Integration of Renewable Energy Sources in Germany

Opportunities and challenges

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egi elia grid international

Overview

1	Introduction of the German Context
2	RE integration main challenges
3	Paving the way toward system transformation

Introduction of the German Context

German RE penetration targets

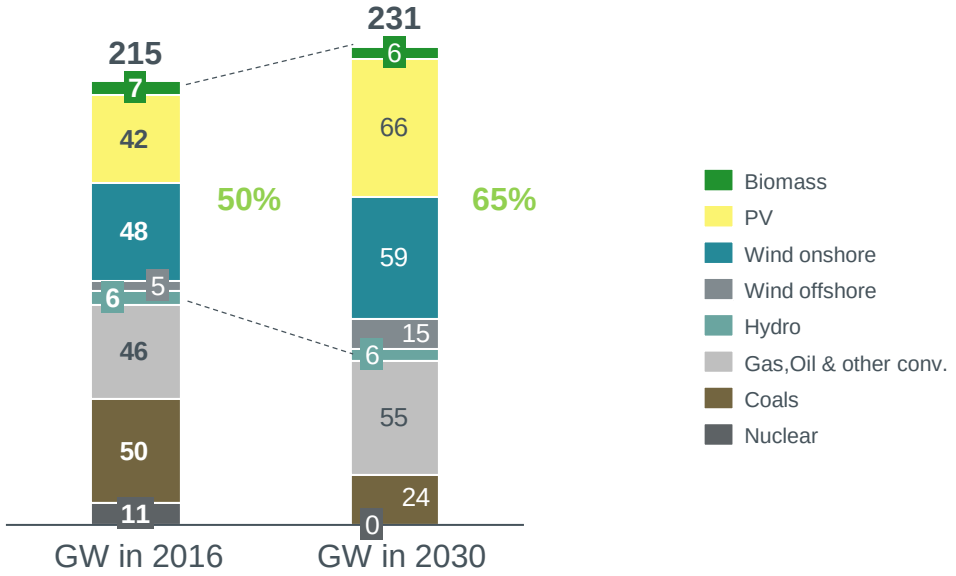
EU targets until 2020

-20%
Greenhouse gas emissions vs. 1990

20%
renewable energy share in gross final consumption

+20%
energy efficiency in primary energy

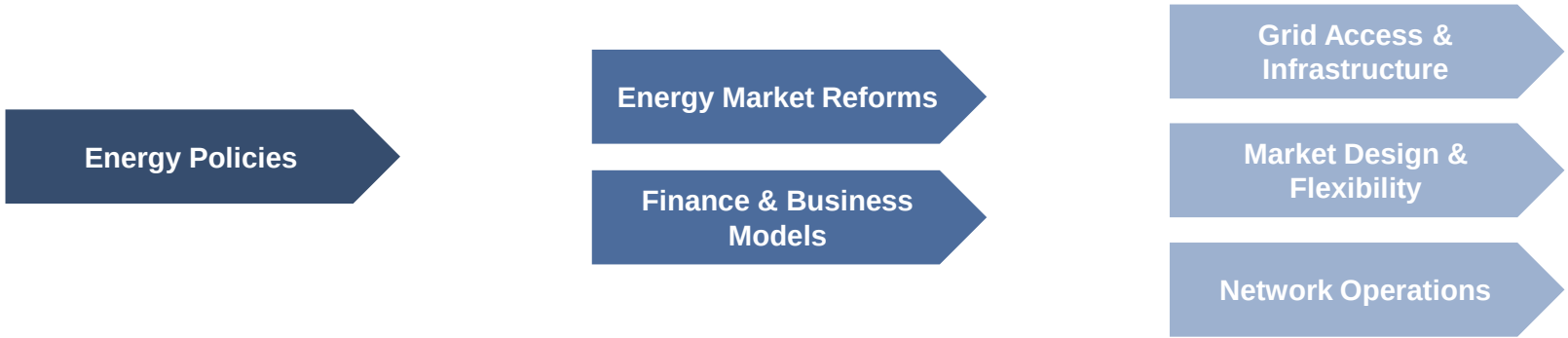
Flexible targets based on German potentials



- Targeted share for 2020 already reached today (50% RES delivered 35% in consumption)
- 65% of capacity in 2030 was set as new target (will equal to 52% in consumption)

The electricity sector must evolve to fully benefit from RES integration at an affordable cost

