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Large-scale Integration of Wind Energy into Power Systems

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Presentation outline



- Operating power systems with high shares of wind power
- Market design and the integration of wind power
 - Energy-only markets
 - New challenges
- Conclusion

EU RES targets



RES directive (2009/28/EC)

- Wind energy according to NREAPs:
- 495 TWh
 - 14% electricity consumption

EWEA Target for 2030:

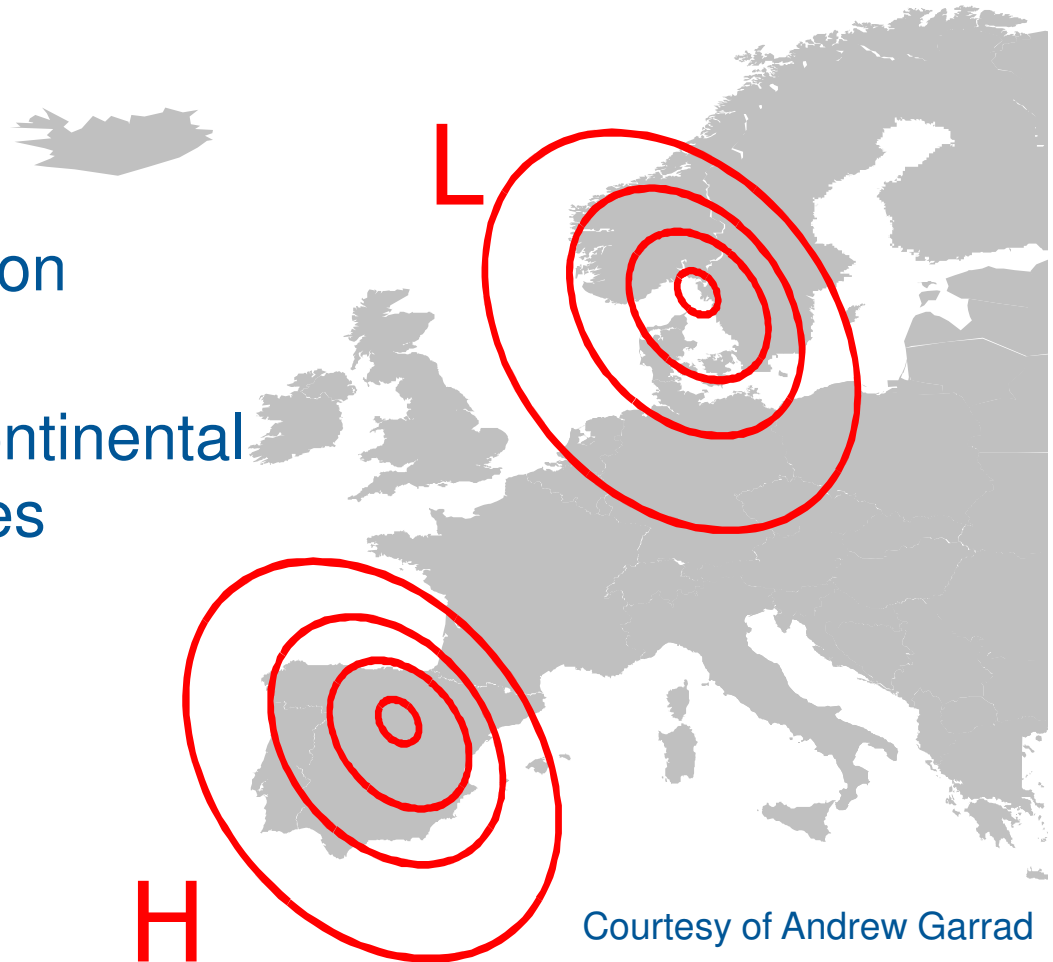
400 GW, of which 150 GW is offshore. 1150TWh,
26.2-34.3% of EU electricity demand

Integrating a continental resource requires a European approach



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- Meteo systems
 - dimensions of 1000 kilometres
- Regional decorrelation
- Utilization of transcontinental decorrelation requires
 - infrastructures
 - markets



