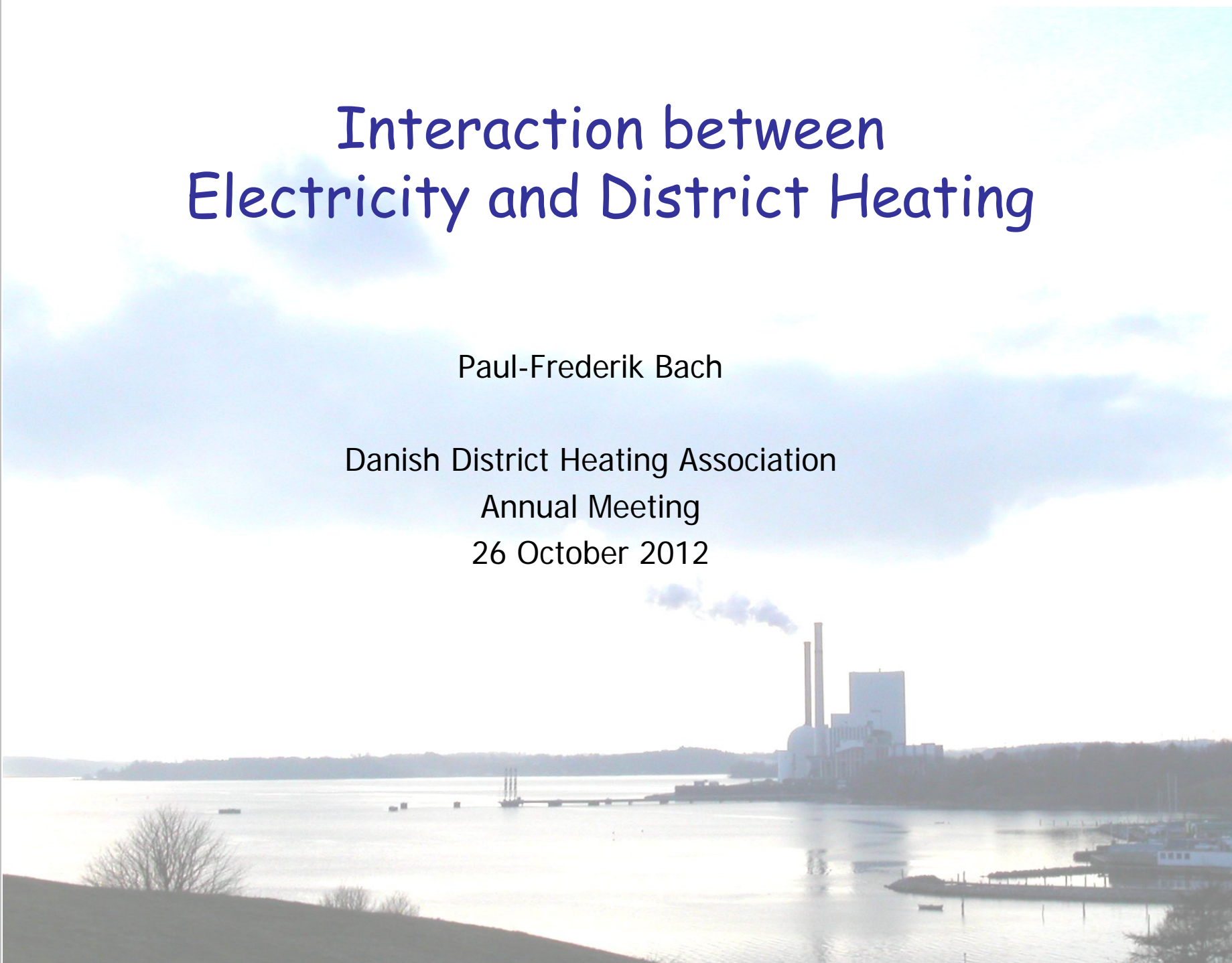


Interaction between Electricity and District Heating

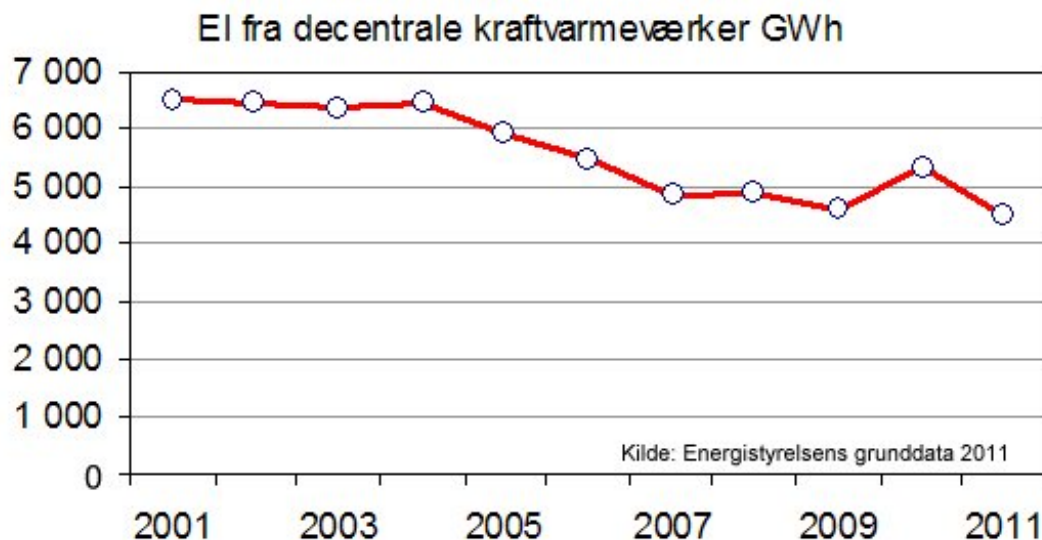
Paul-Frederik Bach

Danish District Heating Association
Annual Meeting
26 October 2012



CHP*) and Wind Power are Competitors

- CHP was at the top of the political agenda during the 1980s
 - The result was a large number of local CHP systems
 - In 2001 about **60%** of the electricity consumption was covered by CHP
