



# Unlock power system flexibility through improved operational practices

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# IEA Wind Task 25 – What Does It Do?

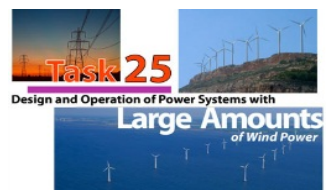
- Started in 2006, now 17 countries + WindEurope participate to provide an international forum for exchange of knowledge
- State-of-the-art: review and analyze the results so far: **latest report end 2018**
- Formulate guidelines- Recommended Practices for Integration Studies: **Update published in August**
- Fact sheets and wind power production time series. Literature list.
- <https://community.ieawind.org/task25/>



Task 25 Fact Sheet

The image shows the cover of the report 'WIND INTEGRATION ISSUES Large Amounts of Wind Power'. It features the title 'WIND INTEGRATION ISSUES' and 'Large Amounts of Wind Power' in large blue and white text. Below the title is a small image of wind turbines. The cover also includes the text 'Design and Operation of Power Systems with Large Amounts of Wind Power' and 'Final summary report, IEA Wind Task 25, Phase three 2012-2014'.

The image shows the cover of the report 'Executive Committee Agency Implementing Agreement for the Development, and Deployment of Energy Systems'. It features the IEA Wind logo and the text 'Executive Committee Agency Implementing Agreement for the Development, and Deployment of Energy Systems'. The cover is primarily white with a blue and green wind turbine graphic.



Wind power plants, like all new generation facilities, will need to be integrated into the power system. This fact sheet addresses concerns about how power system reliability, efficiency, and the ability to balance the generation (supply) and consumption (demand) are affected by the variability and uncertainty of wind power production.

**How is wind power different from other generation?**

The main characteristics that differentiate wind power from other forms of generation are its variability and uncertainty.

- Conventional power plants generate at specified levels that operators can vary up or down as needed—they are dispatchable (except in cases of operational failure).
- Wind power generation varies depending on how wind fluctuates. However, the variation is much smoother when many wind power plants are aggregated over an area in a power system (Figure 1).
- To deal with uncertainty, wind power output can be forecast minutes, hours, and even days ahead. Forecasts for minutes or a few hours should be more accurate than for 12 to 48 hours ahead. Aggregating wind power plants over a wider geographic area will improve the forecast accuracy at all time horizons.

See Fact Sheet: Variability and Predictability of Large-Scale Wind Power

**How do operators balance wind plant output? Does wind power need dedicated back-up?**

Electric power systems experiencing electricity consumption (demand), as well as failures that cause power plants to go off line, all of these are balanced together with wind power.

- To balance the variations in demand and supply system operators adjust the output of some plants. In this way demand is met at all instants and demand and supply are balanced.
- Variations of system demand and wind output often cancel each other out. Sudden large changes of wind and demand can run out and lead to occur simultaneously.

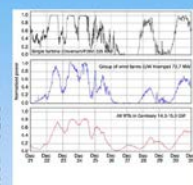


Figure 1. The smoothness of the output of a group of wind plants (middle) and aggregation of the output over an entire country (bottom) compared to the variability of one plant (top). (Source: see 25 summary report, 2006)

