Unlock power system flexibility through improved operational practices

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IEA Wind Task 25 – What Does It Do?

- Started in 2006, now 17 countries + WindEurope participate to provide an international forum for exchange of knowledge
- State-of-the-art: review and analyze the results so far: latest report end 2018
- Formulate guidelines- Recommended Practices for Integration Studies: Update published in August
- Fact sheets and wind power production time series. Literature list.

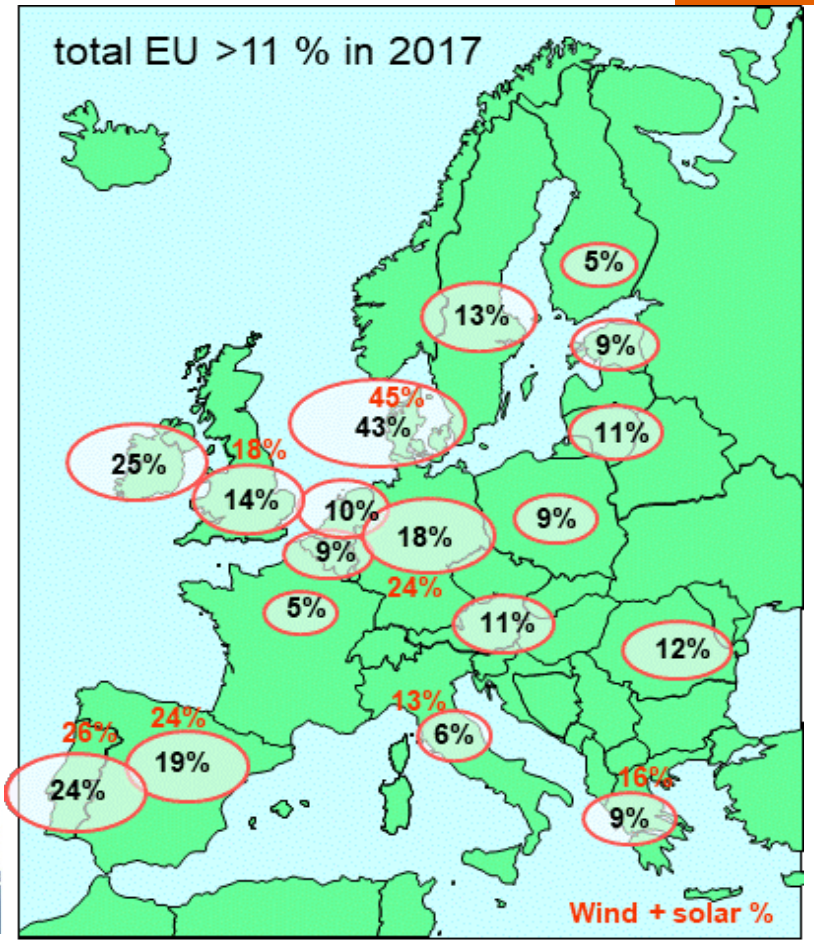
- *https://community.ieawind.org/task25/*

Contents

- Experience on operational practices with wind integration
  - focusing on reaching the first 10% share
  - focusing on system operators and generator side flexibility

Experience of wind integration is increasing

- Hourly maximum wnd shares in European countries
  - Denmark and Portugal > 100%
  - Germany 80 %
  - Ireland > 60 % of demand
- Wind energy in Europe :
  - Ranges 5-52% of installed capacity,
  - max duration of low generation: 38 hours < 10% of capacity



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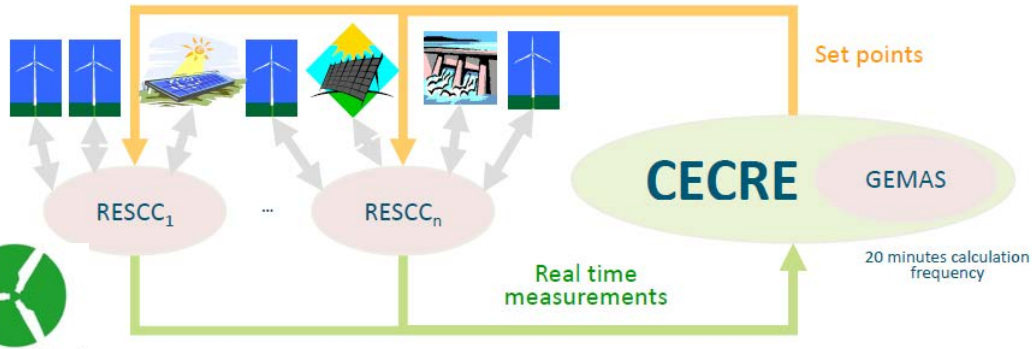
Task 25
Design and Operation of Power Systems with Large Amounts of Wind Power