- In the 1990s the interest moved to wind power
 - In 2011 wind energy coverage was about 28% of electricity consumption
 - The competition from wind power is pressing the CHP plants



The local electricity production has fallen by 30% since 2001

Will the fall continue?

*) : Combined Heat and Power

Electricity Surplus during Cold Seasons

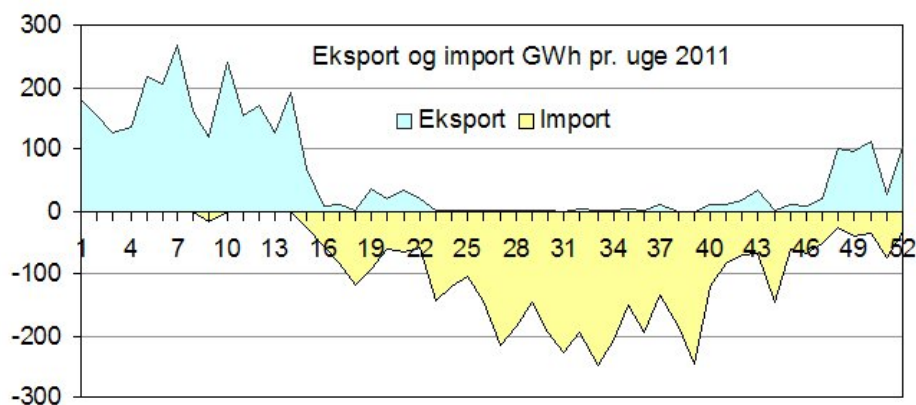
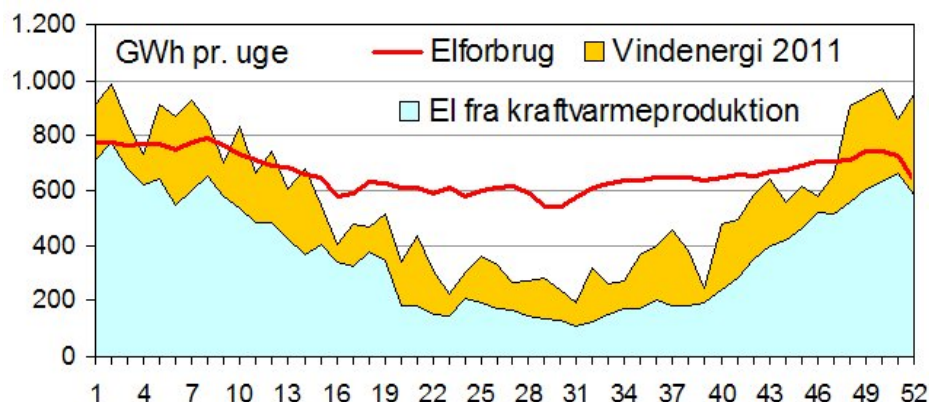
CHP covers a major part of the electricity consumption during the winter

