WEPROG

Weather & wind Energy PROGnoses

EUROPEAN EXPERIENCE:

Large-scale cross-country forecasting with the help of Ensemble Forecasts

Session 6: Integrating forecasting into market operation, the EMS and control centre

UVIG - Variable Generation Forecasting Workshop
Tucson, Arizona
February 2012

Including physical Uncertainty from Ensembles

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Information about 2 initiatives on large-scale, cross border forecasting studies:

- European "SuperGrid study"
- Extended *grid correction corporation* to balance wind power over borders from DK to DE

Using forecast uncertainty to manage the cross-border flow

The challenges and requirements arising from large-scale, cross-border management of variable energy

A "SuperGrid"-Study with cross-country flow

Objectives of the study

investigate impact on predictability of wind and solar power for cross-country control and management

Model Setup

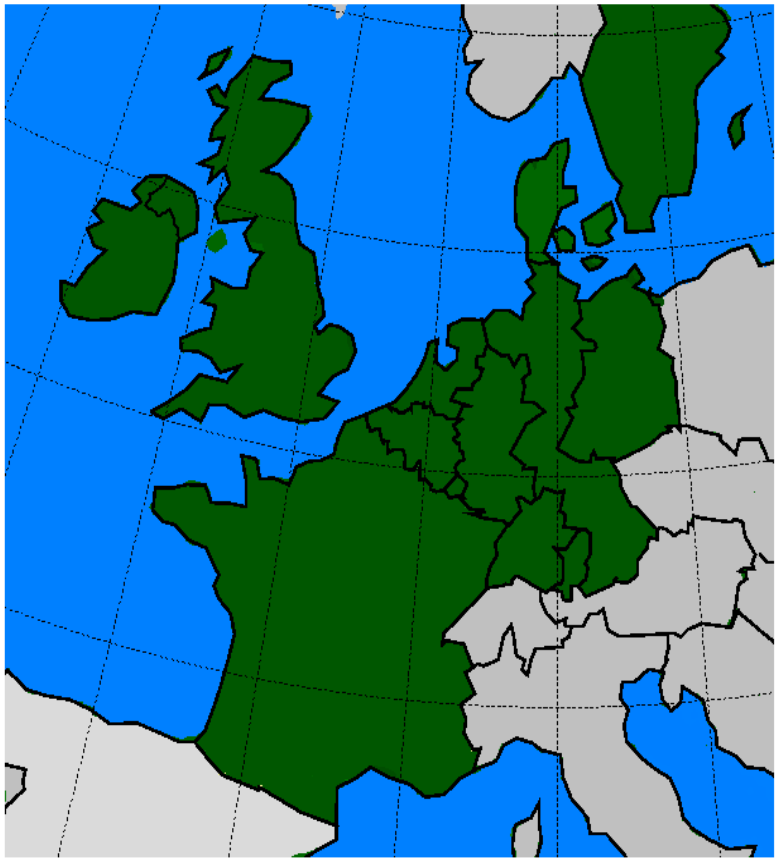
Capacity accumulated in MSEPS model grid points

- initial amount of countries: 13
- ~1400 grid points, 2260 registered wind farms
- power curves from public data in DE, DK, IE