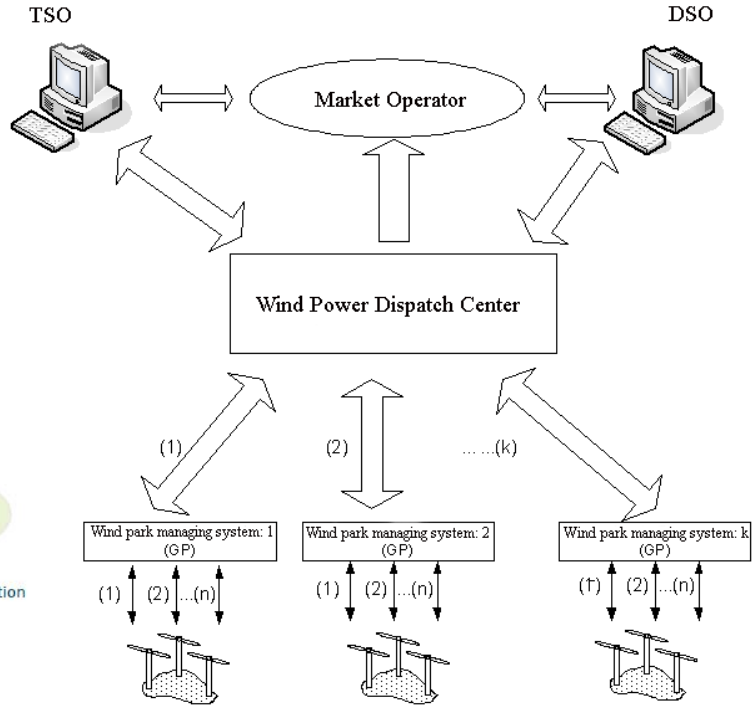
Operational practices from experience of integration

- First 10-20 % share of wind:
  - Updated information from on-line production and forecasts. Possibility to curtail in critical situations
  - Transmission/trade with neighbouring areas recognized as a key enabler, with regional planning efforts
- Higher shares of wind:
  - Technical capabilities of wind power plants used in grid support, also stability
  - Generation and demand flexibility and adequacy
  - Market design and value of wind

On-line data to system operator control room

- Solution in Spain and Portugal: Installation of Wind Dispatch Centres
  - Spain requirement 2007 for all >10 MW
  - The 1st “Wind DSO” started operation in Portugal in 2009





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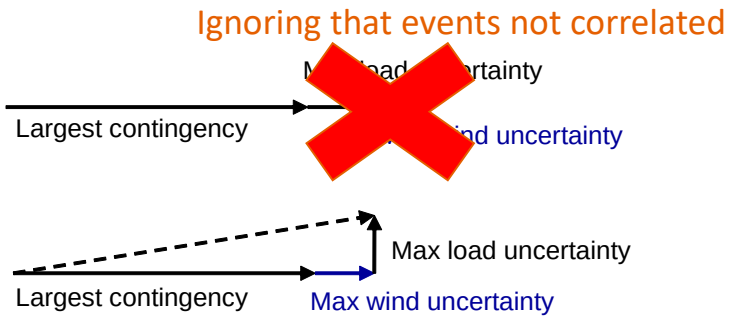
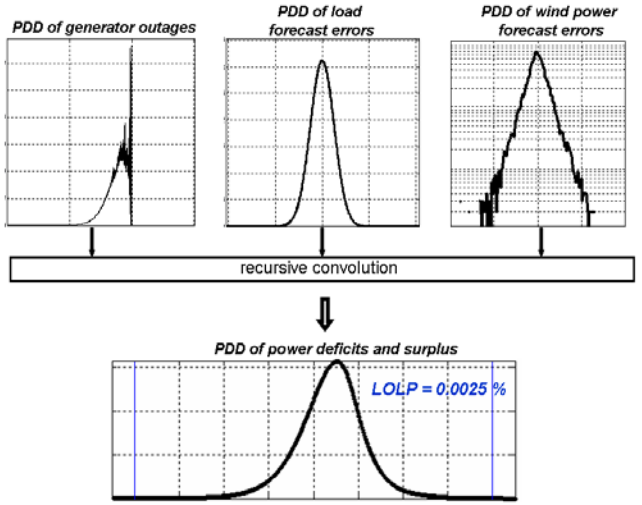
Using short term forecasting

