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Power to Heat

Competition or Interaction between Electricity and District Heating?

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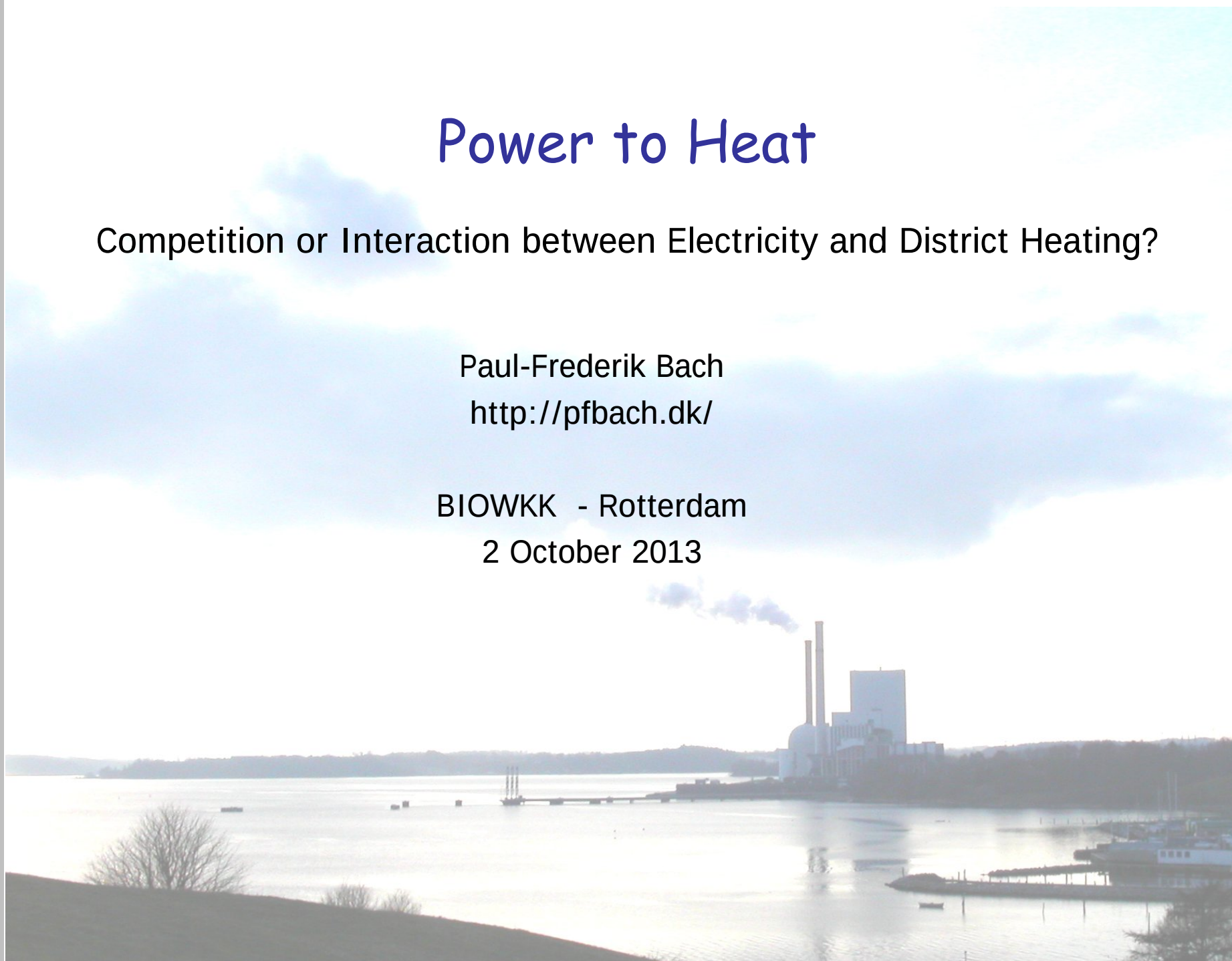
BIOWKK - Rotterdam
2 October 2013