Framework encompassing electricity system paradigm

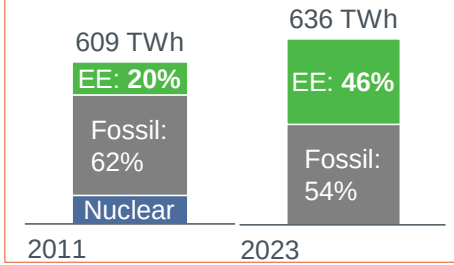


Overview on RE generation integration challenges

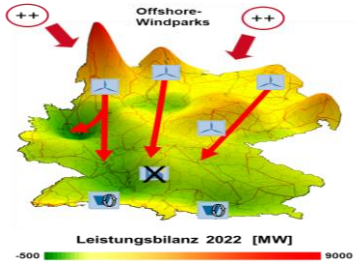
Typical RES integration challenges

Development of RES

Share in German electr.mix

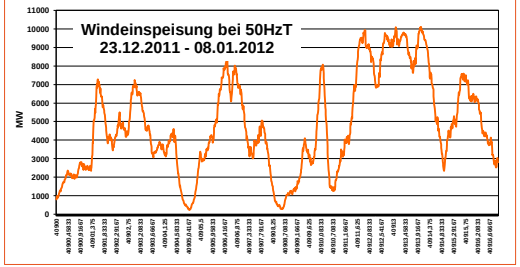


Local distribution



Consequences

Fluctuation and instability



Restrictions in the grid

Challenges

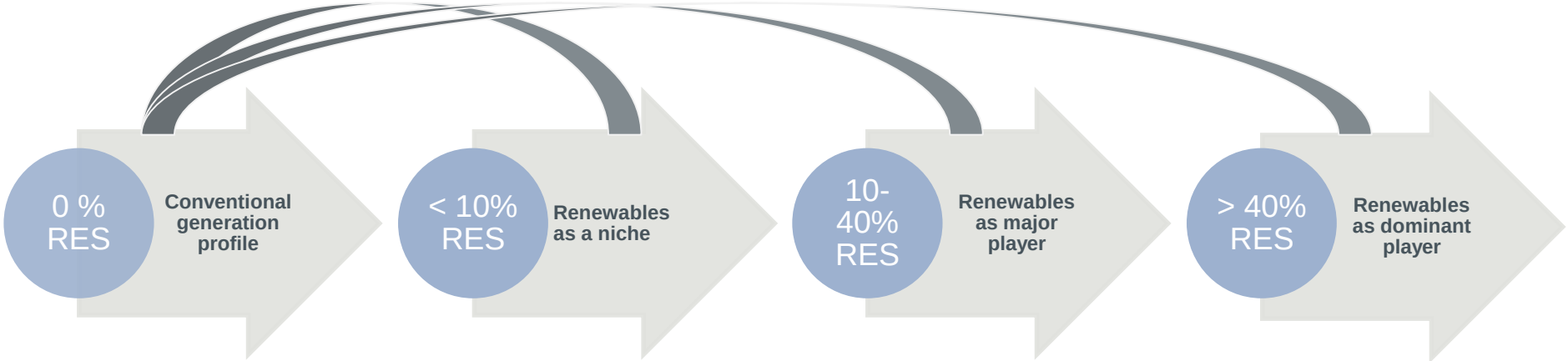
Congestion management

Load frequency control

Voltage stability control

- Needs for alternatives flexibility means

System transformation: Major milestones



System operations : “Business as usual” PLUS be prepared for the future

Enhance generation management

Grid code fit for RE generation

Further develop and use forecasts

Develop processes for information exchange, billing and accounting for RES

System security is not yet affected

Forecasting instruments

Grid reinforcement

Real time data exchange and controllability of RES

RES contribution to ancillary services

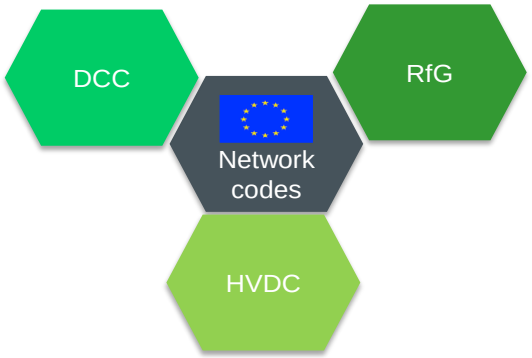
Full steering of conventional plants and RES