„SuperGrid" Simulations

=> 8 countries with similar weather influences

=> Offshore wind power will connect these Countries even more

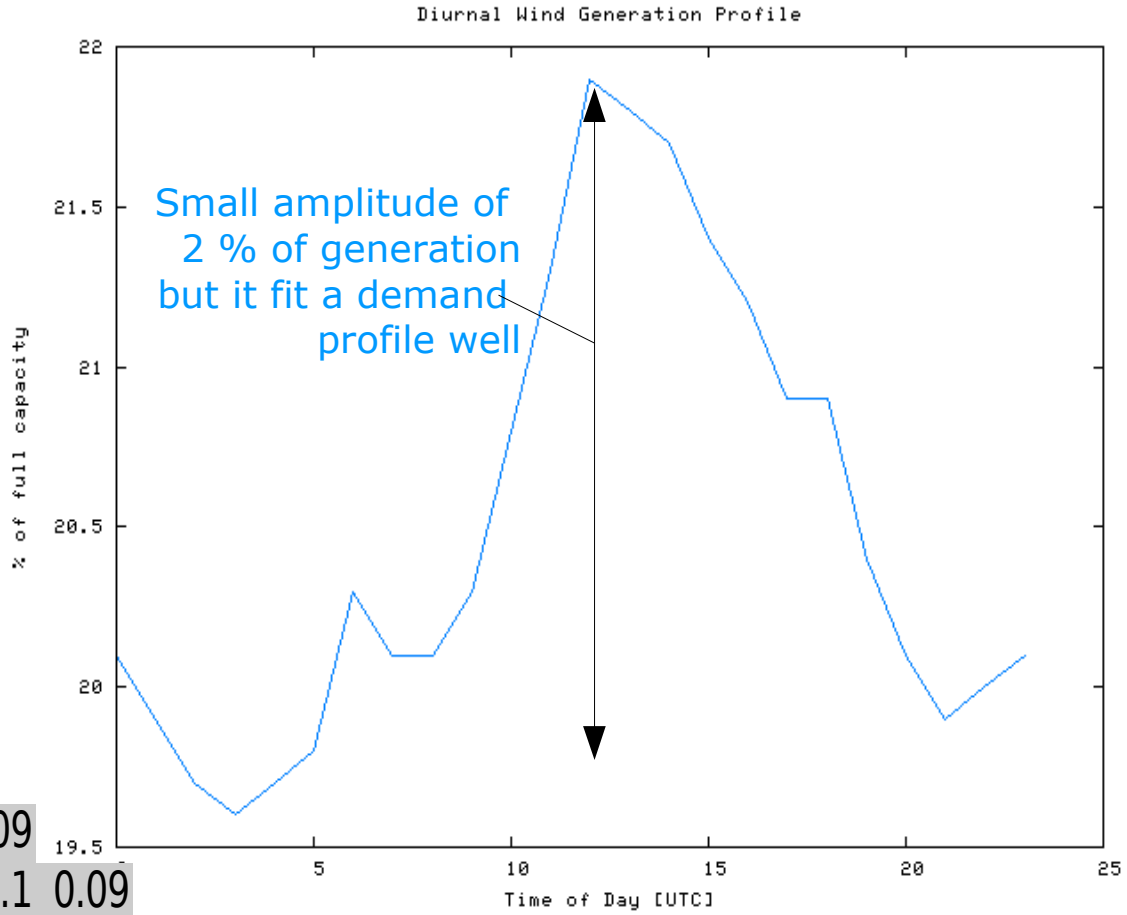


Constraints: a consistent handling of all wind power was required:

- Use of the same model estimate for verification in all countries
- Use of 00UTC and 06UTC forecasts for day-ahead horizon