Courtesy of Andrew Garrad

Operating power systems with high shares of wind power



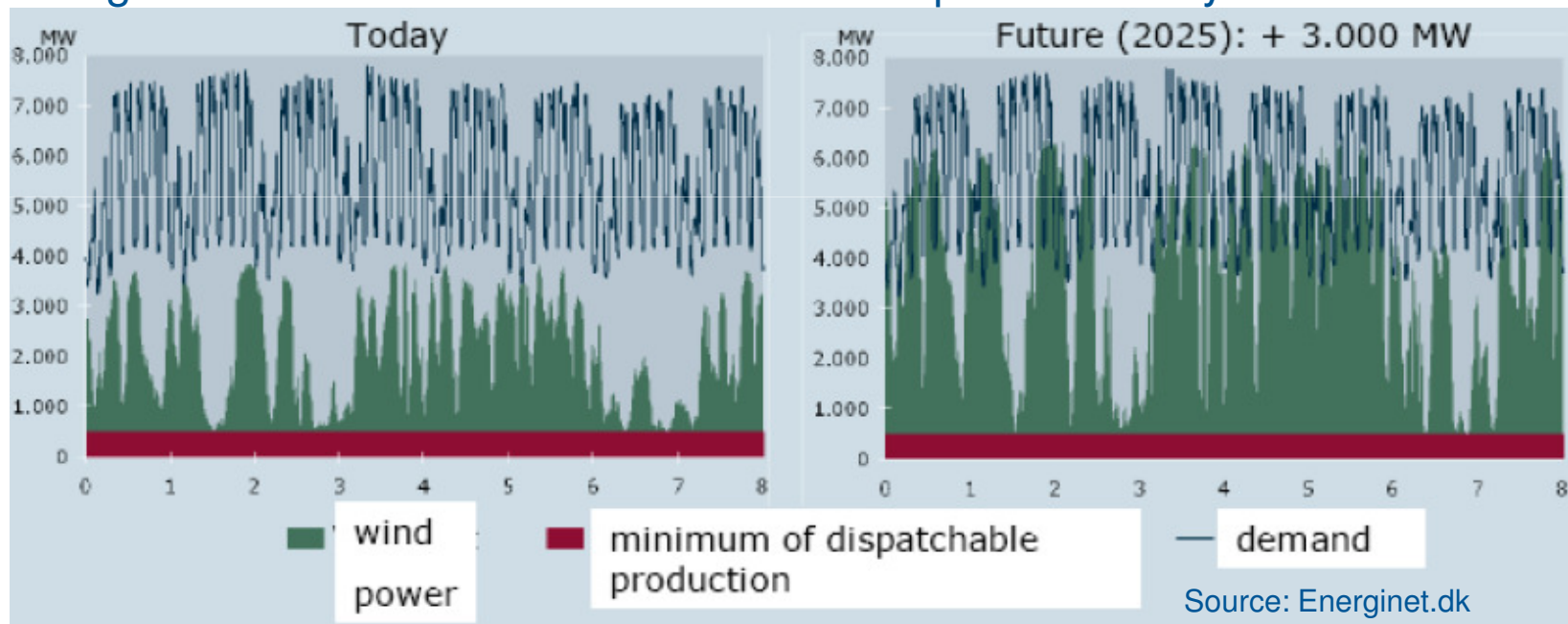
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- Wind power fits well in power systems but requires additional ‘integration efforts’, depending on:
 - Wind power penetration level
 - Flexibility of the power system in question
 - Generation (up and down regulation capability)
 - Demand management and storage
 - Grids (available crossborder capacity)
 - Power market characteristics (e.g. for balancing services): time, geographical area
- Flexibility varies widely in EU
- Integration efforts (e.g. moving to more flexibility) can be implemented by suitable market design
- Limit to wind power penetration level is not technical!

Operating a power system with high shares of wind power – The example of Denmark

The concern of the TSO:

Consequences of an additional 3000 MW on the Danish power system -
The government aim is to move to 50% wind penetration by 2025!



A cost-effective deployment of wind power, and the integration of European electricity markets are fundamentally linked.

Market design and the integration of wind power

- The market's gate-closure time closer to real-time would have a dramatic impact on forecast accuracy and the cost of balancing the system as proven by various power system studies.
- The EU target model aims for EU market coupling and the creation of cross-border electricity markets at all timescales by 2014.

→ EU-wide deployment of intra-day market trading with implicit auctioning and gate closure times as close to real time as possible is crucial.

Market-related issues to be addressed



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Issues with regards to energy-only markets:

- How can energy-only markets be made suitable for supporting the long term RES policy goals?
- Increased price variability and lower average spot market prices might dampen investors appetite

- ➡ Market transparency and cross-border integration must be ensured
- ➡ Provide for more market liquidity and a bigger market place in general
- ➡ New market forms like for ancillary services might provide for an additional revenue stream for generators without creating additional market distortions



Why are we talking about capacity markets ?

- Motivation: Ensure investment/development of sufficient capacity
- Variable RES tend to have low contribution to planning reserves
- Variable RES tend to induce lower capacity factors from conventional units.
- Business case for slow-ramping, inflexible power generation assets (typically mid-merit) seems to slip

➡ High share of variable RES tend to increase the need for flexible capacity



Why are we talking about capacity markets ?

Issues:

- In theory, CM implementation is easy, in practise it is very complex
- At your peril: further market distortion – examples of markets gone bad abound
- Disincentivises investments in infrastructure and demand –side management

Items to be clarified:

- Is there a capacity problem in the EU at all?
- How much firm capacity do you get from variable RES in a Pan-european perspective?
- How do you eliminate free riders and other externalities?

To conclude: How do we achieve a high penetration of RES? Lessons learned up to now...



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Impediments:

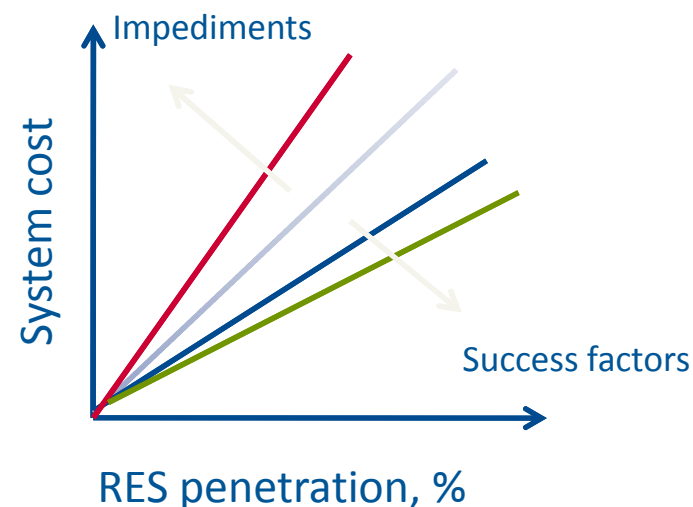
- Lack of transmission
- Lack of TSO cooperation
- Inflexibility due to market rules and contracts
- Unobservable RES – behind the fence
- Inflexible operation strategies during light load and high risk periods

Success factors:

- Forecasting
- Thermal fleet:
 - More quick starts
 - Deeper turn down
 - Faster ramps
- More spatial diversity
- RES + DG + DSM
- Grid-friendly RES

System cost:

- Unserved energy
- Higher fuel costs
- Higher emission costs
- Higher O&M costs



What's the « limit » is never quite the right question!



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Thank you

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