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

Could that be a problem?

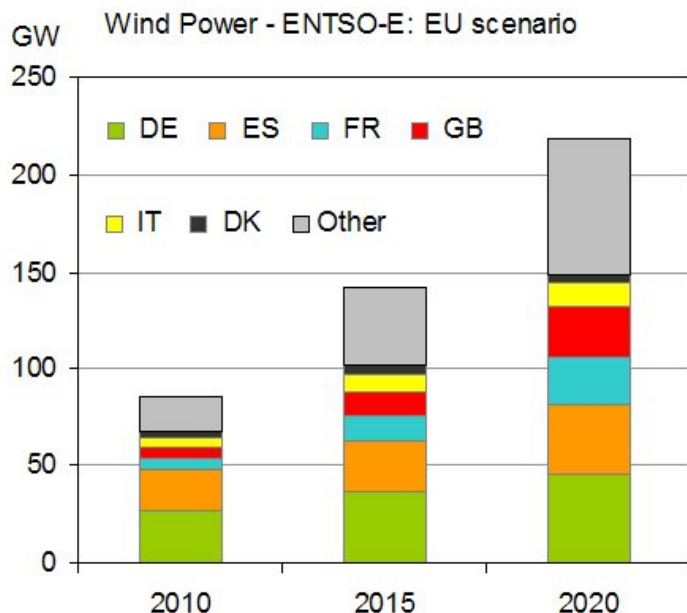


Dependency on Foreign Countries – for better or worse

- It is widely accepted that self-sufficiency is achieved when a year's purchase and sale of electricity are in balance
 - This is claimed for households, companies, municipalities and nations
- But the electric grid is not an infinite storage
 - Somebody must maintain the balance every second
 - Balancing services are exchanged across national borders
 - We shall consider the Danish balance hour by hour for a year
- There is nothing wrong in purchasing balancing services
 - But the supply seems to be uncertain in the long term
 - This concern is shared by the Danish TSO, Energinet.dk.
- Therefore a diversified effort is planned
 - New and reinforced interconnections
 - Domestic future measures, known as 'Smart Grid'

**The CHP systems can already now supply
domestic balancing services**

Future Balancing Services in Short Supply



- ENTSO-E expects 125 GW additional wind power capacity in Europe
- The plans for the necessary balancing capacity are vague in most countries
- **The Danish strategy based on both international and domestic initiatives seems to be reasonable**

- Statnett prepares for another great Norwegian export business
 - The Norwegian investment is expected to be 12-20 billion NOK
 - The capacity of the new interconnectors (up to 7 GW) will be modest compared with the 125 GW
- Balancing services will be a seller's market

