German Energiewende

Experiences and Challenges from a TSO Perspective

Tokyo, 17. September 2014
Dr. Klaus von Sengbusch

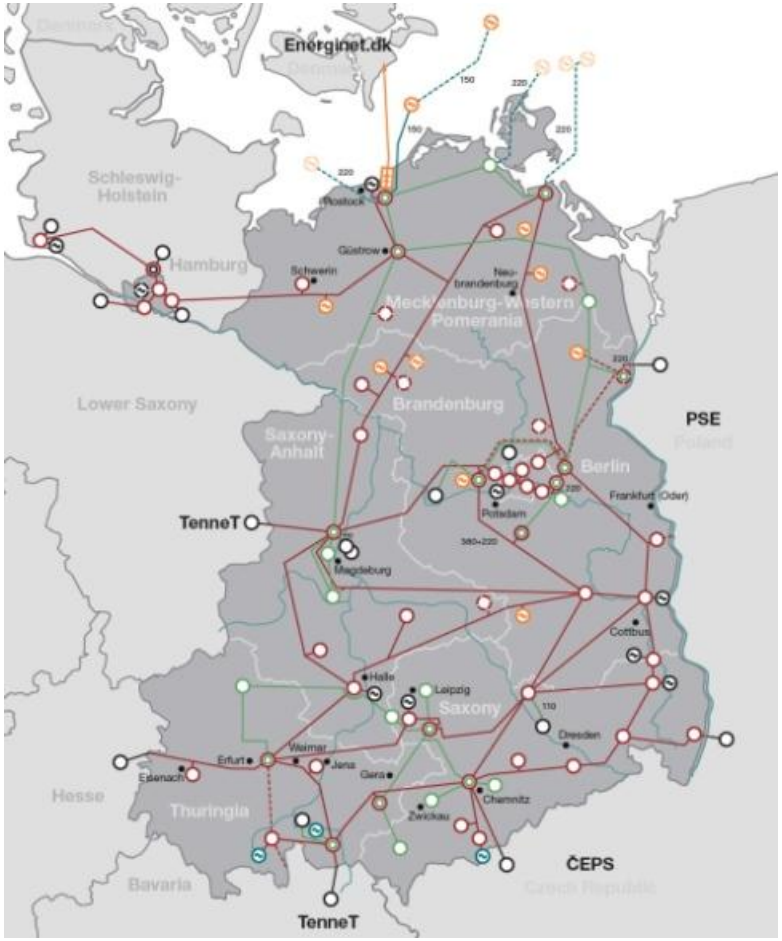
Agenda

- 50Hertz
- Energiewende in Germany - Aims & current Status
- Key Challenge 1: Minimize Costs for new RES
- Key Challenge 2: Balancing of volatile Generation and Load
- Key Challenge 3: Dealing with uncertain forecasts

The Transmission System Operator 50Hertz

- Ensures the supply of electricity to over 18 million people in Germany
- System operator for Berlin, Brandenburg, Hamburg, Mecklenburg-Western Pomerania, Saxony, Saxony-Anhalt and Thuringia
- Responsible for the operation, maintenance and expansion of the "Electricity Highways“ (220 kV and 380 kV)

50Hertz at a Glance



	Value (Share in DE)
Surface area	109,360 km² (31%)
Total length of lines	9,995 km (29%)
Maximum load	~ 16 GW (21%)
Energy consumption (based on electricity supplied to final consumers in acc. with the EEG)	~ 98 TWh (20%)
Installed capacity: - Renewables - Wind	~ 44,539 MW (~24%)* 22,727 MW (~28%)* 13,408 MW (~40%)*
Workforce	821
Turnover - Grid	8.6 billion € 0.9 billion €

* provisional data, approved values will be available on June 2014

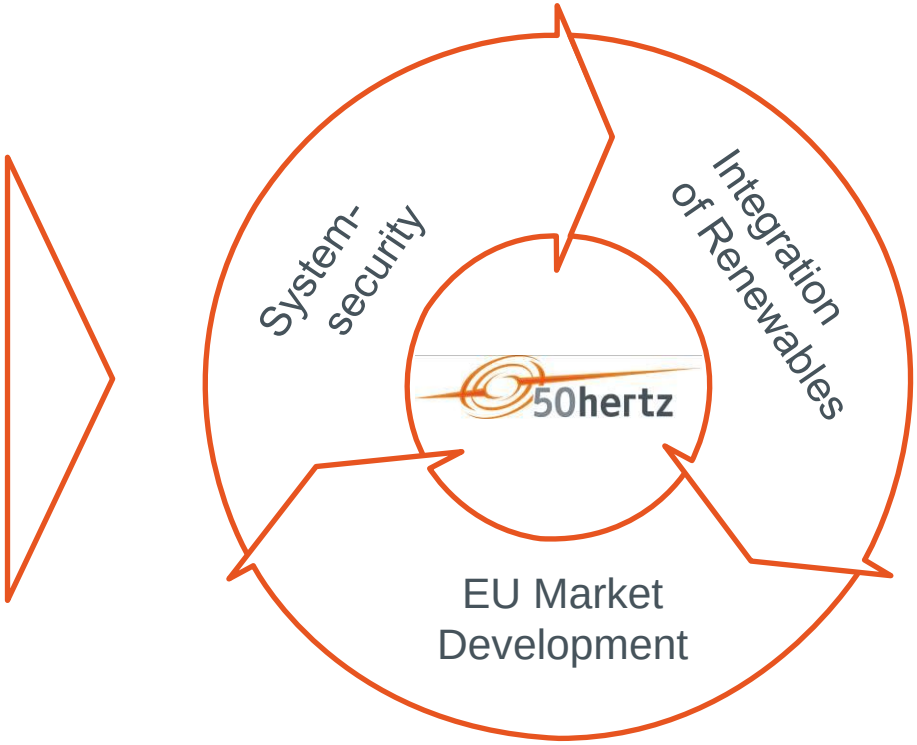
Source: 50Hertz, as at 31/12/13

TSOs are the Backbone for the Energy Supply

The four Core Activities:

- Transmission Grid Operator (On- and Offshore)
- System Operator
- Market Facilitator
- ”Trustee“ for RES- and CHP-Processes

