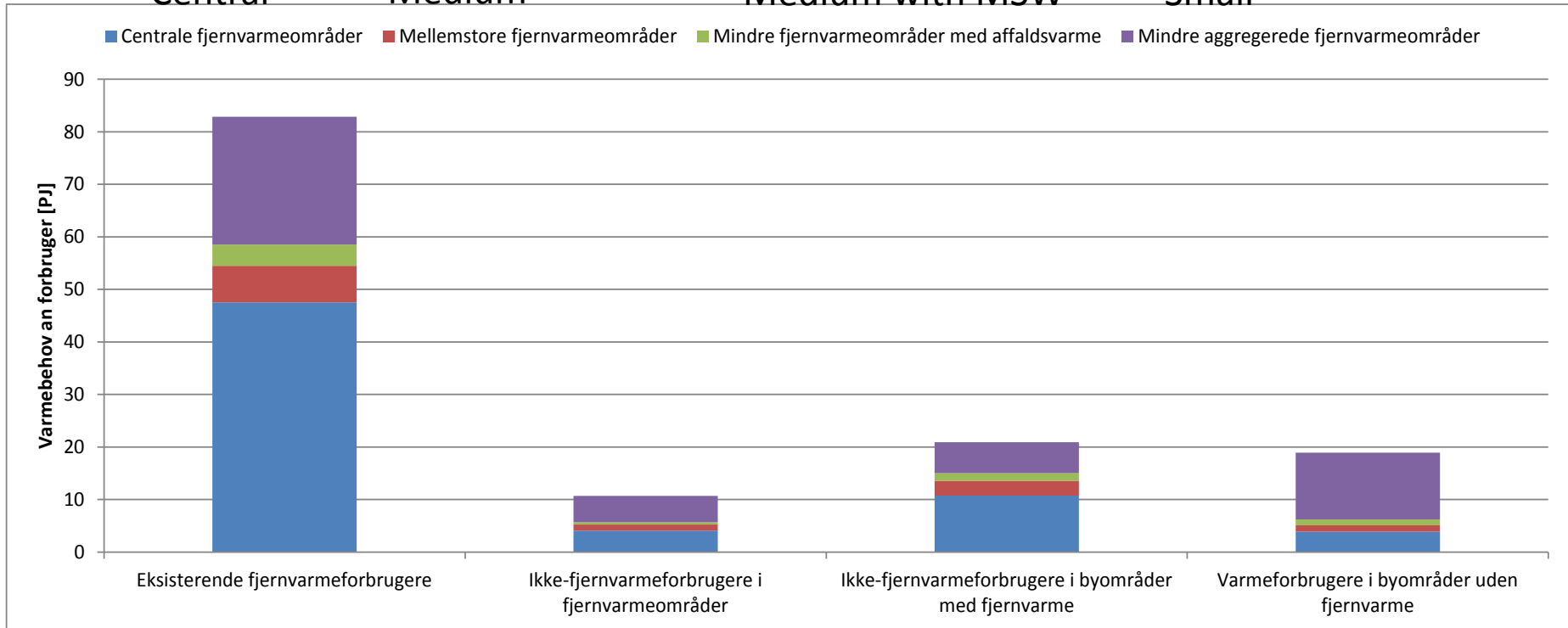
Technical potential (80 % of total heating)

Central

Medium

Medium with MSW

Small



Existing DH
(50 % of
heating)

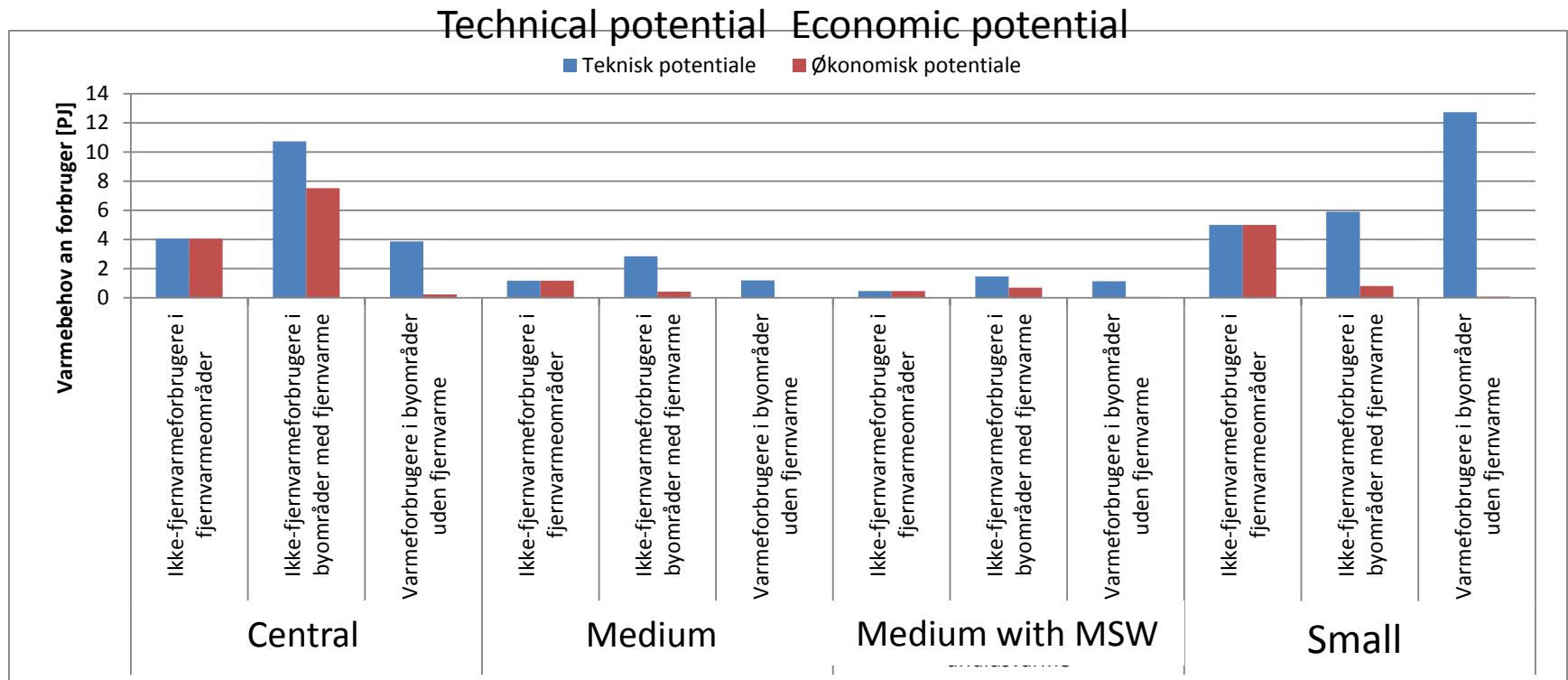
Individual heating
in DH areas

Individual
heating in town
areas with DH

Individual heating
in town areas with
no DH

Socio economic potential 2035

- Economic potential in central case: 62 %
- Mainly in areas within existing DH or close to existing DH



Development of DH

No taxes no subsidies

Heat demand [PJ]	2013	2020	2035
Total DK	199	189	166
City areas	160	152	134
DH coverage	50 %	69 %	62 %

- The table shows the results in the central scenario
- A number of sensitivity analyses carried out: Robust result that DH in 2035 should cover from 57 % to 67 % of Danish heat demand