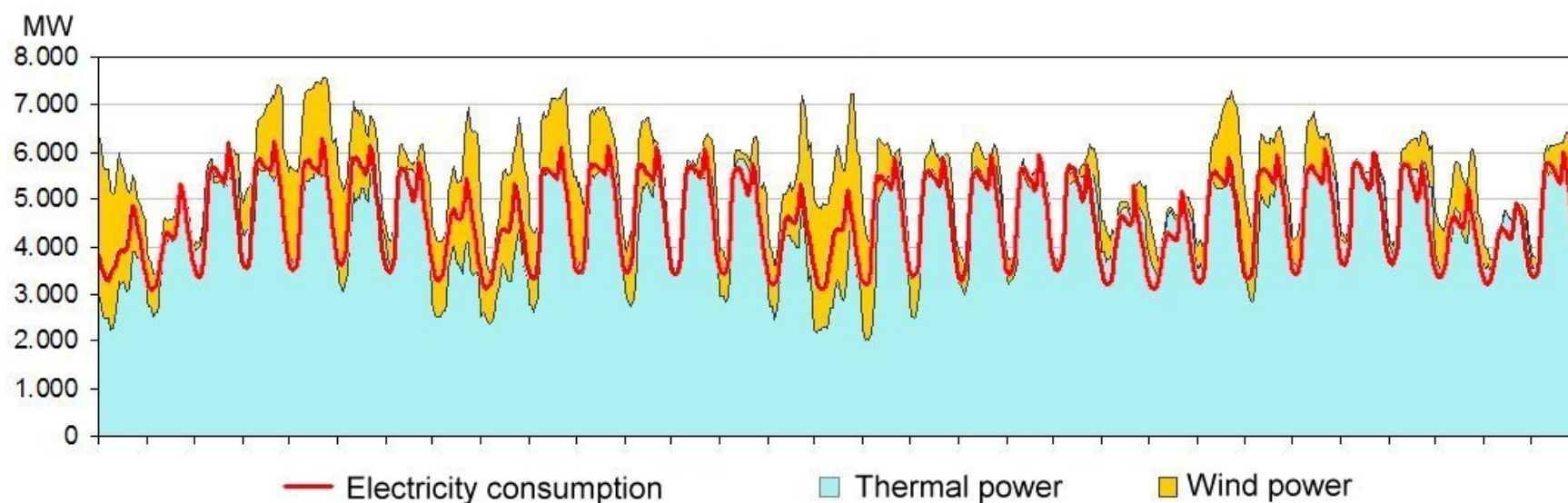
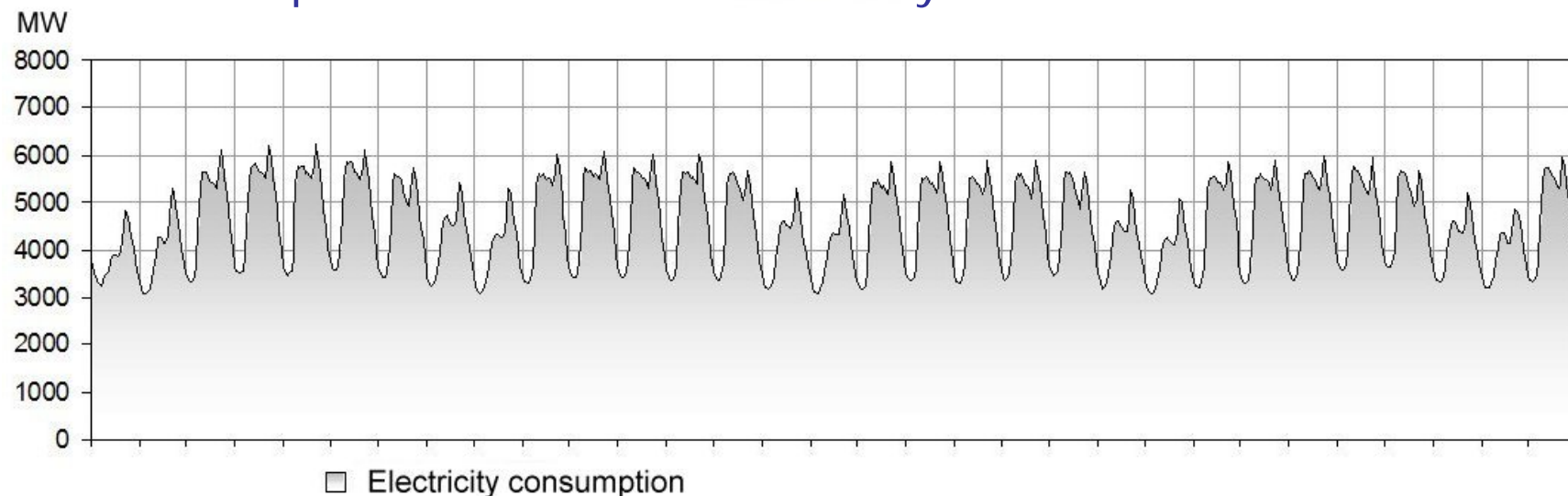


FIGUR 10.2: Potensielle nye utenlandsforbindelser.

