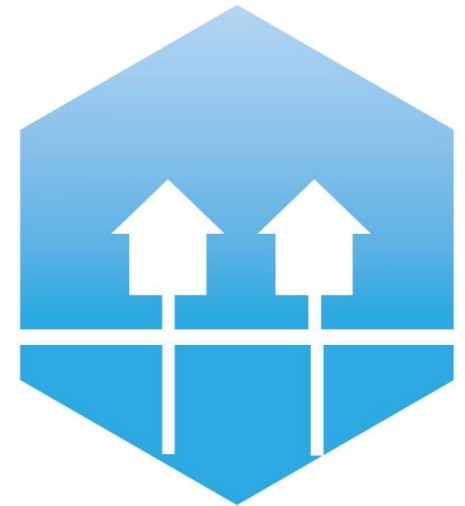
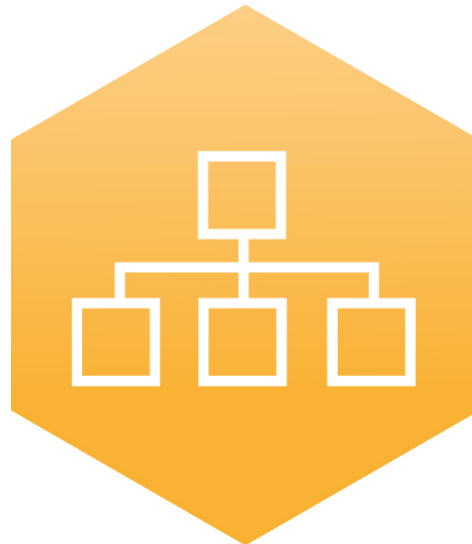


*The transition of
small-scale CHP into
market-based smart
energy systems*



AALBORG UNIVERSITY
DENMARK

Peter Sorknæs, AAU

4DH

**4th Generation District Heating
Technologies and Systems**

The relevance of Combined Heat and Power (CHP)