Substantially develop demand-side response

Real-time coordination between transmission and distribution

Paving the way toward system transformation

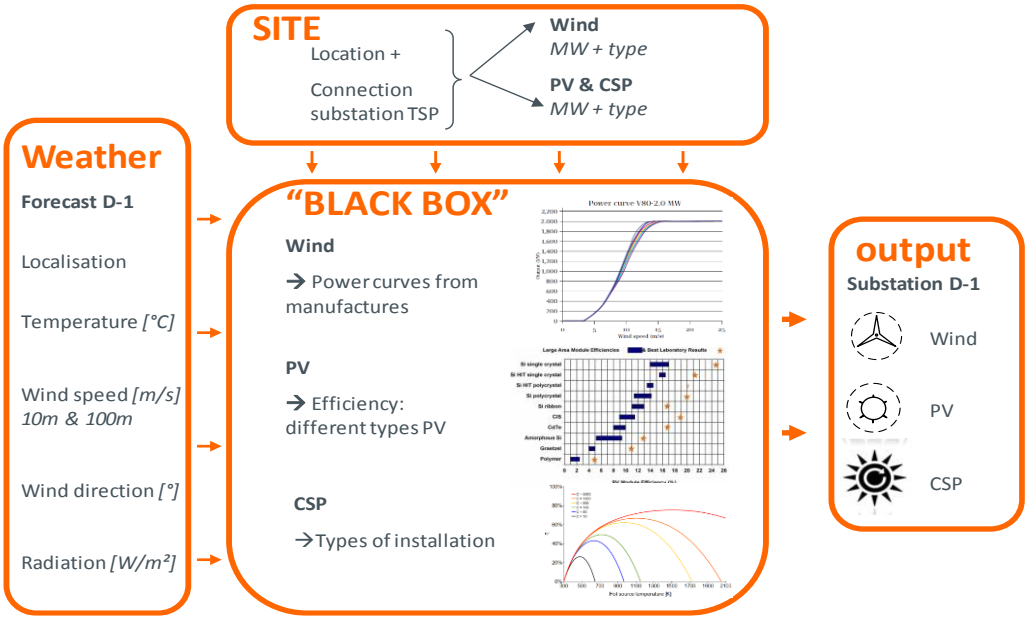
Harmonized state of the art grid codes



Grid Connection Related Codes

- Integration of new market players and leveraging flexibility
  - Demand units as significant Grid User
  - Level playing field for ancillary services:
    Voltage support
    Balancing and frequency support
- RES enhancing system not a burden
  - Controllability of active /reactive power to address congestions and participate in ancillary services
  - Maintain system robustness: FRT capabilities, fault-current support
  - Decentralized emergency and restoration functions (islanding, black start…)

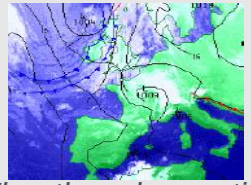
HL Renewable forecasting tools



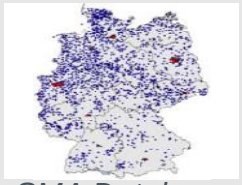
Key insights

- Power is aggregated per electrical node / operating region
- Indication of power decrease and increase ramping (MW / min) can be estimated eg for dust & sand storms
- Use different models to estimate power output:
  - ✓ Have redundancy of forecasts
  - ✓ Overall better performance

Forecast of PV generation

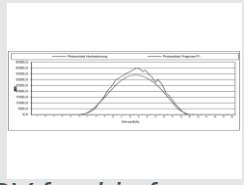


Wheather observation



SMA Database

Conversion to power



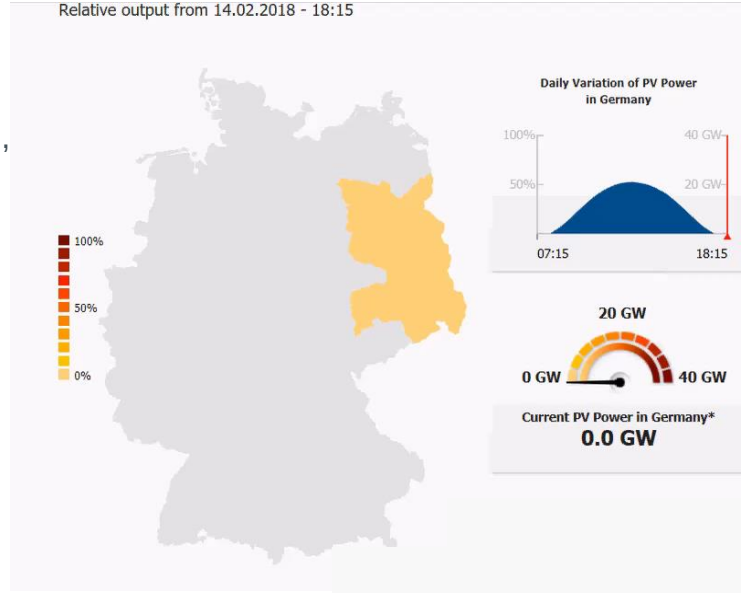
PV feed-in forecast

External input of meta-forecast:

- Solar power forecast 5 suppliers (EnergyMeteoSystems, Meteocontrol, Enercast, EnergyWeather, Meteologica) (in operation)
- Areas: Germany, 50Hertz, DSO regions and substations
- Horizon day-ahead <= 96 hours; horizon short term <= 8 hours
- 3 daily updates; ¼ hour short-term updates

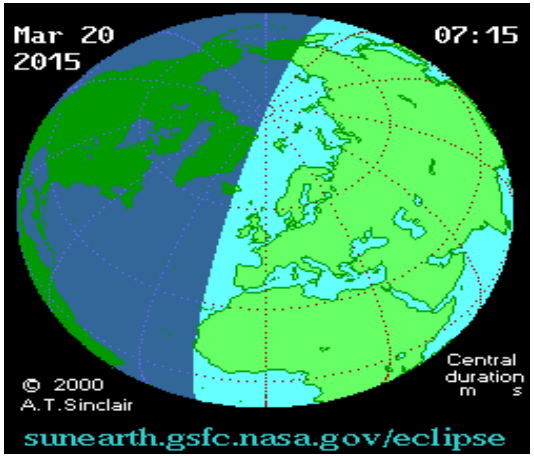
Combined Forecast with weighted experience by 50Hertz

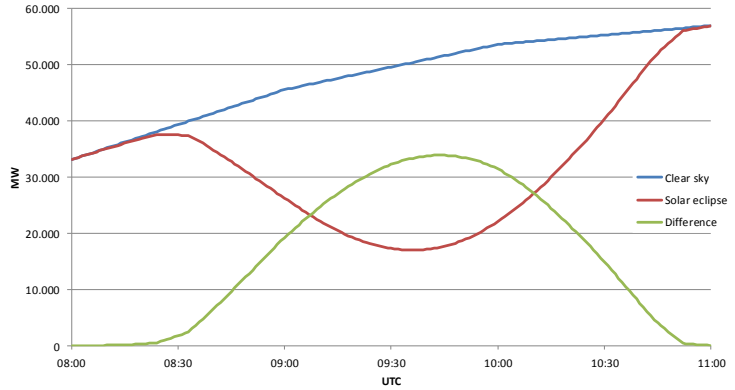
- Linear combination of commercially available forecasts and internal data from extrapolation

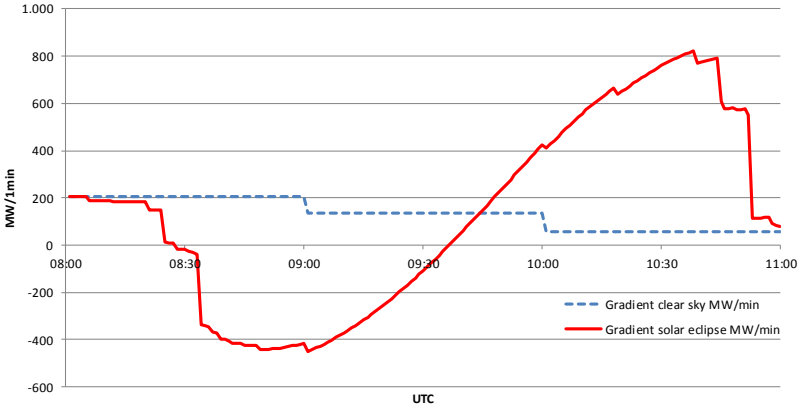


Accuracy of D-1 solar forecast has reached 1-2% Root Mean Square Error (RMSE), excluding night hours per week

Exceptional scenarios: Solar eclipse 20 March 2015







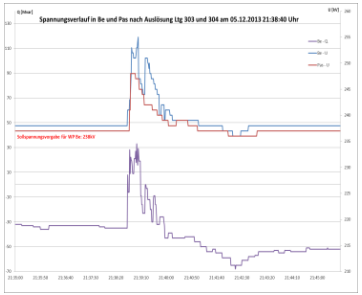
Highest impact at 9:43

- Germany (50%)
- Italy (21%)
- France (6%)
- Spain (4%)
- Belgium (4%)

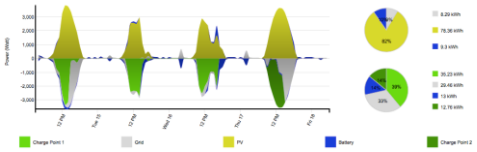
50Hertz mastering operational complexity and coordination

