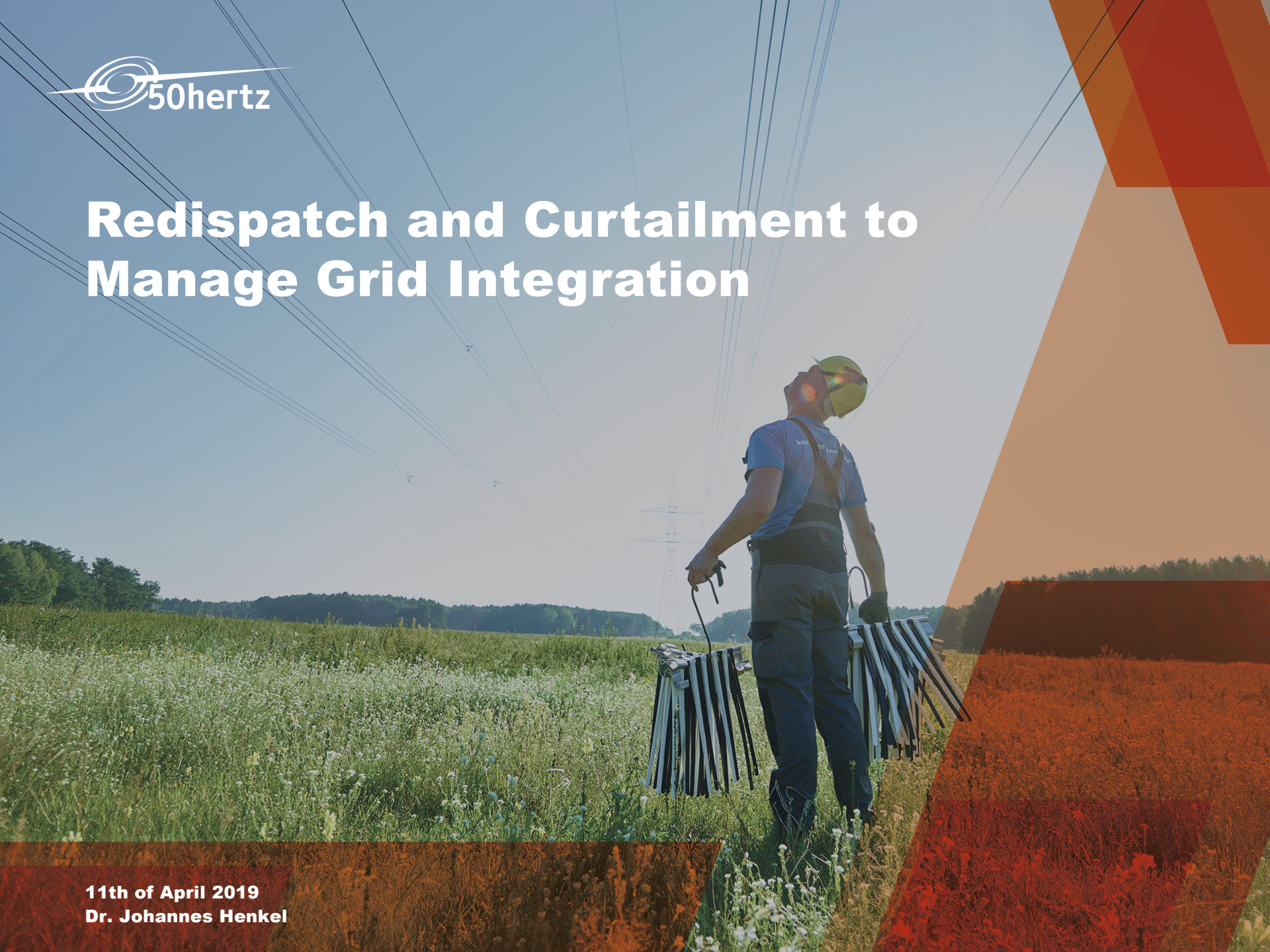
Redispatch and Curtailment to Manage Grid Integration



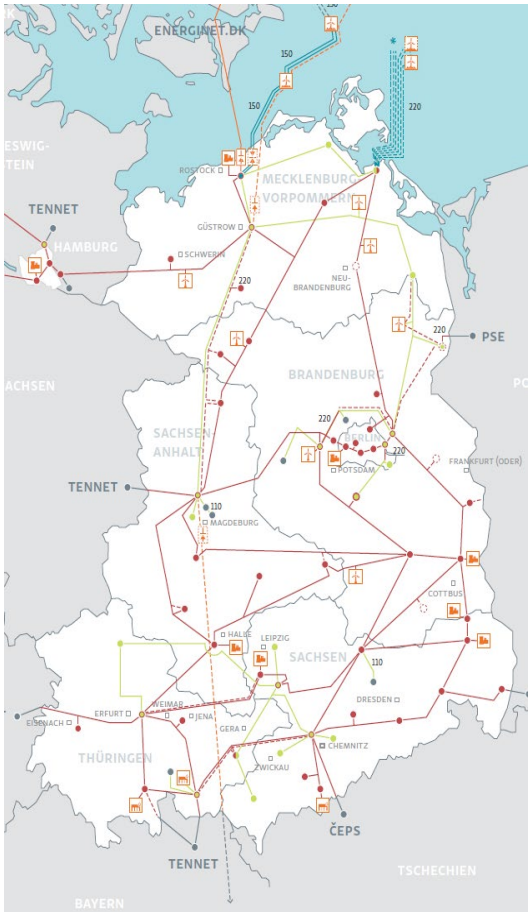
11th of April 2019

Dr. Johannes Henkel

Agenda

1. **Introduction 50Hertz**
2. Integration of Renewables – Market Design
3. Integration of Renewables – Grid
4. Conclusions