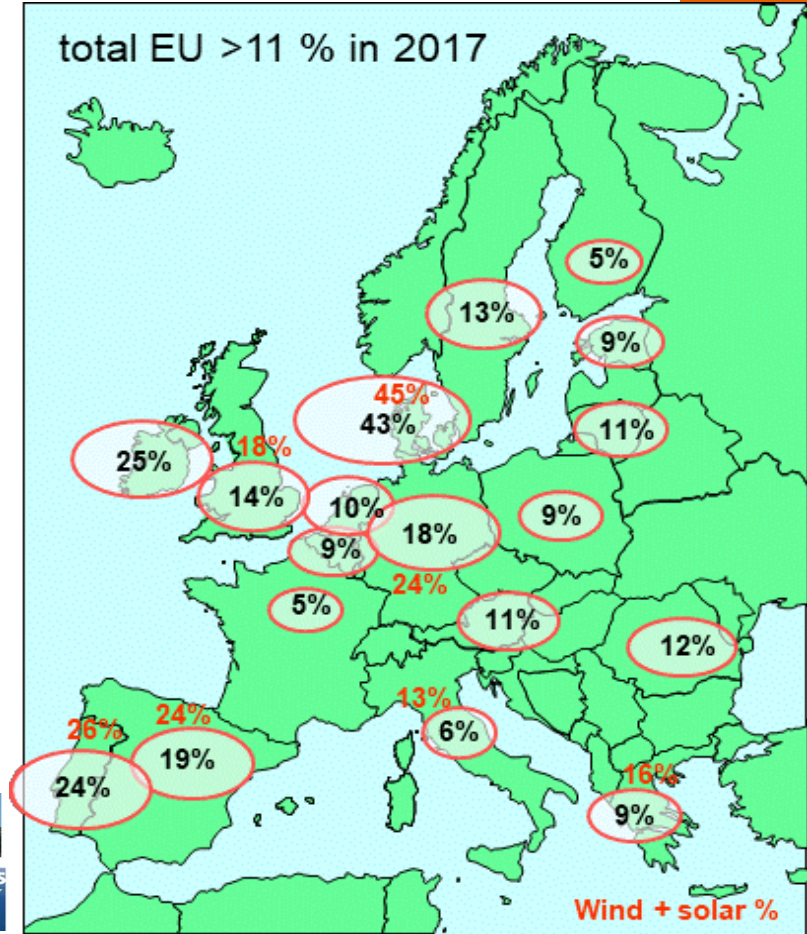
# Contents

- 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 wind 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



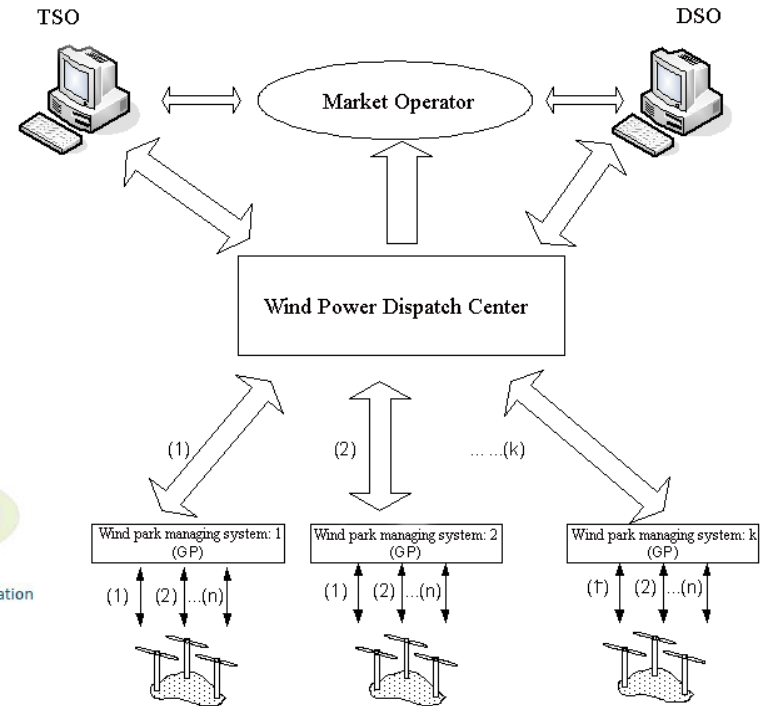
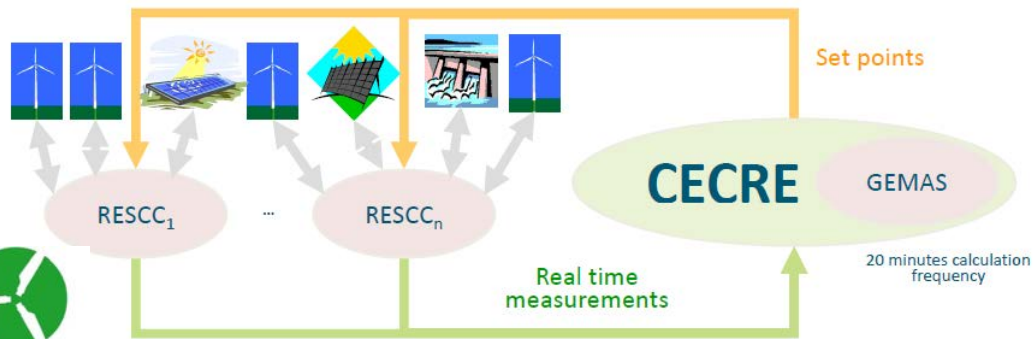
# Operational practices from experience of integration