Responsibility for Society



RES: Renewable Energy Sources

CHP: Combined Heat and Power

The TSOs play a key role for the German Society

Energiewende

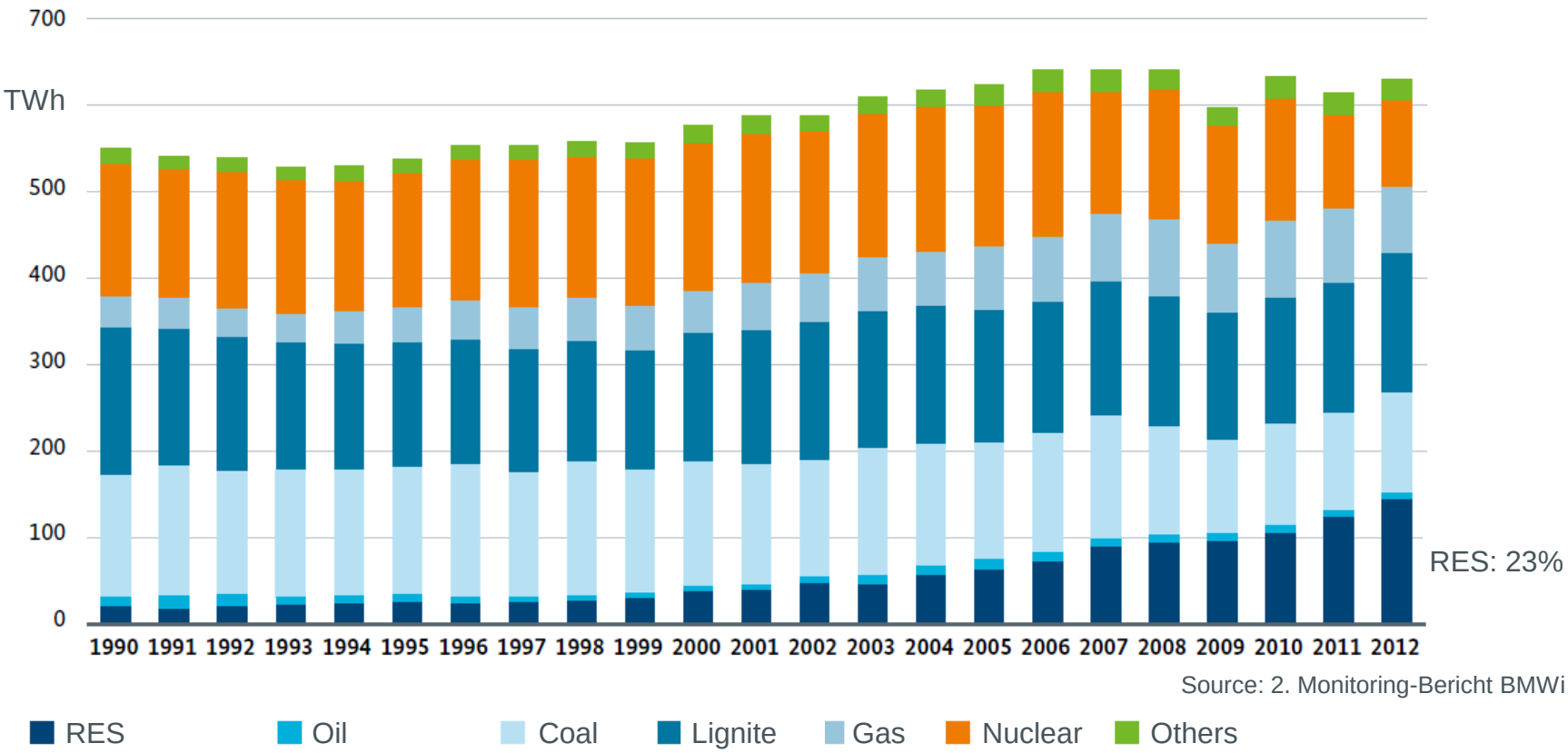
Aims and current Status

Aims of German Energiewende

	2020	2050
Greenhouse gas emissions(reference 1990)	-40%	<-80%
Primary energy (reference 2008)	-20%	-50%
Primary energy: share of RES	18%	60%
Consumption of electricity (reference 2008)	-10%	-25%
Electricity generation: share of RES	>35%	80%
Energy consumption heating (reference 2008)	-20%	-80%
Energy consumption traffic (reference 2005)	-10%	-40%
Electric cars	>1 Mio.	
Nuclear phase out	until 2022	