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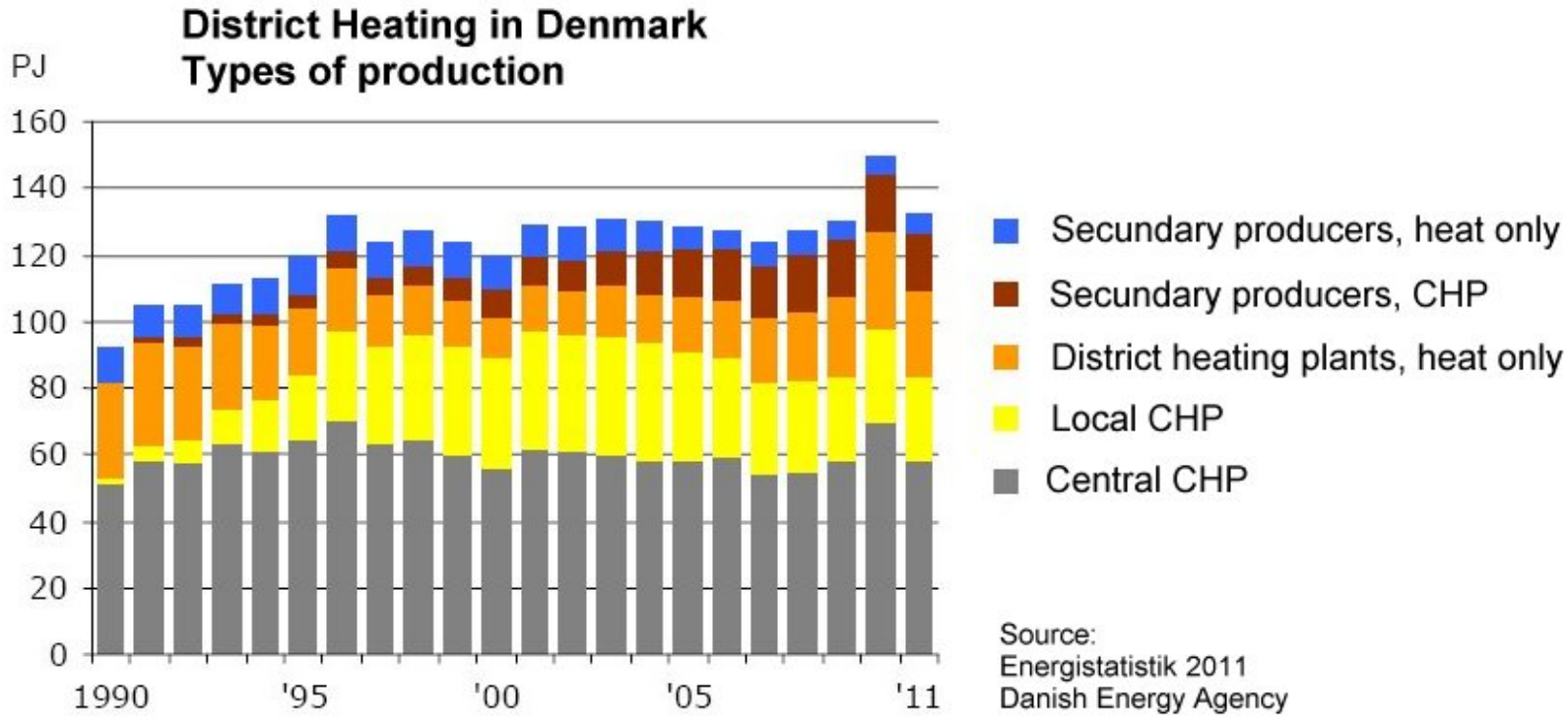
Combined Heat and Power (CHP) in Denmark

District heating serves about 60% of all space heating in Denmark
The CHP process serves 65% of the thermal electricity production



Local CHP was established during the nineties,
but the production has been halved since 2000

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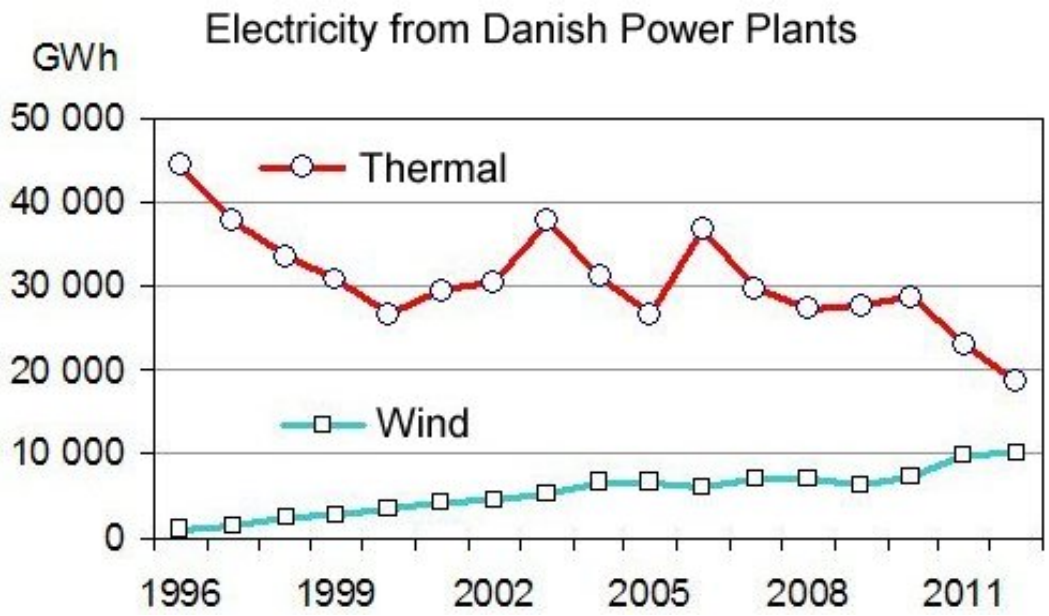
Wind Energy is Displacing CHP in Denmark

- Wind energy production was 28% of the electricity consumption in 2012
- The national target for 2020 is 50% wind energy
- **CHP and wind are competing for a limited electricity demand**

The thermal power plants are losing market shares and money

Thermal power plants provide reserve capacity and balancing services

Can we do without thermal power plants?



How are the prospects for 2020?