- 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



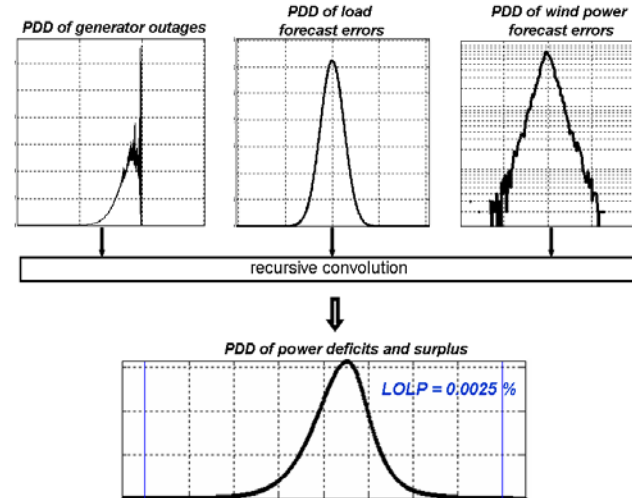
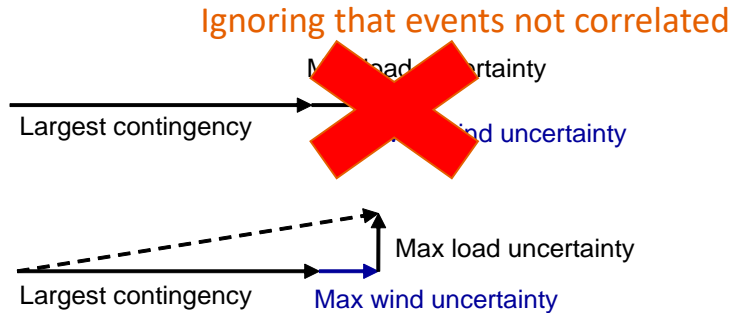
# On-line data to system operator control room