Correlation of Generation & Diurnal Generation Profile

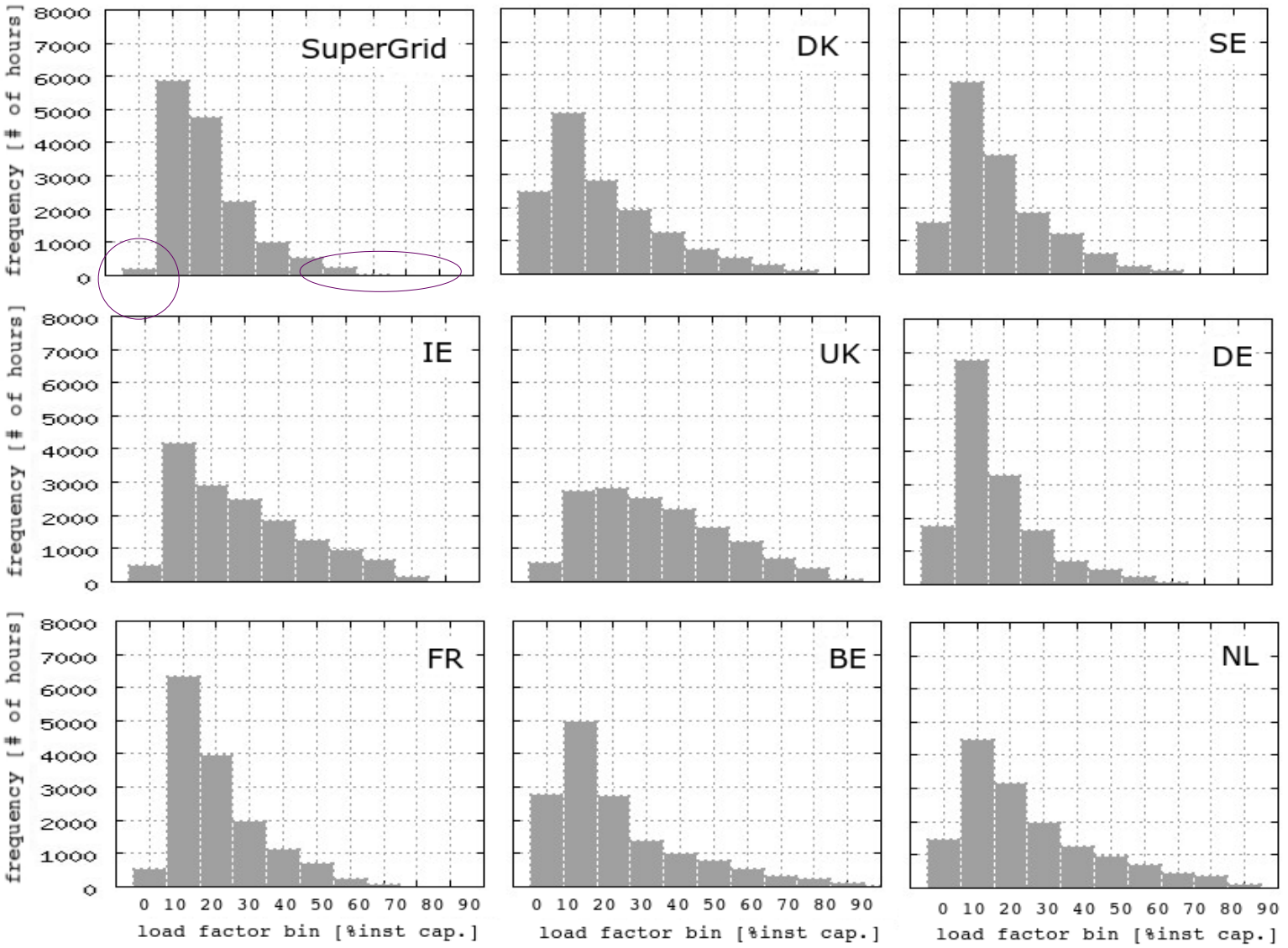
selection criteria:
CORR > 0.3 to SuperGrid
CORR > 0.4 to at least 1 more country



	All 13	SG	ie	de	dk	at	be	es	fi	fr	it	nl	no	se
SG	0.94													
ie	0.29	0.32												
de	0.88	0.95	0.17											
dk	0.67	0.74	0.21	0.68										
at	0.23	0.14	0	0.2	0.03									
be	0.72	0.77	0.28	0.63	0.34	0.04								
es	0.45	0.13	0.04	0.1	0.06	0.19	0.09							
fi	0.21	0.19	0.09	0.14	0.21	0.02	0.1	0.09						
fr	0.61	0.58	0.2	0.45	0.16	0.1	0.82	0.24	0.12					
it	0.24	0.02	-0.06	0.01	-0.07	0.39	0.05	0.39	0.04	0.21				
nl	0.79	0.86	0.29	0.74	0.51	0.03	0.86	0.06	0.13	0.6	0.01			
no	0.22	0.17	0.15	0.09	0.2	0.04	0.08	0.13	0.46	0.14	0.12	0.11		
se	0.51	0.52	0.17	0.45	0.68	0.06	0.25	0.12	0.56	0.17	0.02	0.34	0.47	
uk	0.66	0.72	0.42	0.49	0.53	-0.04	0.59	0.08	0.14	0.4	-0.03	0.74	0.17	0.34

Gray rows do not correlate and hardly help on balancing wind and solar, while green do

Frequency distribution of the Generation



Very few hours with more than 50% concurrent generation and few hours with no generation

The impacts of an enlarged Aggregation Area of wind power?

