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The Unknown Flexibility of District Heating [1])

Development efforts required for an efficient interaction between the systems for electricity supply and district heating

Wind Power and District Heating:
New Business Opportunity for CHP: Sale of Balancing Services [2])

[1]): ”Fjernvarmen” no 4/2011
[2]): ”EuroHeat & Power” English edition IV/2011

Translation of presentation
The Danish District Energy Development Centre
Seminar 5 March 2012

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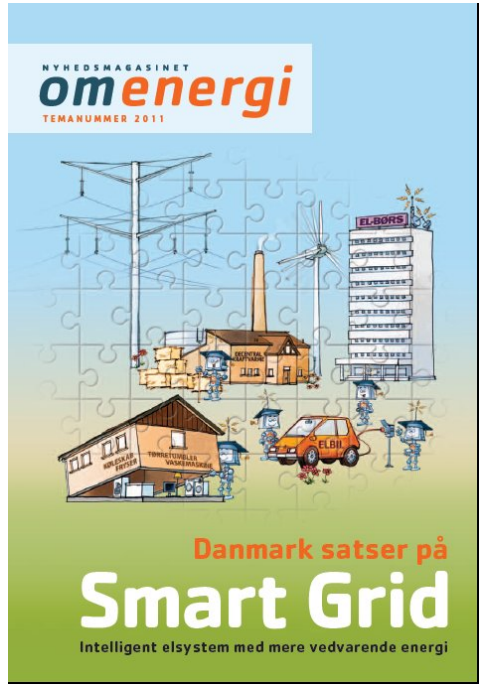
Integration of 50% wind energy

- Energinet.dk: EcoGrid.dk phase 1 (2009)
  - Fields of action:
    - New system architecture
    - International markets
    - **Integration with heating systems**
    - Flexible electricity demand
- Wind power and CHP*) are competitors
  - Danish electricity demand is insufficient during winter for both CHP and 50% wind energy
- However, CHP can contribute actively to the solution of the variability problems of wind power
- Simulations are used for a demonstration
  - The purpose of the simulations:
    - Visualizing the operational conditions
    - Quantification of the effects of an interaction



*) CHP: Combined Heat and Power

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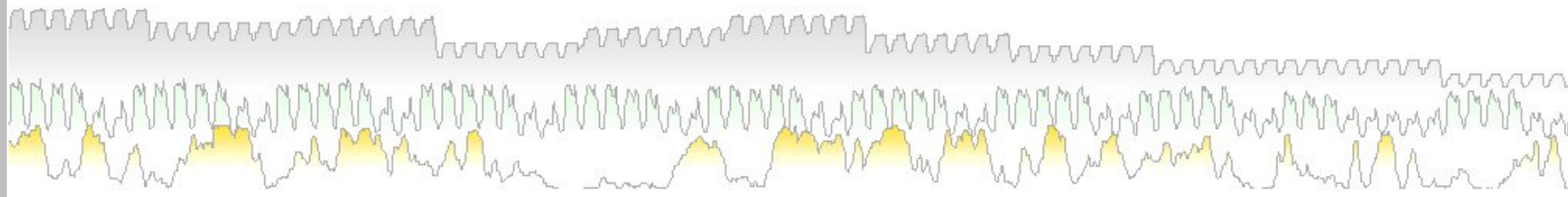
Elements of the simulations

- Three time series (1 year, 8760 hours):
  - Traditional electricity demand
  - Heat consumption
  - Wind power
- Hot water storages: 10 GWh centrally and 30 GWh locally
- 2 operational strategies
  - Full CHP production (and export of electricity overflow)
  - Minimized export of electricity (and some heat production moved to boilers)
- No economical optimization
  - ...because economical forecasts are always wrong
  - Real operation will change from year to year between the two extremes