Fra Statnetts Nettutviklingsplan 2010

Hourly variations

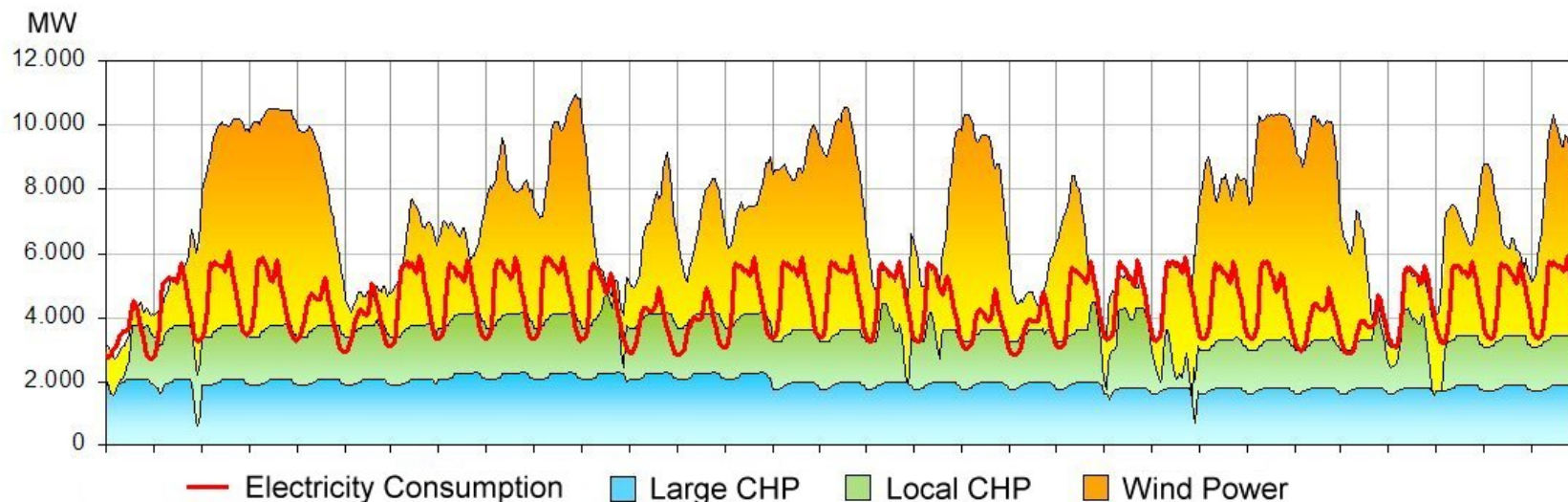
Consumption and Production: January 2011