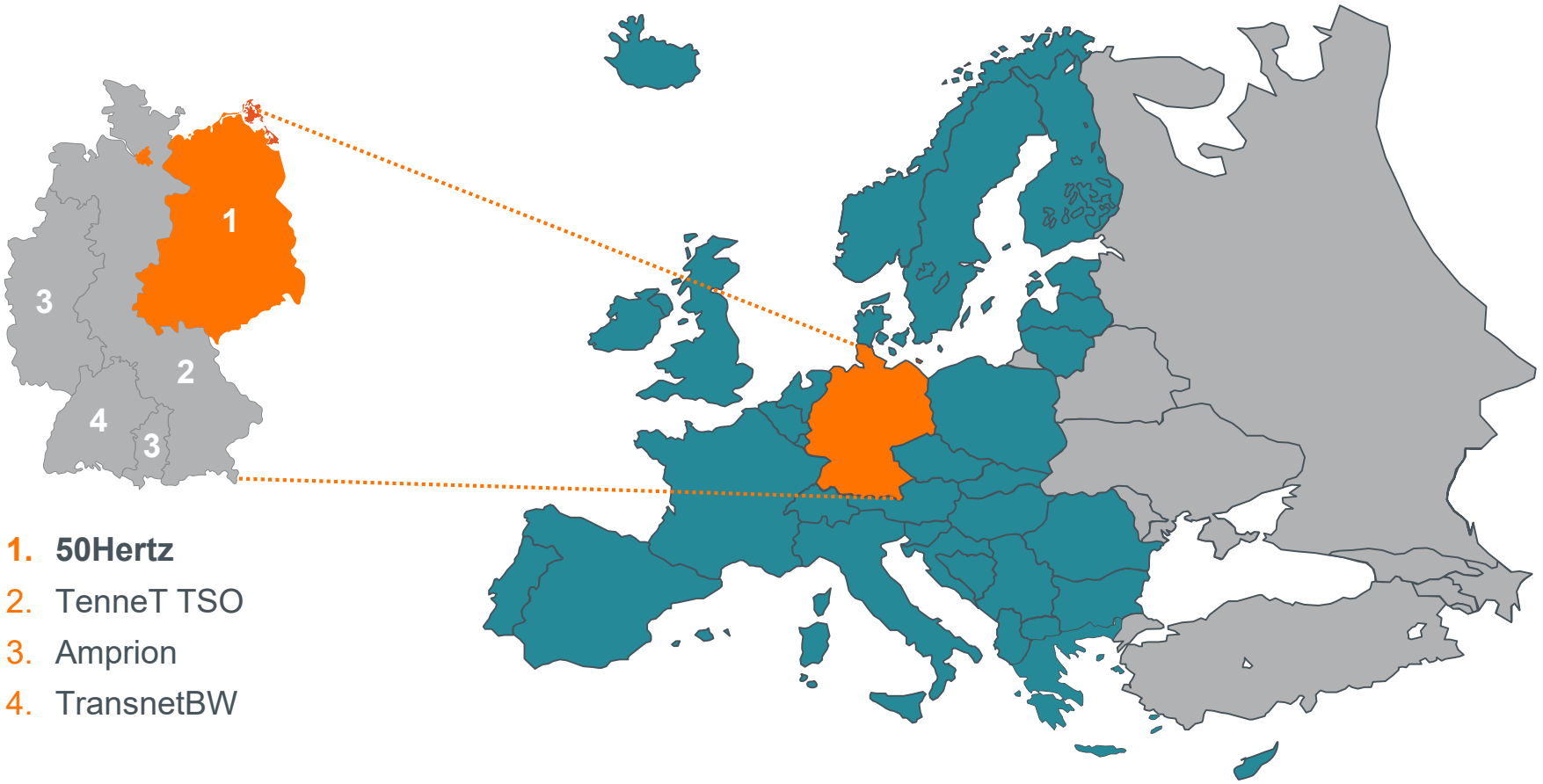
50Hertz at a glance



	2010 (share Germany)	2017/18 (share Germany)
Grid area	109,589 km² (~31%)	109,619 km²(~31%)[1]
Length of lines	9,800 km (~30 %)	10,200 km (~30 %)[1]
Max. load	~ 17 GW (~20 %)	~ 16 GW (~20 %)[1]
Power consumption (based on electricity supplied to end-consumers in acc. with Renewables Energy Law „EEG“)	~ 98 TWh (~20 %)	~ 96 TWh (~20 %)*
Installed capacities - of which Renewables - of which Wind	38,354 MW (~35%) 15,491 MW (~30%) 11,318 MW (~40%)	54,069 MW (~26%)[1] 32,931 MW (~29%)* 19,403MW (~35%)*
RES share in power consumption	~ 25 %	~ 55.0 %*
Turnover - of which Grid	5.6 bn. € 0.6 bn. €	9.9 bn. €[1] 1.3 bn. €[1]
Employees	643	1,043[1]

Source: 50Hertz; [1]as of 31/12/2017; *preliminary data; as of 08/01/2019

50Hertz as part of the European Electricity System



1. **50Hertz**
2. TenneT TSO
3. Amprion
4. TransnetBW

Transmission grids are the technical backbone of the energy supply in Germany and in Europe