1. **Better frequency distribution** of generation and correlation to demand
2. **Less variable generation** (+ forecast), which is easier to manage in the intraday market
3. **Smaller forecast errors** in the day-ahead and intra-day market
4. **Part of the forecast error will be hidden** and balanced inside the enlarged area
5. **Less price volatility**, less start/stop on scheduled generation, lower marginal costs

A *grid correction corporation* strategy for balancing wind and solar power

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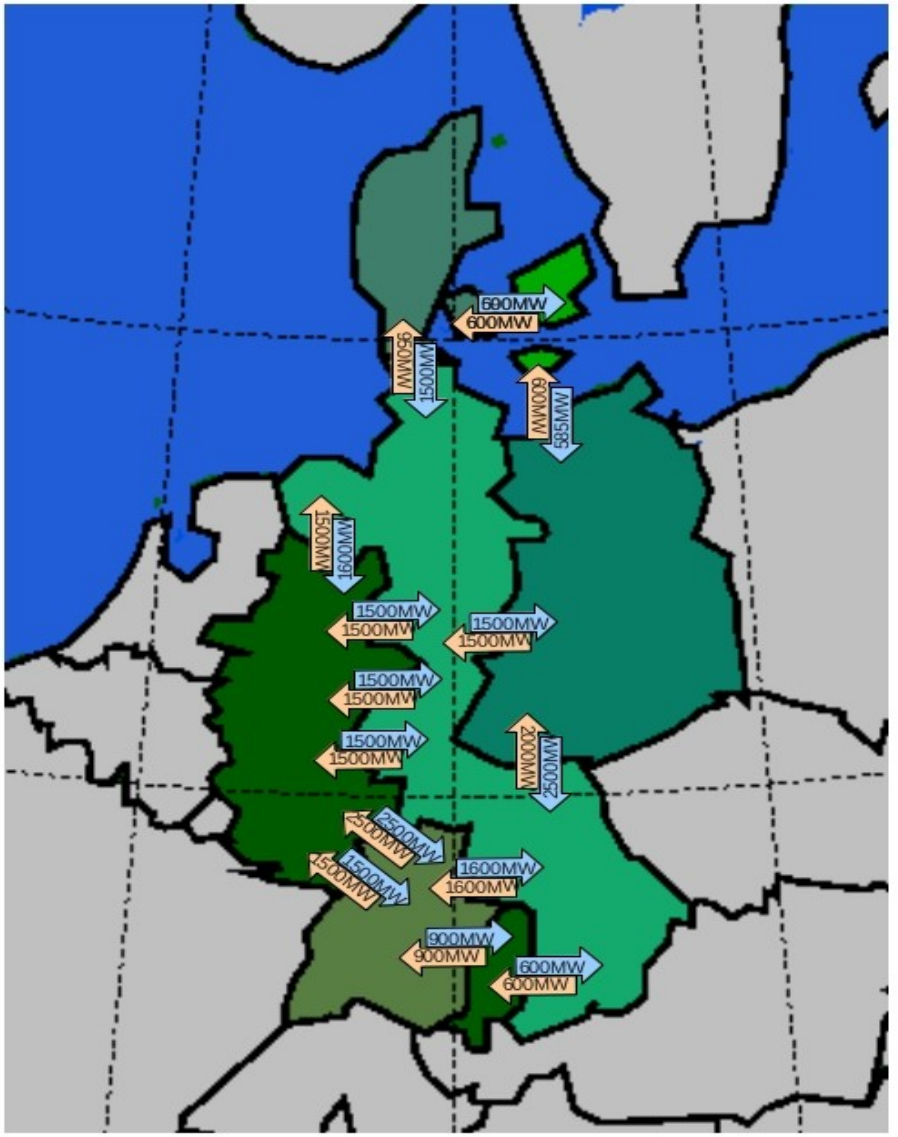
Demonstration targets for the DE-DK study were:

1. **Verification of benefits of area aggregation with "real data"**
   Quantification using actual standing data and published on-line generation

2. **Verification of a new short-term forecast technique using objective uncertainty**
   Effective pre-balancing wind power on the 2-hour horizon using the intraday market with a minimal of "double trading"

3. **Introduction of a *conditional bidding scheme* as second spot market auction**
   Scheme is designed for maximum competition also during congestion

4. **Dynamic reserve allocation**
   Estimate the potential reserve reduction for a large dispersed pool of wind power

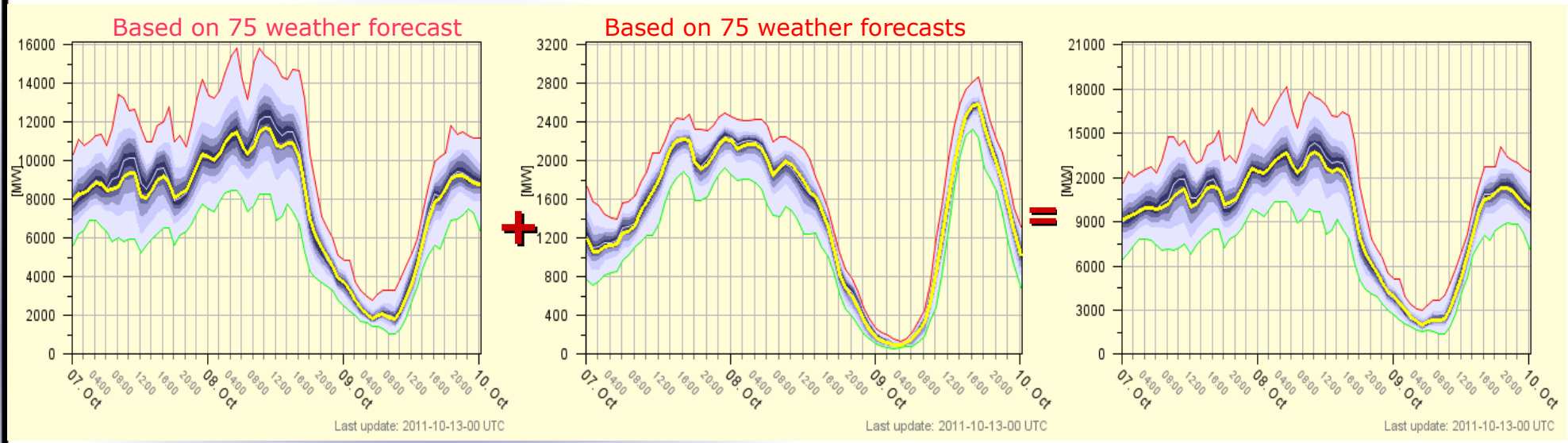


Forecast spread and power distribution in the enlarged area

Wind DE

Wind DK

DE+DK Pool



27.8GW

4.2GW

32GW

=> Computation of the entire DE+DK Pool to take advantage of smoothing effects

=> Uncertainty computations are nearly always better on the total pool:
„spread(DE) + spread(DK) >= spread(DK+DE)"

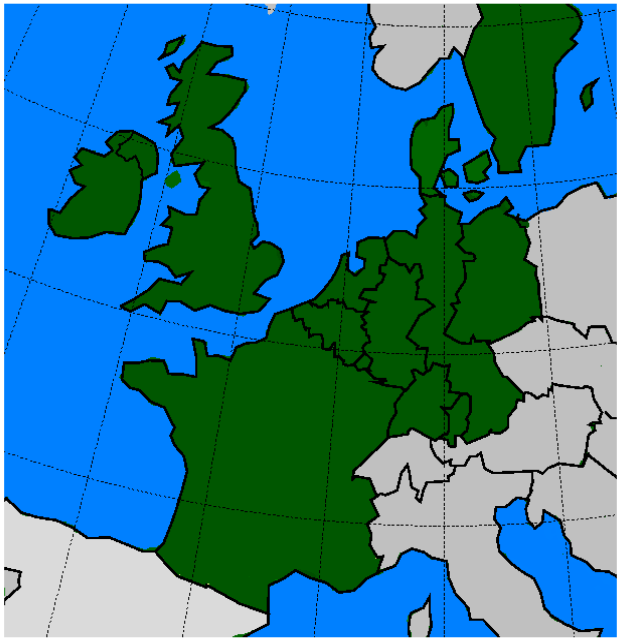
=> Inter-connector limitations did not change this pattern, but need attention!

