



Integrating Wind & Solar power in a Grid

ELIA GROUP INTERNATIONAL

A strong, reliable and sustainable partner

Symposium Getting Power from Wind and Sun

Tokyo, March 8th 2018



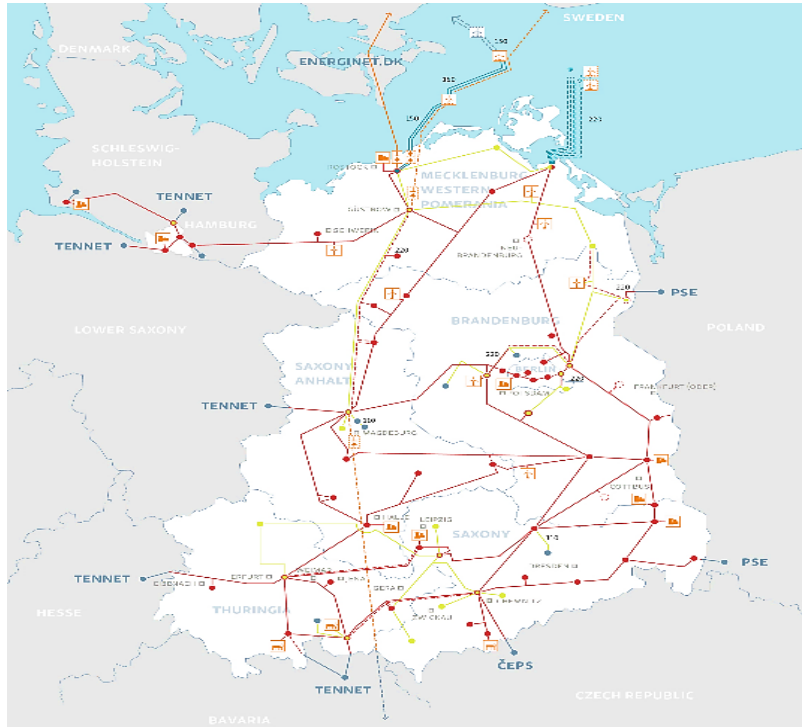
One Group

Two TSOs (transmission system operators) with International Activities



The Elia Group is expanding its international activities through Elia Grid International

50Hertz at a glance



Figures (50Hertz share in Germany) as of 2016/12/31

Grid area	109,589 km ² (~31 %)
Length of lines	10,215 km (~30 %)
Max. Load	~ 16 GW (~20%)
Power consumption (based on electricity supplied to end-consumers in acc. with Renewables Energy Law "EEG")	~ 96 TWh (~20 %)
Installed capacities:	
- of which Renewables	52,268 MW (~26 %)
- of which Wind	29,017 MW (~30 %)
	17,236 MW (~37 %)
RES share in power consumption	47.8%
Turnover	9.449 bn€
- of which grid	1.290 bn€

Activities of 50Hertz as a German TSO



Owner of the transmission grid

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 operator

Responsible for **system stability** of the transmission system around the clock: frequency control and voltage regulation, congestion management.



Market developer

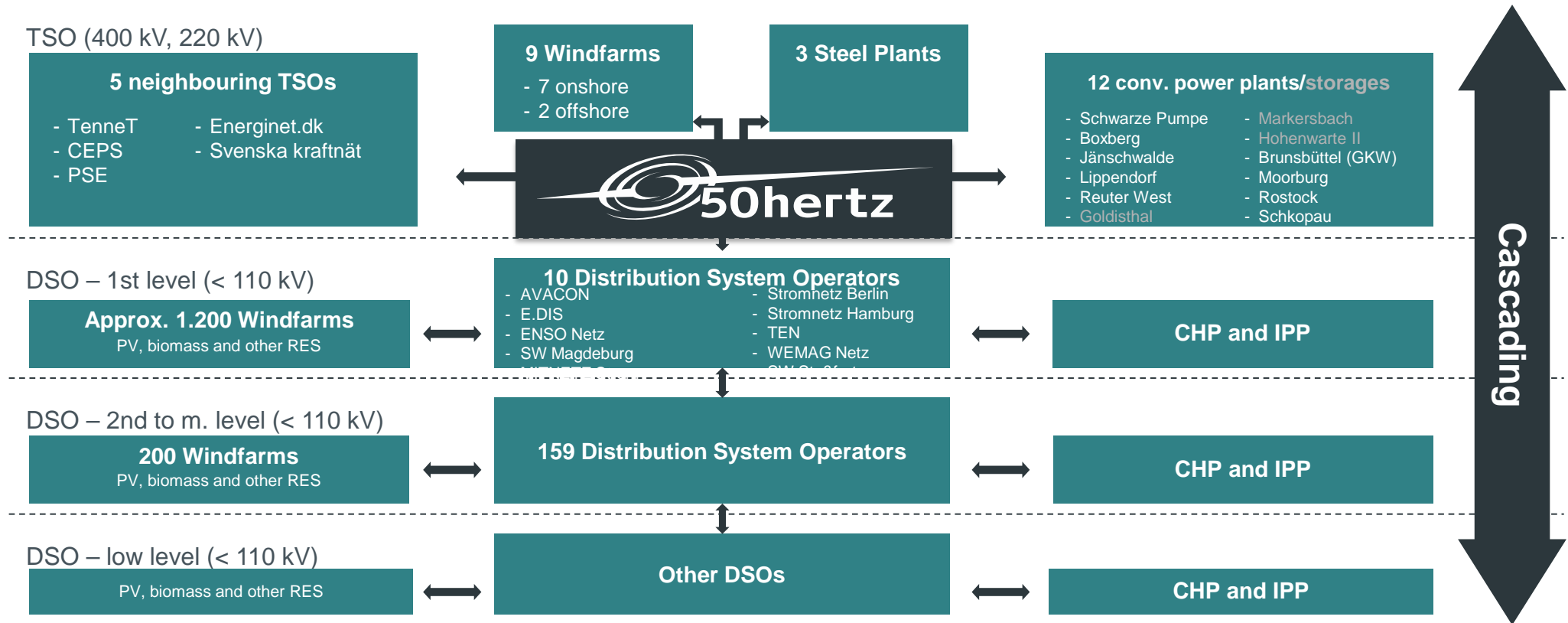
Catalyst for the **development of the energy market**, especially in Northern and Central-Eastern Europe.



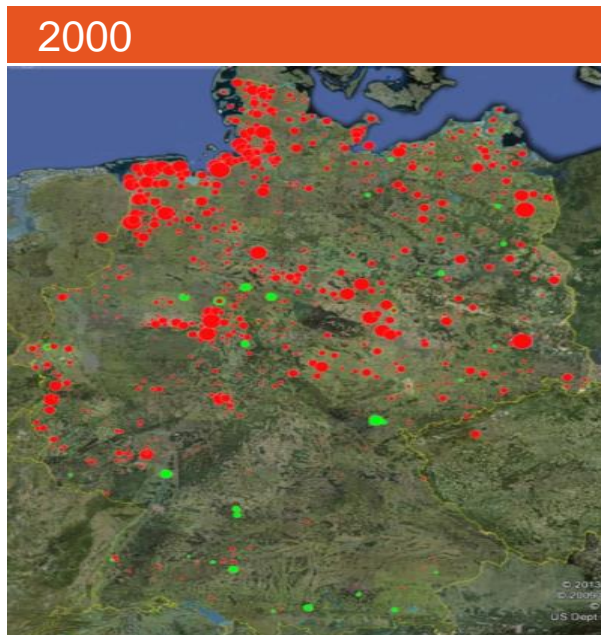
„Trustee“ for managing surcharge systems

Responsible for the **financial management of renewable energies (EEG)**.