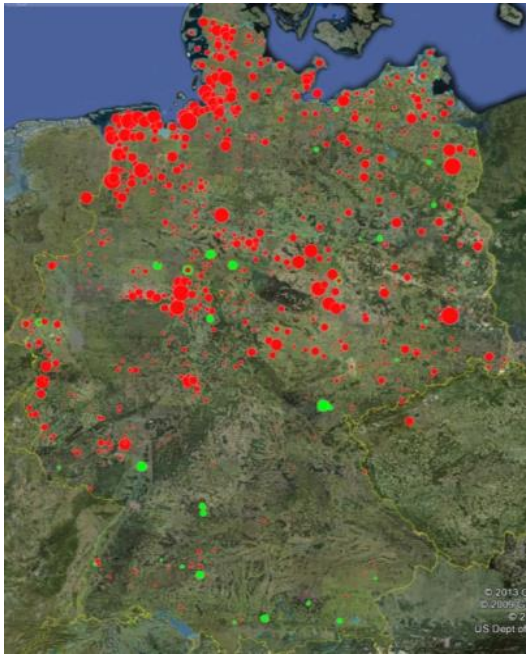
 Transmission grid ownership	In charge of operation, maintenance and the development of **extra-high-voltage lines** and **power junctions** (substations) as well as for the connection of **large-scale generators** and **consumers** (including offshore)
 System operation	Responsible for system security: **system stability** of the transmission system around the clock: frequency control and voltage regulation, congestion management.
 Market development	Catalyst for the **development of the energy market**, especially in Northern and Central-Eastern Europe.
 Trusteeship	Responsible for managing cash flows **resulting from the Renewable Energy Law (EEG*)**.

Source: 50Hertz *German Renewable Energy Law

RES development in Germany

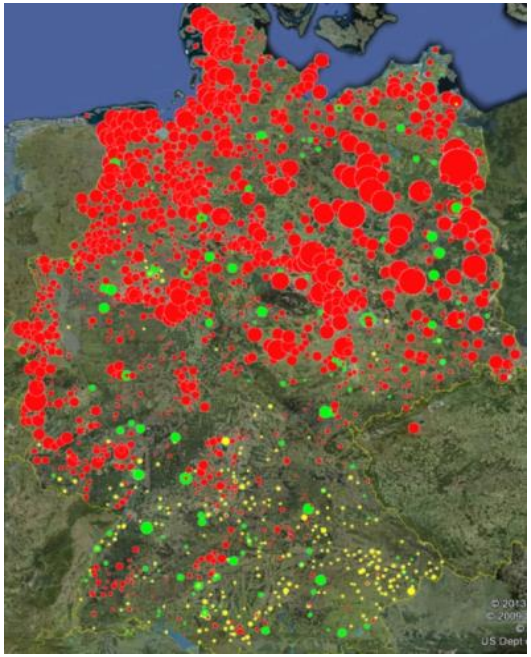
Area proportional to the installed capacities

2000



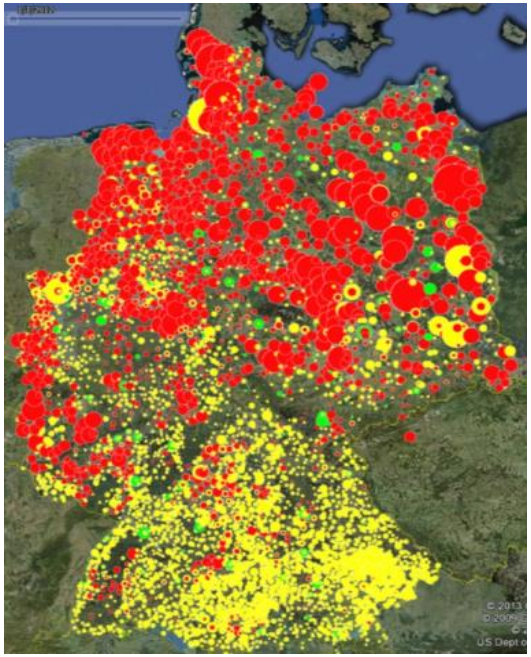
- ~ 30,000 plants
- 1,665* MW inst. wind in Germany

2006



- ~ 221,000 plants
- 2,233* MW ins. wind in Germany

2018



- > 1,600,000 plants
- 49,628* MW inst. wind in Germany
- 41,687* MW PV

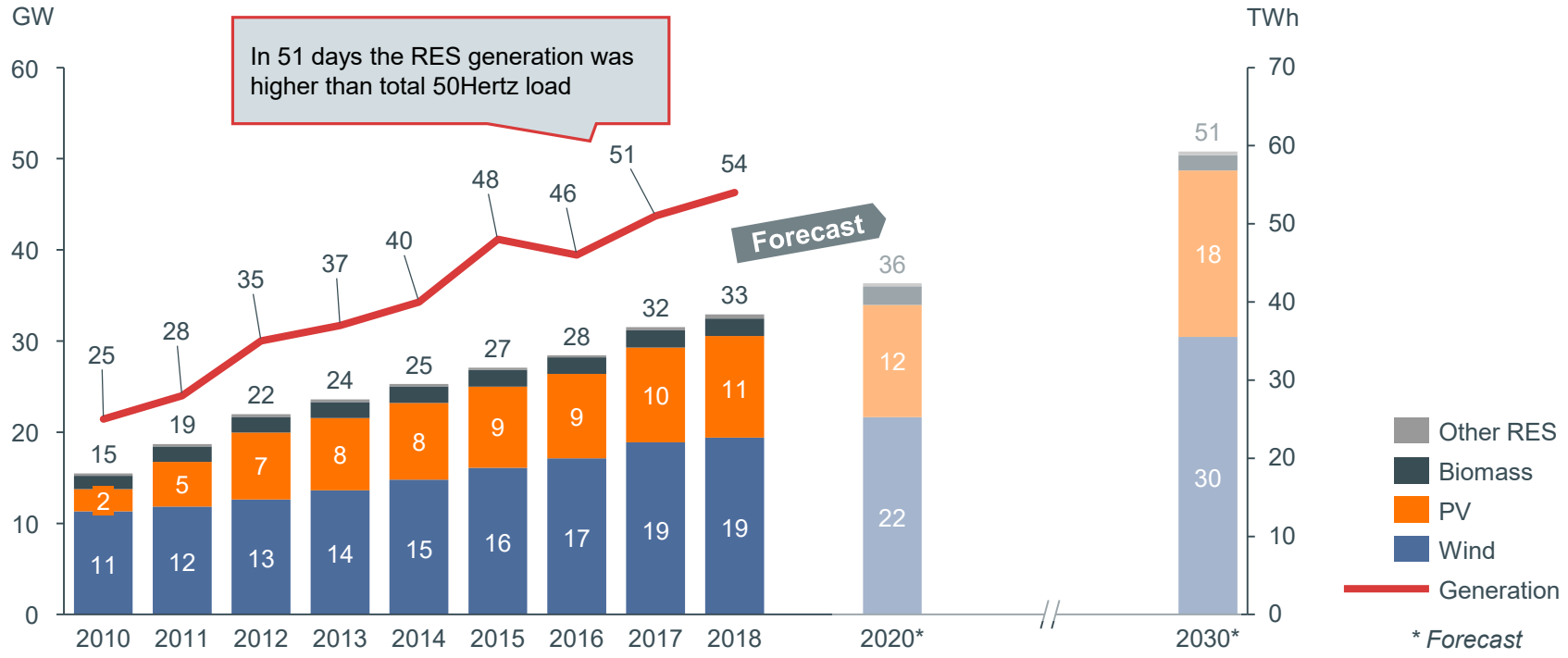
The implementation of the German Renewables Energy Law (EEG) led to a massive growth of RES in Germany.

