WHAT OPTIONS ARE THERE FOR INTEGRATION OF RENEWABLE ENERGY SOURCES?

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WÄRTSILÄ POWER PLANTS

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The challenge of renewable electricity in Poland

- Demand expected to increase
  - Consumption expected from 140 TWh to 170 in 2020 and 217 in 2030
  - Peak from 25 GW to 34.5 by 2030
- Goal is to diversify fuel mix
  - Currently about 92 % of energy and 89 % of capacity is coal
- Commitment to 20 % renewable target
  - If only wind capacity is increasing, about 17 GW is needed by 2020
- Aging infrastructure in transmission, generation and district heating

Wind impact on conventional generation:

→ Capacity has to be maintained due to intermittent nature of wind power

→ Lower running hours and lower average load = less income

→ More starts and stops, faster ramp ups and downs, more part load operation = lower efficiency, starting costs & cycling damage

→ Lower average market price due to certificates

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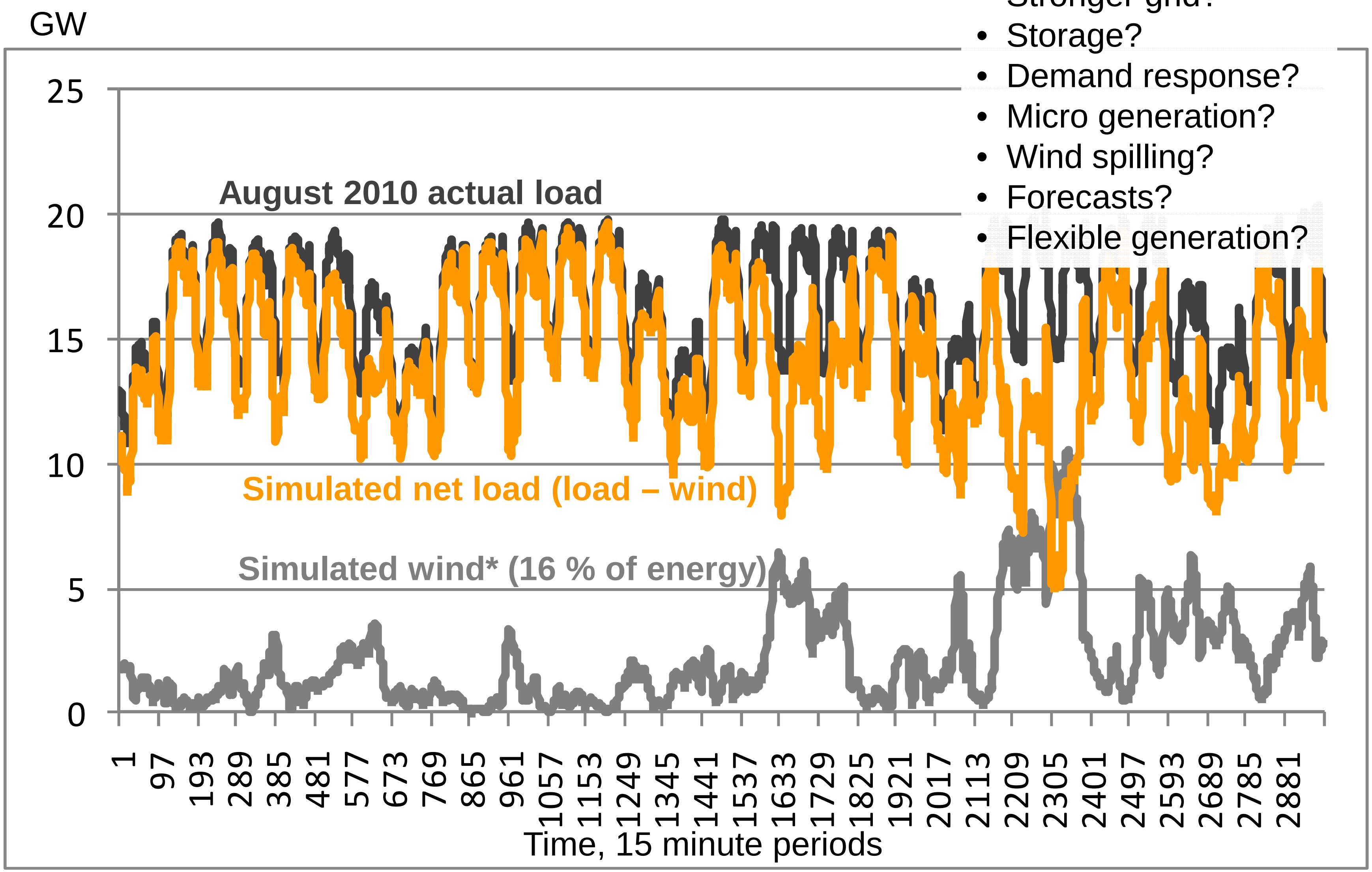
Wind integration in Poland?