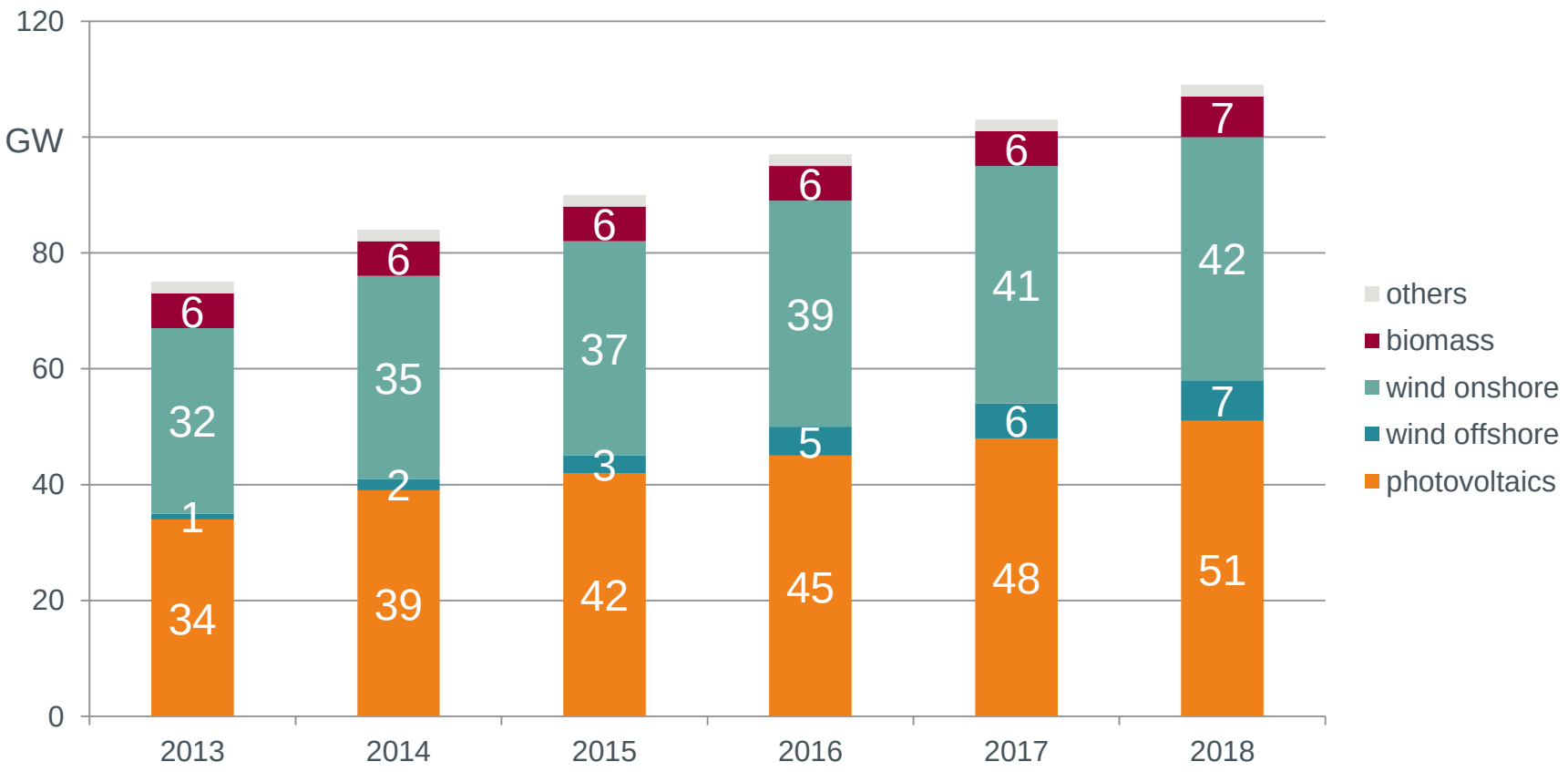
High relevance for TSOs

Electricity Production in Germany



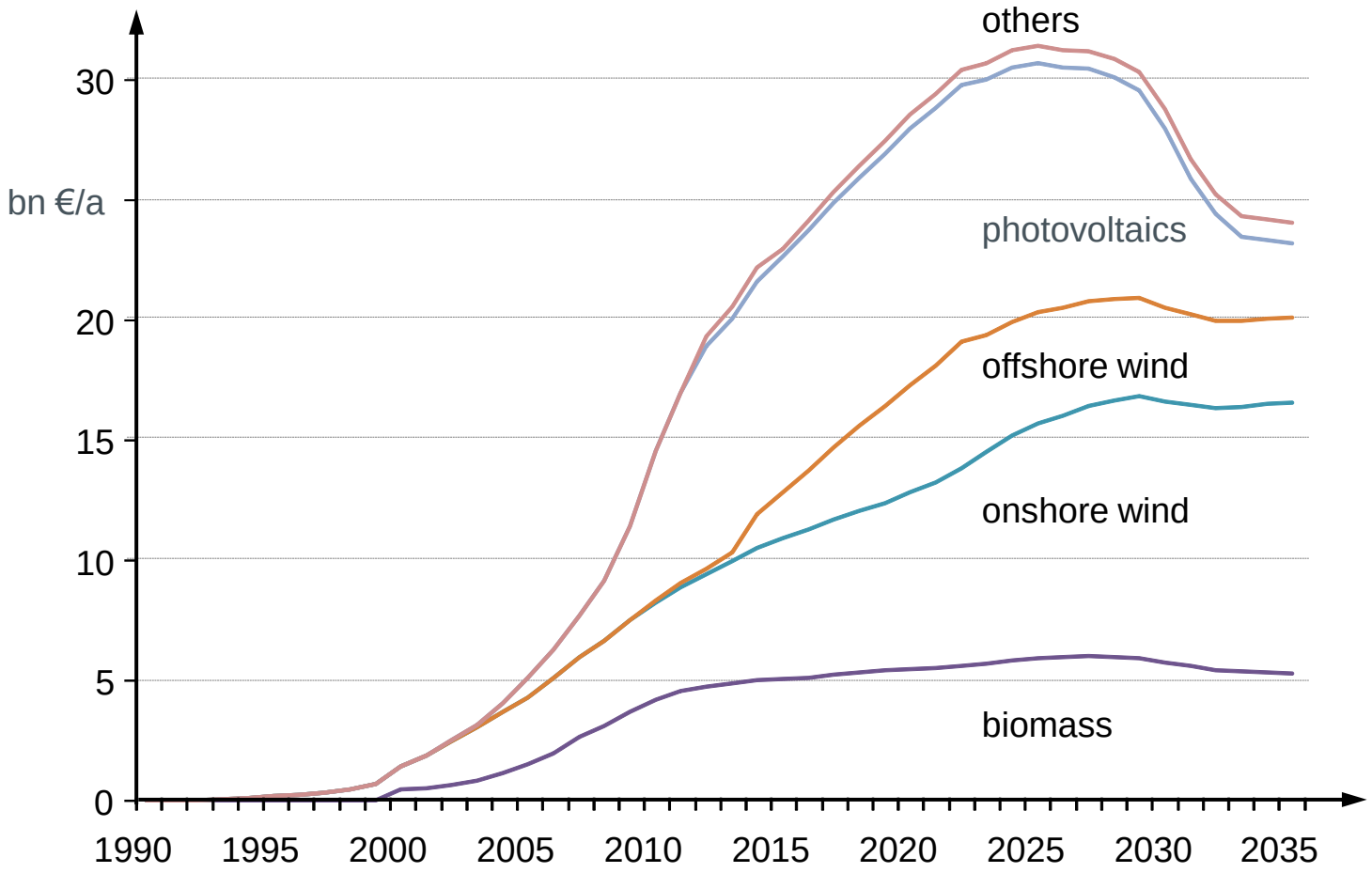
Current expectation: The 2020 aims in the areas “share or RES” and “nuclear phase out” will be reached