PV Wind Biomass

Source: 50Hertz; 50Hertz, TenneT, Amprion, TransnetBW, Google Earth; *preliminary data

Installed RES capacity in 50Hertz area has doubled since 2010

Installed RES capacity and RES generation in 50Hertz



Electricity from RES covered ~55 % of consumption in the 50Hertz area. Thus Eastern Germany is a pilot region for the energy transition.

Source: 50Hertz

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The Introduction of the Feed-in-Premium in Germany created a large Incentive for better Forecasts

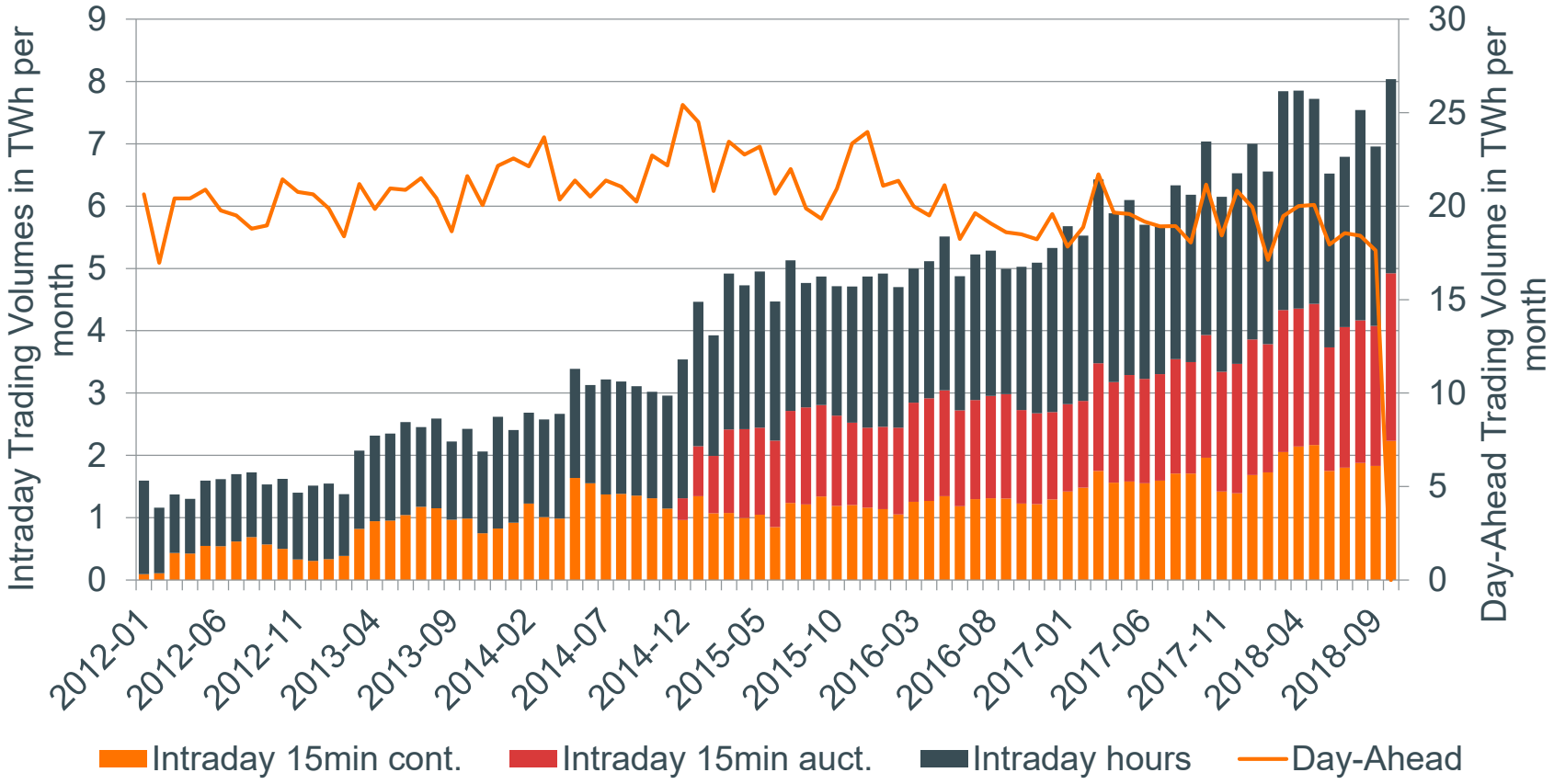
Promotion level, determined in auction

The market premium is determined monthly by the TSOs (ex-post). It is the difference of promotion level and the calculated market value for a certain month.