What is the impact on large-scale cross-country area aggregation ?

Benefits

Significant Day-ahead forecast error reductions
permanently reduced 600-700MW confirmed by:
„SuperGrid" Study: aggregation of 8 countries – 44GW -
DK+DE area Study: aggregation of 2 countries - 32GW -

More competition on production
lower prices and reduced balance costs

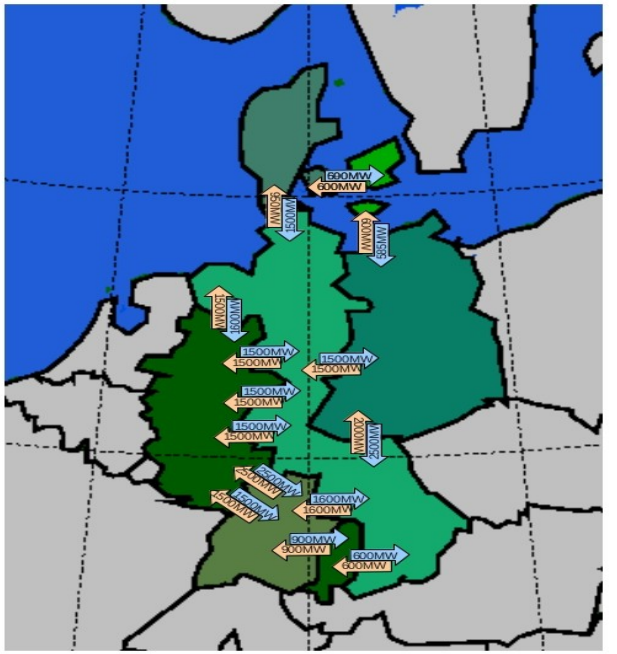


Challenges

More complex system and transmission
need to consider congestion

Less detailed treatment of wind and solar power

Local strong ramping issues remain
The size of the area does not change the ramping characteristics of large (Offshore-) wind farms



One fundamental problem that needs consideration:

Inter-Connectors only provide 1-way Regulation

The forecasting process must consider 3 cases to maintain the possibility to exchange imbalances on the SuperGrid:

A) Full import (use lower percentiles or minimum of wind power forecast)

B) Import and Export (use RMSE optimized forecast or P50)

C) Full export (use upper percentiles or maximum of wind power forecast)