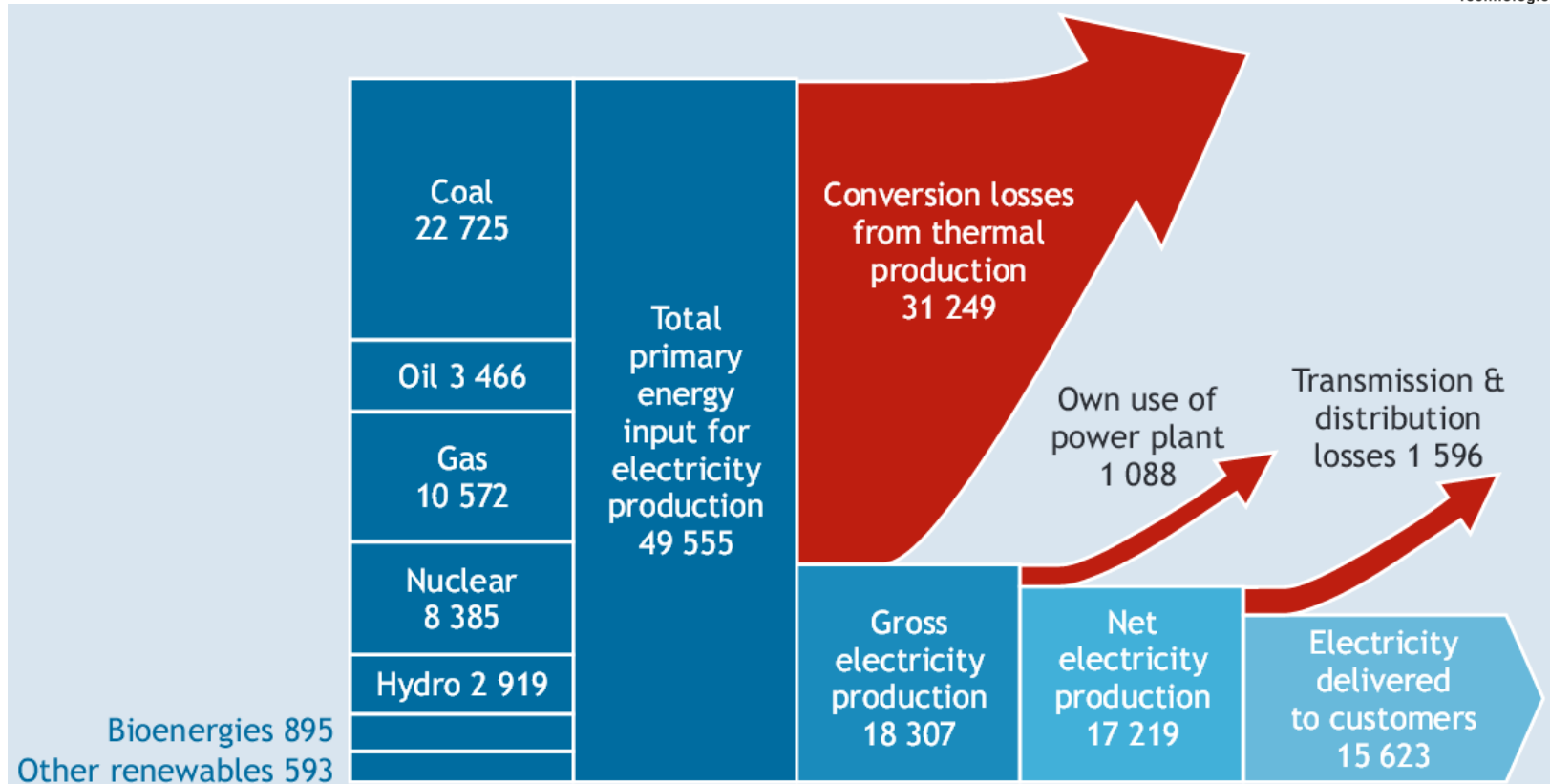


Figure from: IEA. Combined Heat and Power: Evaluating the Benefits of Greater Global Investment. Paris: IEA; 2008.