The power system in the 50Hertz grid area



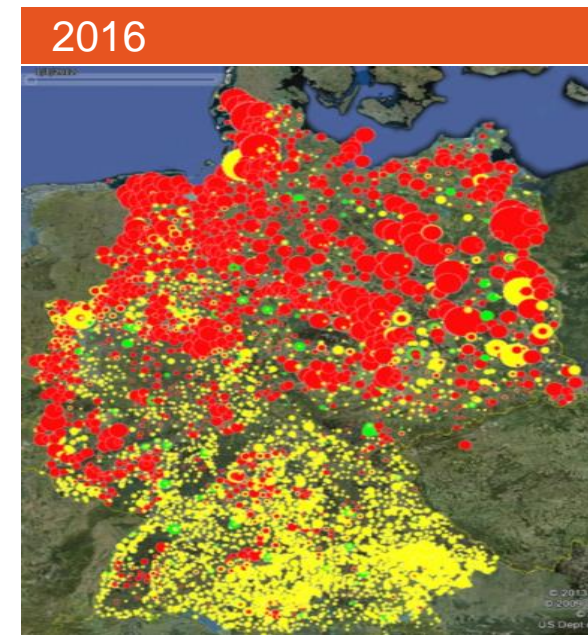
RES development in Germany



- ~ 30,000 plants
- 1,665* MW installed Wind in Germany



- ~ 221,000 plants
- 2,233* MW installed Wind in Germany



- ~ 1,600,000 plants
- 45,910* MW installed wind in Germany

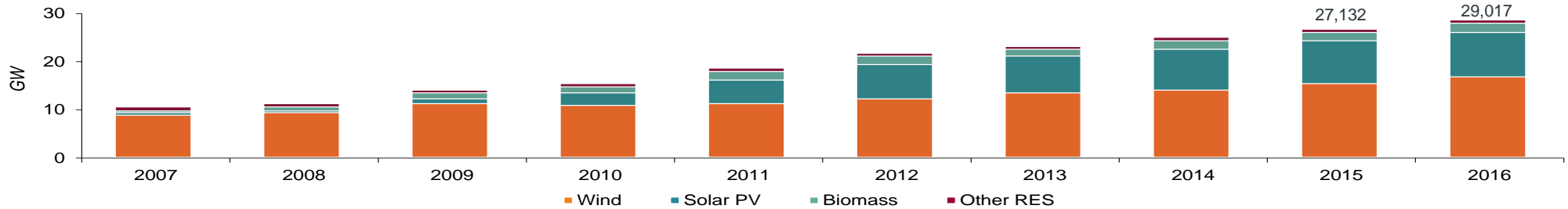
Massive RES growth in Germany since the introduction of the Renewables Energy Law (EEG) in 2000 – with Wind and PV as the main growth drivers

● PV ● Wind ● Biomass

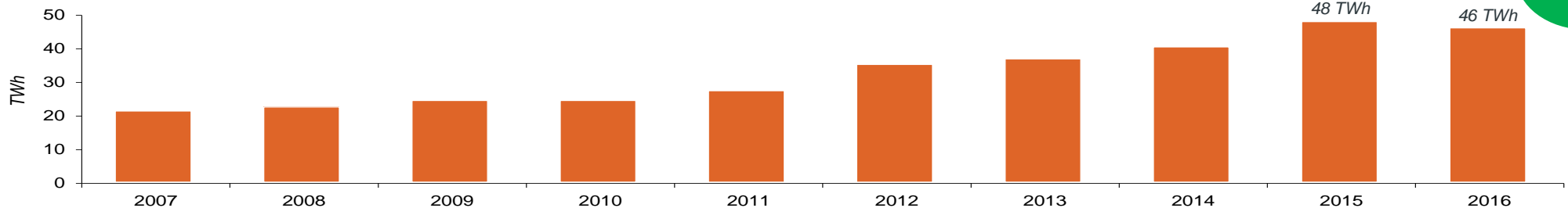
* BWE Figures

RES development in the 50Hertz grid area

DEVELOPMENT OF INSTALLED CAPACITIES IN THE 50HERTZ GRID AREA



DEVELOPMENT OF RES SHARE IN POWER CONSUMPTION IN THE 50HERTZ GRID AREA



≈ 48%

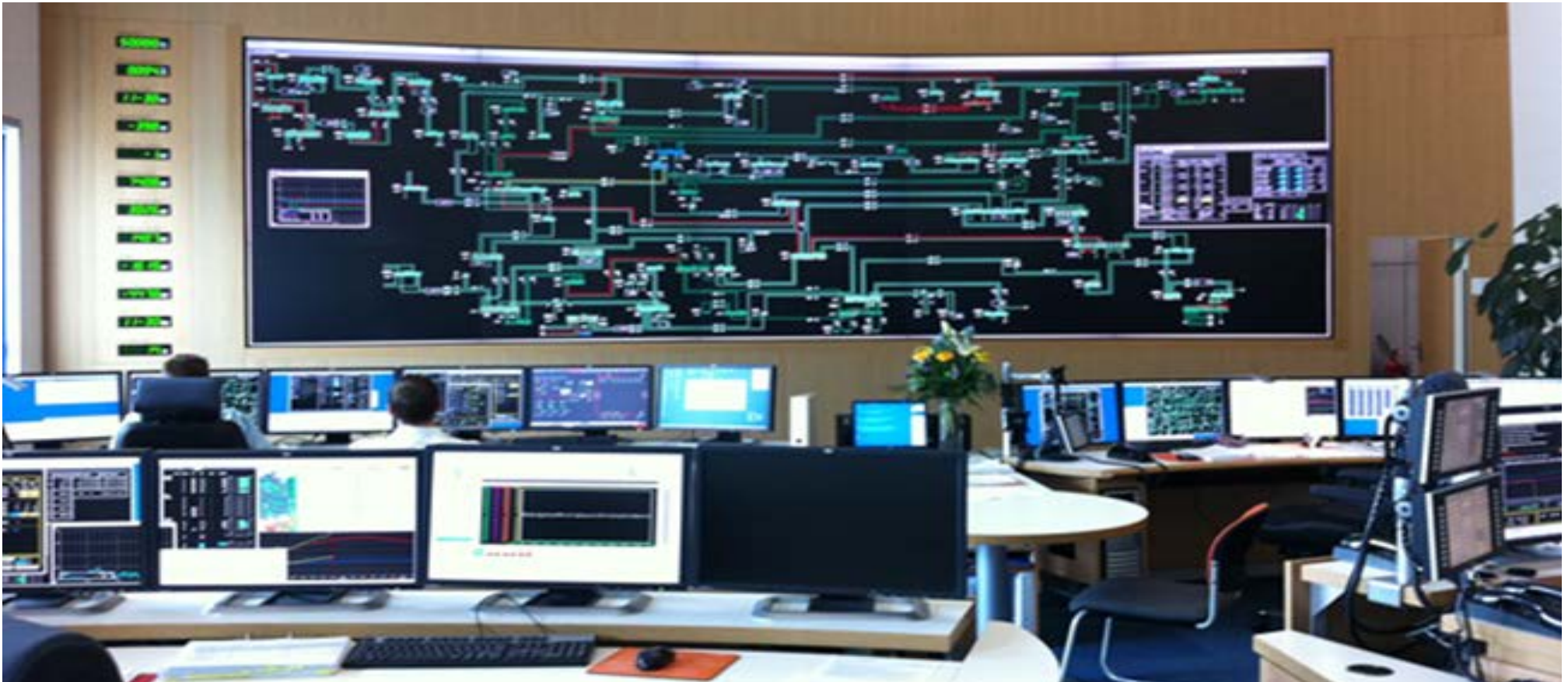
50Hertz is world-leading in the integration of intermittent RES with an integration rate of ~48% in 2016 – with respect to ~32% in Germany.