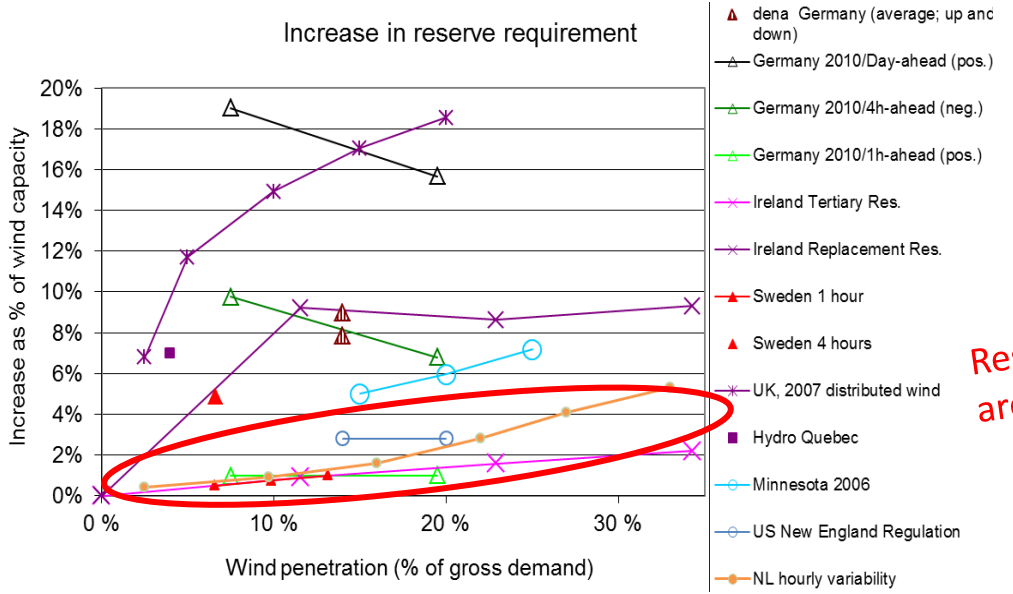
- Make sure wind and solar energy is taken in the day-ahead unit commitment and dispatch, to enable other power plants to flex down
  - Energy traded at markets with forecasting
- Flexibility during operating hour: forecast errors determine the need for operating reserve





Recommendation. Should be dynamic (D-1) for higher shares of wind

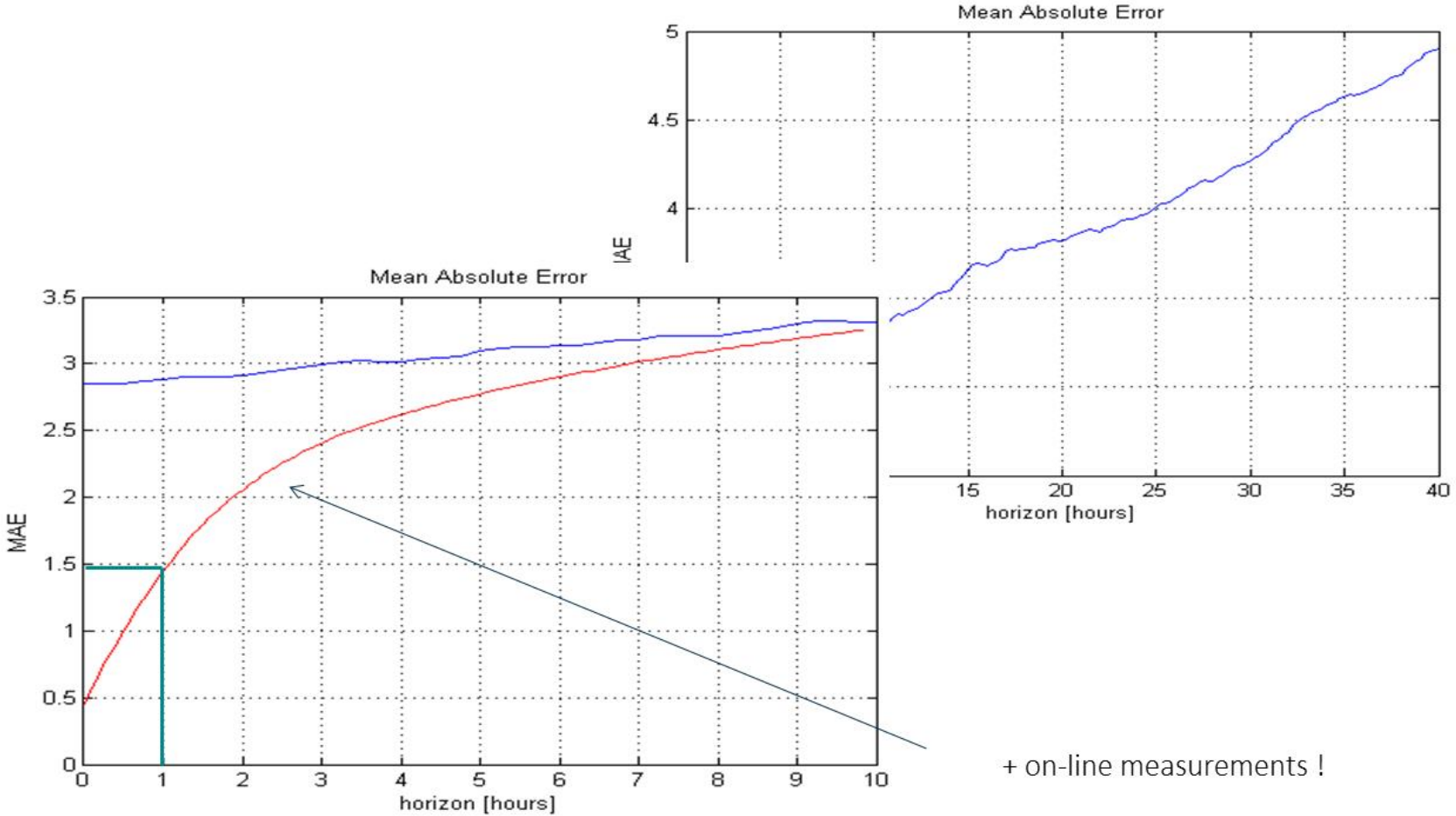
Reserve requirements – summary (static)