Electricity capacity in Denmark

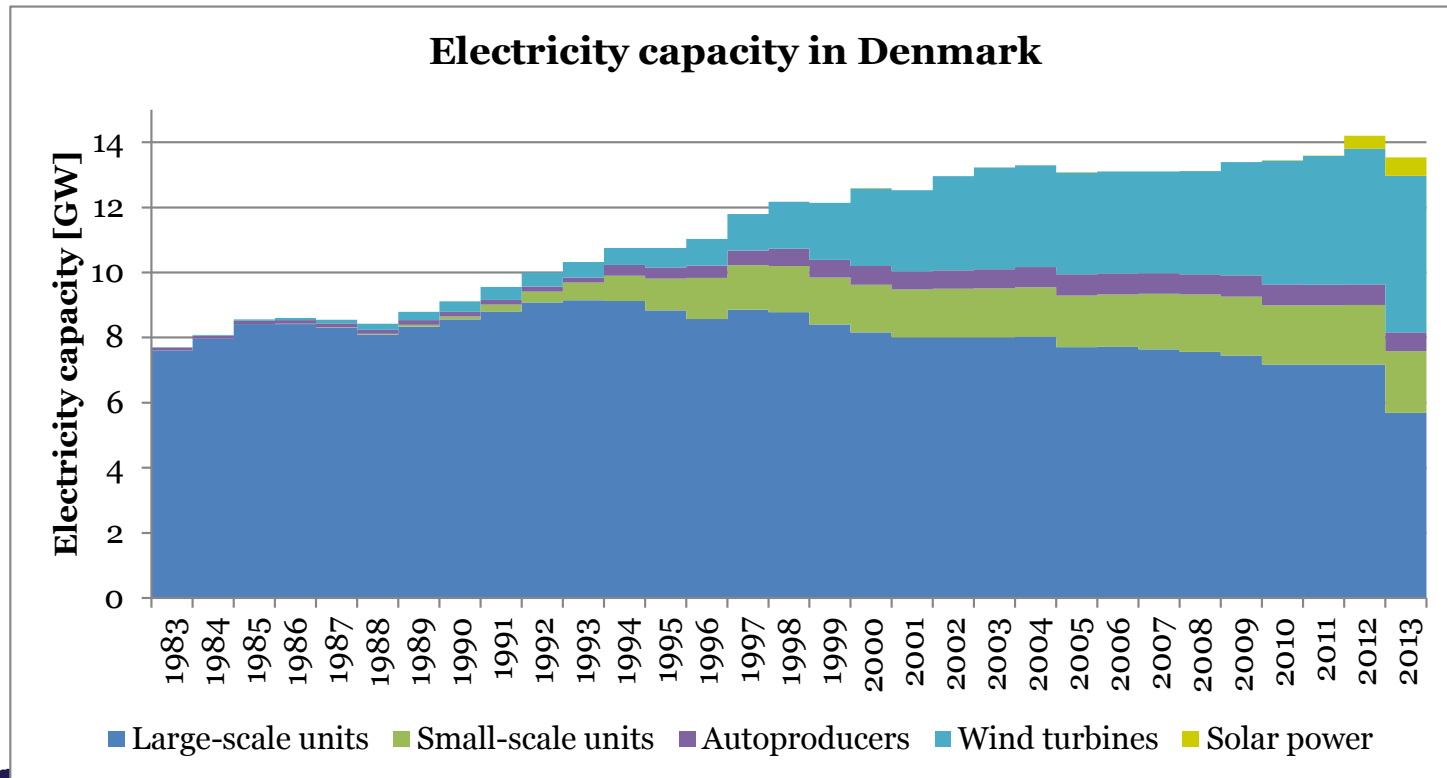


Figure based on data from: Danish Energy Agency. *Energistatistik 2013*. Copenhagen: Danish Energy Agency; 2014.