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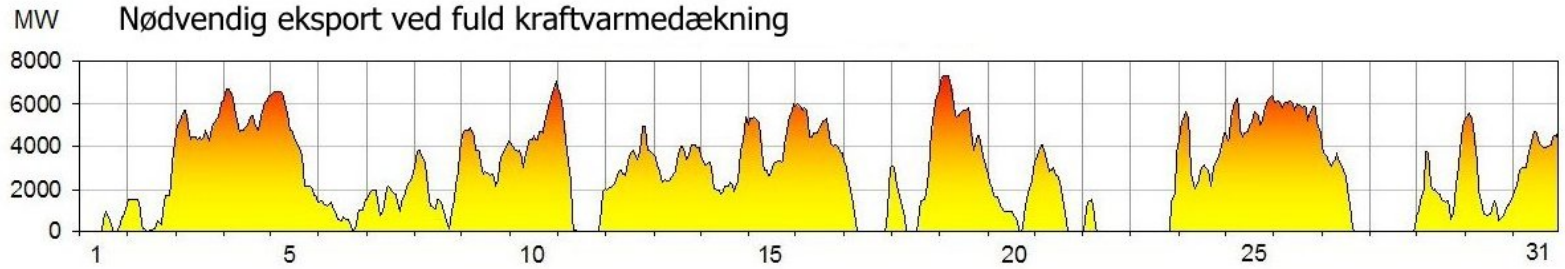
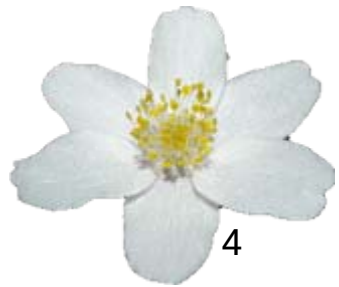
Wind Power and Export of Electricity

- The wind power profile is an example
  - Offshore wind may change the profile
  - Typical wind power ”wawes” are much longer than 24 hours



- Annual export: 6.8 TWh
  - ...or 40% of the annual wind energy output
- The essential questions:
  - **Will it always be possible to export the electricity overflow?**
  - **When not, can we utilize the electricity overflow?**



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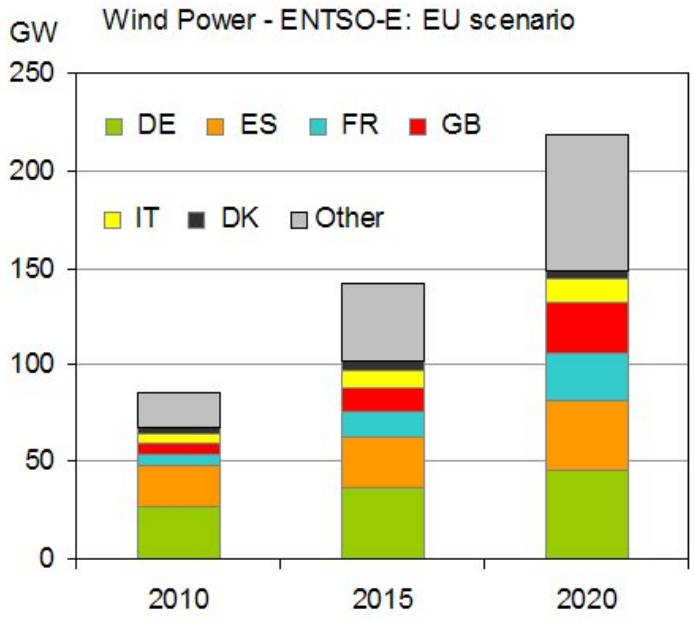
Increasing Demand for Regulating Power



- 125 GW new wind power in Europe
- Only vague ideas on the corresponding regulating capacity
- Only poor wind power smoothing from international aggregation
- **Local regulating power may become excellent business**

- Statnett preparing a new Norwegian export business
  - The Norwegian investment estimated at between 12 and 20 billion NOK
  - Up to 7 GW to be added to the transfer capability
    - **But this is much below the additional need for balancing capacity**

FIGUR 10.2: Potensielle nye utenlandsforbindelser.
Fra Statnetts Nettutviklingsplan 2010