Forecasted RES Capacity in Germany



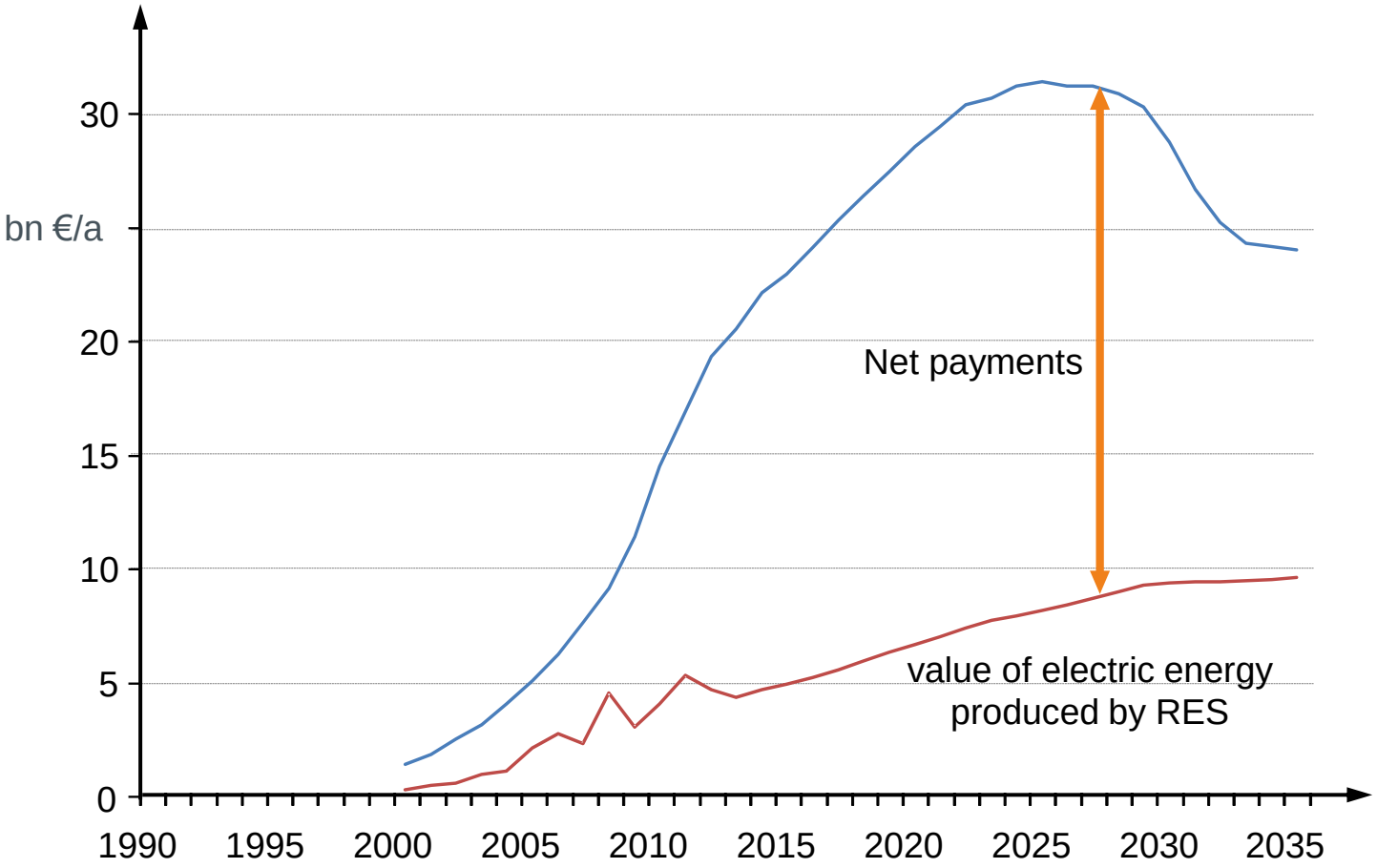
Source: r2b

Gross Costs of RES in Germany



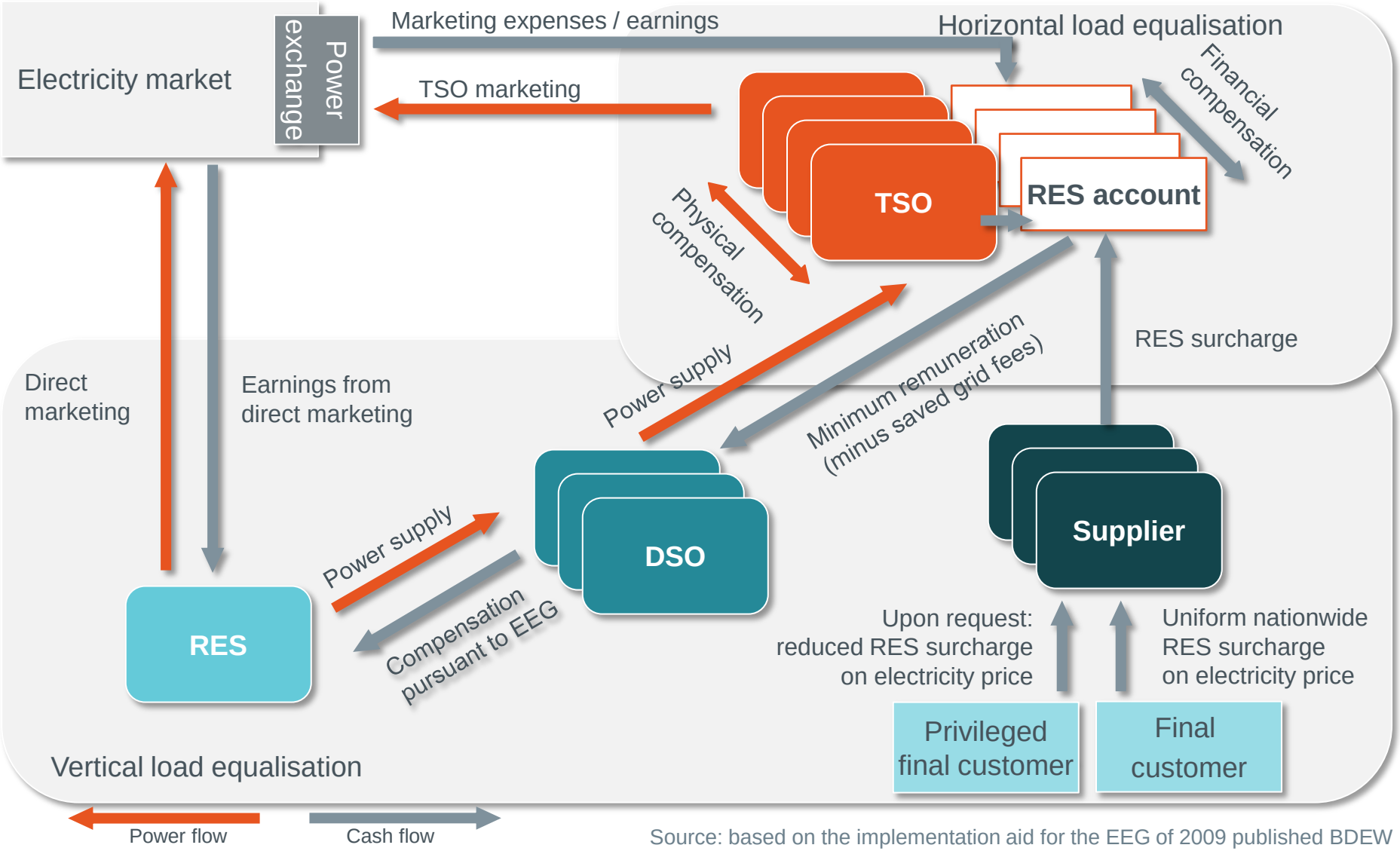
Source: TU Berlin, Prof. Erdmann

Gross and Net Costs of RES in Germany



Source: TU Berlin, Prof. Erdmann

RES-Process in Germany



Source: based on the implementation aid for the EEG of 2009 published BDEW

Changes resulting from the new legislation (1/2)