Results for hourly variability are similar for the studies

- Different time scales for uncertainties captured
- All static – how to present dynamic results still to be developed

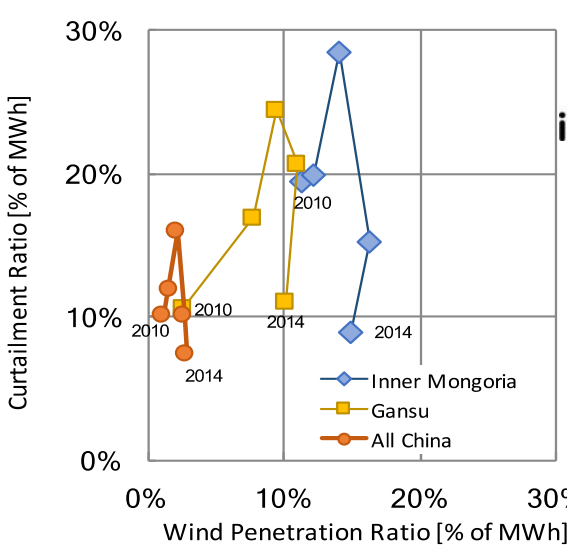
WIND POWER FORECASTS TO REDUCE IMBALANCES

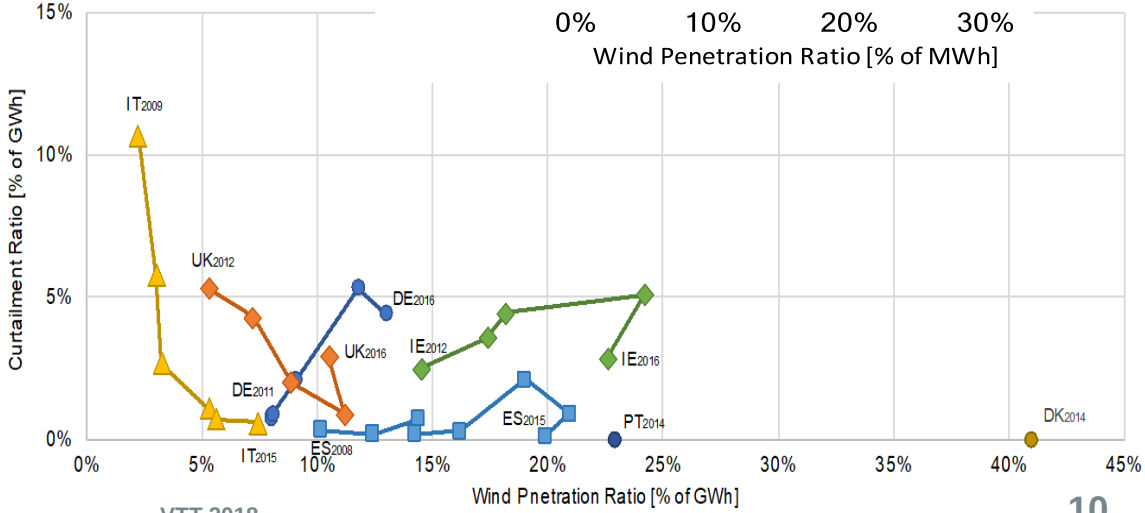


+ on-line measurements !