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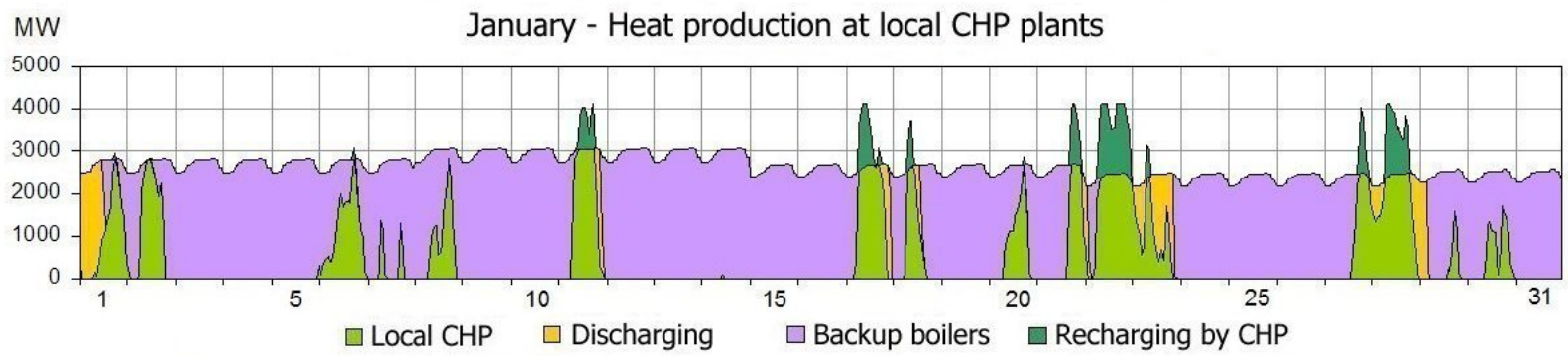
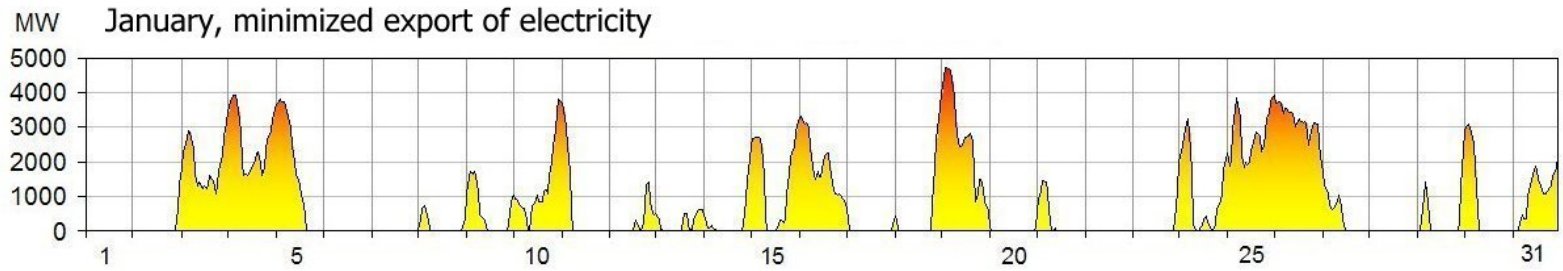
Minimised export of electricity

- Local CHP in January 2025 is used for demonstration
- In this strategy most CHP heat production is replaced by backup boilers



- The backup boilers produce annually 23.7 PJ (24% of heat demand)
- Export of electricity reduced from 6.8 to 2.9 TWh (17% of the wind energy)
  - ...but at the expense of most of the local CHP production in January