Onshore Wind:

- target corridor for new installations incl. repowering: 2,500 MW/year
- base tariff: 89 €/MWh
  - reduction of base tariff for new installations based on corridor
  - cuts in payments for locations with good wind conditions

Photovoltaics:

- target corridor: ~ 2.500 MW/year
- stop of support scheme when reaching 52 GW (installed capacity Q1 2014: ~36 GW)

Offshore Wind:

- target corridor: ~ 850 MW/year
- base remuneration: 154 €/MWh for maximum of 20 years (-5 €/MWh/a starting 2018)
  or 194 €/MWh for maximum of 8 years

Biomass:

- target corridor of 100 MW/year (!) … ongoing discussions

RES-mix still defined by politics as further “learning curves” are expected

Changes resulting from the new legislation (2/2)

Direct marketing (DM):

- DM based on floating market premium mandatory for new RES above 500 kW in 2015 and above 100 kW in 2017

Introduction of tendering:

- First auctions in 2017 for large PV systems

RES-surcharge on self-produced electricity:

- Full RES-surcharge for new non-RES and non-CHP generation units
- 40% RES-surcharge for new RES or CHP generation units > 10 kW or > 10MWh
- No RES-surcharge for new RES or CHP generation units <= 10 kW and <= 10 MWh

Small-scale decentralized generation (e.g. residential PV systems including storages) is further subsidized by new legislation

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Key Challenge 1:

Minimize Costs for new RES

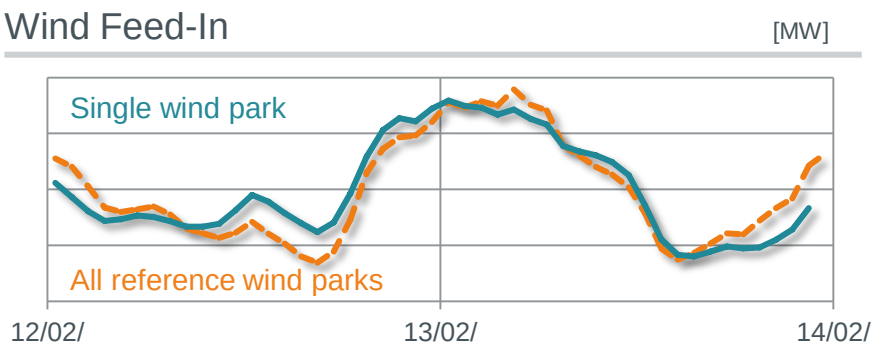
Floating Market Premium

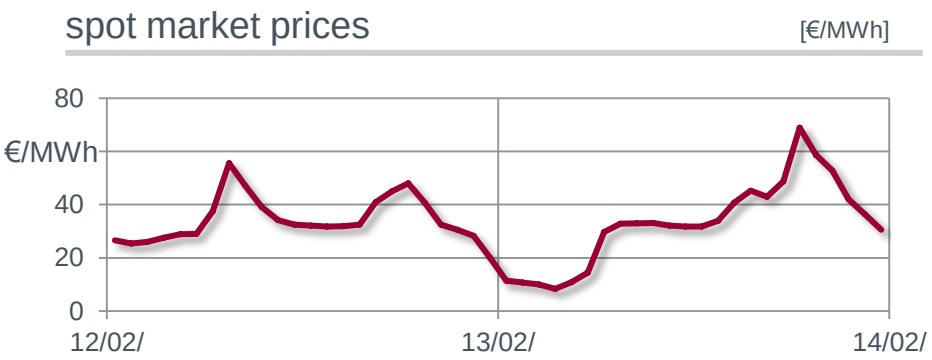
Assumption:
Target remuneration for wind is **89 €/MWh**

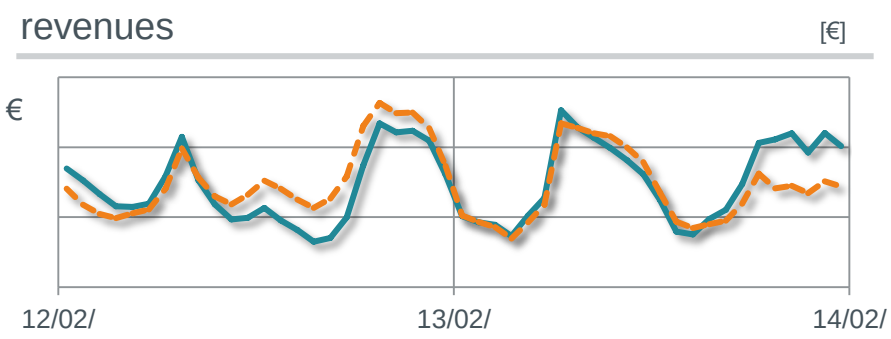
Market premium is calculated monthly ex-post based on the in-feed from **reference wind-parks** and **day-ahead spot market prices**.

Example	Single Wind Farm	Reference wind parks
Feed-In	100 MWh	1100 MWh
Feed-In multiplied with spot price	3,397 € (33.97 €/MWh)	37,576 € **(34.16 €/MWh)**
Market premium		89.00 – 34.16 = **54.84 €/MWh**
Payment (excl. management premiums etc.)	33.97 + 54.84 = **88.81 €/MWh**	*34.16 + 54.84 = 89.00 €/MWh*

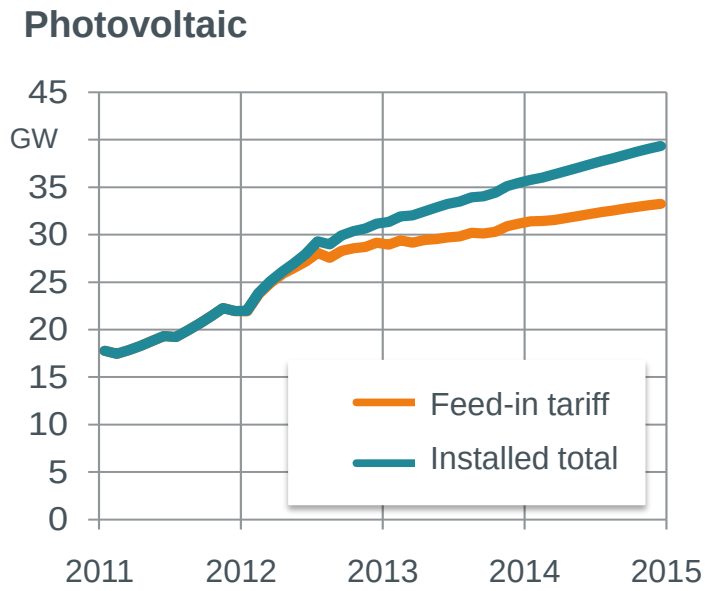
No long- or mid-term price risk for investors