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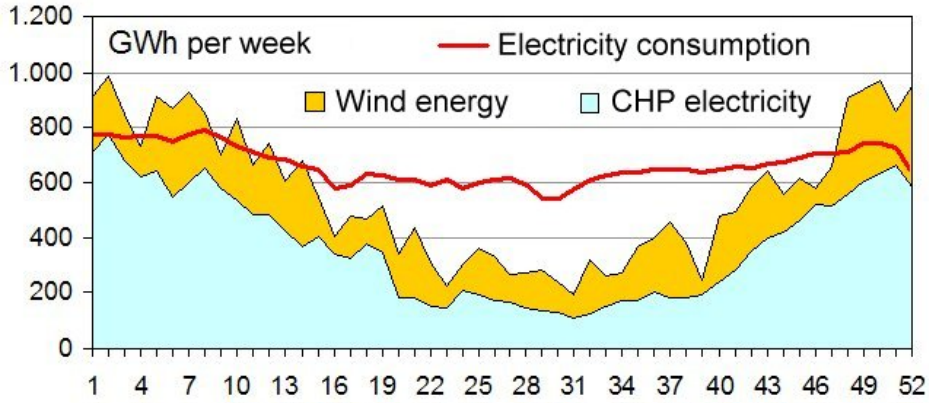
Electricity Surplus during Cold Seasons

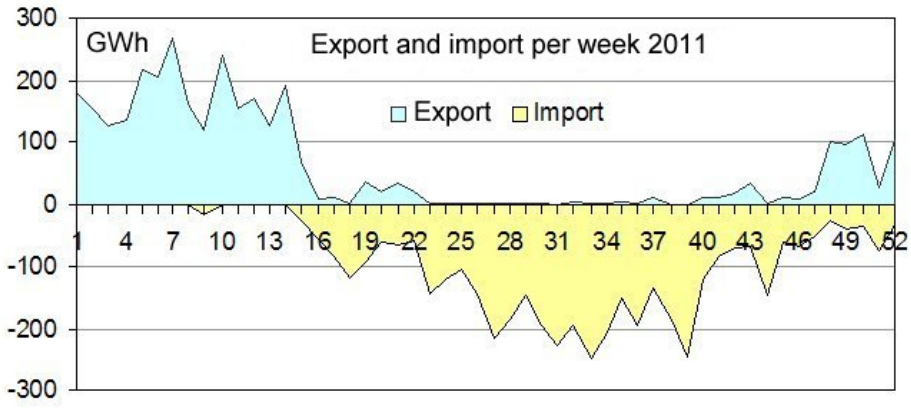
CHP covers a major part of the electricity consumption during the winter

Wind power causes electricity surplus in winter and less need for alternative supply during summer

So Denmark has a need of having electricity moved between winter and summer

For the time being an essential part is set off by export and import





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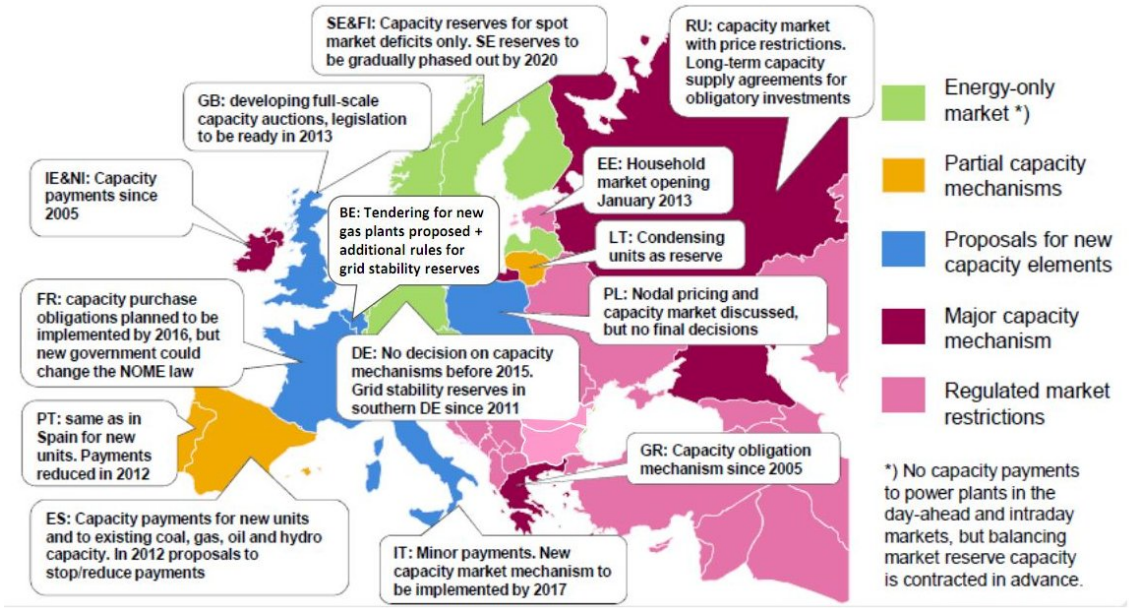
Uncertain Future for Thermal Power Plants in Europe

- Variable costs are setting the prices in the electricity spot markets
  - This is insufficient for maintaining existing power plants and for replacing run-down units
  - Several European power stations have already been closed or moth-balled
- Capacity support for Danish local CHP stations will expire in 2018
  - This can be the end of the story for local CHP in Denmark
- Possible capacity arrangements are being considered in several European countries
  - But NOT in Denmark