Electricity production in Denmark

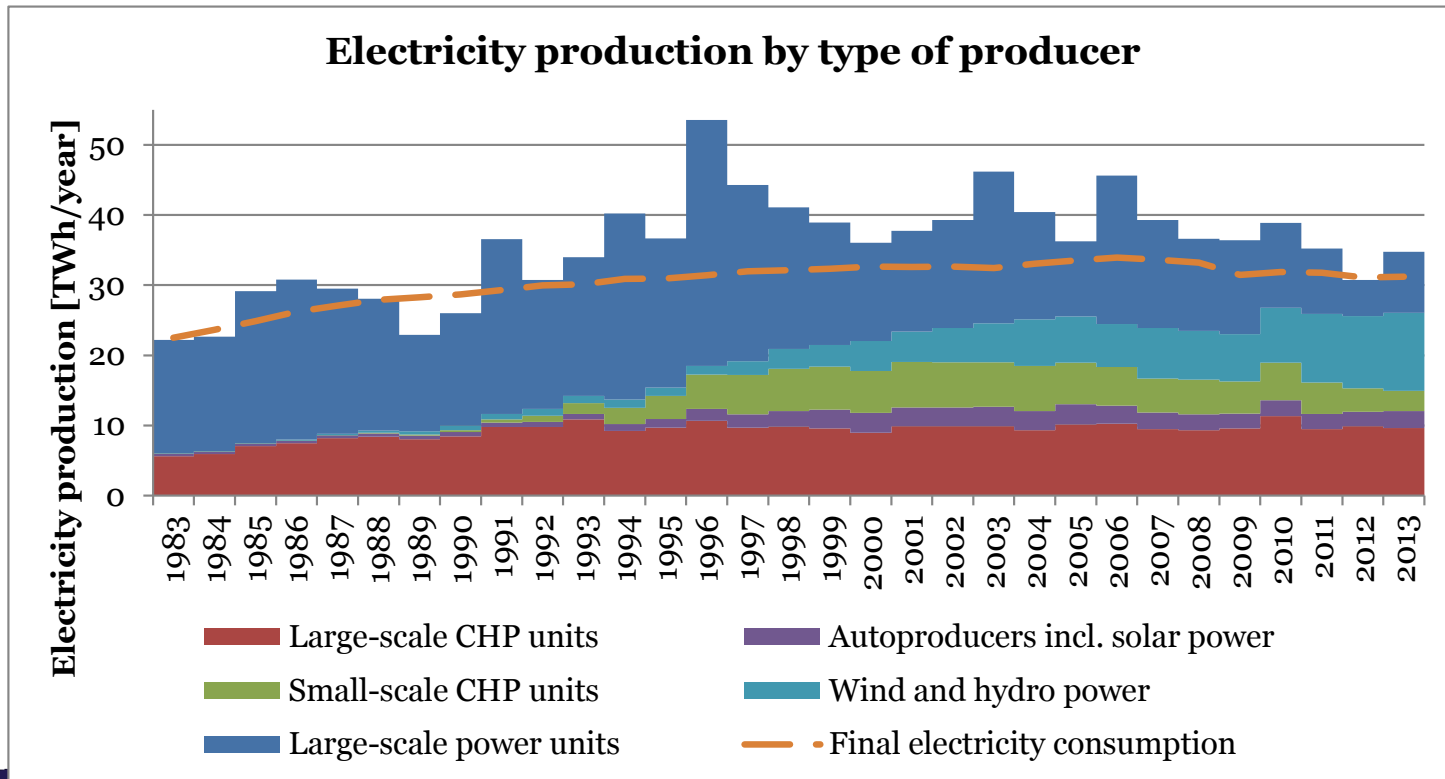


Figure based on data from: Danish Energy Agency. *Energistatistik 2013*. Copenhagen: Danish Energy Agency; 2014.