The market value is the average monthly wholesale price (Day-Ahead) weighted with an **average generation profile** (**technology specific**)

With the shift from FIT to FIP full balancing responsibility (forecast errors!) in hand of the generators

Electricity Trading Volumes in Short Term Markets are increasing strongly

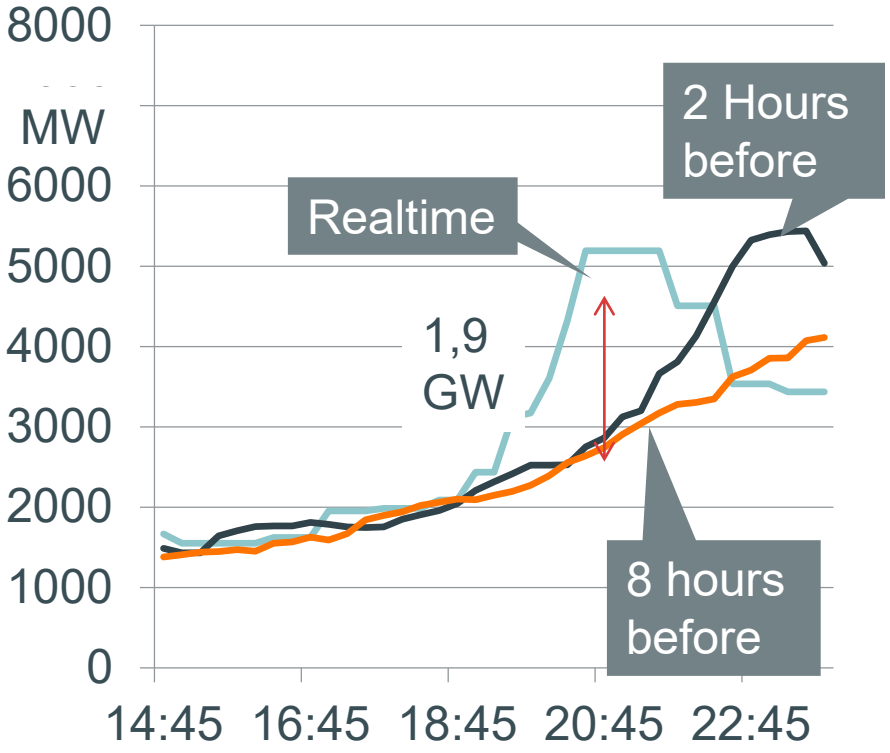


RES generators / aggregators have a strong incentive to be balanced and therefore correct all forecast errors in short term markets.