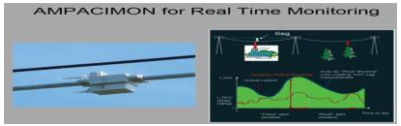
Innovative solutions

Self-healing network

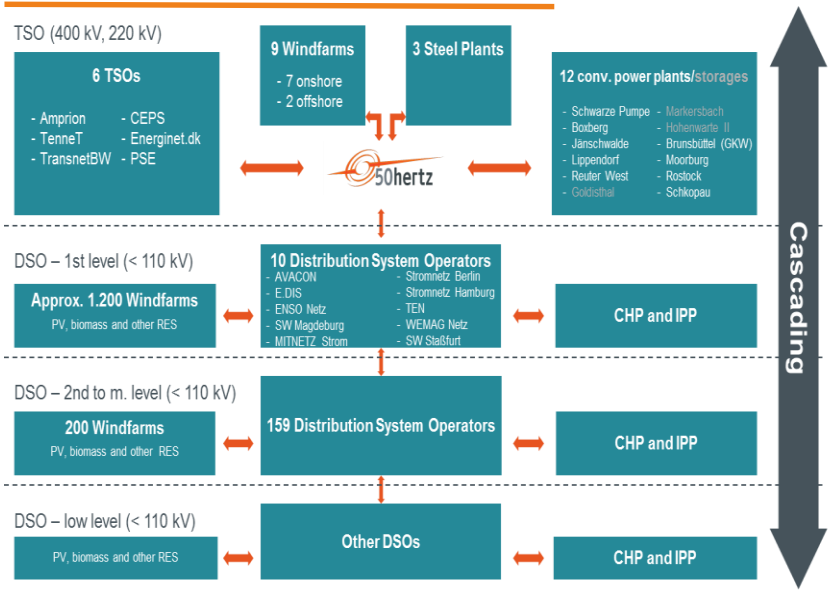


Intelligent network





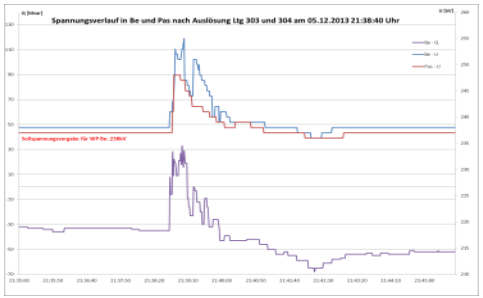
Coordination



Better Coordination between generation, regional and National Control Centres

Innovative approaches towards system and market integration of renewables

Example voltage control



- Storm „Xaver“2013/12
- After a loss of one two system line, wind park brings voltage back to the initial level
- Special protection schemes