Electricity prices on Nord Pool Spot

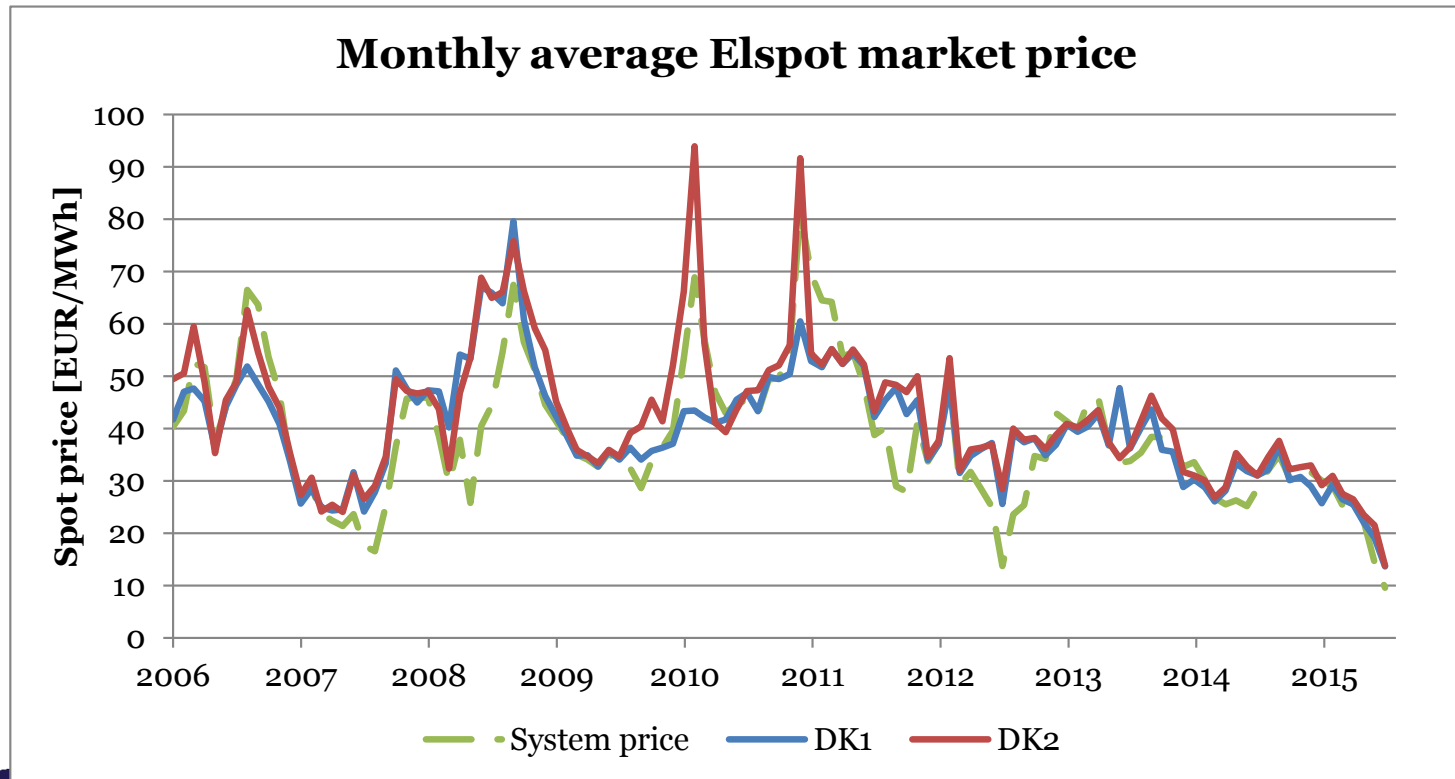


Figure based on data from: Energinet.dk,
<https://www.energinet.dk/EN/EI/Engrosmarked/Udtraek-af-markedsdata/Sider/default.aspx>



Example of the type of small CHP units focused on here

- Approx. 4,000 consumers, with a total sale of heat in 2012 of 89,535 MWh and a heat loss in the grid of 21.6%
- Natural gas fired engine (8.8 MWe, 10.3 MWth)
- Electric boiler (12 MWth)
- 30,000 m² solar panels (22 MWth)
- 4 natural gas boilers (total 40 MWth)
- 3 heat storage tanks (1,500 m³ and 4,500 m³)