System operation - possibility to curtail surplus generation

- Curtailments are a signal of lack of flexibility
  - Delays of transmission: Italy and Texas – diminished after grid build out. Germany, still an issue
  - Inflexibilities of coal power plants and tariffs: China
  - Limits of non synchronous generation: Ireland (small system)
- Denmark and Spain: market operation of wind power plants offering down-regulation (not in the graphs)





Source: Prof Yasuda, Kyoto University

Trade with neighbouring areas will help balancing

- Denmark integration of close to 50% wind share is based on using Nordic power system flexibility
- Sharing balancing task with neighbouring system operators in Germany has resulted in reduction of use of frequency control, while wind and solar have increased

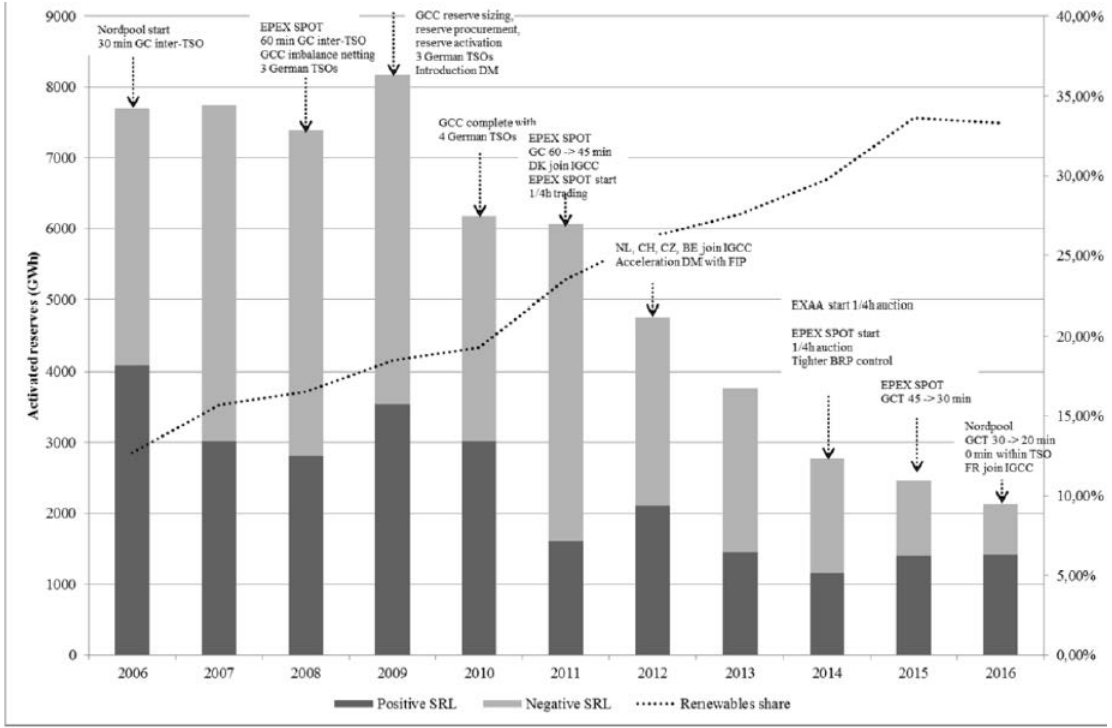
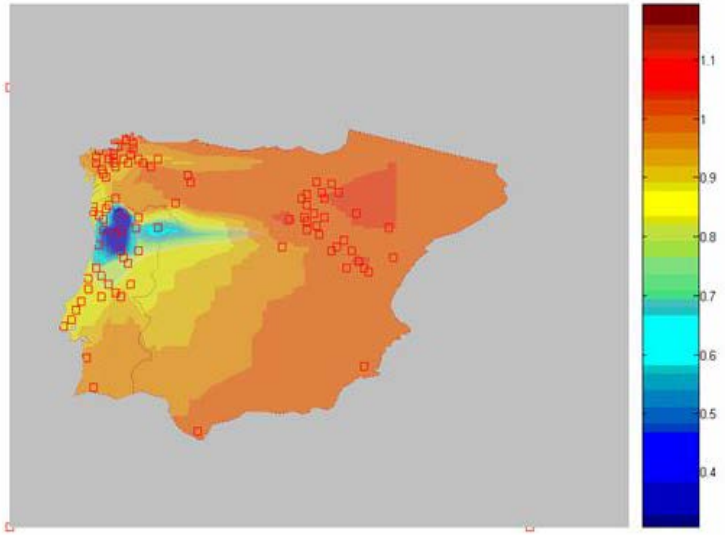


Figure 13: Total activated German Secondary Reserves (or aFRR) per year marked with events considered in this paper.