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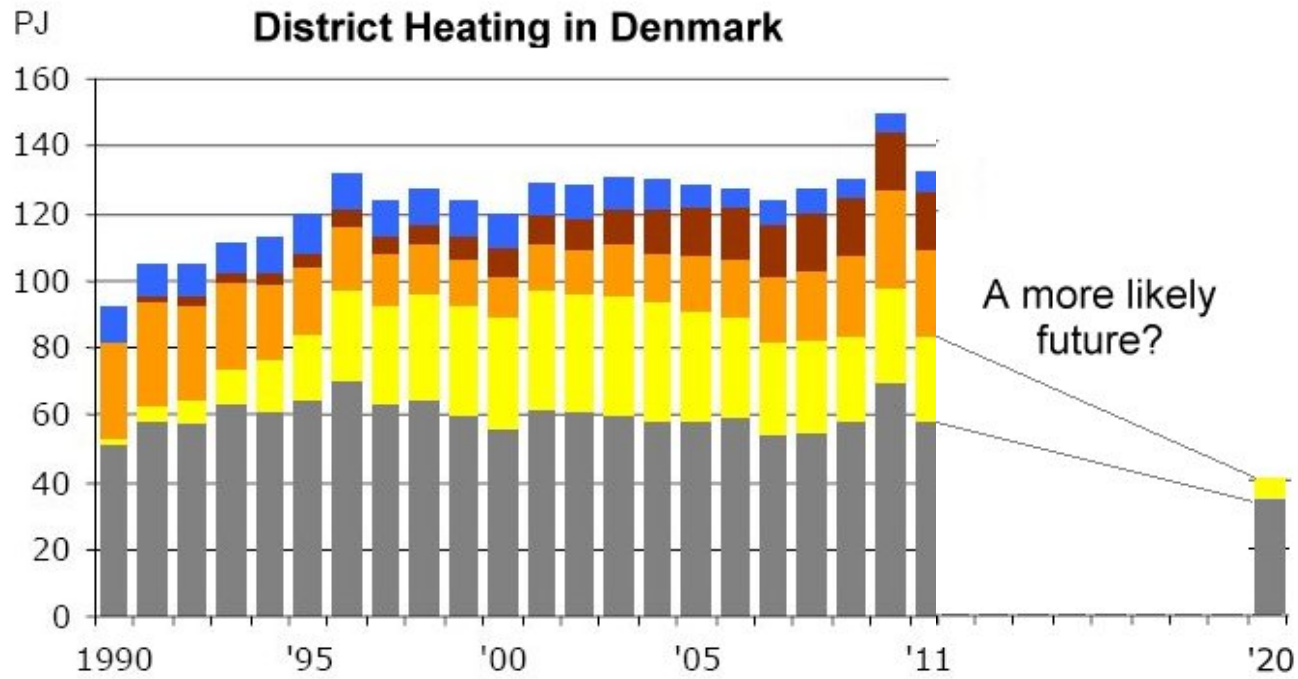
Scenarios for the future

- There are huge uncertainties for the future of CHP in Denmark
- Scenarios are stories which describe different, though plausible, futures
- We have created four scenarios for CHP in Denmark in 2020
- The extreme cases:



- Visions for a more distant future will not be discussed here

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The Dilemma: Finding a Balanced Solution

- Wind energy is renewable, but unreliable
- CHP is efficient and flexible, but not necessarily renewable
- Phasing-out fossil fuel is on the top of the political agenda
- The consequences have not yet been fully recognized:
  - Deficit of regulating and balancing capacity
  - Lack of reserve capacity for dark and calm periods
- Aggregating European wind and PV resources will not create a smooth or reliable power supply

- Norway will offer balancing services
  - 7 GW new interconnectors planned
- However, 125 GW new wind power expected in Europe
- CHP systems are potentially very flexible
- **Closed CHP systems will be missing in future energy systems**

FIGUR 10.2: Potensielle nye utenlandsforbindelser.