Going forward – An example from the CEESA project



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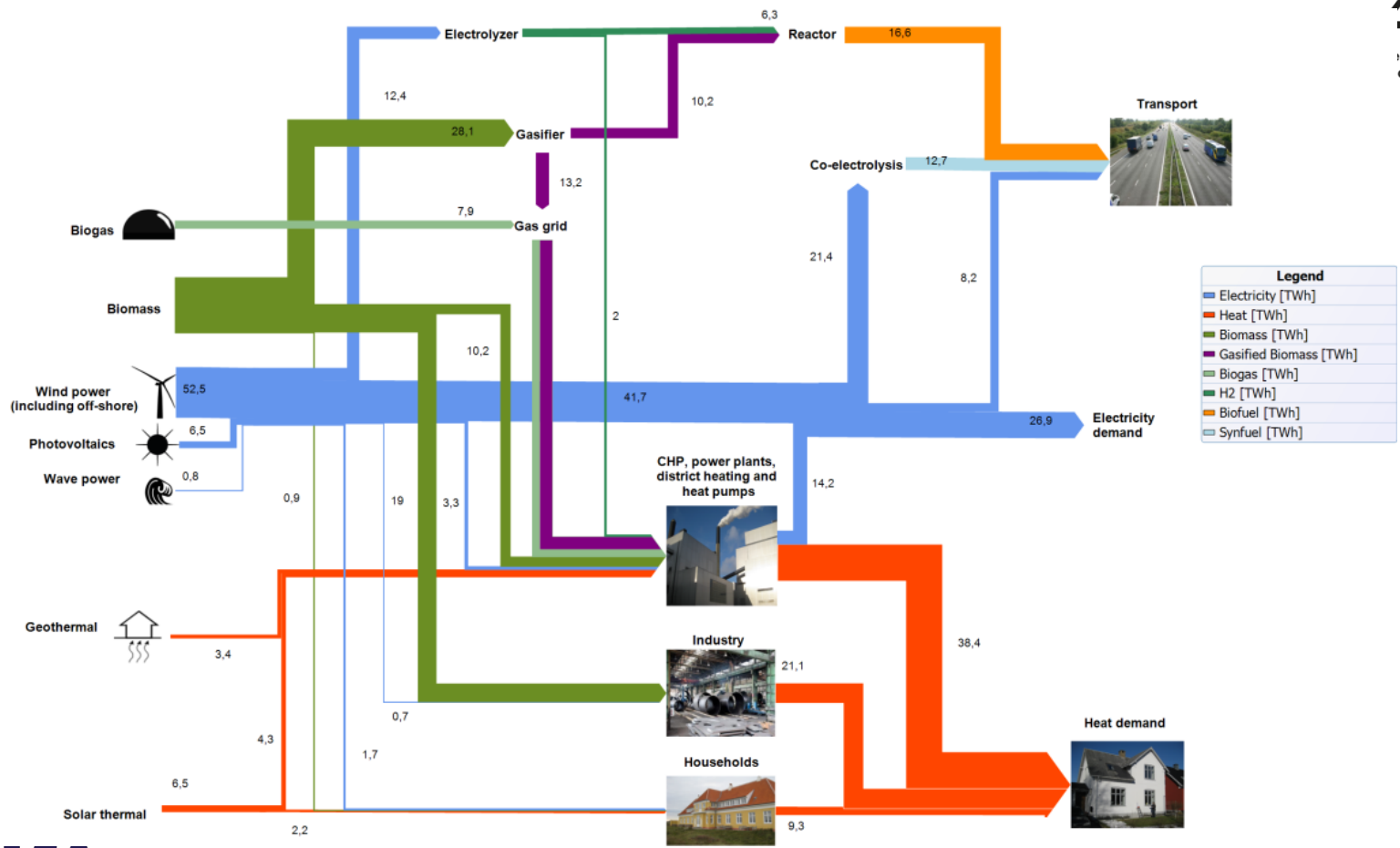
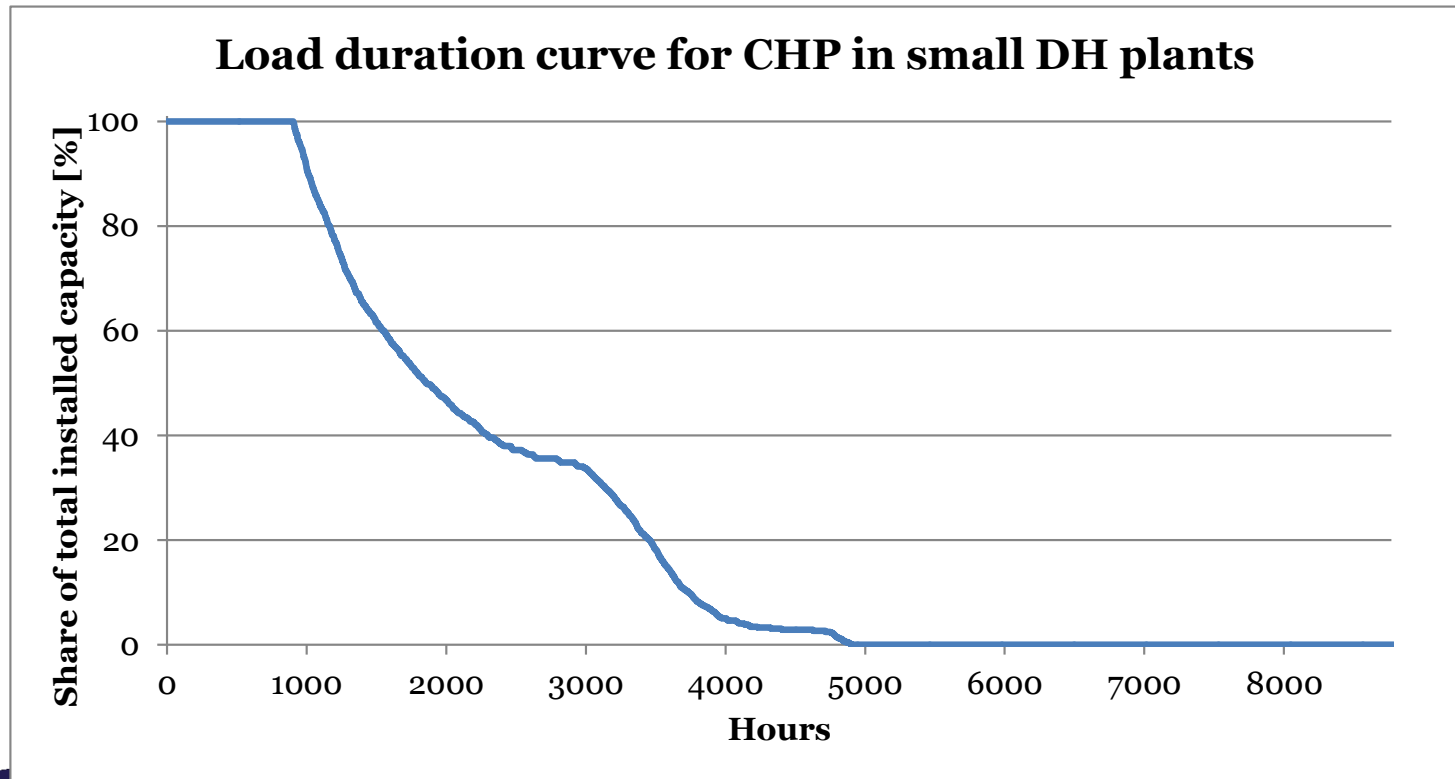