Rena Kuwahata, Peter Merk, WIW17

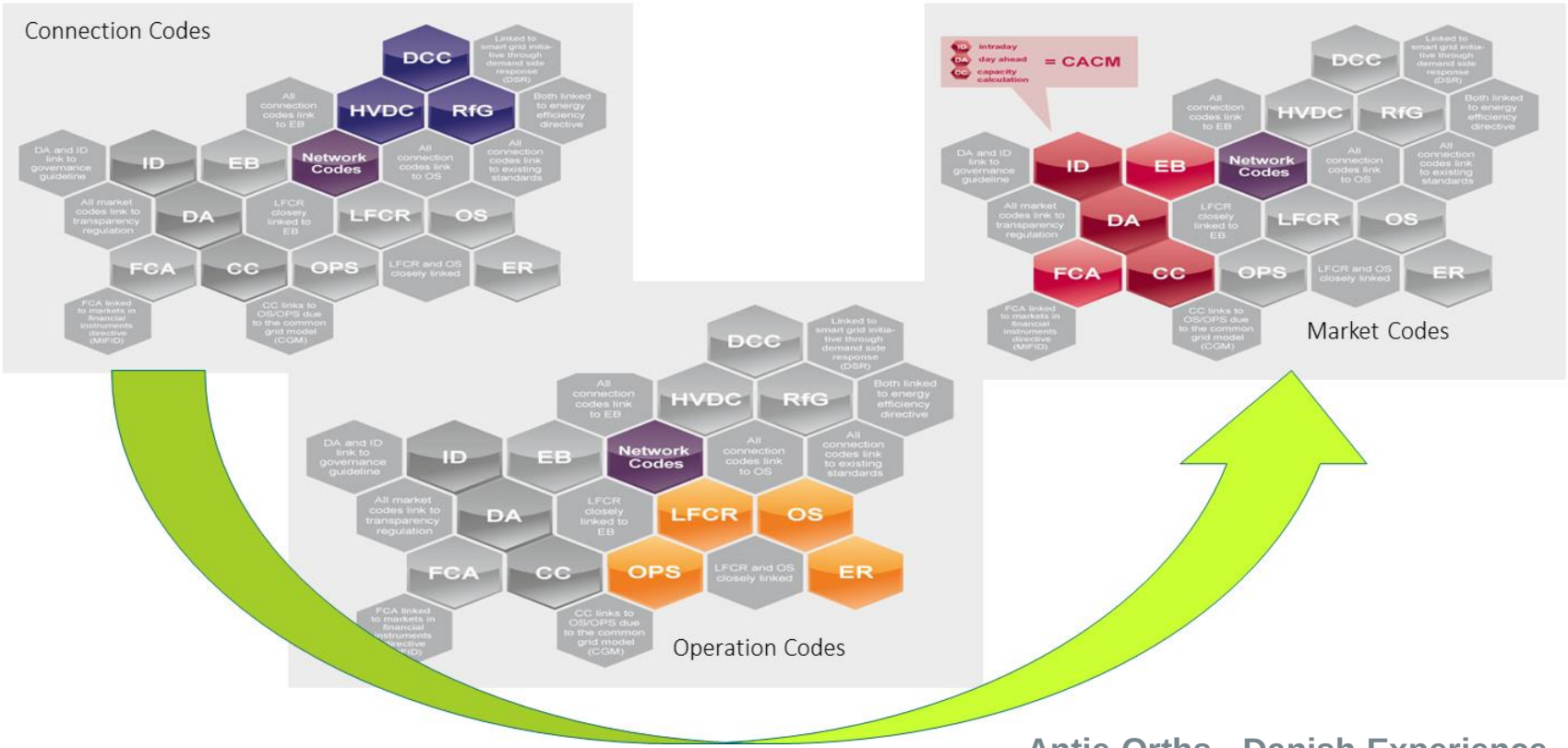
Experience with grid codes: Requiring fault-ride-through, and setting frequency/voltage limits when trip-off

- Low voltages due to short-circuits may lead to the disconnection of large shares of old technology wind power production
- Modern turbines comply with this – Australia case, for weak systems need to require many consecutive faults



Ride through fault capabilities attenuate the problem.