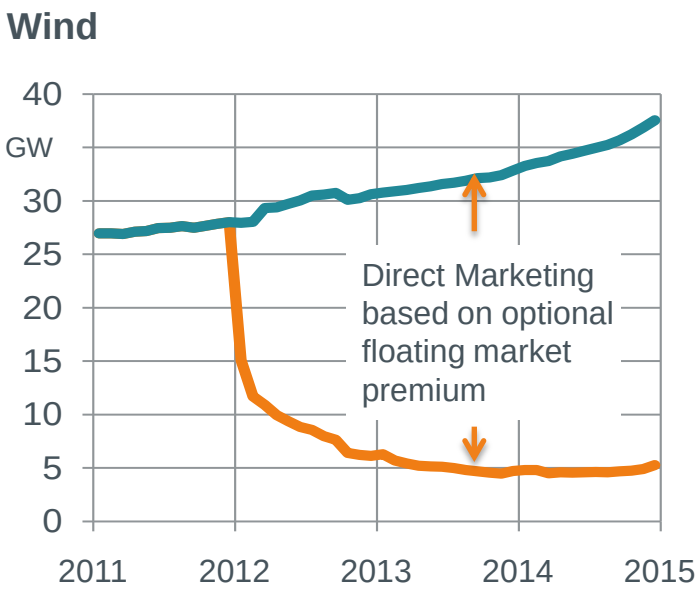






Share of Feed-in Tariff System
based on installed capacity





- Experiences with floating market premium exist; costs of direct marketing similar compared to marketing costs of TSOs for large RES (e.g. wind farms)
- For small RES (e.g. residential PV systems) marketing by TSOs is more efficient
- New legislation: Mandatory direct marketing for large RES gives better incentives for investments in controllability

Minimize Costs for new RES
Conclusions

Lessons Learned

- In case of large RES the costs for marketing of TSOs and other market participants are similar
- Mandatory direct marketing is beneficial e.g. for driving the process of sourcing control power from RES and for market base curtailing of RES
- To minimize subsidies of new RES, risks for investors have to be minimized; this can be reached by the floating market premium as well as the fixed feed-in tariff
- The main potential for further reduction of subsidies (if the RES-mix is defined by politics) is the process of negotiating the needed remuneration for special projects; Therefore a tendering process will be tested now.

Future Challenges

- How can the impact of the RES surcharge on industry can be minimized?
- How can market distortions due to the RES surcharge (e.g. by self production) be minimized?

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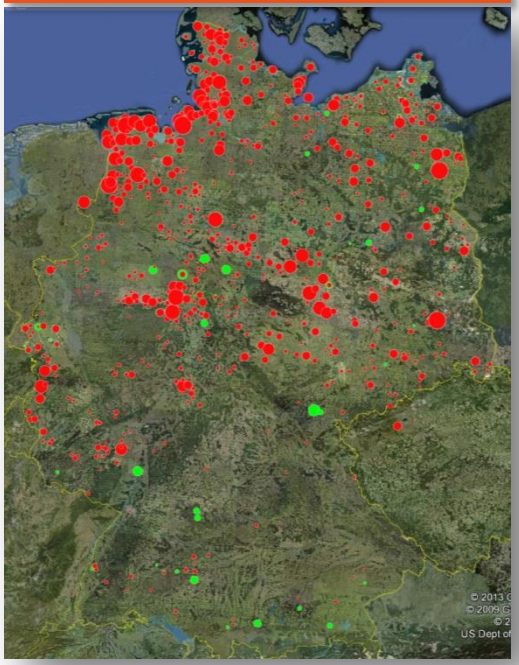
Key Challenge 2:

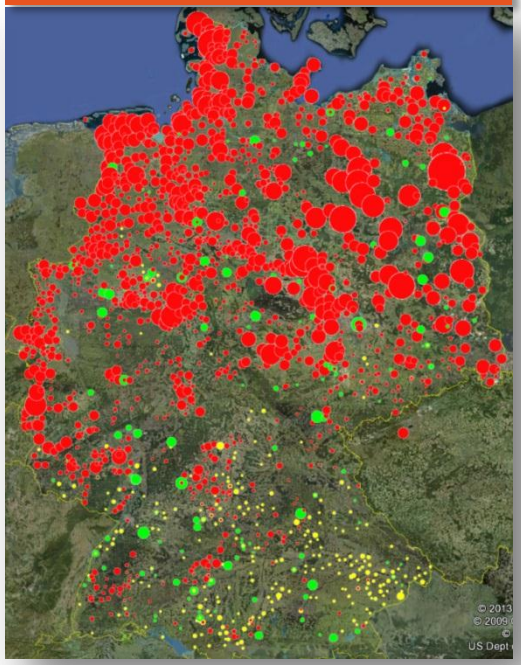
Balancing of volatile Generation and Load