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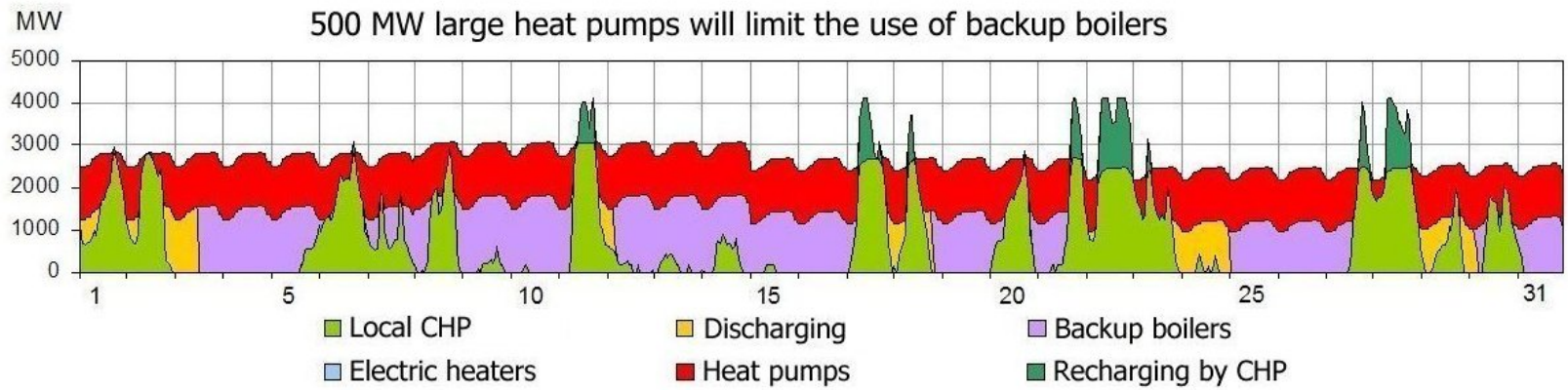
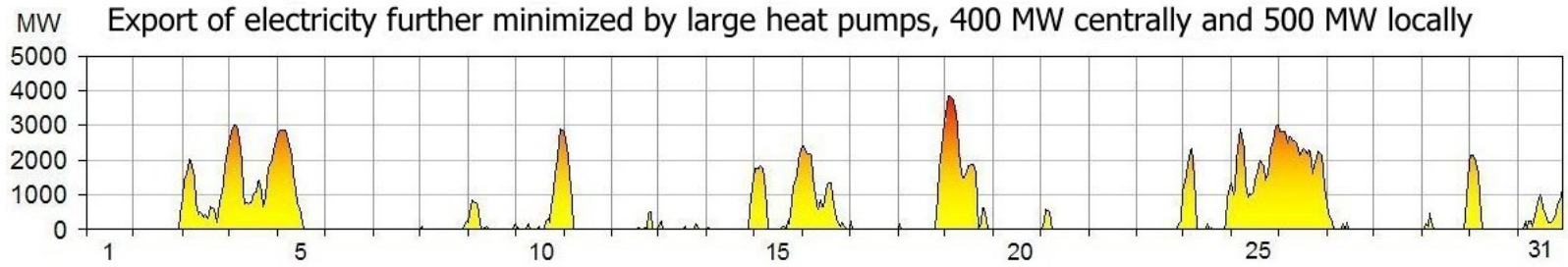
Large heat pumps: 400 MW centrally and 500 MW locally



- The increased demand for electricity leaves room for more CHP
  - Because producing heat from CHP + heat pumps is more efficient than backup boilers
- Backup boiler production reduced from 23.7 to 8.0 PJ (for a full year)
- Export reduced from 2.9 to 1.7 TWh (10% of the wind energy)