Fra Statnetts Nettutviklingsplan 2010

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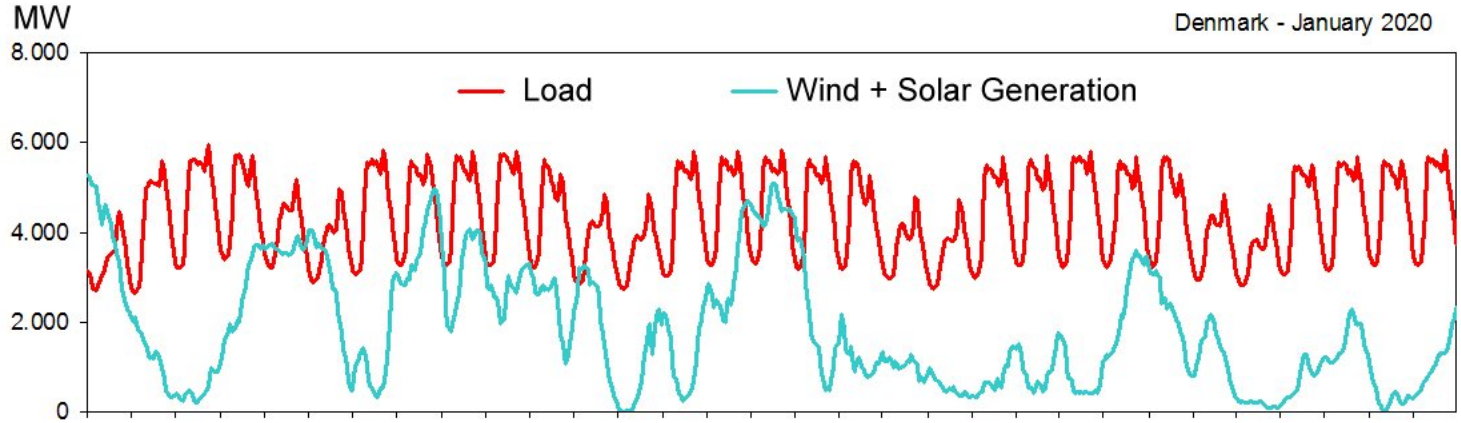
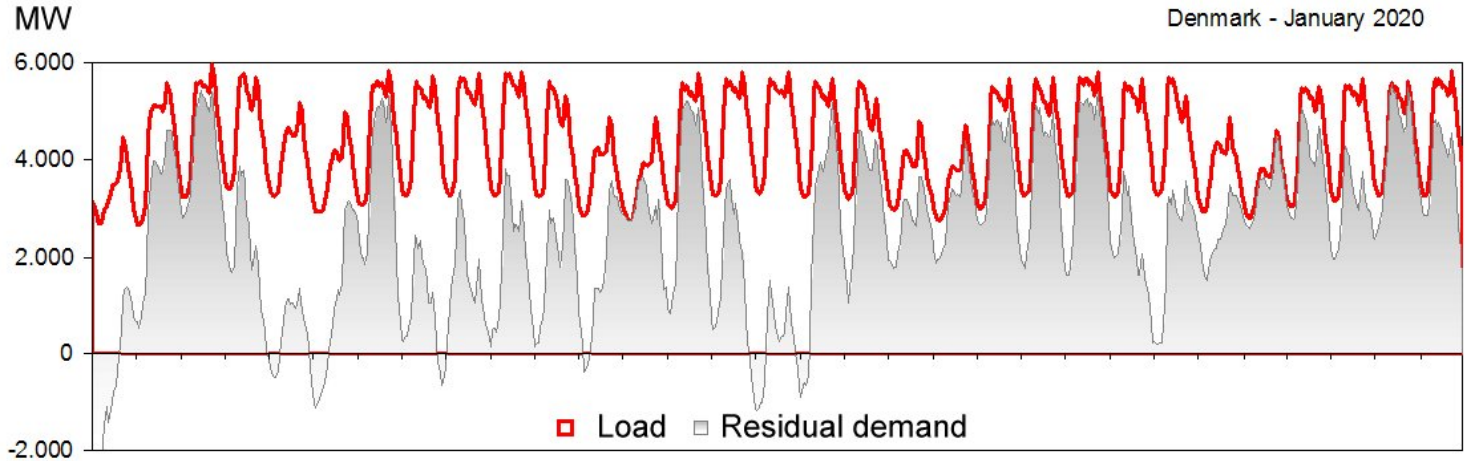
Denmark January 2020



Residual demand = Load – Wind – Solar

The residual demand must be covered by thermal generation (or import)



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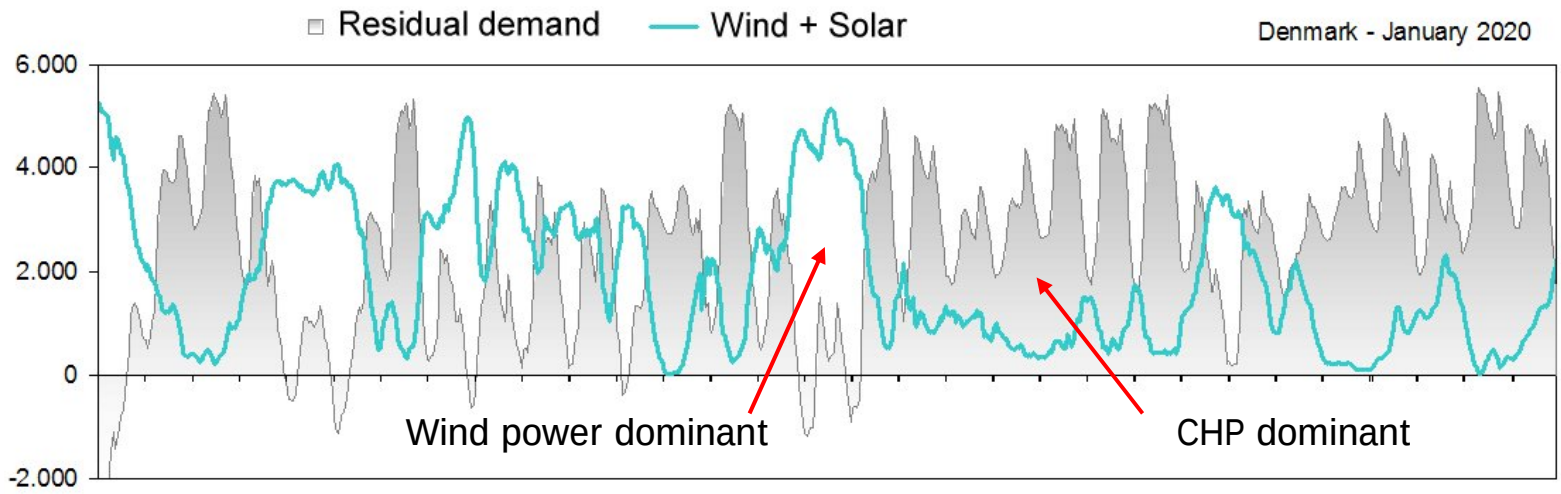
The Operational Challenge