- 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



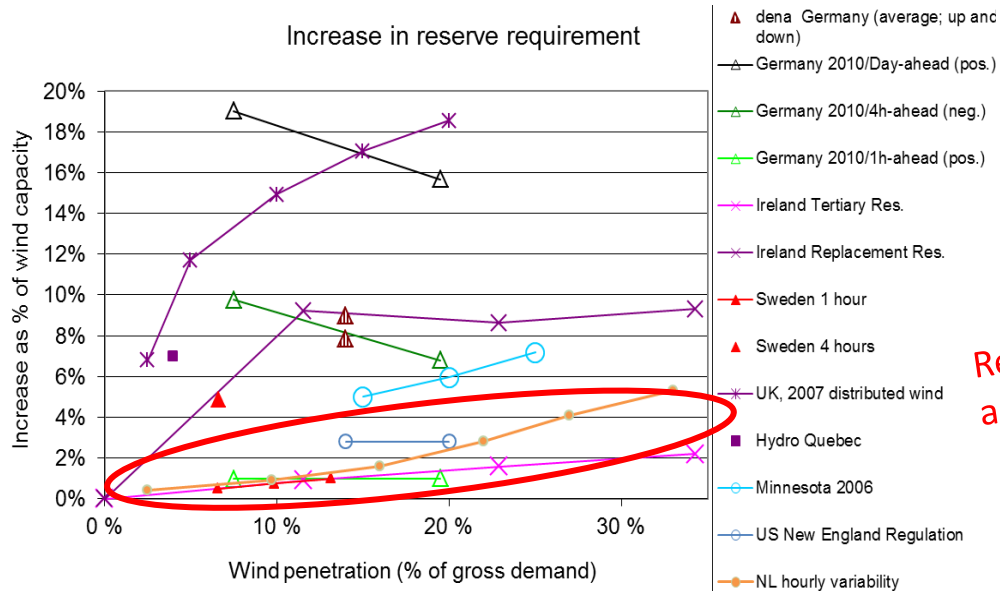
# Using short term forecasting

- 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

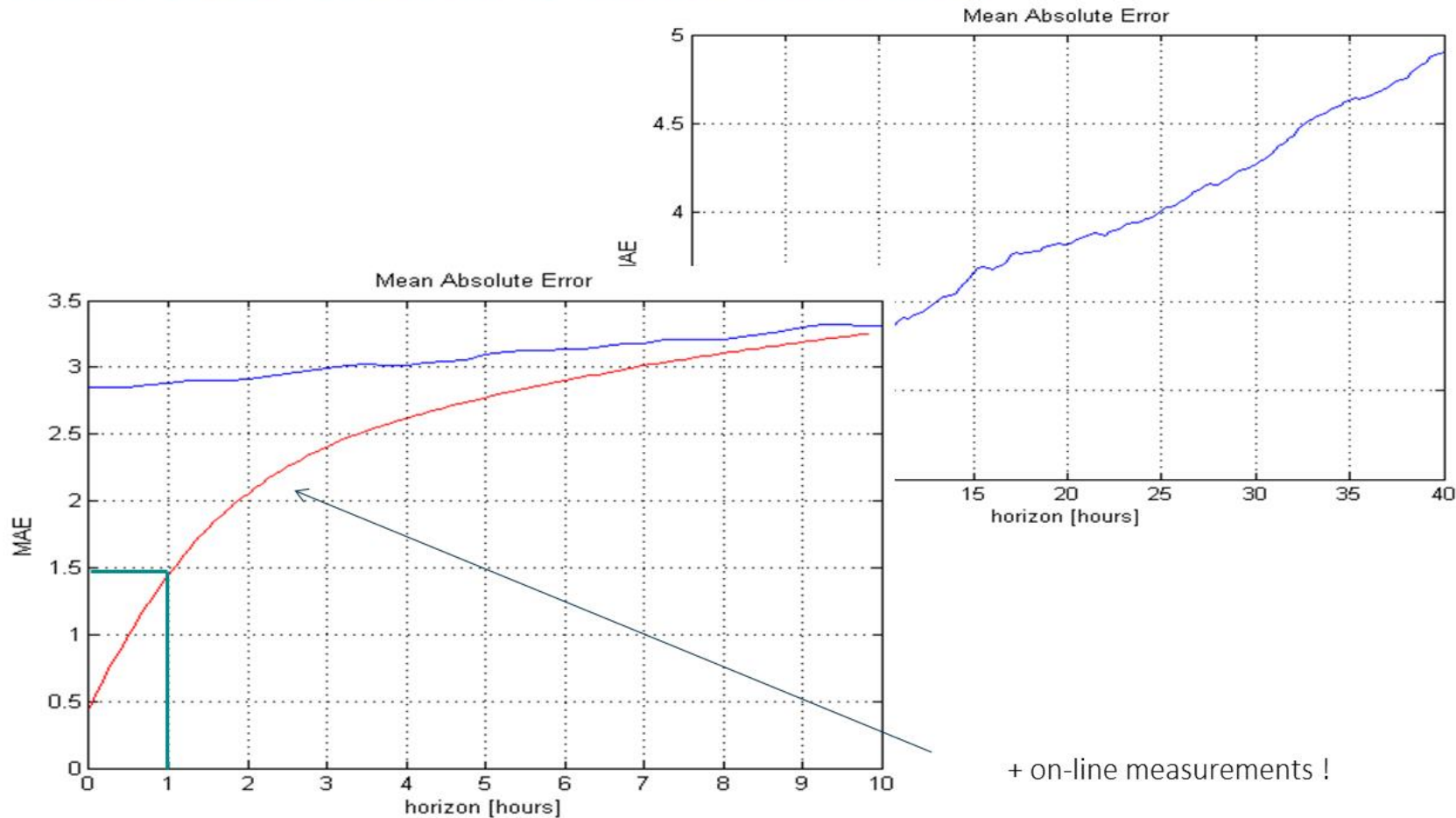
# Reserve requirements – summary (static)