NETWORK CODES TO ENSURE GRID SUPPORT FROM ALL ASSETS



Towards higher shares : enabling system services from wind and solar

- Asking for capabilities in grid codes, and paying for services of system support if needed/used
- Experience of frequency response: Very fast (inertial) in Quebec, fast (primary) response in Texas, secondary in Colorado. Market compliance in Spain, Denmark

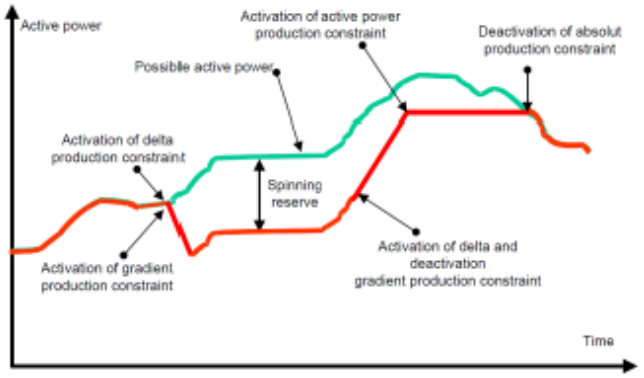


Figure 12: delta control mode – denoted with spinning reserve (Energinet.dk, 2010)

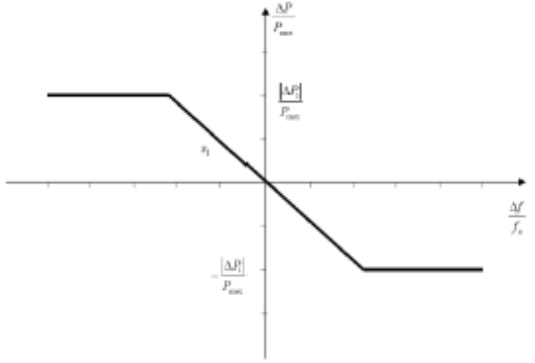
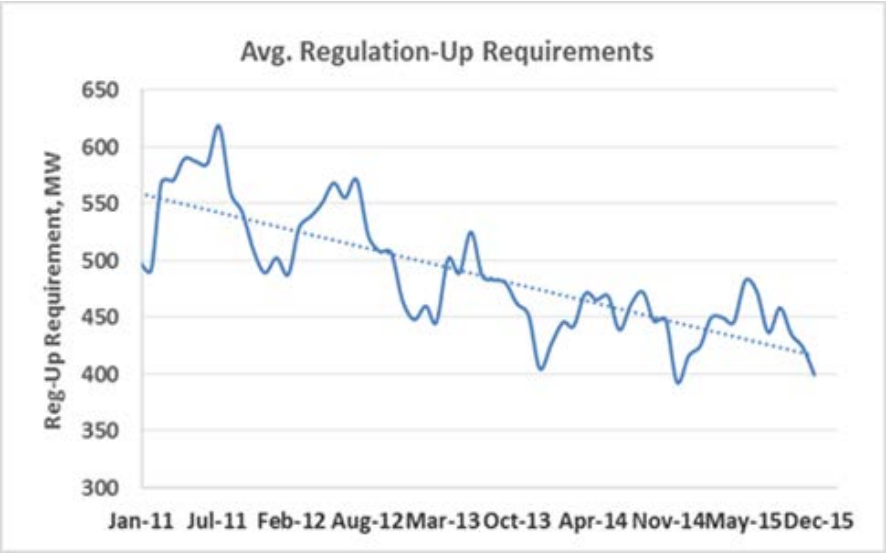


Figure 13: active power setpoint as a function of frequency deviation (ENTSO-E, 2012)