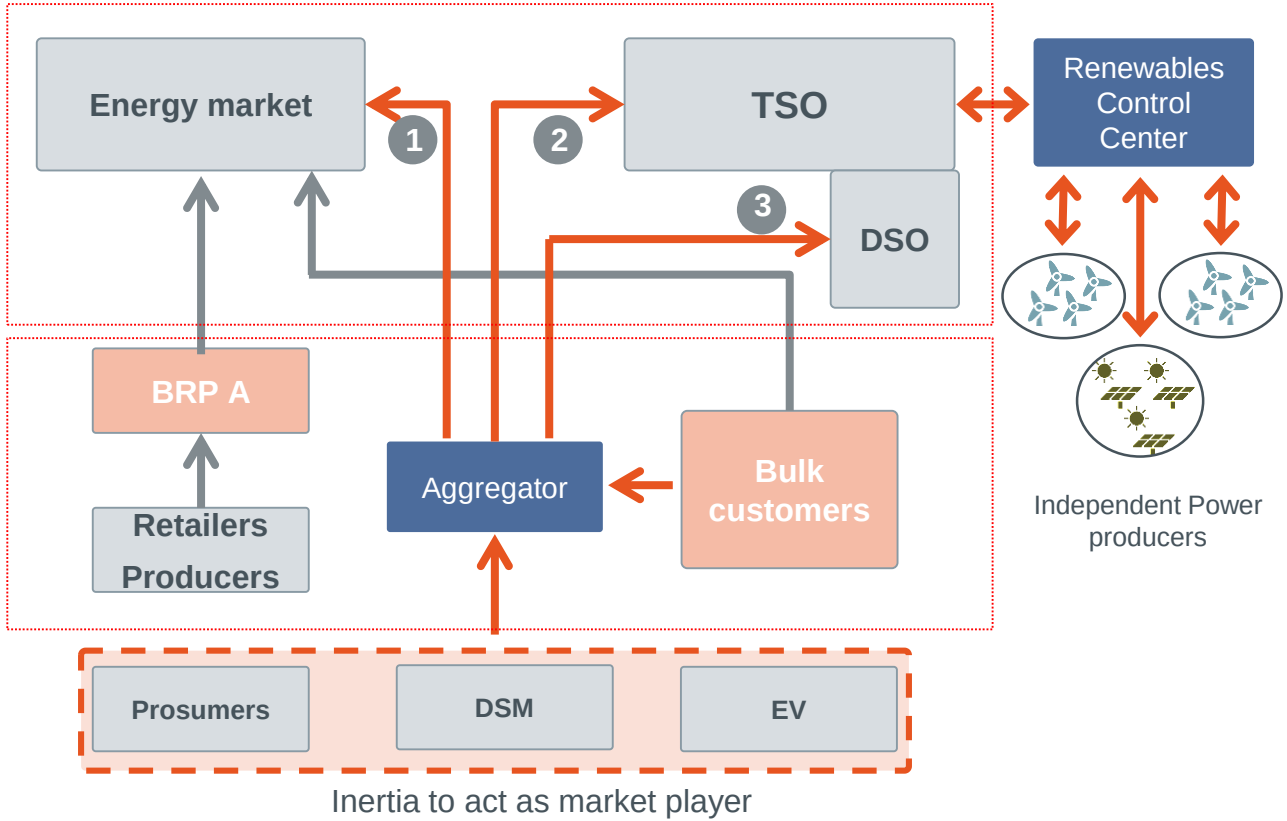
Example flexibility

- 5 batteries in the area of 50Hertz provide frequency control
- E-mobility as peak shaving solutions possible in the future
- Industrial client providing frequency control

Example negative control power

- February 2016: Prequalification of two wind farms (60 MW) for tertiary reserve by 50Hertz
- RE generation have already good downward regulation potential

New actors toward system flexibility



Business case: Aggregator

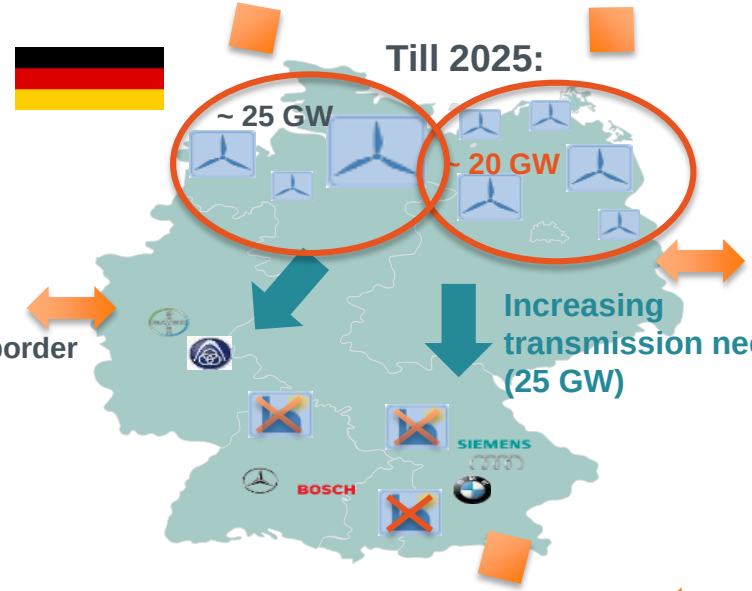
1) **Peak shaving of Day Ahead market prices**
   By shifting the consumption towards hours with lower prices, customers can reduce their energy cost. Participation in the capacity market could also be a source of revenue.
2) **Offer balancing services to the TSO**
   Different kinds of reserves can be sourced from TSO or DSO connected demand
3) **Congestion management and voltage control for the DSO**
   By using flexibility, DSOs can avoid grid reinforcement investments

Business case: RenCC

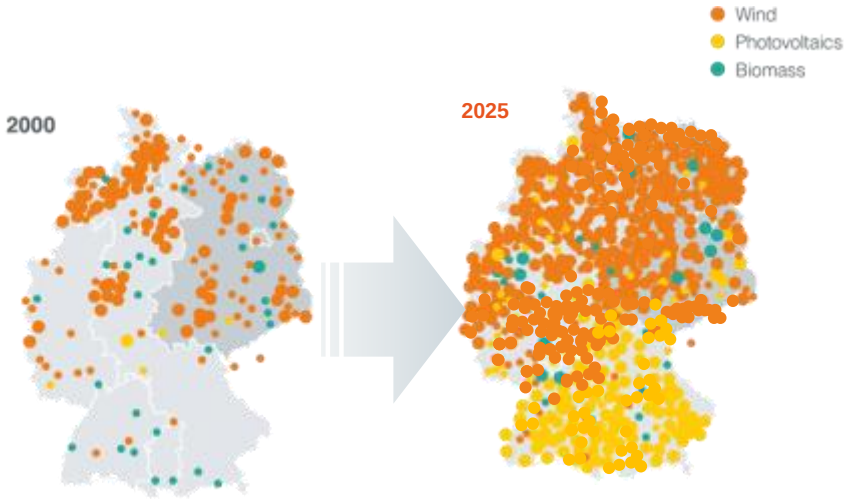
- **Services to TSO**
  Provide aggregated **forecasts** of RES production and offer controllability
- **Services to RES producers**
  Assist with connection requirements and system integration