TCC – Visitors coming from all over the world



Since 2012 visitors from 70 countries have been in Neuenhagen

TCC Berlin – Control Room



50Hertz has been investing intensely in system operations and runs a state-of-the art system for well trained and highly reliable operators

Part of the 50Hertz IT-infrastructure builds the backbone of successful system operation




IT-Security & Governance



Business-IT Applications

Applications


- Energy Settlement
- Finance/Controlling
- Asset Management
- Commodities



IT-Infrastructure

Systems/Platforms

- Data-center Management
- Server-Management
- Database-Management
- Application Firewalls



Data-communication

Systems/Platforms

- IT-Network setup
- IP-System Management
- Data-Transmission Network Mgt.
- Telephony Mgt.



Network-Management-Center

Network

- 24x7 Network Monitoring & Management



Real-Time-IT Applications

Applications



- Scada Management
- Load Frequency Mgt.
- Data Exchange TSOs/DSOs
- Scheduling System Management

Challenges and solutions within system and markets


Current Situation

	Fast RES growth not synchronized with grid development		Shift “central” into a highly “decentral” energy landscape
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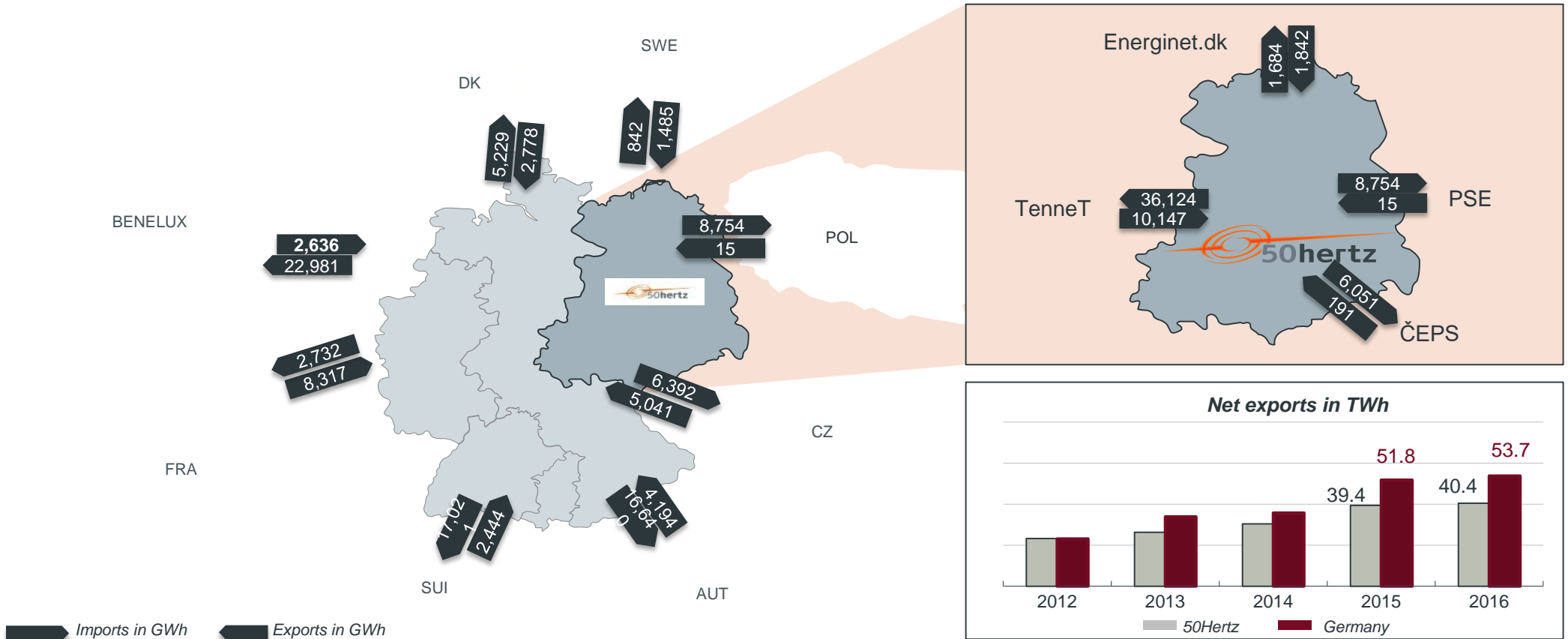
Resulting challenges

	Grid congestion		Decentralization with distributed generation and active costumers
	RES intermittency		Increasing energy costs for customers

50Hertz solutions

	Fast and efficient grid development		Innovative congestion management concepts
	Market development		Foster cooperation on EU level

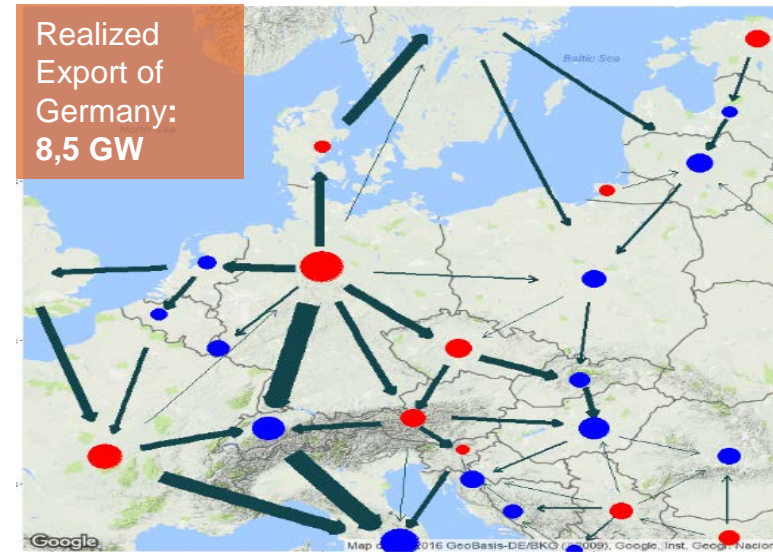
Physical imports and exports Germany and 50Hertz (2016)



50Hertz grid area is main exporter of electricity in Germany and Europe (~ 40 TWh).

Significant redispatch is needed – also cross border – to master congestion

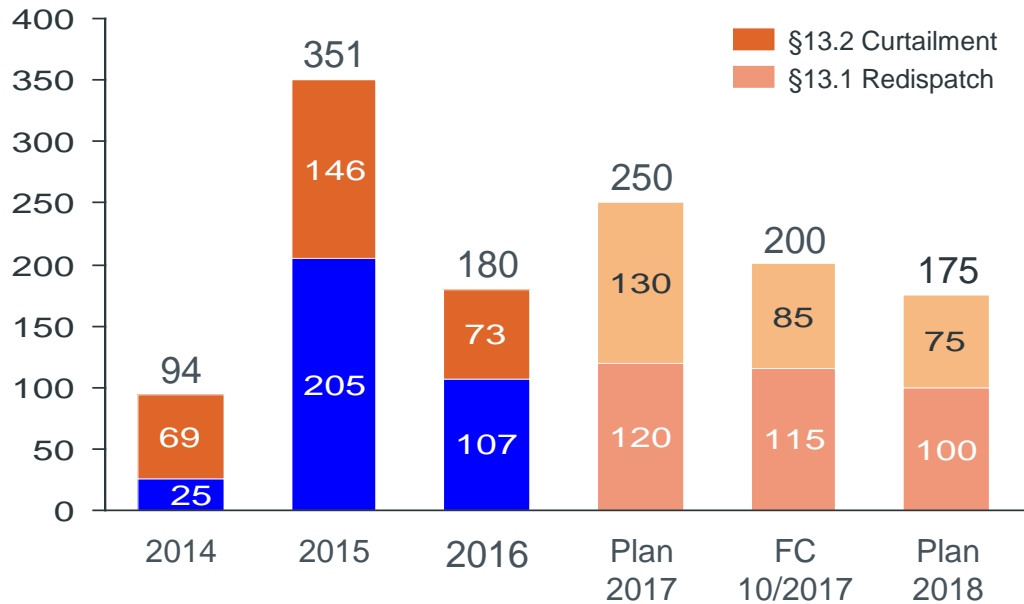
Scheduled flow versus physical flows (after redispatch)