- The residual demand is a challenging market with high demands on regulation and with frequent stops
- Smart Grid concepts have been suggested for smoothing the demand
  - But they are all far from ready for use in industrial scale

Wind power and CHP production in counter phase:



- The district heating systems can use existing hot water storages for
  - Saving surplus heat from periods with high electricity demand
  - Converting surplus electricity to heat in periods with electricity surplus

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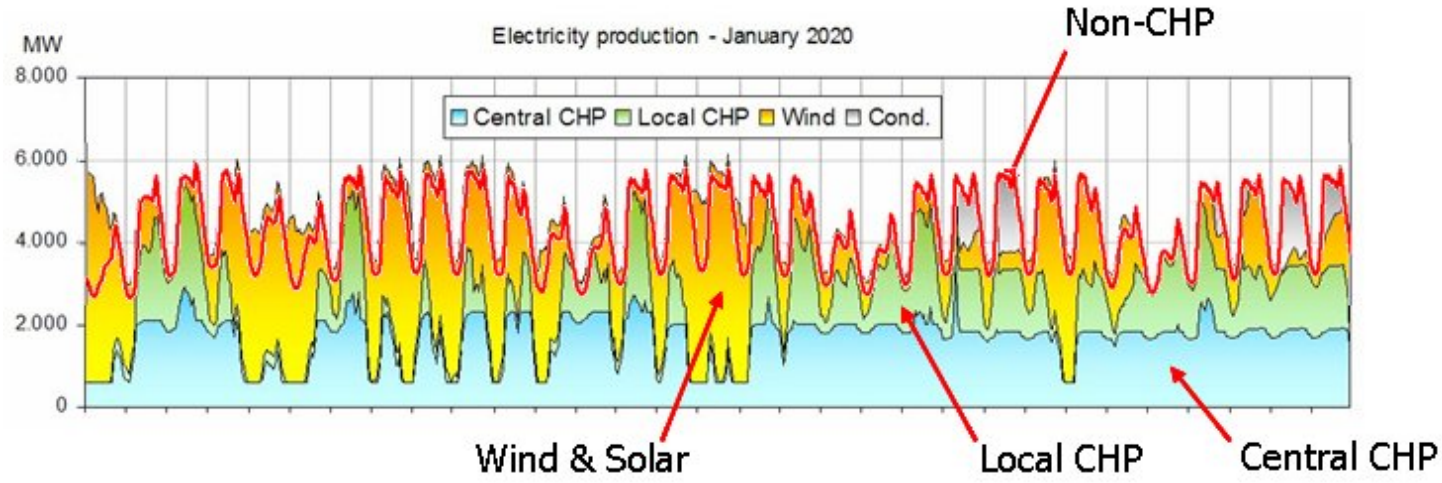
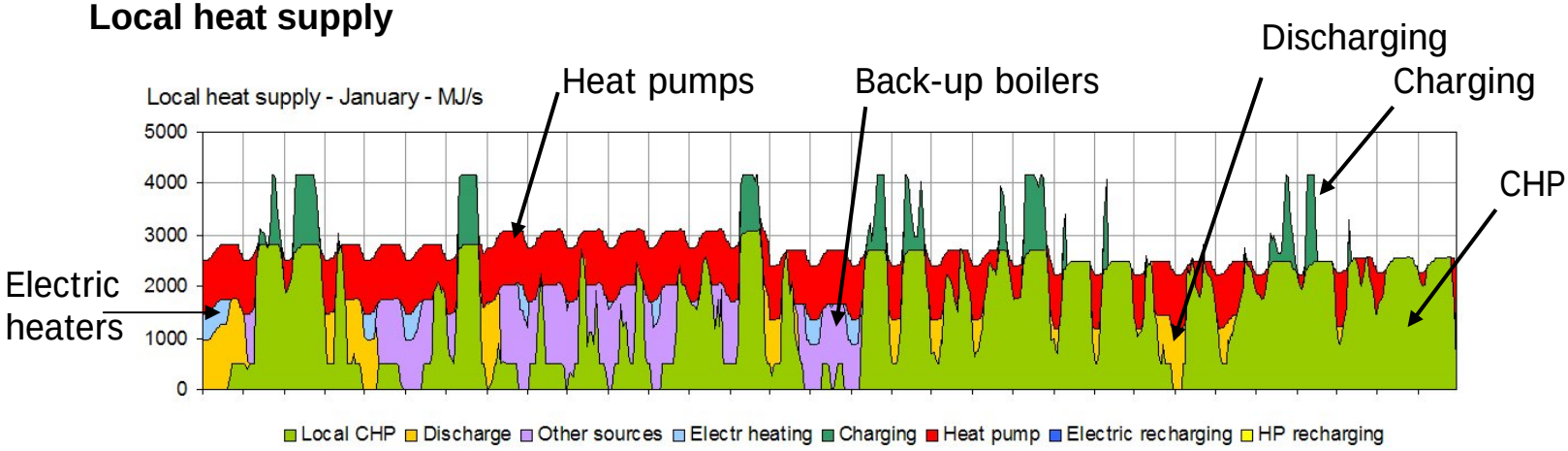
Case: Full Local Capacity in 2020