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

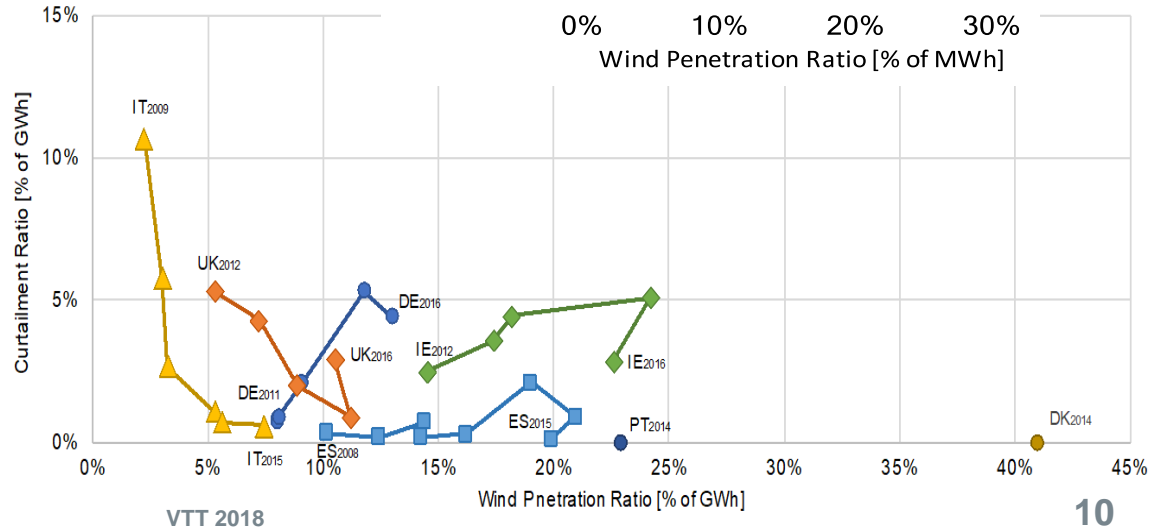
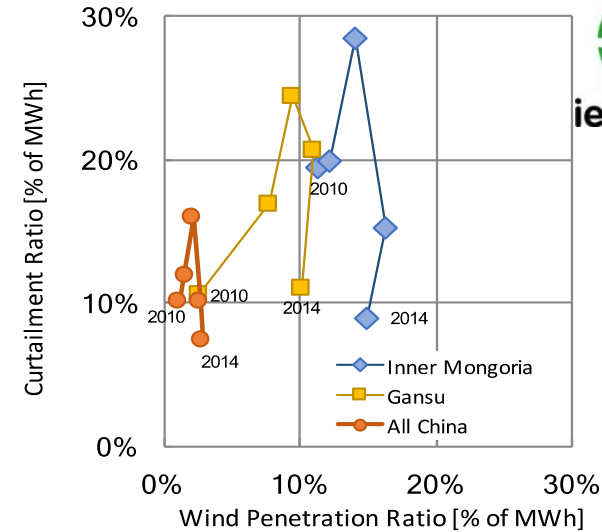




+ on-line measurements !

# 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

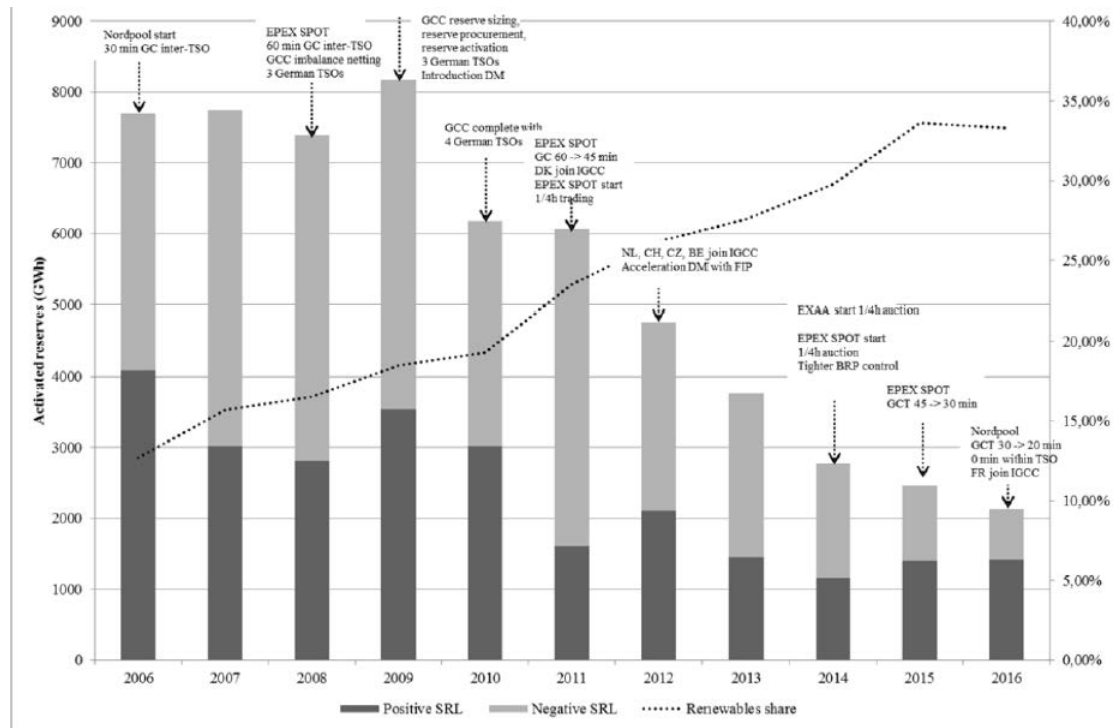
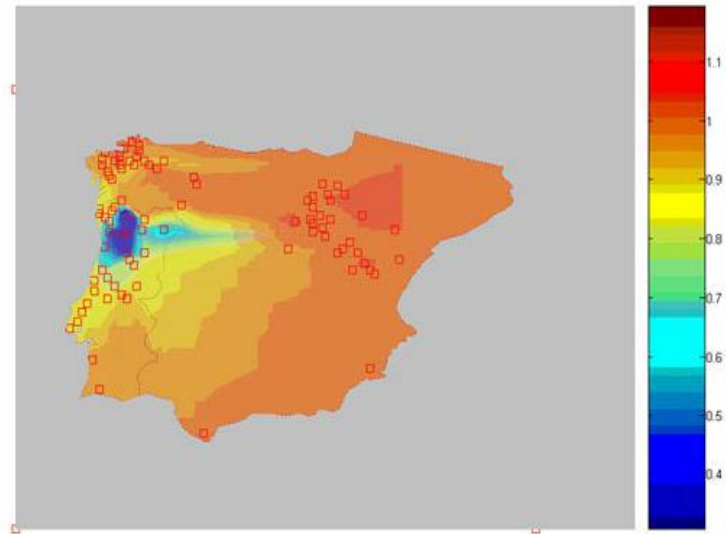