Production surplus is typical for January

Wind Power scaled up to 50% of Annual Electricity Consumption

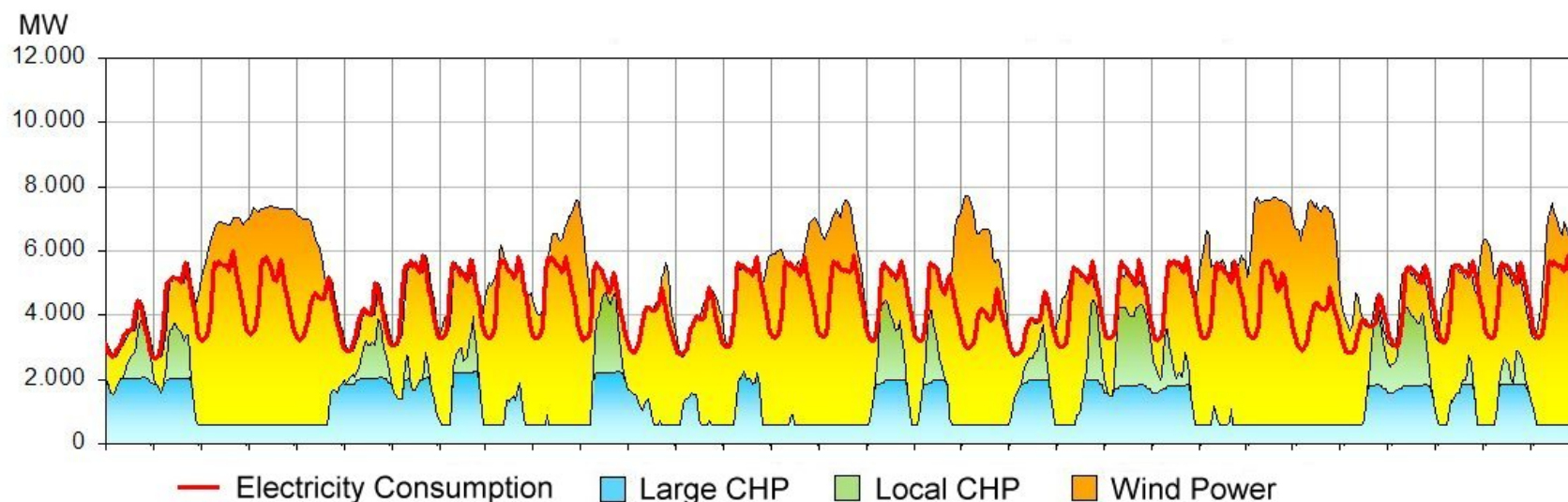
Electricity from the CHP process and from wind
- again with January as an example



- This picture does not look realistic
 - The production in January exceeds consumption by 62%
 - The electricity overflow is 6,8 TWh for a year - or 40% of the wind energy
 - Up to 7,000 MW export capacity will be needed
 - Germany and Denmark will have overflow simultaneously

Low Market Prices force CHP Production down

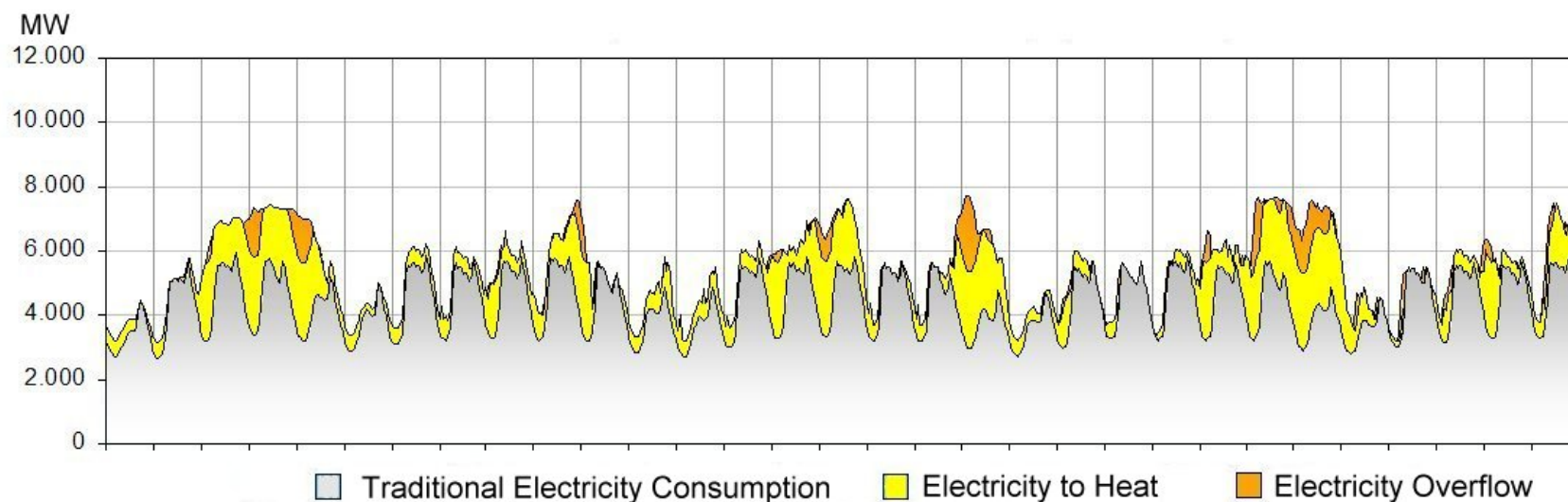
In this case 55% of heat demand in January is covered by backup boilers
A certain minimum thermal production is maintained for security reasons