Expansion of Renewable Energy Sources in Germany

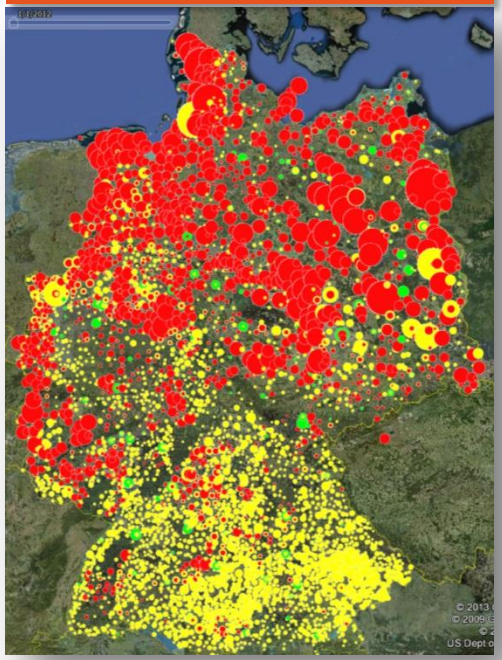
2000



2006



2012

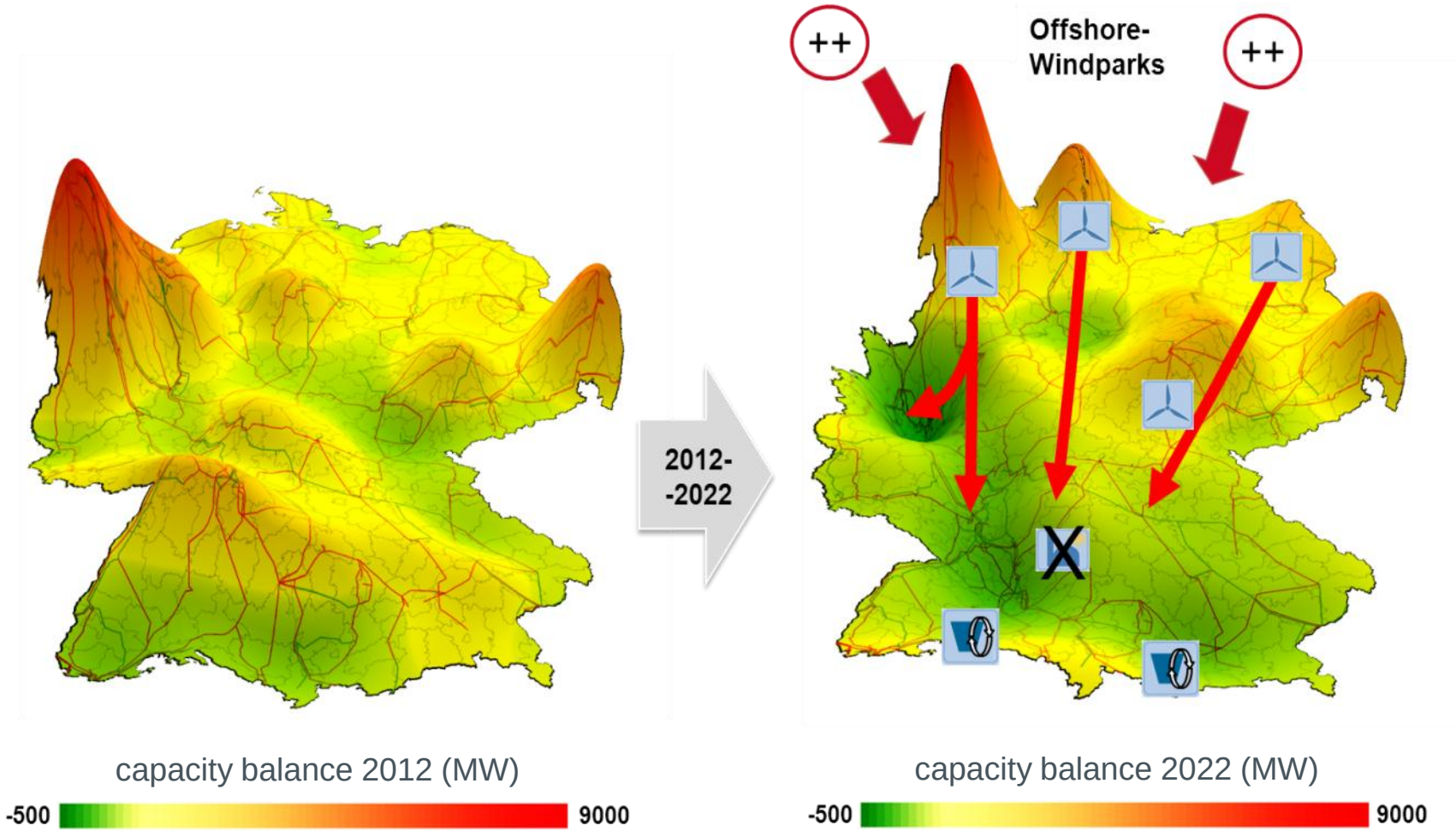


- wind
- photovoltaics
- biomass

Area proportional to installed capacity

Source: 50Hertz, TenneT, Amprion, TransnetBW, Google Earth

Increasing Distance between Consumption and Production



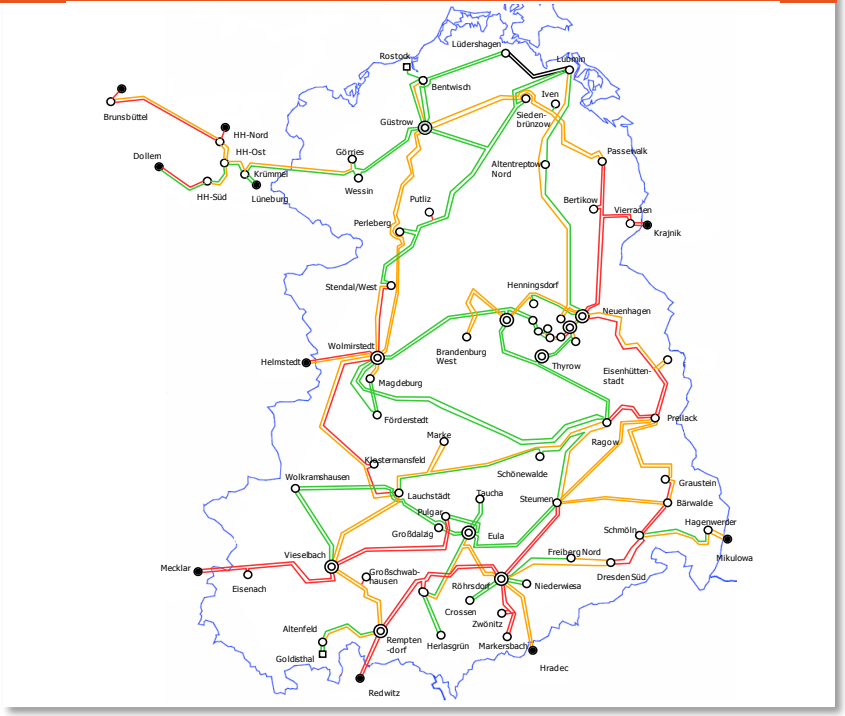
Source: GDP 2012, German TSO 31.01.2012

Grid load in the 50Hertz area

Asynchronous line load > 5h/a

2009