300 MW heat pumps and 800 MW electric heaters

Electricity: Utilizing CHP flexibility



Local heat supply



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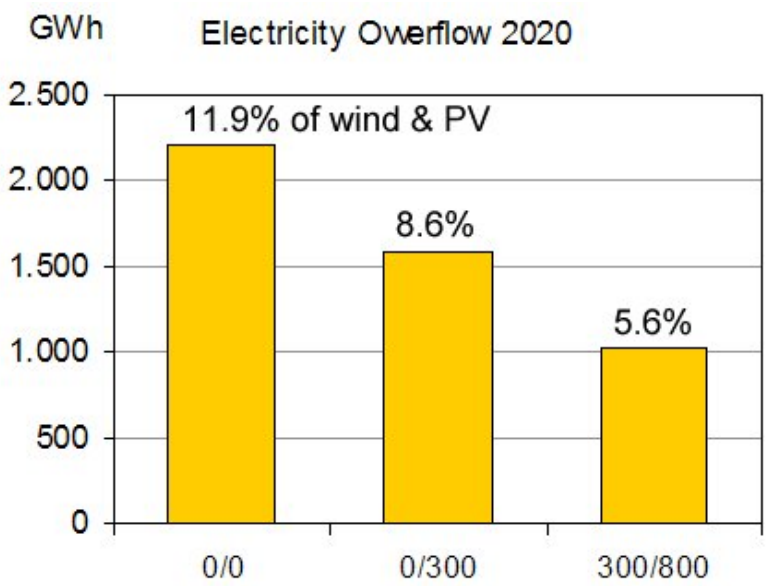
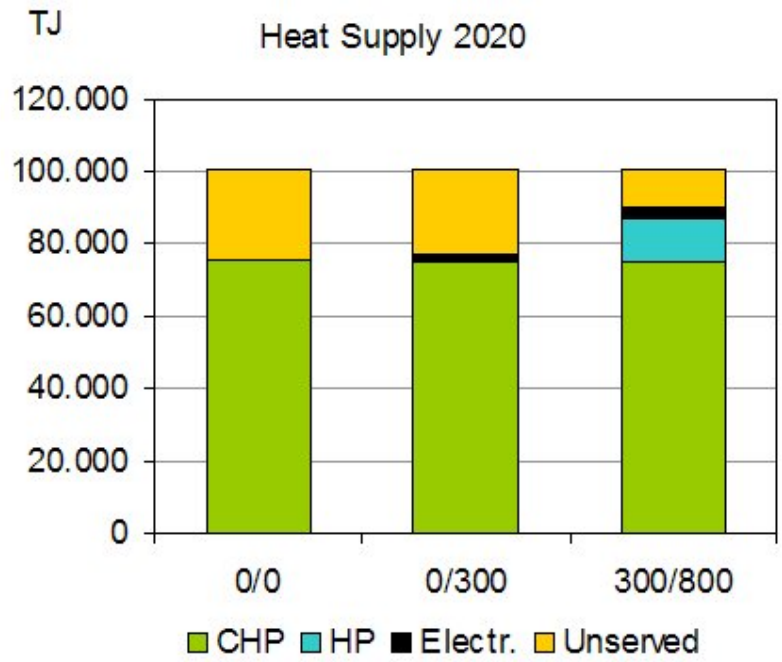
Comparisons

- No heat pumps and not electric heaters **(0/0)**
- No heat pumps, but 300 MW electric heaters (as now) **(0/300)**
- 300 MW heat pumps and 800 MW electric heaters **(300/800)**





”Power to Heat” can reduce electricity overflow and deliver useful energy

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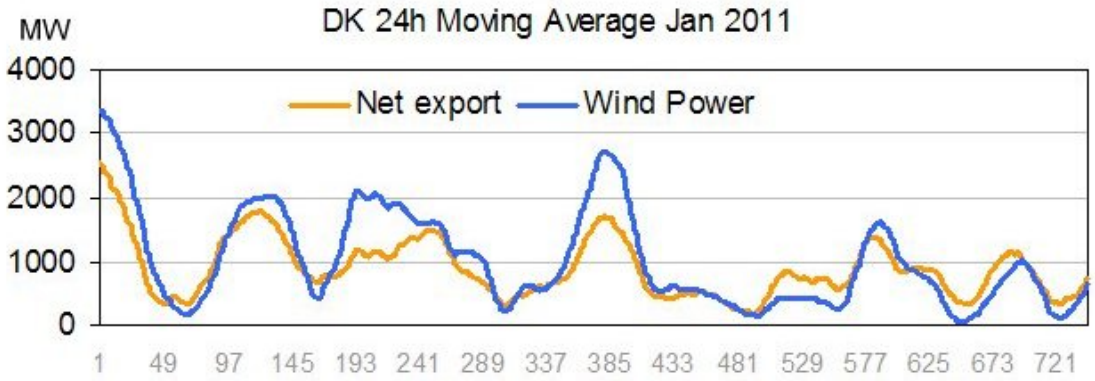
The Present Situation in Denmark