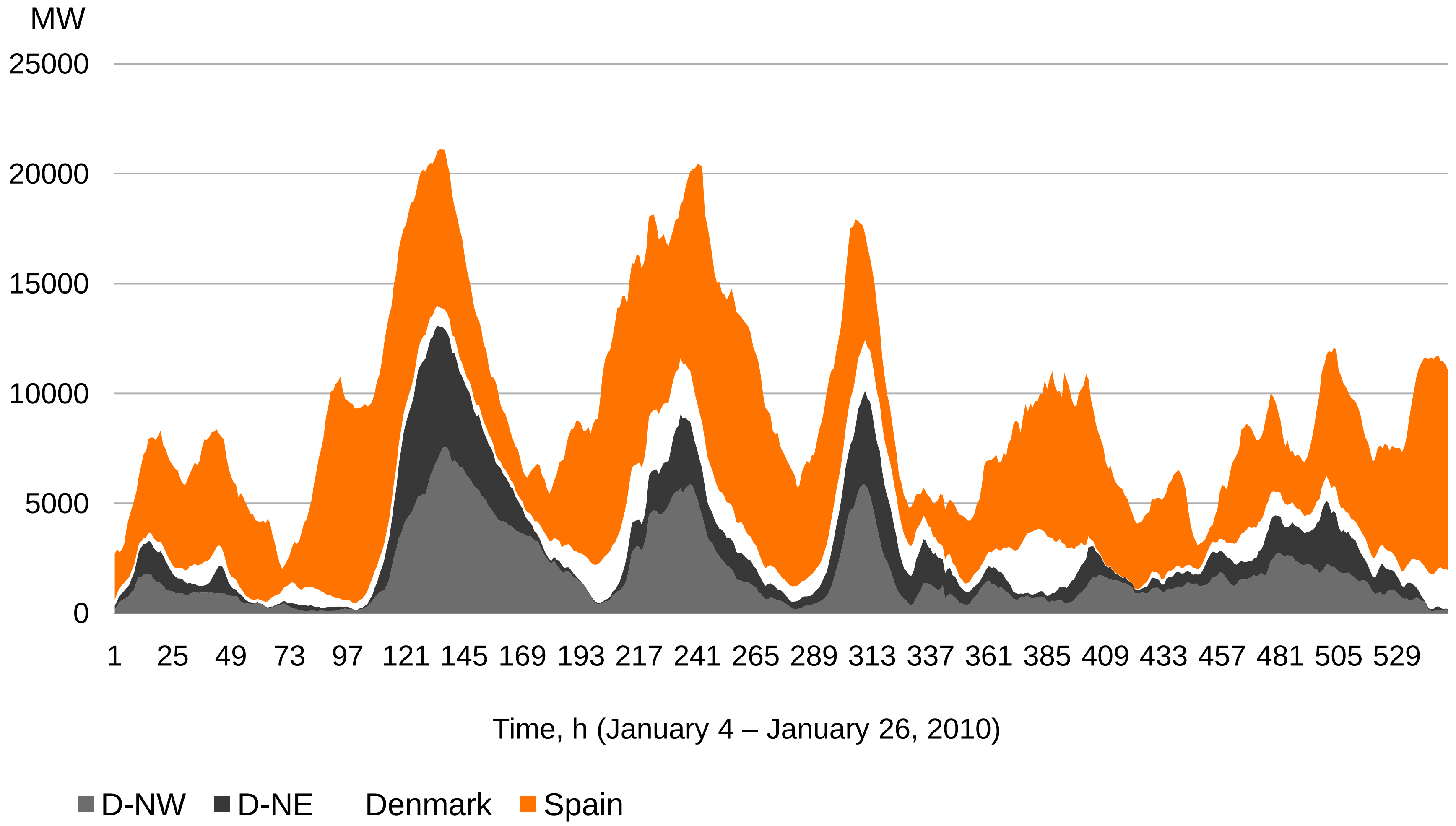


Potential solutions

- Stronger grid?
- Storage?
- Demand response?
- Micro generation?
- Wind spilling?
- Forecasts?
- Flexible generation?