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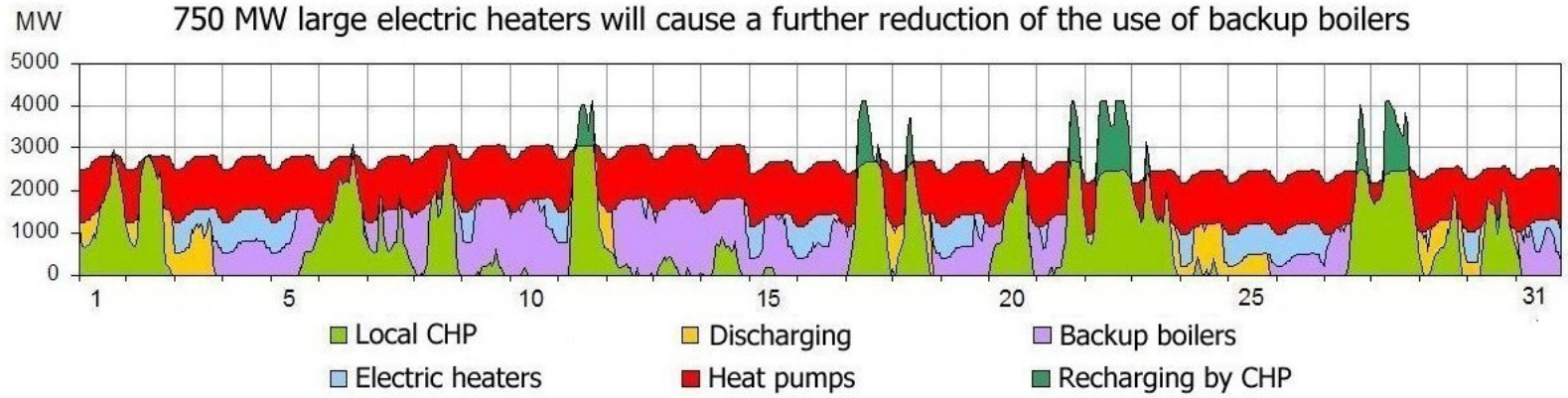
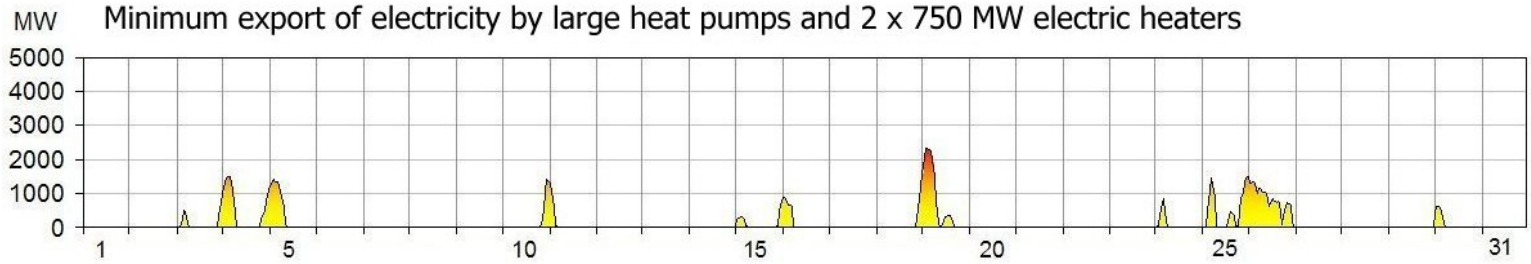
Electric heaters: 750 MW centrally and locally



- Limited effect: no advantage from using CHP combined with electric heaters
- Use of backup boilers reduced from 8.0 PJ to 5.0 PJ
- Duration hours for this case:
  - Heat pumps in local CHP systems: 2,424 hours
  - Electric heaters in local CHP systems: 801 hours
- Export reduced from 1.7 to 0.8 TWh (4% of the wind energy)



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Flexibility in practice

- Products in the physical electricity market:
  - Spot market (day ahead)
  - ELBAS (hour ahead)
  - Regulating power (real time)
  - System services (simplified) *)
    - Primary and secondary reserve
    - Manual reserves and black start capability
    - Short circuit capacity, reactive reserves and voltage control
- Local CHP units can supply the full range
  - Currently Energinet.dk purchases regulating power and system services for about 1 billion DKK per year
- More operational choices for the CHP systems
  - CHP systems can optimise operation within the range between the two strategies and with regard for market prices of fuel, electricity and system services
- The flexibility will make Denmark more robust to natural market variation

*): http://www.energinet.dk/EN/El/Systemydelser-for-el/Sider/Systemydelserforel.aspx

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Some questions

- What are the heat accumulator capacities in the DH systems?
- What is the technical potential for installation of large heat pumps?
  - Large heat pumps seem to require complex concepts (See John Tang: ”Fjernvarmen” 6/2011)
  - Can we simulate system operation with the relevant concepts?
- Do we know the hourly profile of a year’s solar heat production?
- What is the optimal combination of large heat pumps, electric heaters and heat accumulators?
- Who can make a robust estimate of the economy of large heat pumps and electric heaters?

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Needed development

- Design, implementation and maintenance of a set of data for analyses:
  - Relevant profiles of heat demand, electricity demand, solar inflow and wind power
  - Technical data for existing production and transmission facilities
  - Technological catalogue with relevant data og prices
    - Large heat pumps
      - Description of possible concepts, including operational constraints
      - Identification of potential realistic projects
    - Other new concepts, e.g. seasonal storages and solar heat systems
- Development and maintenance of models for analysis and simulation
  - Should reflect all relevant concepts and their operational constraints
  - Should demonstrate operational conditions, flexibility security of supply etc.
- Other tasks
  - Communication (see CHPCOM-project, www.chpcom.dk)
  - Description of the options of CHP systems in each segment of the electricity market
  - Assessment of risk and economic advising
    - New scandals should be avoided
    - External advisors may have their own agendas


Thank you for attention!