Experience: Wind power frequency response is fast and high quality

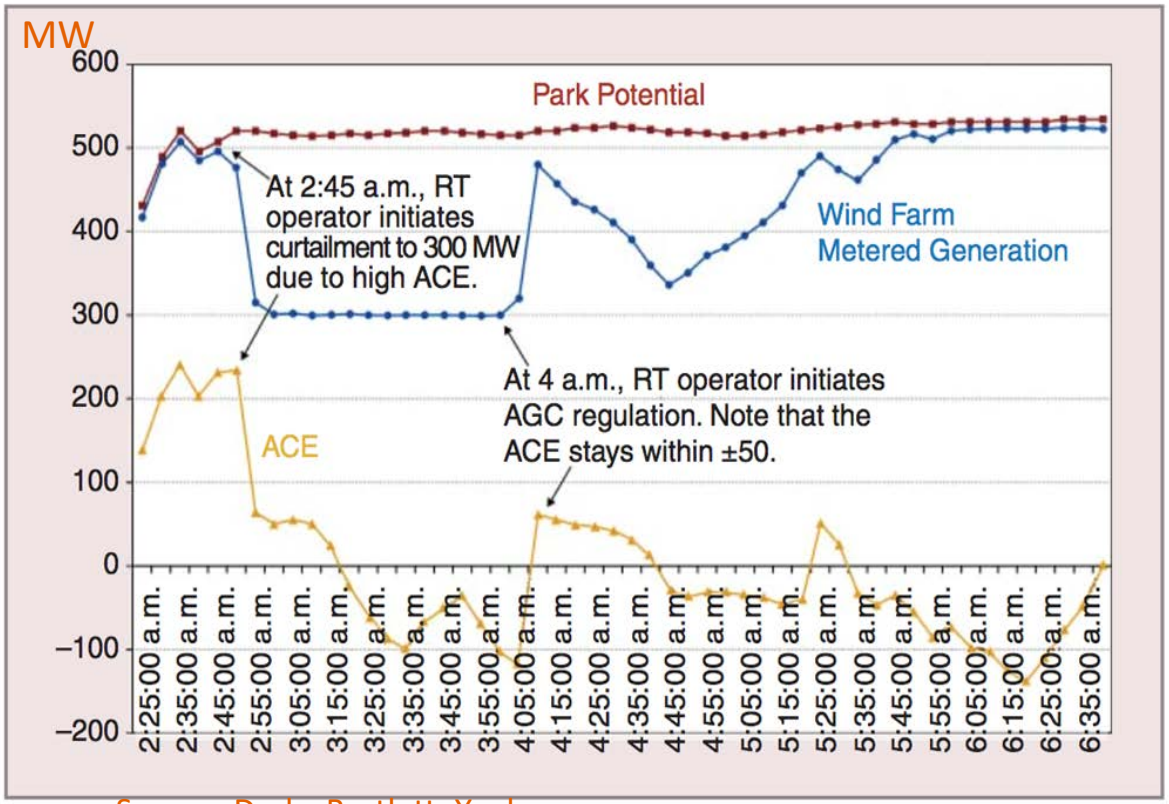
- System operator ERCOT in Texas: wind power plants actively used in frequency control
- fast response of WPPs actually reduce the overall need for automatically activated frequency support services



Source: Julia Matevosjana, ERCOT

Experience: using wind power plants at AGC when they are being curtailed

- Wind power plant in Xcel/PSCO is first manually block curtailed and then put on AGC regulation.
- Resulting area control error is shown in yellow.



Source: Drake Bartlett, Xcel

Using flexibility of thermal plants. Case Denmark.

- Changing the tariffs of smaller CHP plants to operate according to market prices
- Retrofitting the larger thermal plants
- Using the flexibility of hydro power from Nordic market

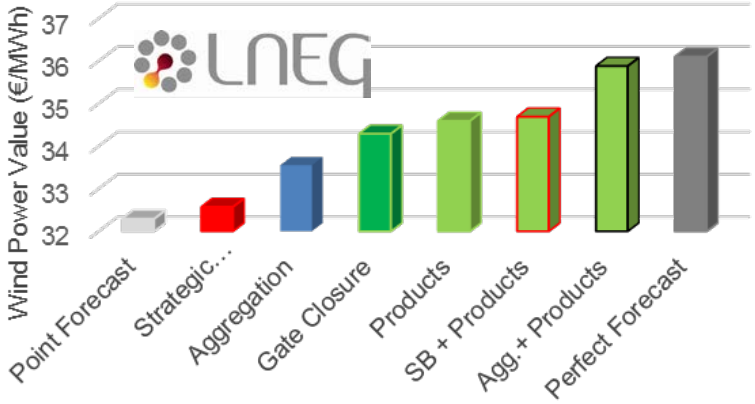
HIGH FLEXIBILITY OF POWER PLANTS

Operational range:
10–100%

Regulating rate:
3-4% per minute

Operational practices: market design to enable all flexibilities to bid

- Enabling also wind power plants to bid their flexibility to the markets
- With extra gains from balancing products



Ways to mitigate impact of wind and solar– large markets, and system services

- Larger market area – less correlated wind power production
- Faster markets – following better the load/net load

- Offering system services: frequency control
  - In situations where surplus energy /very low prices, wind can operate part load and offer fast up- and down-regulation
  - Often this becomes cost effective at larger (>20%) shares of wind and solar

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Summary

- A lot can be made to integrate wind and solar in existing power systems – operational practices the key
  - Access to on-line information from wind and solar, forecasting energy in dispatch, possibility to curtail in critical situations
  - Assessing flexibility from neighbouring areas – also smoothing impact reducing need for balancing
  - Assessing existing flexibility from thermal and hydro power plants, preparing to use flexibility from wind and solar power plants
- For high shares of variable generation, need for more flexibility from thermal plants, demand side and potentially also storages

Thank you!

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Recommending methods for integration costs – work of IEA WIND Task 25

- Comparing studies for Balancing costs, Grid infra costs, and Capacity value of wind;
  - Depend on share of VRE and flexibility available in the system
- Recommended practices on methods: **Outcome cannot find a proper way to draw estimates of integration costs**