- During a long period the use of electricity for heating was unacceptable
  - Electric heating was prevented by high duties
- This policy was not sustainable
  - Negative spot prices indicated inefficient electricity markets
  - A considerable share of the wind energy was exported



- More flexibility by integrating electricity with heat and gas
  - Since 2008 a special legislation allowed large electric heaters
  - 325 MW large electric heaters installed so far
  - Another legislation is expected to pave the way for large heat pumps

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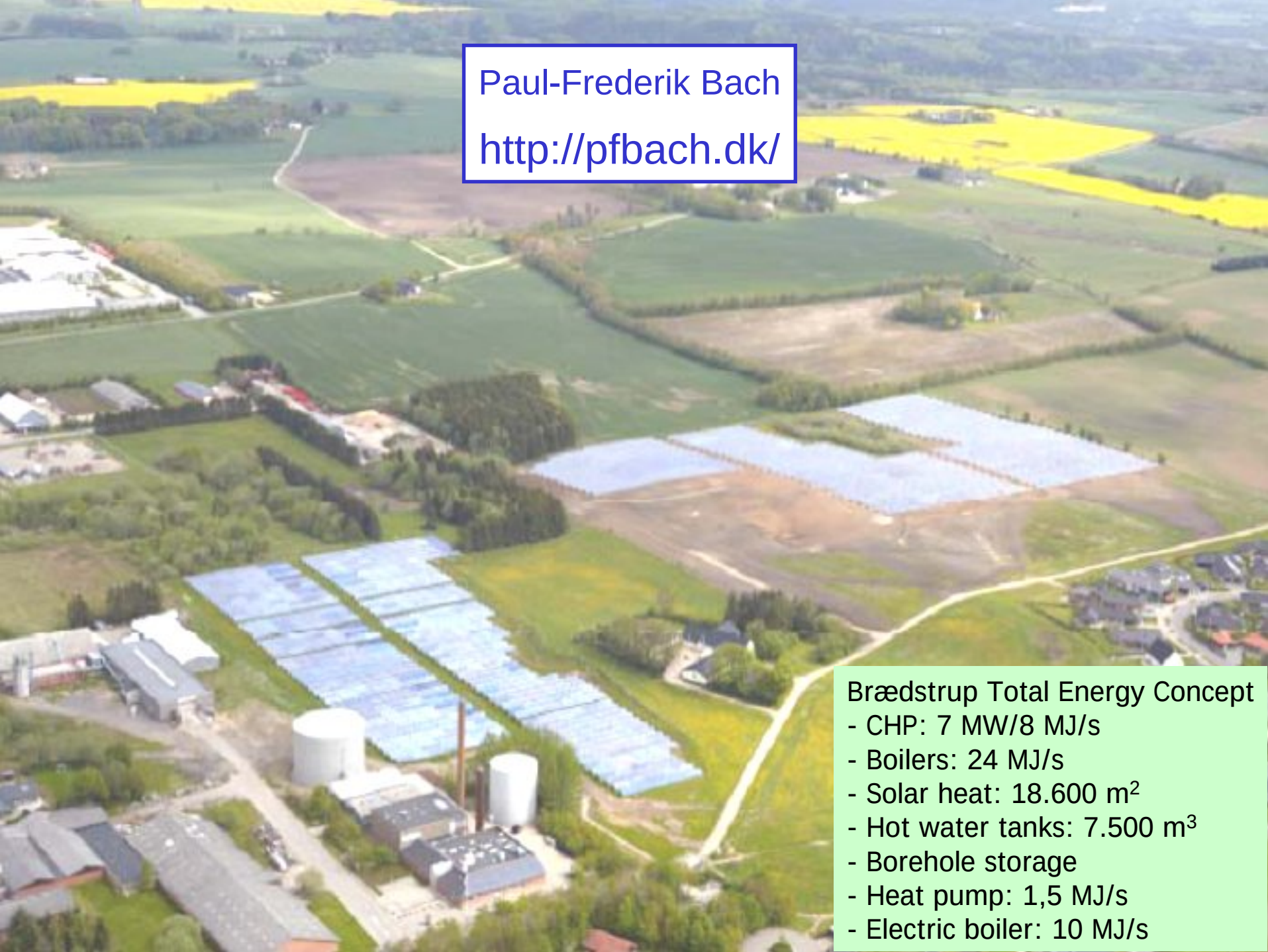
The Future of CHP Depends on Capacity Markets

- The first electric heaters were very profitable
  - They sold auxiliary services and traded in the spot market
- The present capacity, 325 MW, seems to have saturated the market
  - The power companies are reluctant to invest in more capacity
- Heat pumps require a suitable natural environment
  - The potential is currently being analysed
- The heat pumps and electric heaters in my case may be useful to society, but they are not necessarily profitable to the owners
  - It is interesting that Vattenfall is considering closing down its pumping storage facility in Germany though this technology is simple and efficient
  - The power system operators must realize that the closure of thermal power stations means the end of free auxiliary services
- **The future of CHP, including heat pumps and electric heaters, will depend on future national frameworks for financing production capacity and auxiliary services**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Brædstrup Total Energy Concept
- CHP: 7 MW/8 MJ/s
- Boilers: 24 MJ/s
- Solar heat: 18.600 m2
- Hot water tanks: 7.500 m3
- Borehole storage
- Heat pump: 1,5 MJ/s
- Electric boiler: 10 MJ/s