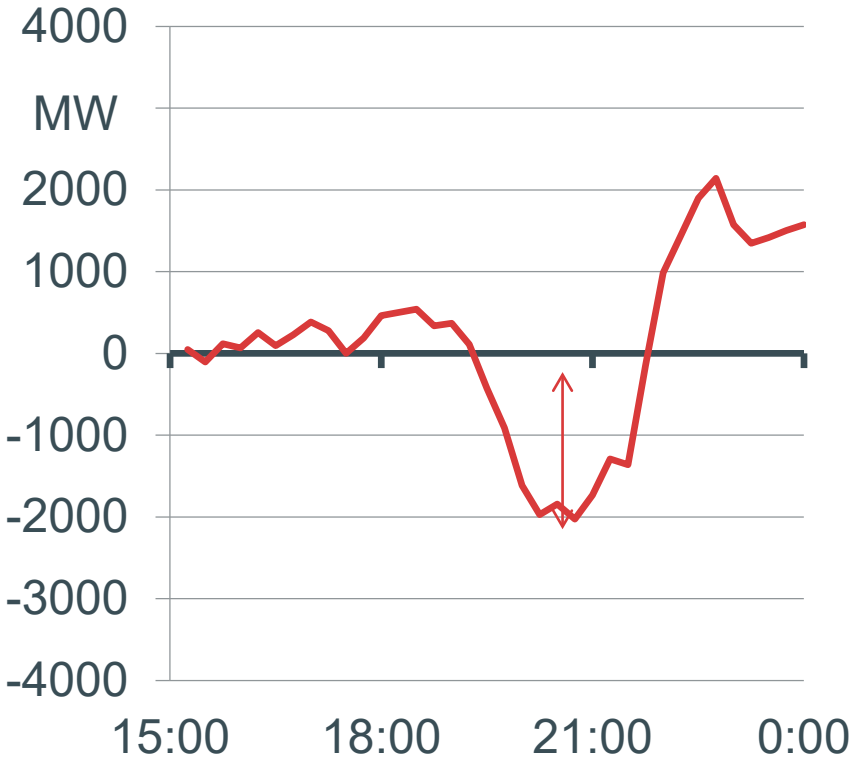
Ultra-short term volatility

Grid Situation Sunday, 2016/08/28

Wind Forecast



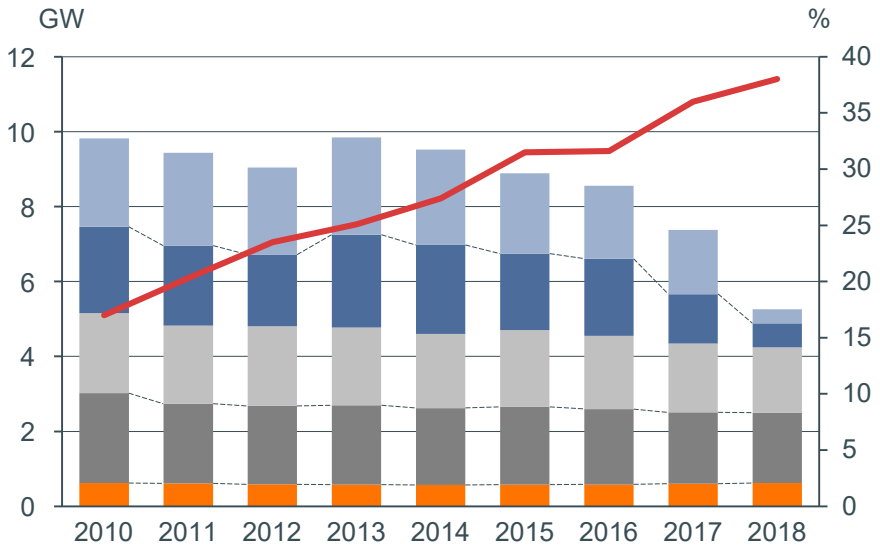
Balancing demand 50Hertz



- **The system must be able to react fast to changing forecasts**
- **Solution: Enhanced forecasts, short term trading**

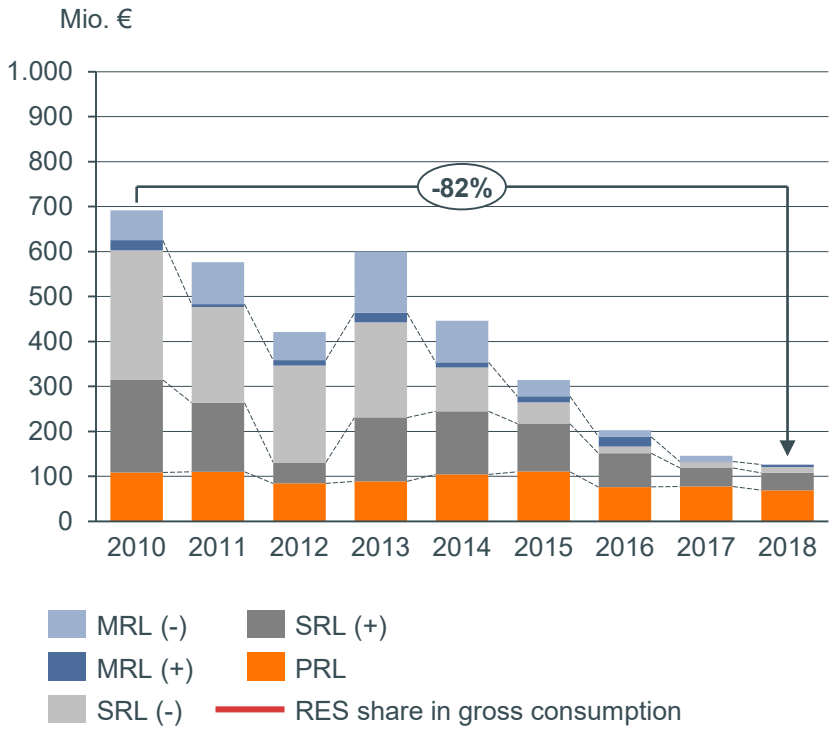
In Germany the necessary control power is decreasing in volume and costs

Control Power Provided [1]



German Control Power „Paradox“:
Despite increasing RES, demand for control power is decreasing

Costs of Control Power Provided [2]



Reason for the significant decrease is two-fold: Incentives for good forecasts (market design) as well as TSO imbalance netting (TSO process adaptation)

[1] total Germany, [2] only capacity costs, costs for activations not included.