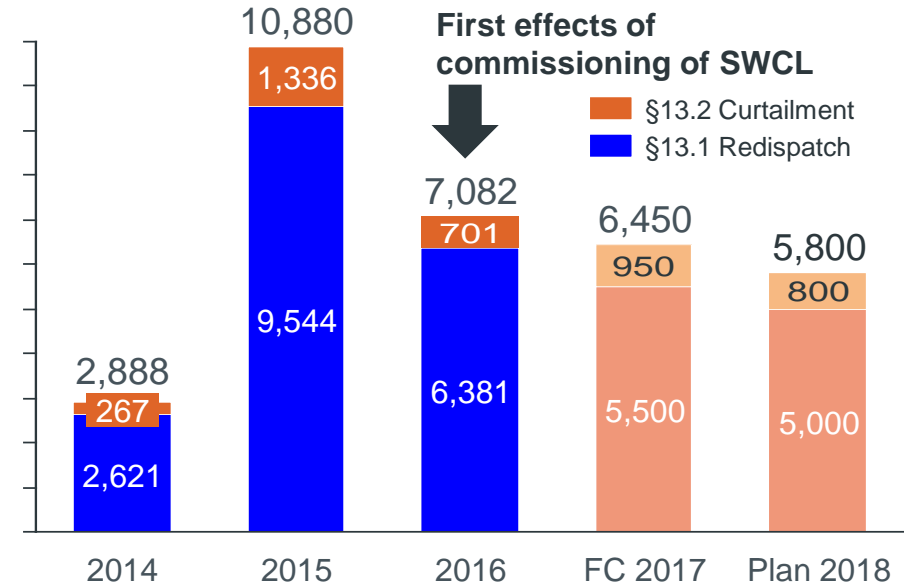
During high wind periods Germany's potential commercial export is much higher than physical export capacities allow. Exceeding power flows are turned back by redispatch.

50Hertz has been successfully reducing redispatch costs with extension and innovation

REDISPATCH AND RES CURTAILMENT COSTS IN m€

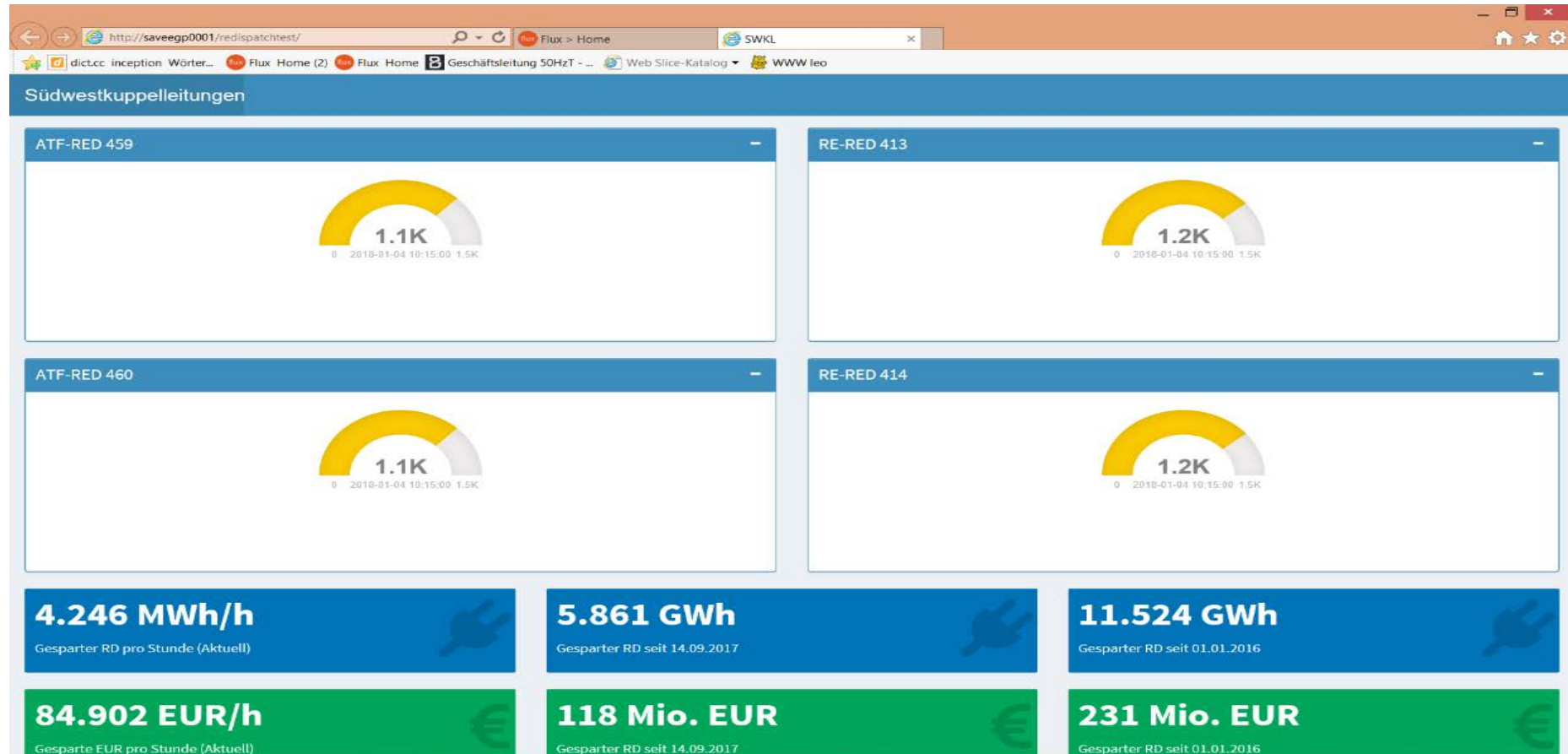


REDISPATCH AND RES CURTAILMENT AMOUNTS IN GWh

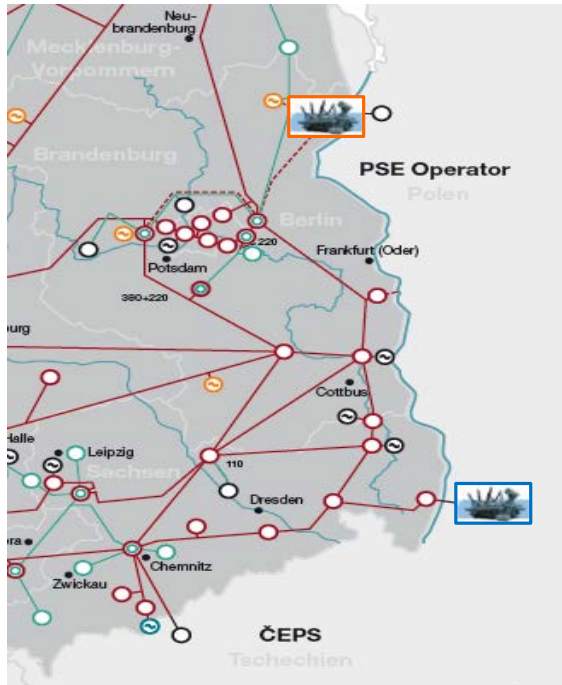


- Grid development and process improvements are showing to be effective
- **Risk:** ACER/European Commission request for higher trading capacities can significantly increase costs for congestion management.