RES and grid development the in Germany

Bulk transmission level



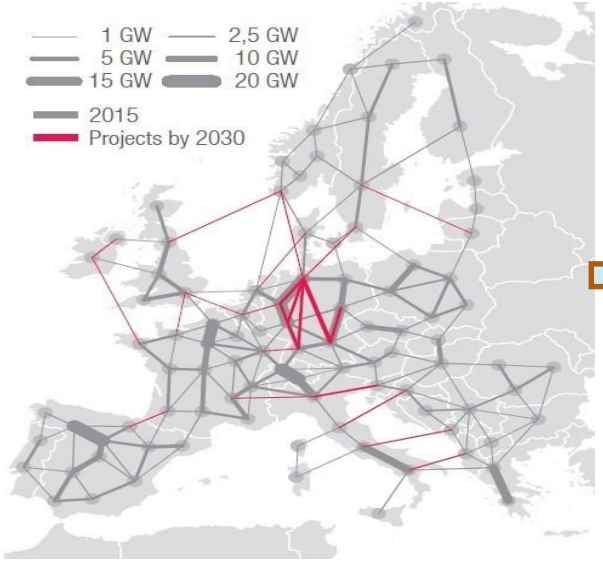
Decentralized level



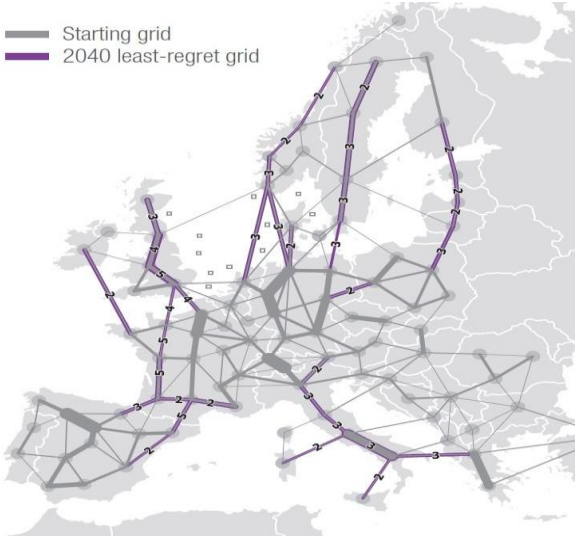
Development of 3 North-South HVDC corridors
Reinforcing backbone transmission network
Reinforcing cross-border interconnections

Massive DG RES (currently more than 1.6M units)
Reinforcement at distribution level