* Simulated wind is based on Germany NE wind generation in the same period. Capacity is scaled so that the wind covers 16 % of the energy demand.

Wind patterns in Europe



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Wind integration in Poland – Potential options?

- Balancing wind with strong interconnections only is not a solution, when there is too much wind, there is typically too much wind all over the Europe
- Storage has limitations in large scale – too long storage times/too much capacity is needed
  - Hydro and pump hydro works, but is not sufficient. E.g. limitations in water level variation limit the potential
  - Requires grid investments as hydro resources are located far from wind generation, very costly if matching the maximum wind generation (i.e. no wind spilling)
- Demand response – definitely beneficial and needed, but cannot handle the long term variation; consumers' willingness to participate is doubtful
- Micro generation – is expensive and solar PV also intermittent
- Wind spilling – works for limiting the extreme impacts without too much lost energy but will save in grid investments, want to avoid in order not to lose free energy
- Forecasts – needed and helpful – give time for response, but do not remove intermittency
- After all also conventional generation has to respond -> smart power generation
  - Shut down when there is too much wind, run when needed
  - Generation technology mix has to be reconsidered
- Conclusion: a full pallet of solutions is needed – and a firm policy to support that

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Characteristics of Smart Power Generation

Flexibility - runs when needed and doesn't run when not needed

- Fast start up & shut down times without cost impact
- Fast ramp rates up & down
- Unrestricted up/down times
- High availability and starting reliability

Any output with high efficiency (€/MWh)

- Part load operation
- Flexible plant size and siting close to loads
- CHP with heat storage where applicable

Low capital cost (€/kW)

Communication with smart grid

- Possibility for automatic response and start & stop

Low environmental impact

- CO_2 and traditional emissions even when ramping and on part load

Fuel flexibility

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Smart power generation for wind integration?

Planning the long term solution mix for wind integration on the system level

- Wind is the key technology for meeting the renewables target by 2020. Find the most economical solution mix for integration?
- Power generation has to be part of the solution mix – increase flexibility

Combining power generation and district heating offers room for innovative solutions

- Danish examples of combining combustion engine power plant, conventional boiler, heat accumulator (storage) and electric boiler

→ Increase the overall efficiency (lower fuel consumption) of thermal plants with CHP

→ Flexible engine plant and storage enable decoupling power generation from heat demand – generate power when the price is high

→ Electric boiler allows storage of excess wind power – use when price is very low

Need policies to guide the system to the wanted solution mix

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Example: Skagen CHP Plant

- CHP capacity: 13 MWe and 16 MWth
  – Three 4.3 Mwe Wärtsilä Natural Gas engines
- 250 MWh heat storage
- 37 MW peak load boilers
- 10 MW electric boiler
- Heat pumps investment under consideration

- Operated together with a waste Incineration plant (heat only).

Towards smart power generation? – what is needed?

1. Better understanding of the challenges the system faces – and the need for wide range of solutions – from grid investments to smarter generation
   - Supporting capacity has to be maintained due to intermittent nature of wind
   - Challenging environment for conventional capacity
     - Lower running hours and lower average load for conventional capacity = less income
     - More starts and stops, faster ramp ups and downs, more part load operation = lower efficiency, starting costs, cycling damage & higher emissions
2. Planning the long term solution mix on the system level
   - Which technologies are part of the solution, e.g. how much flexible capacity is wanted or how much wind can be spilled?
   - E.g. are CHP plants with heat accumulators and electric boilers part of the picture? (Danish model)
3. Policies to guide the system to the wanted solution mix
   - Guarantee sufficient generation capacity - Energy only markets do not give incentives for sufficient capacity in the new world
   - If CHP is part of the solutions, integrate district heating in the policy

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Towards smart power generation? – what is needed?

4. Quicker response for short term balancing requires new type of markets (or other incentive mechanisms) – shorter time periods etc.
   – Markets should be neutral for demand and supply response – or a combination of these
   – Enable smooth collaboration between response mechanisms in different types of balancing needs
   – Different time scales require different response (e.g. limited storage & time to start up generation) -> need to forecast. Is it possible to automate?
5. Policy makers (regulators etc.) are the drivers
   – Responsibilities, market structures, goals, etc.
   – System benefits v.s. private benefits – need for new types of incentive mechanisms
     - Avoided capacity cost, savings from wind spilling, etc.
   – Agree on the information that is shared (response time, length, current status…) and rules for the response / market mechanisms

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Smart Power Generation