Figure 13: Total activated German Secondary Reserves (or aFRR) per year marked with events considered in this paper.



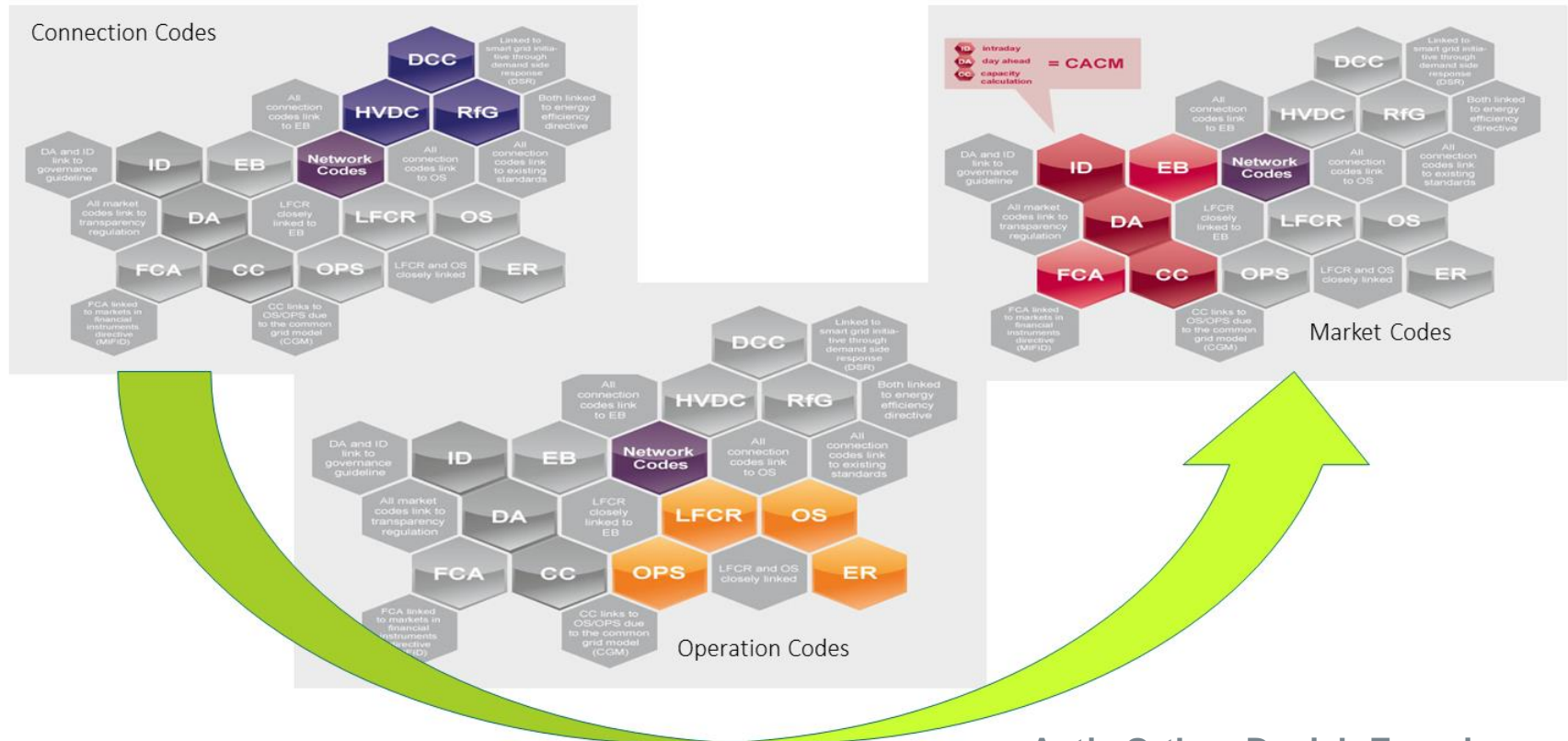
# Experience with grid codes: Requiring fault-ride-through, and setting frequency/voltage limits when trip-off