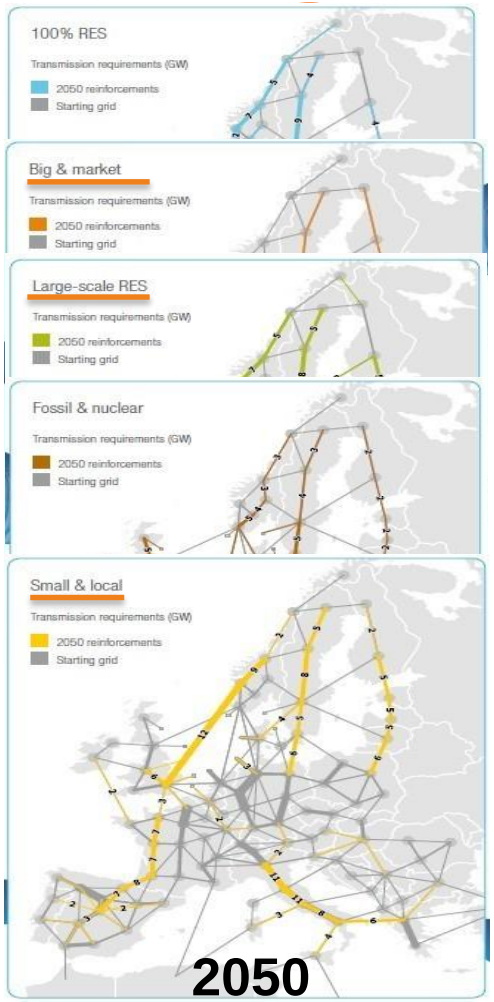
Pan-European: Network Development Plan



2030

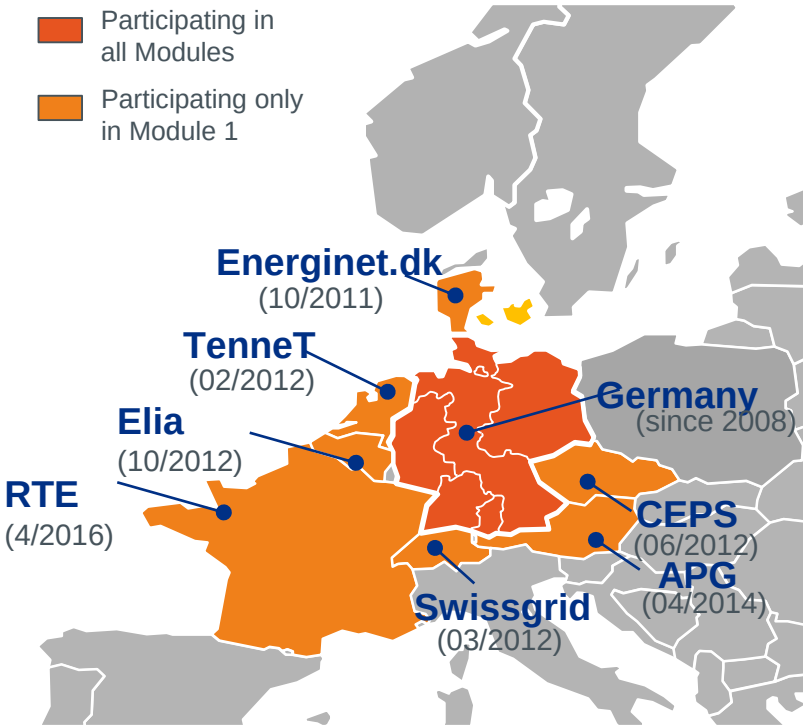


2040



2050

Toward full market integration and coordination



Grid control cooperation – functioning in four modules

- **Module 1:** Avoid activation of secondary control power in the opposite direction
  → reduction of secondary control energy
- **Module 2:** Joint dimensioning and mutual support with secondary control power among participating TSOs
  → reduction of secondary control power
- **Module 3:** Joint activation procedures: Activation signal will be provided by that TSO where the generator is connected
  → one common market area
- **Module 4:** Common Merit Order List or common control energy prices
  → further cost optimization

GCC – IGCC – full harmonized German market cooperation of TSOs to avoid activation of aFRR

So far RE has been a driver for improvement !

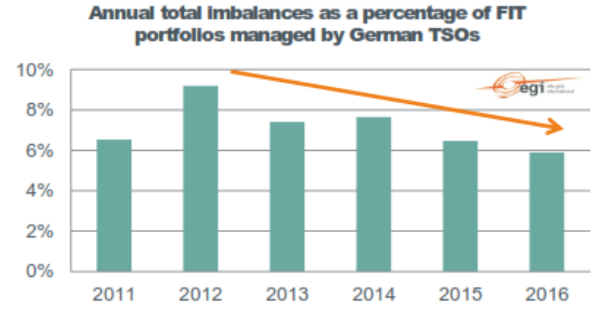
Enhancing RE generation forecasting

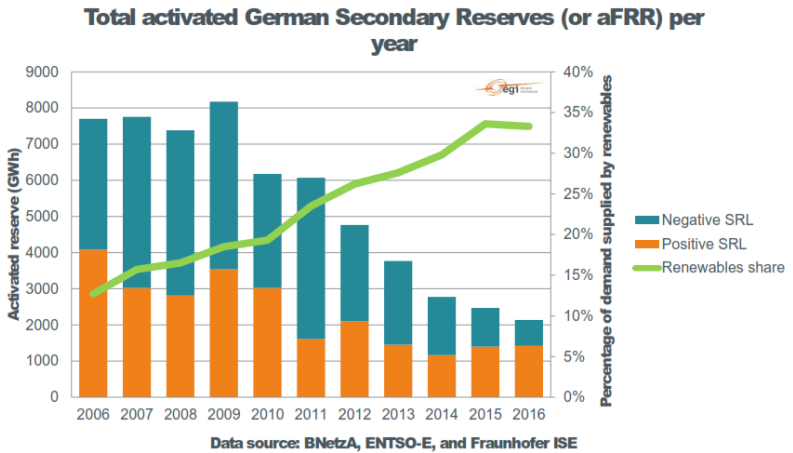
Enhancing system controllability and observability

Enhancing system flexibility and grid development

GCC – full harmonized German market

IGCC – cooperation of TSOs





Thank you for your attention

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