Grid extension reduces congestion and redispatch costs



Phase Shift Transformers (PSTs) at the Polish and Czech borders steering power flow and reduce congestion



Main functionalities of PSTs

- Limit/regulate (unplanned) cross-border flows at the German-Polish and German-Czech borders
- Prevent congestion at interconnectors and in the network close to the border

Implementation





- **Hagenwerder-Mikułowa (DE-PL):** Polish PSTs in operation since 2016
- **Vierraden-Krajnik (DE-PL):** Two step approach:
 - commissioning of two PSTs and upgrade of the interconnector on 380 kV in 2018
 - final state with four PSTs is foreseen for 2020
- **Roehrsdorf-Hradec (DE-CZ):** German and Czech PSTs in operation since 2017

Challenges and solutions within system and markets

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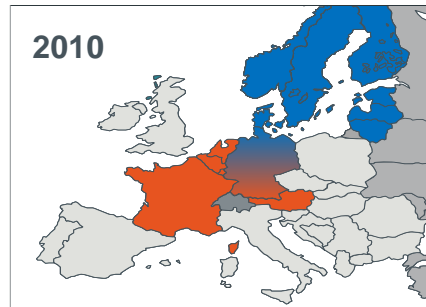
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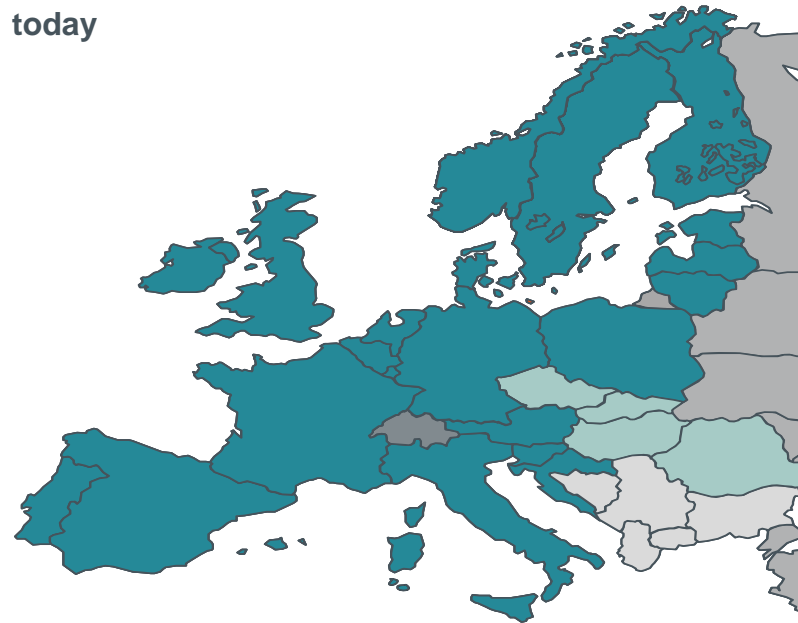
50Hertz solutions

	Fast and efficient grid development		Innovative congestion management concepts
	Market development		Foster cooperation on EU level

European market design is based on a zonal concept with bidding zones coupled via power exchanges



today

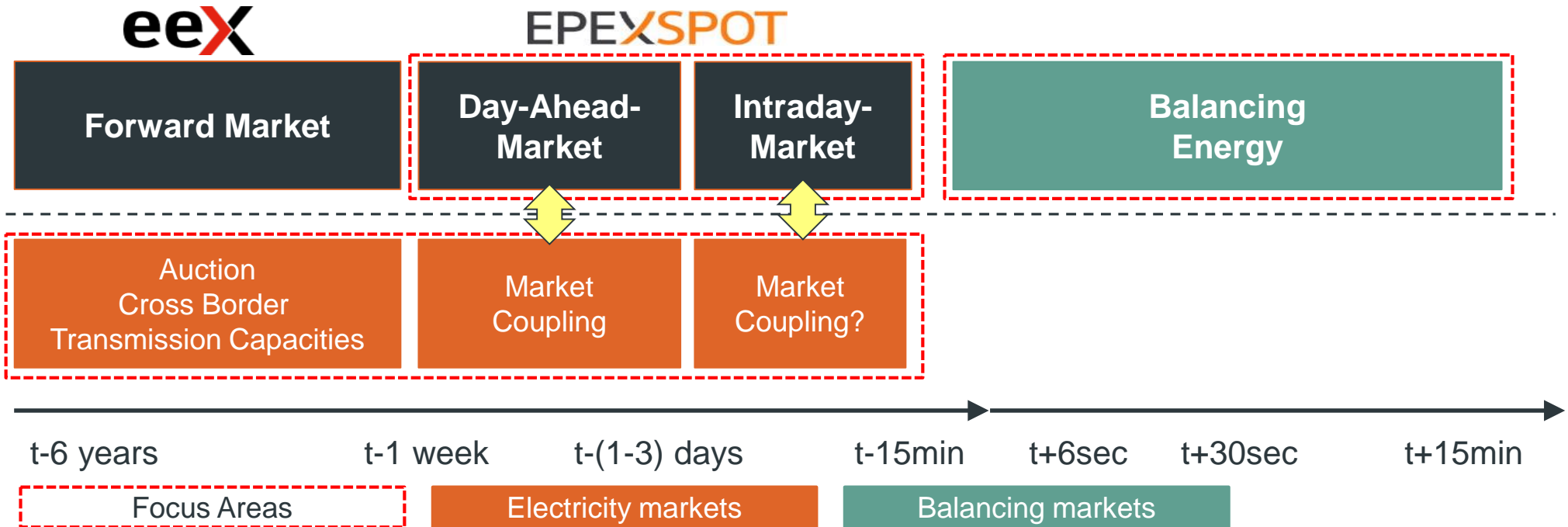


Orange: Market coupling Central-Western Europe
 Blue: Market coupling Northern Europe
 Green (dark): Single European Price Coupling
 Green (light): Coupling of CZ, SL, HU & RO only (interim-step)

- **Price Coupling** successful on the **Day Ahead spot market**, step-by-step expansion towards a common European Price Coupling.
- Ongoing project to introduce European Price Coupling in the **Intraday spot market**.
- Ongoing project to introduce **Flow-based Market Coupling** in Central Europe (exp. 2020)