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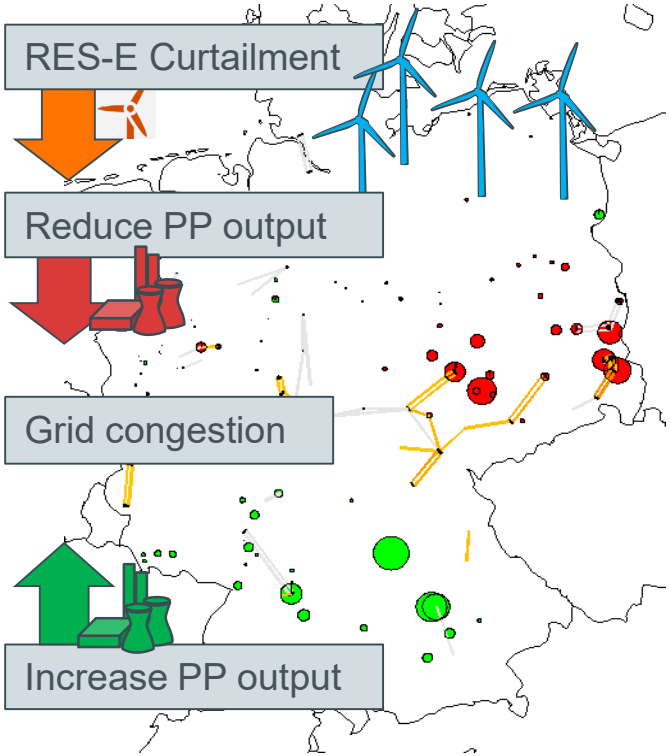
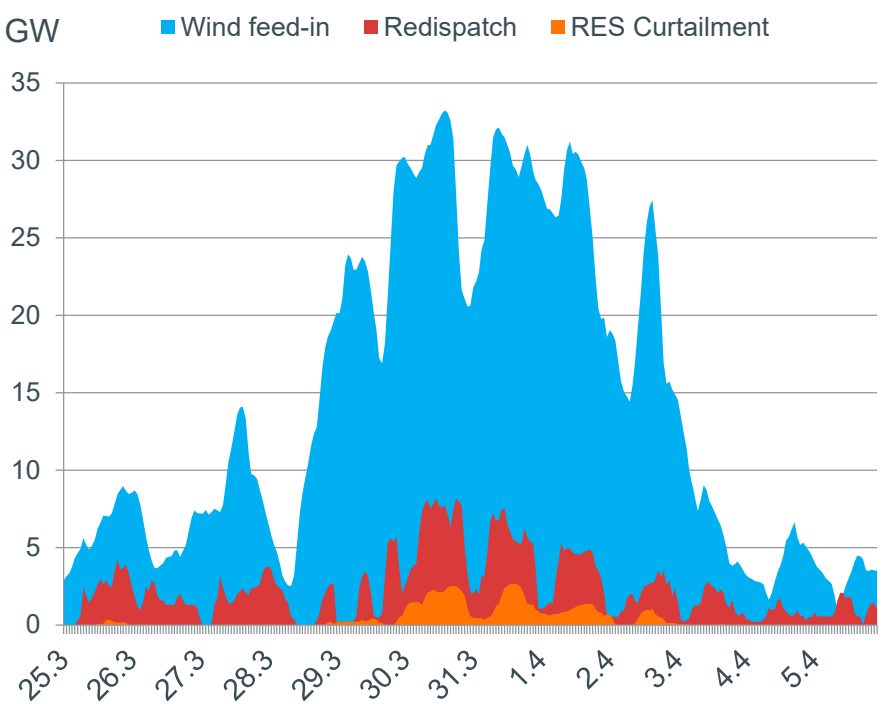
Grid congestion is addressed by redispatch and RES-E curtailment by TSO

German layout for congestion management



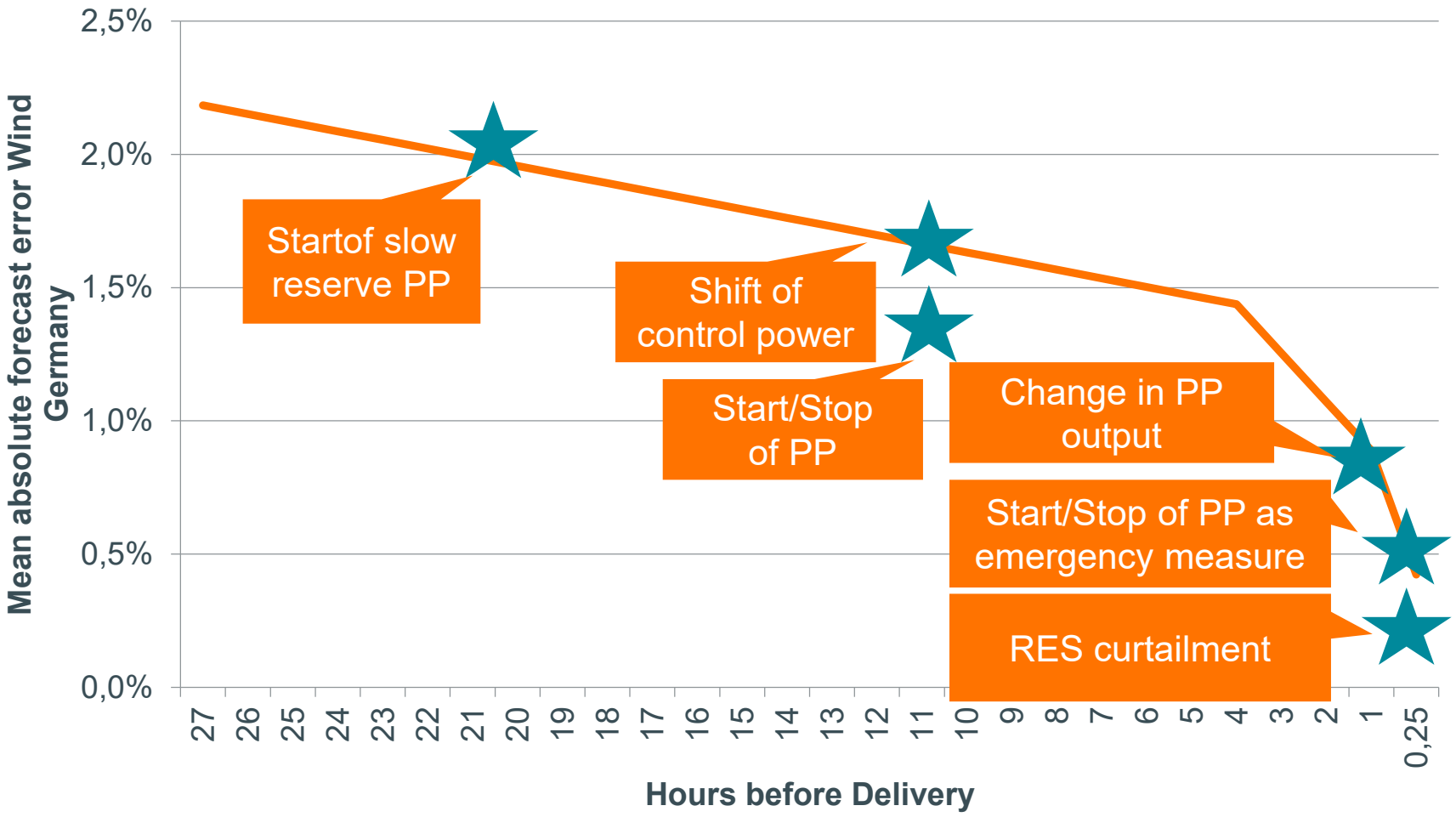
Wind feed in, redispatch and RES-E curtailment[1]



South bound grid extension and additional interconnectors are possible measures to address costly redispatch and RES-E curtailment.