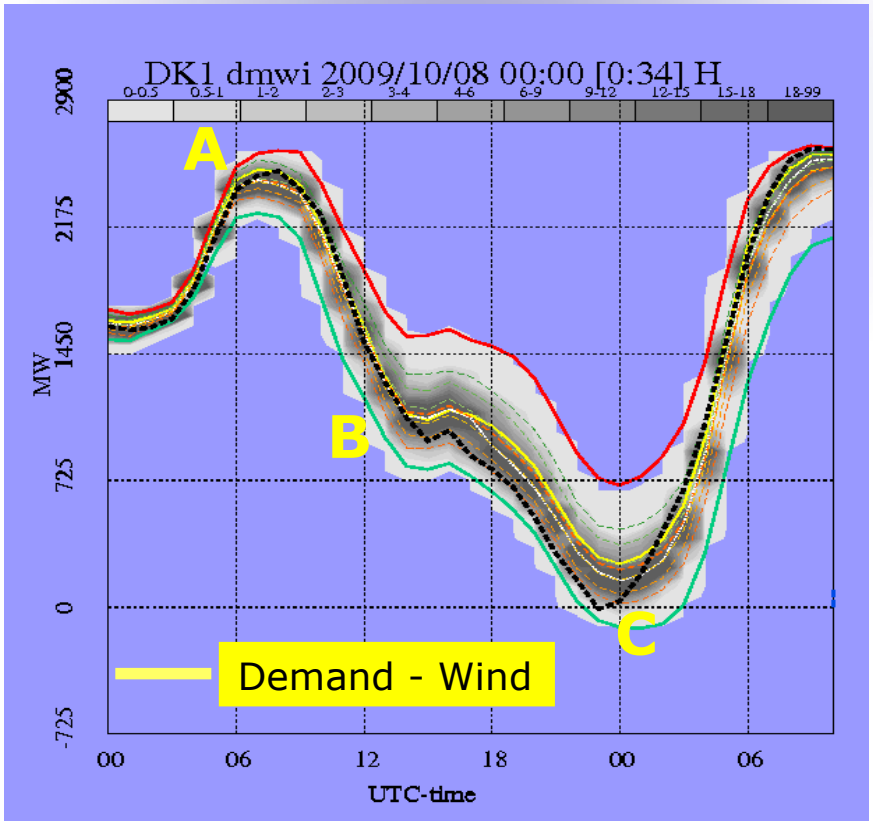
Forecast Step 1: Determine prices and flow direction with P50 forecast

Forecast Step 2: Select percentile from flow (cannot change flow direction)

If the N-1 criteria in case C does not lead to an issue, this process provides the highest level of grid security, because it requires less local reserve, while the overall level of reserve is kept at a maximum.

Competition factors within each Price Zone Confirm the use of Percentiles in Forecasting

Wind	Competition	Demand-wind	Preferred error	Wind Forecast choice
Low (A)	Low	High	-	Minimum or P10
Medium (B)	Medium	Medium	unknown	RMSE optimised
High (C)	High	Low	+	Maximum or P90



Case A: It is difficult to buy more power in the market, because all cheap generation is in use. The demand peak is short, so the most flexible and cheap Generation is already active

Case C: The challenge is to get rid of the power in the market, while many scheduled generators are eager to start especially because this wind peak is short lasting

How can a SuperGrid balancing be implemented ?

- **all wind and solar plant in the SuperGrid have to sign in**,
  -> small pools will not be competitive

- **establishment of a central independent Market Operator** (MO)
  -> for all interconnector flow
  -> obligation to get as much power sold as is technically feasible
  (with successive auctions if required)

- **central payment structure**: MO -> country representative -> owner
  -> payment according to each country's own specific incentive scheme

- **full transparency of data to the market with regular publication**
  -> publication every 6 hours "Demand-intermittent generation"
  -> standardized format of data files and graphics

- **MO uses a large number of forecast providers, where each has to forecast for the entire SuperGrid.**
  -> only MO knows the weight of each forecast provider.

There is no MO yet, but establishment of a regional coordination centre for Western Europe is indeed ongoing...

CORESO – Coordination of electrical system operators, whose shareholders responsibilities represent more than 40% of EU's population

goal:
provide services of coordination with regards to the forecast and operation of electricity flows

objective:
to help European TSOs to enhance the level of Security of Supply by looking at a larger part of the grid

Main tasks at present:

- merge real-time power flow information to build a representation of the European grid

- perform calculations to assess the stress level of the grid

- manage possible congestions in a coordinated way

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Major Challenges for a European SuperGrid from a "forecasting" perspective

DATA MANAGEMENT

=> requires "public" and standardized availability and access to production, demand and standing data also for forecasters !

=> power flow and market data need to be collected and made available to all involved parties (participants, TSO's, forecasters)

CONGESTION and MARKET MANAGEMENT

=> Congestion risks requires consideration of production uncertainties

=> including uncertainty requires market changes, e.g. a "Conditional Bidding Scheme"

=> TSO grid management and market management has to be merged and be more interconnected

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Thank you for your attention !

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