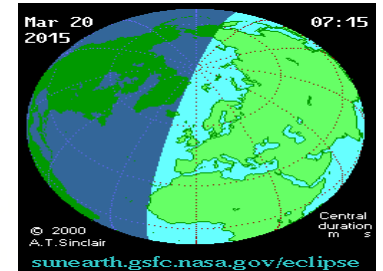
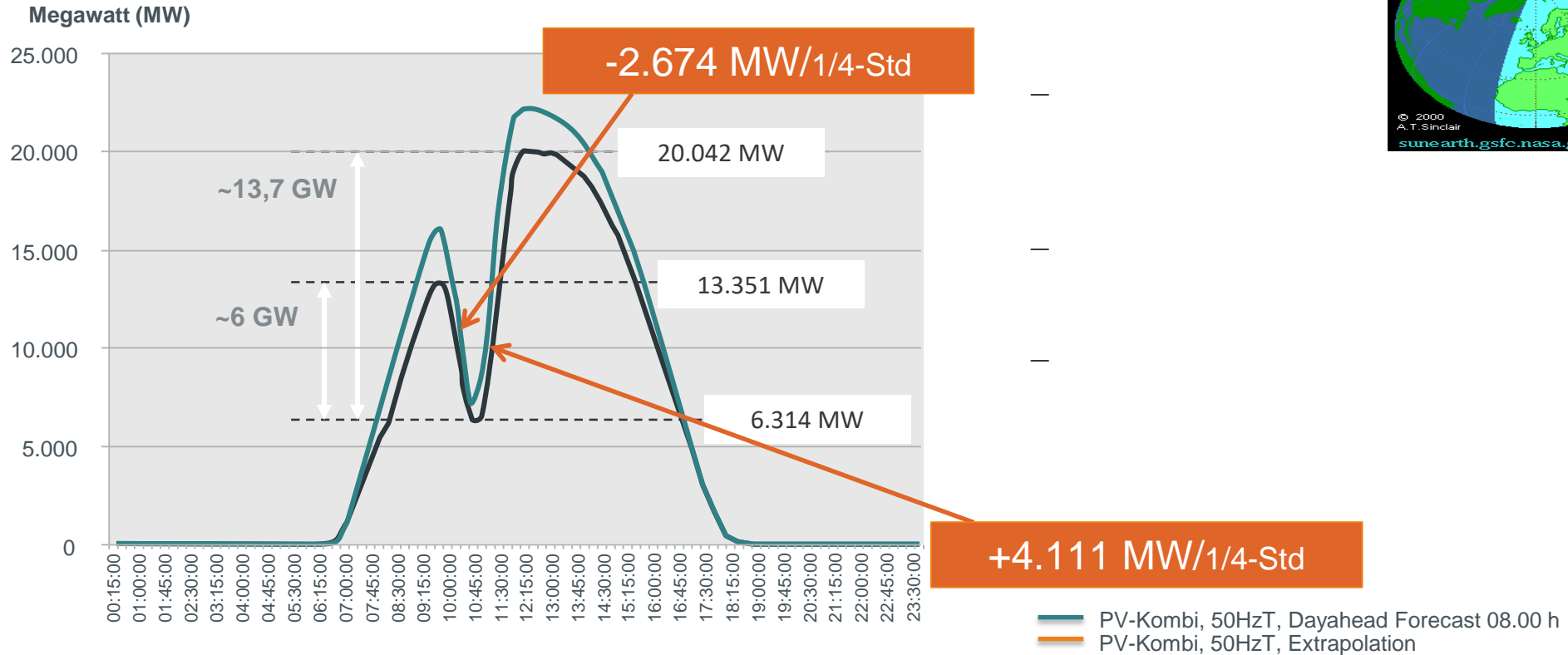
European market integration has been very successful and facilitates the integration of volatile renewables.

Development of short-term and balancing markets is in the focus of the market development strategy



Operational Challenges from PV: Solar Eclipse 2015 March 20

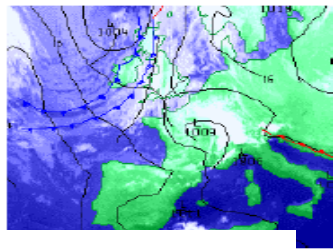
PV-forecast – Live extrapolation Germany



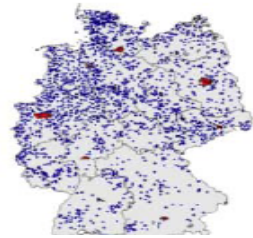
German TSOs can count on market mechanism for basic balancing.

Good renewables forecasts are key for successful integration

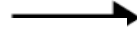
Sophisticated RES forecasts in place, further improvements are needed



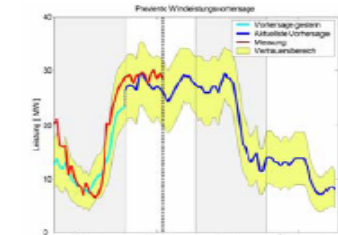
Weather Forecast



Plant Database



Feed-in calculation



Feed-in forecast



- Day-ahead forecasts for wind and solar leave room for improvement intraday.
- 50Hertz build up strong competences in short term forecasting and intraday trading.
- Estimates are applied where real time data are not available.
- Service providers deliver online data and forecasts. They are continuously benchmarked against each other.
- Remaining deviations after market closure are to be levelled out by TSOs by activating control power.

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50Hertz solutions

	Fast and efficient grid development		Innovative congestion management concepts
	Market development		Foster cooperation on EU level

New players with low opportunity costs will offer flexibility on a competitive market of limited size

New players



*Power to Heat
Stadtwerke Schwerin*



*DSM aluminium
production
Trimet Hamburg*



*DSM Steel
production
Hamburg*



*DSM provided via
aggregators*



*Small CHP-
assets*



*Control power by RES
(depending on legal
framework and subsidy
scheme)*



*Lichtblick pilot
("At Home" power
stations)*

Distributed flexibility requires the system's further **digitilization**. Increasing **competition** on the flexibility market complicates business cases for storage.

The cooperation between DSOs and TSOs is being refined

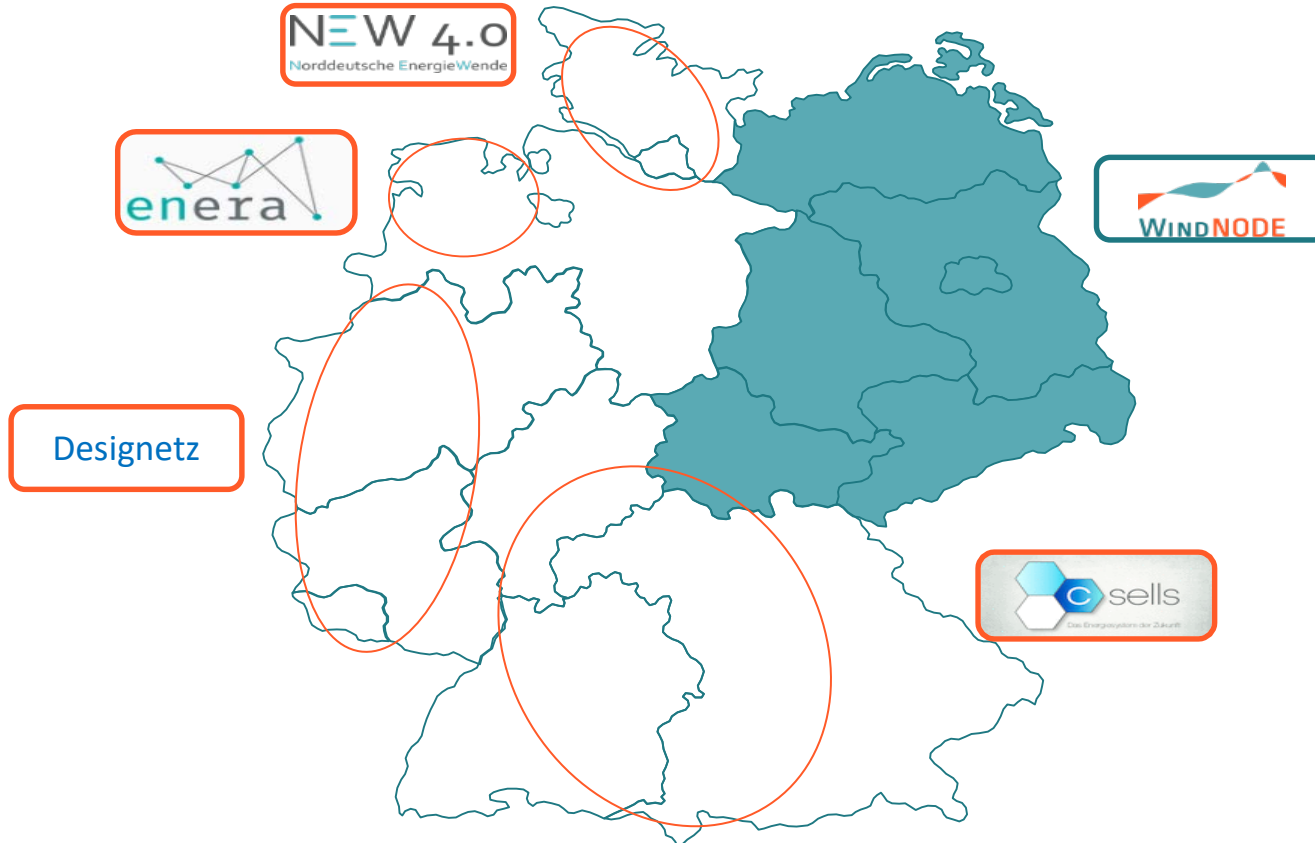
Guiding principles for integration of distributed flexibilities

- Striving for the socio-economic optimum using flexibilities on different voltage levels.
- Going for market oriented competitive solutions - while observing market power issues.
- Implementing new transparent processes for flexibility providers and network operators.
- Developing coordination concepts that take DSO constraints into account.
- Using digitalization for innovative solutions.