Figure from: Lund H, Hvelplund F, Mathiesen BV, Østergaard PA, Christensen P, Connolly D, et al. Coherent Energy and Environmental System Analysis. 2011.

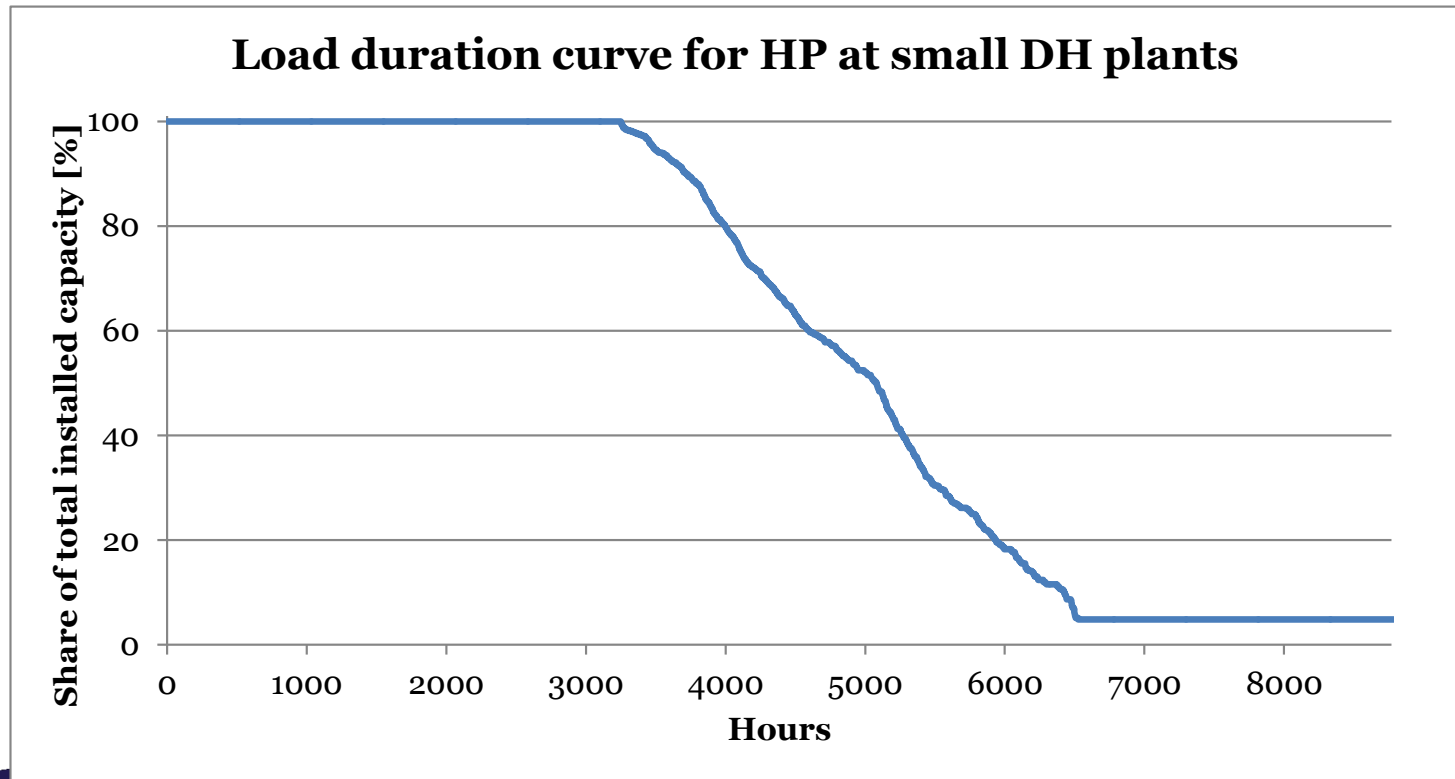
The role of small district heating plants in the CEESA scenario