- For a full year:
 - Backup boilers have taken over 24% of the heat production
 - Electricity overflow reduced from 40% of the wind energy to 17%
 - The need for export capacity reduced by 2,600 MW
- This picture is more likely

Electricity converted to Heat

900 MW large heat pumps and 1,500 MW electric boilers are added
- introducing additional controllable electricity consumption



- For the full year:
 - The backup boilers' share of the heat supply reduced from 24% to 5%
 - Electricity overflow reduced from 17% to 4% of the wind energy
 - Thus CHP has absorbed 90% of the electricity overflow from case 1

Coordination of electricity and heat is a very effective domestic measure for balancing variations from renewable energy

Lessons Learned from the Cases

- Increasing surplus of electricity to be expected during the cold season
 - Stronger competition on sale of electricity
 - Decreasing electricity production from power plants
 - The fall of CHP production will continue
- The CHP systems can offer flexibility to the power system
 - Surplus of electricity can be used for heating
 - The CHP plants can increase the electricity production when needed and store the heat for later use
 - The varied facilities of the electricity market have made it possible
- Low annual utilisation of the plants necessary as wind power backup
 - Weak economy of power plants and storage facilities
 - Uncertainty about the future and reluctance in investment decisions
 - 'Dansk Energi' predicts closed large and local power plants in Denmark
- Phasing out CHP means lost flexibility

There is no easy solution.

A balance between economy and security must be found.

The CHP menu – A broad Range of Options

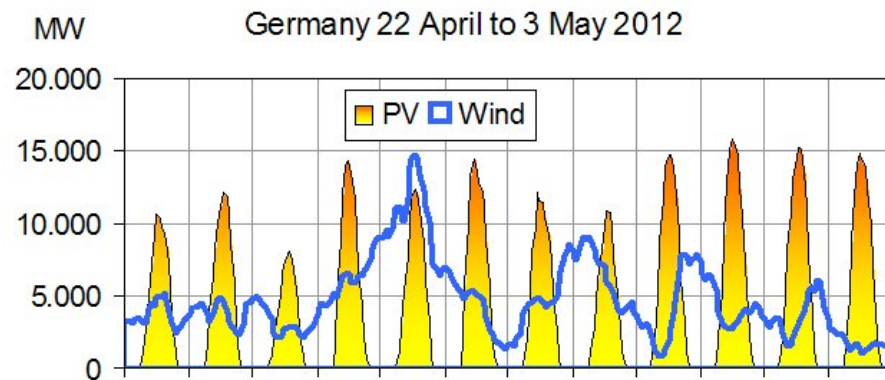
- Power plants for combined production of electricity and heat
- Solar panels for water heating
- Hot water tanks for storage
 - Estimated total capacity in Denmark: 40 GWh
- Seasonal heat storage
 - Full scale demonstrations in progress (for instance at Brædstrup)
- Electric boilers
 - 300 MW installed in Denmark so far
 - The market seems to be temporarily saturated
 - Average utilisation in case 3: 650 duration hours (capacity factor: 7%)
- Large heat pumps
 - By and large prevented in Denmark by energy taxes
 - Average utilisation in case 3: 1840 duration hours (capacity factor: 21%)
 - Uncertainty about the technical potential

Which CHP characteristics are needed in a national energy system?

Which economic framework can support the desired structure?

Perspectives

- The impact of PV*) was until recently unnoticed
 - In 2011 Germany had 25 GW PV and 29 GW wind power
 - The development can easily overtake official targets
 - A large increase of PV in Denmark will add to the pressure on CHP
 - An extended analysis is desirable
- It is easy to decide new green electricity production
 - It is more difficult to foresee the behaviour of the energy system
 - The practical result could be a gradually phasing out of CHP
 - "Smart Grid" is a magic word, which is supposed to solve the problems
- The green development is controlled by economic incentives
 - CHP systems can supply flexibility
 - It takes
 - A clear vision for the future role of CHP
 - An adjustment of the economic framework for CHP with the necessary incentives



*) : PV: Photovoltaic

Discussion