Within the ministry's SINTEG program 50Hertz leads the WindNODE project

Overview of the five SINTEG projects







- ✓ **Project goal:**
develop and demonstrate solutions for energy transition, enabling intelligent communication and interaction among different players for an efficient renewables integration
- ✓ **WindNode support:**
about 40 m€ over 4 years, since 12/2016
- ✓ **Project partners:**
about 70 partners from industry, utilities, academics, ...

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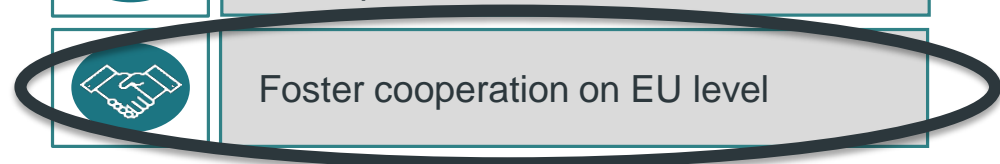
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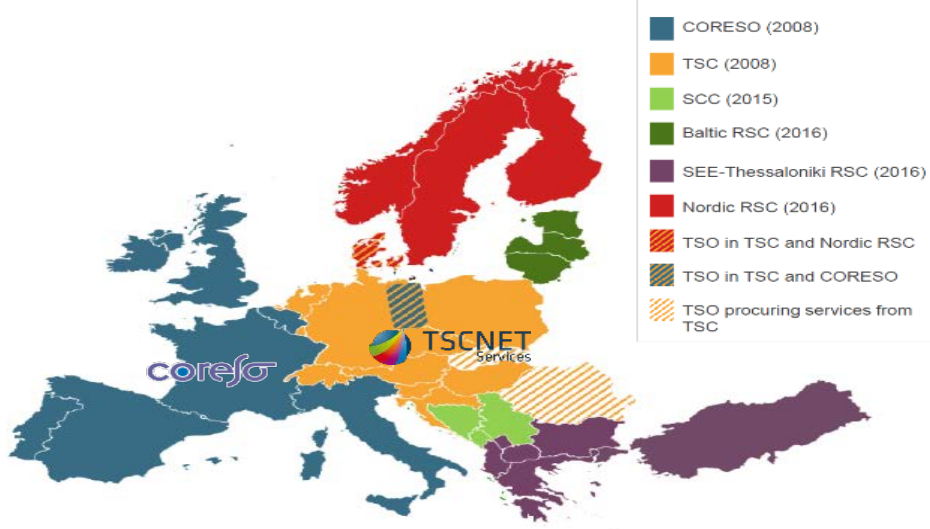
50Hertz solutions

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50Hertz is well engaged and committed in the European context

RSCs across the European grid system as service-providers to TSOs



Joint entities for commercial operation of interconnectors

Regular bilateral meetings/contracts

ENTSO-E as main platform



Design and successful implementation of market coupling

Successful development of grid codes

- There are already well-functioning regional and European TSO cooperations on technical and commercial level.

Challenges and solutions within system and markets





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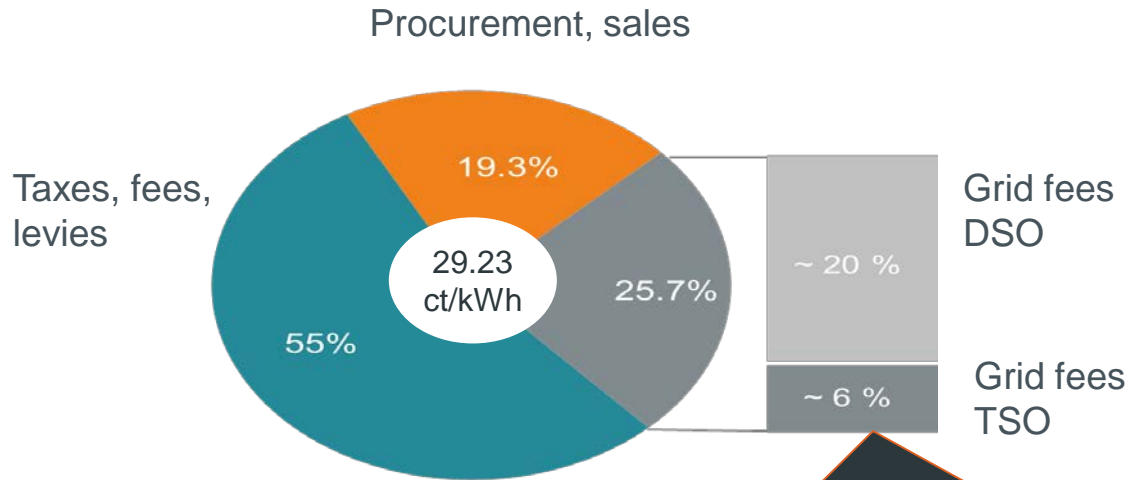
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Grid fees account for 25% of household electricity prices being only part that differs from region to region

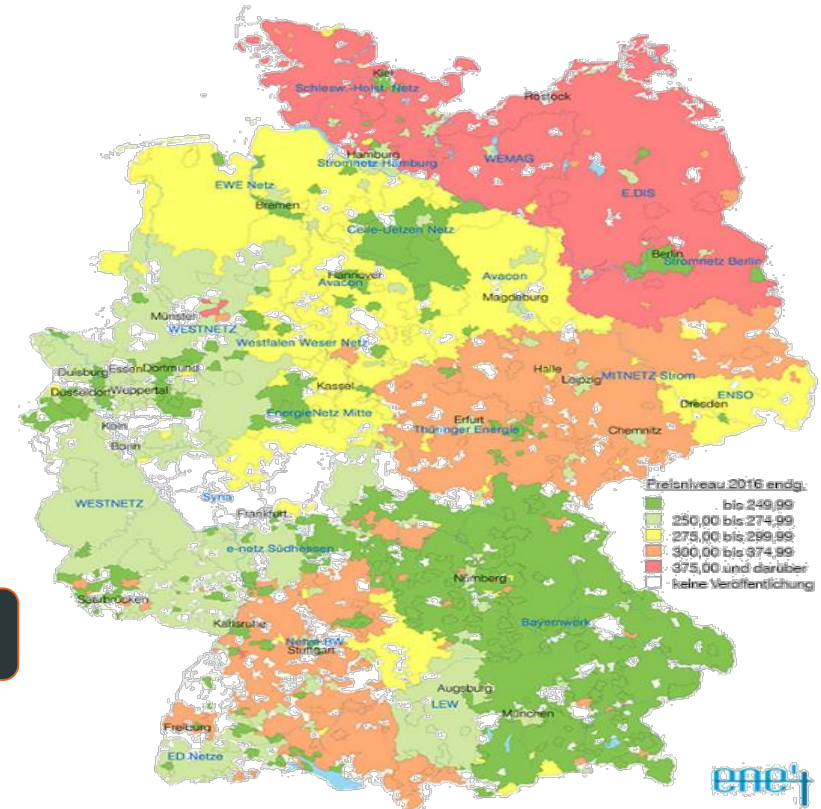
SPLIT OF HOUSEHOLD PRICES IN 2017



Rising grid fees and regional differences need to be managed actively

Average composition of the electricity prices 2017, German household with yearly consumption of 3,500 kWh