DH = District Heating

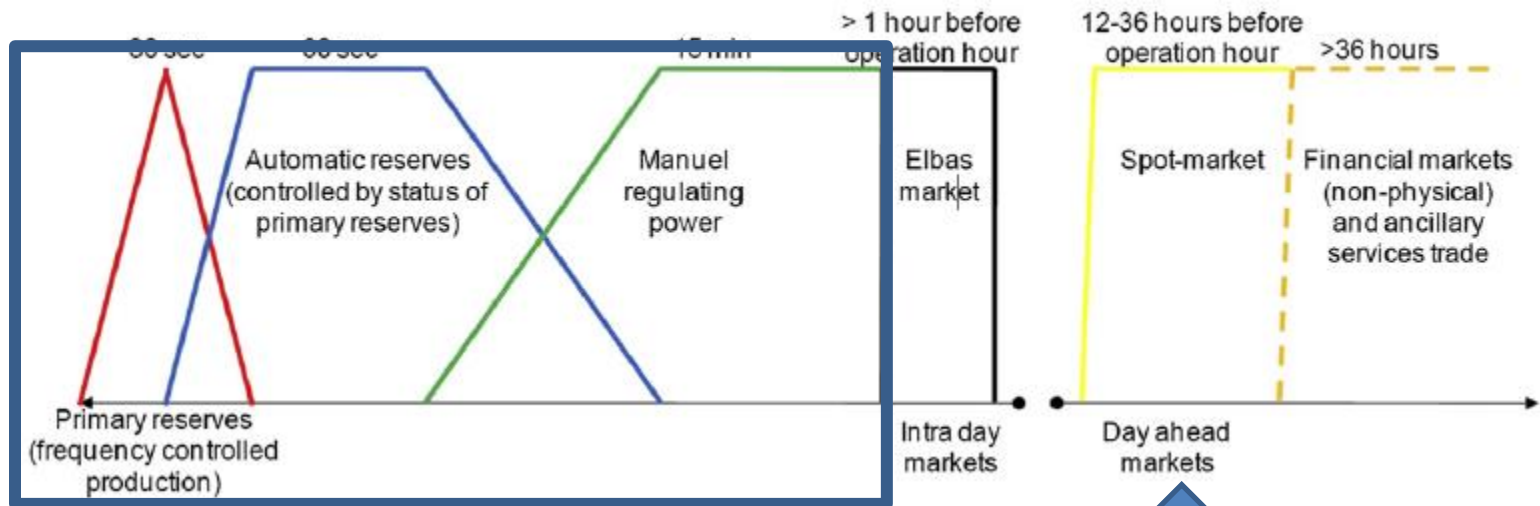


The role of small district heating plants the CEESA scenario



HP = (compression) Heat Pumps

Increasing CHP economic viability



Balancing reserves



Nord Pool Spot



Challenges/potential extra costs for CHP plants on balancing reserves



- The plant has to produce non-useable or non-storable heat by operating the CHP unit in order to be able to deliver balancing reserves.
- Participation on balancing reserves reduces the spot market trading. This can for example occur due to the displacement of heat production using thermal storage systems.
- Etc.



Organising balancing reserves for small CHP plants



- Set the gate closure for bids as close to the actual delivery time as possible, or make it possible to change bids for activation close to the actual delivery time. Additionally, not requiring winning capacity in order to be allowed to deliver activation would help.
- Keep the period of delivery as short as possible. If a long period of delivery is necessary, then make it possible for participants to deliver balancing reserve electricity without having to already be in operation.
- Avoid basing balancing reserves on the pay-as-bid settlement principle, unless it is likely that an actor will be able to exercise market power.
- Keep the minimum capacity or energy requirement for participation as low as possible.
- Make the balancing reserve asymmetric.



The business case for flexible small CHP plants in future energy systems



On the system level, participation on balancing reserves is not sufficient to make up for the reduced sale on the spot/day-ahead markets.

Other options to consider:

- Capacity Remuneration Mechanisms
- Tax rules
- Subsidies
- Etc.