- 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



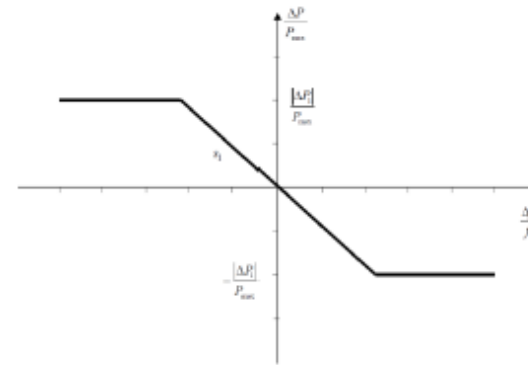
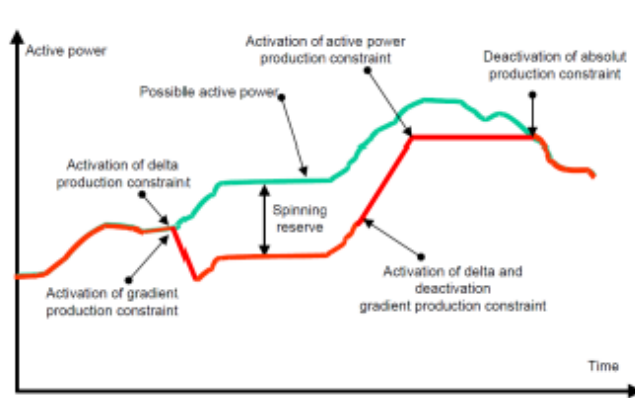
**Ride through fault capabilities  
attenuate the problem.**

# NETWORK CODES TO ENSURE GRID SUPPORT FROM ALL ASSETS



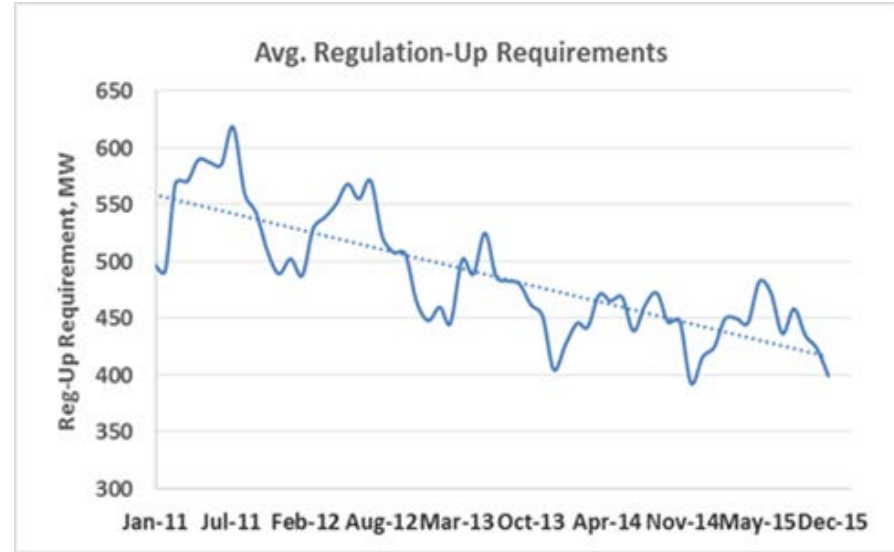
# Towards higher shares : enabling system services from wind and solar