[1] German real data from March and April 2015; Source: underlying map: IAEW, RWTH Aachen 2013; Data: 50Hertz

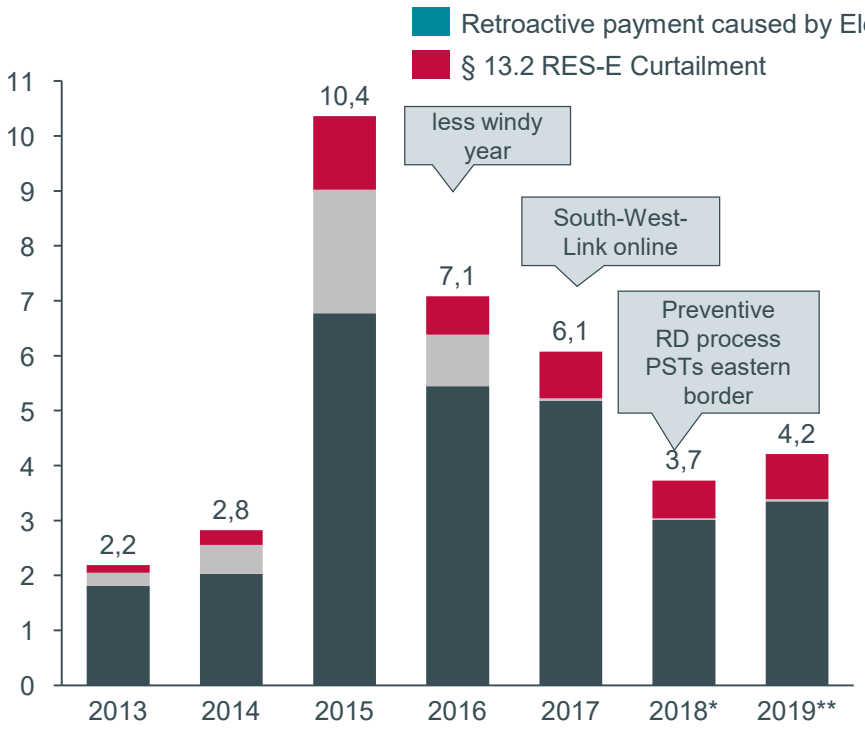
Redispatch: Action Options in Time



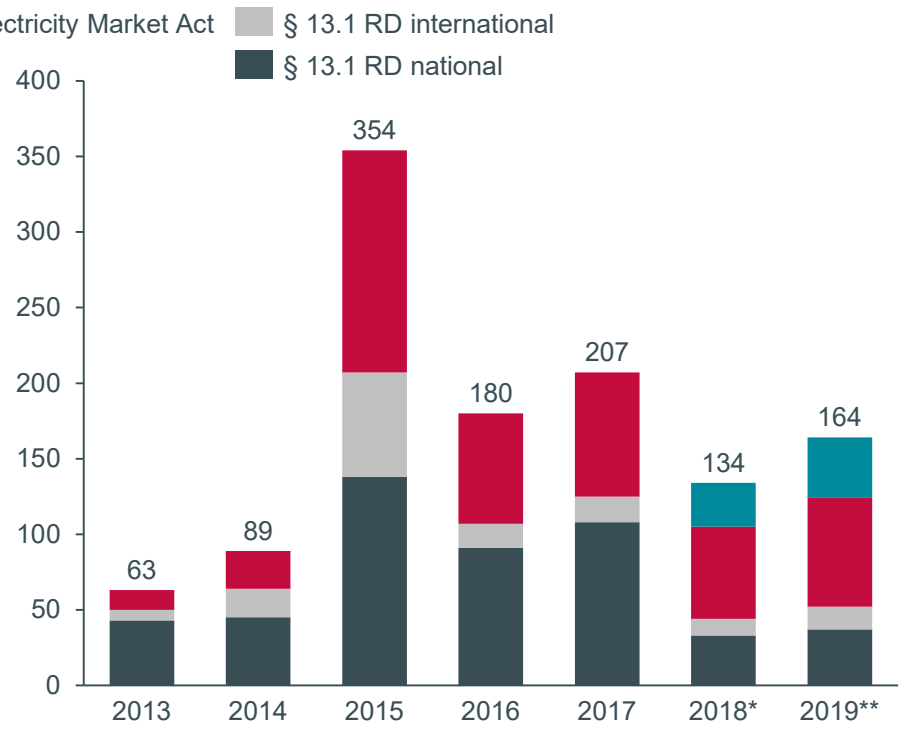
TSO Processes for Congestion Management

Congestion management in the 50Hertz area is declining due to grid expansion

Volume of redispatch and RES-E curtailment in TWh



Cost for redispatch and RES-E curtailment in million €



Stabilisation of RES curtailment and significant redispatch costs reduction in 2018 – despite an RES expansion of 2,400 MW.

Source: 50Hertz; *preliminary data, as of 28/01/2019 **prognosis data, as of 28/01/2019

Conclusions

- Integration of Renewables is supported by
  - Market design with the right incentives for good RES forecasts (short / medium term)
  - Efficient TSO processes like redispatch, curtailment and imbalance netting in order to adress balancing and congestion issues (short / medium term)
  - Grid extension where necessary (medium term / long term)
- Up to a certain limit, RES curtailment is efficient – as it is not economically viable to build grid for the „last kWh“

Thank you! Questions?

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