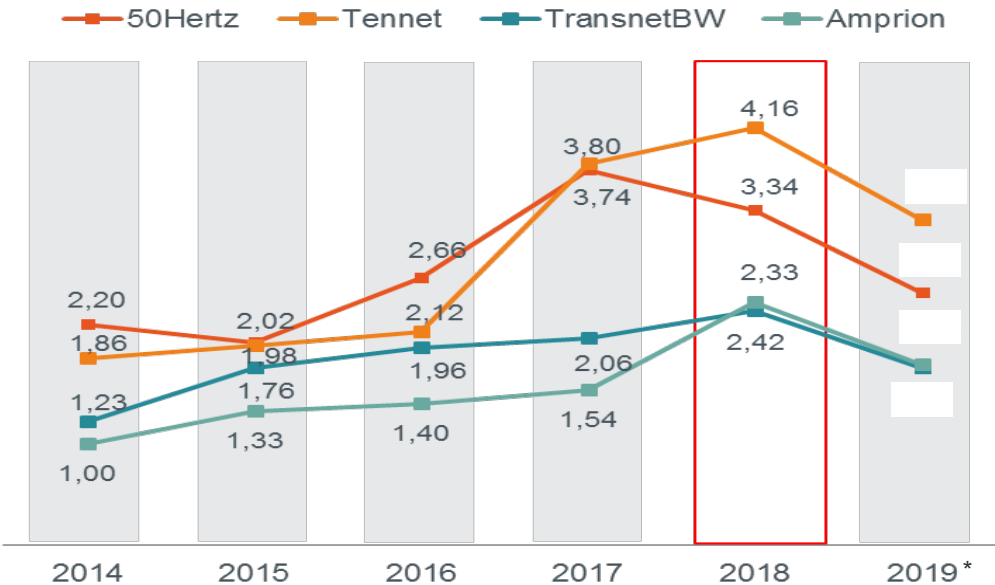
GRID FEES (€) ELECTRICITY IN JANUARY 2016



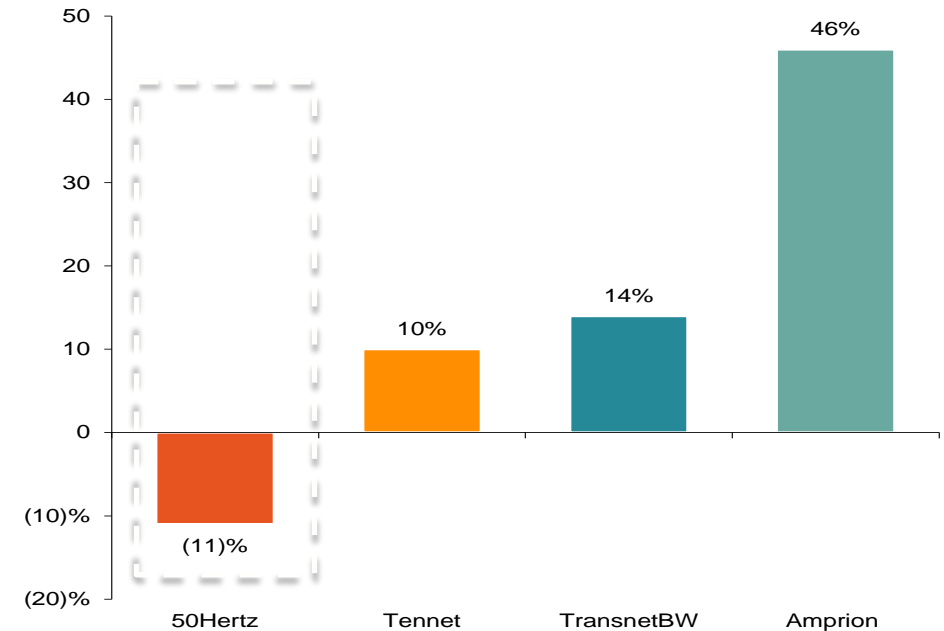
Development of average TSO grid fees for 2018

Basis: temporary grid fees 2018, situation as of October 2017 [ct/kWh¹]

TSO GRID FEES DEVELOPMENT FOR 2018



CHANGE IN GRID FEES FROM 2017 TO 2018



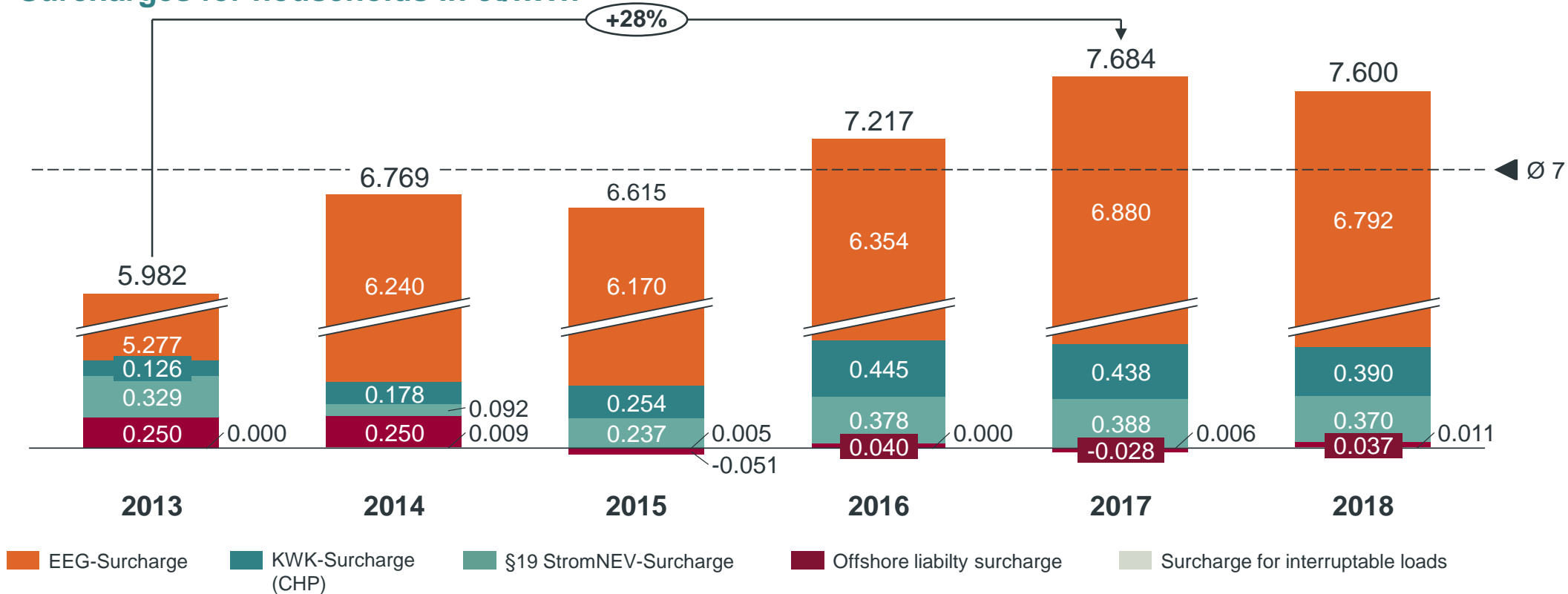
- 50Hertz' initiative for unified TSO grid fees will lead to strongly decreasing grid tariffs within next five years.

¹Calculated with average grid fees of EHV and EHV / HV with annual utilisation time of 1,000 hours, 3,000 hours and 5000 hours
* Rough estimate

Strong increase of surcharges due to renewables development

EEG-surcharge is the main component

Surcharges for households in ct/kWh



Thank you for your attention

Q&A

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