- 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



# 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

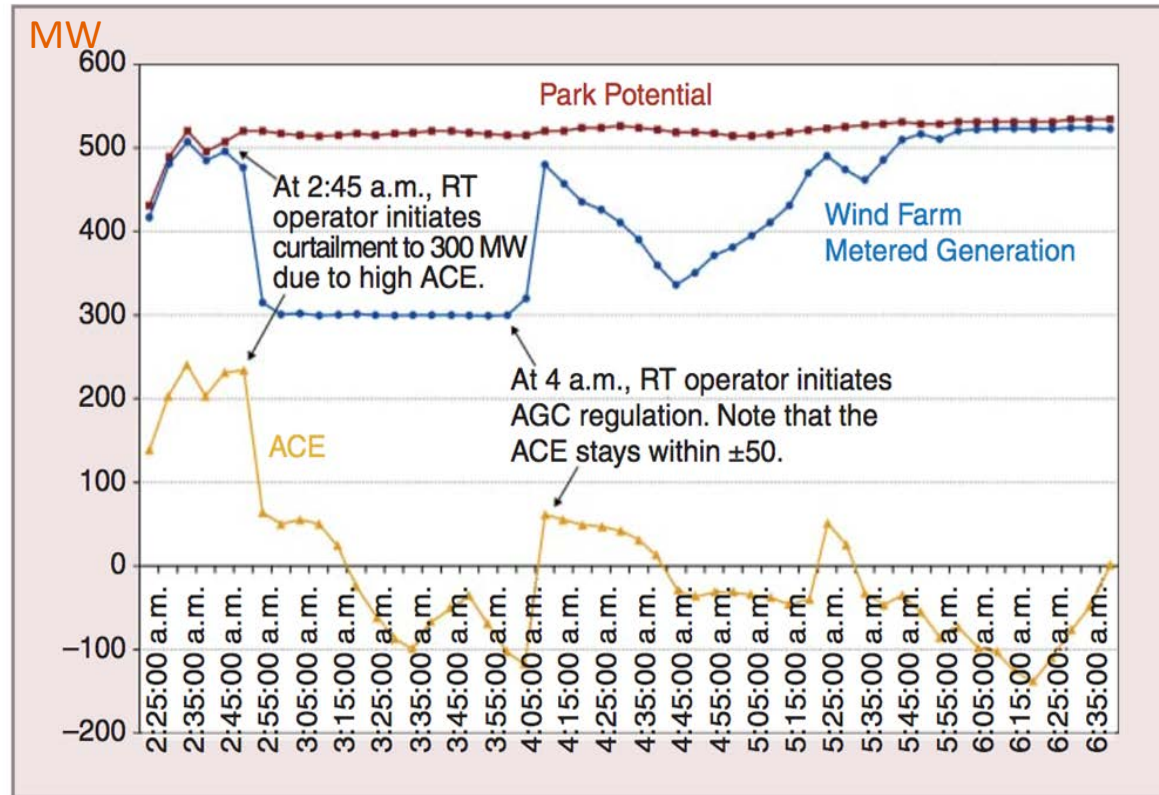


Source: Julia Matevosjana, ERCOT



# 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



ENERGINE

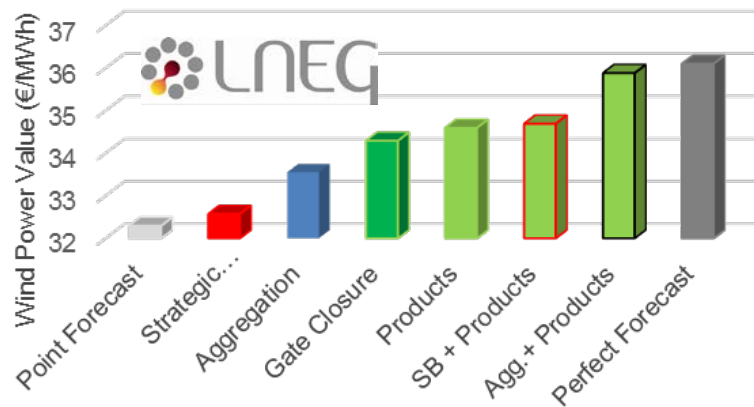
Antje Orths - Danish Experience



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# 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



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- 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



## 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!

# 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**