2013



Load ≤ 50%

Load ≥ 70%

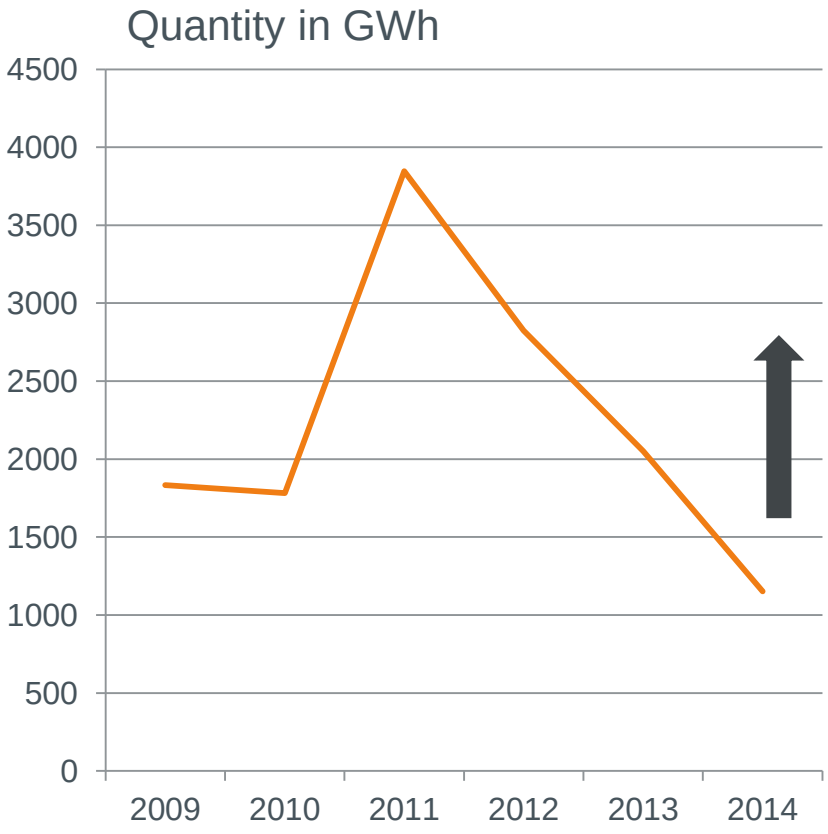
50% < Load < 70%

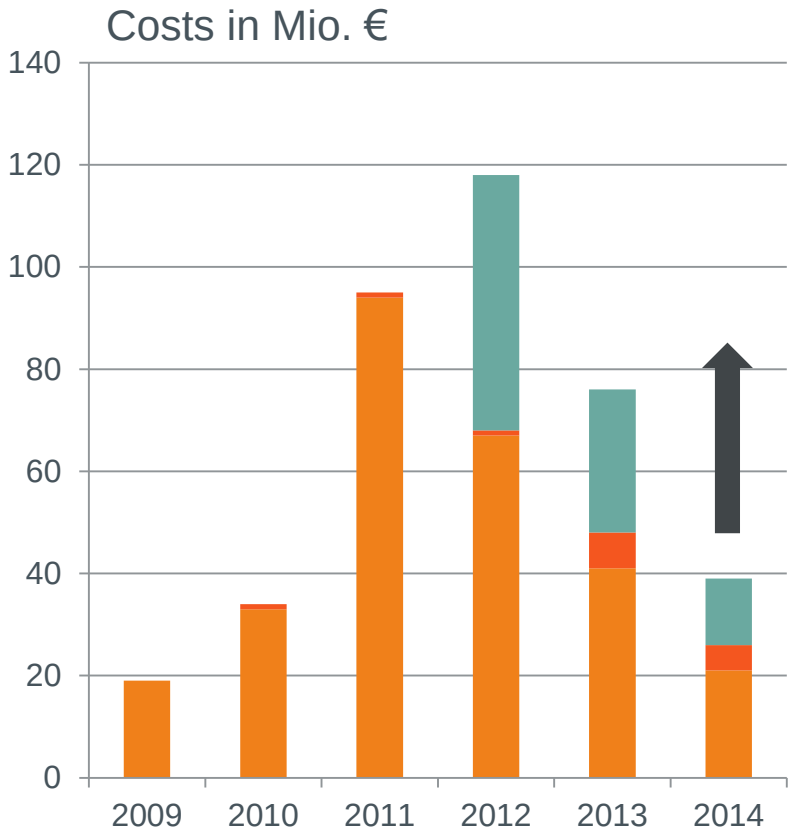
No Values

Grid load increases dramatically due to the changes in energy production.

System Security: Interventions in Grid and Market

Redispatch volumes and costs

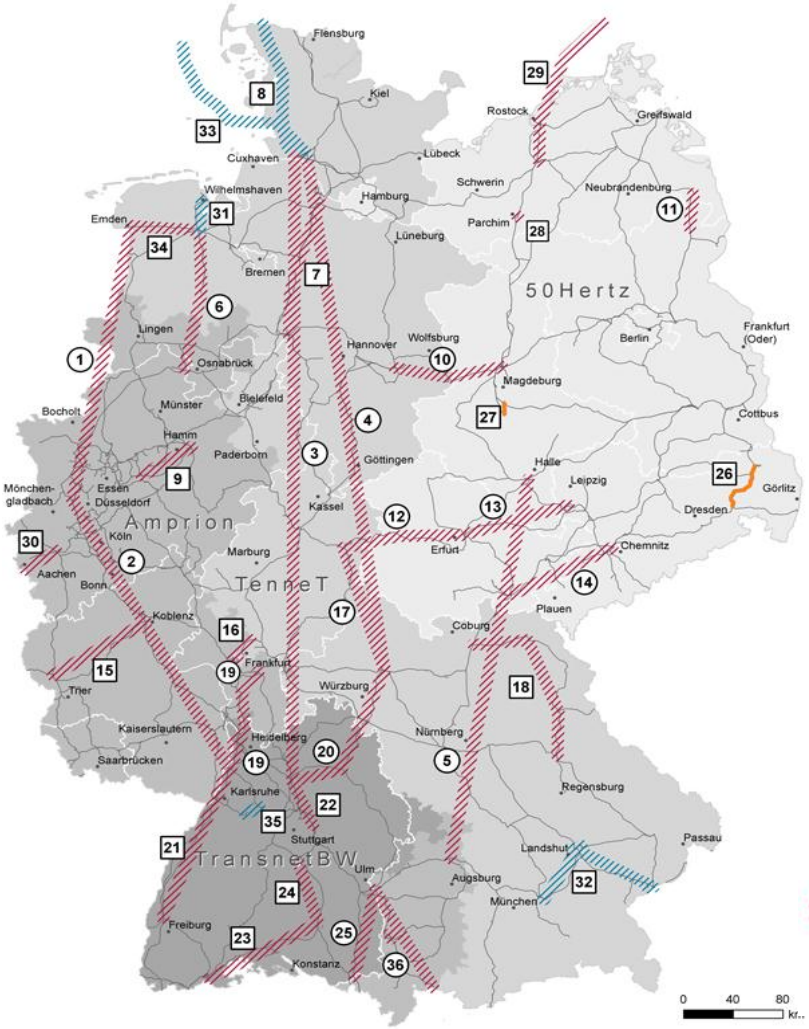




TenneT Redispatch in direction 50Hertz
Redispatch international
Redispatch national grid area 50Hertz

Situation as at 31/05/2014*
*provisional data

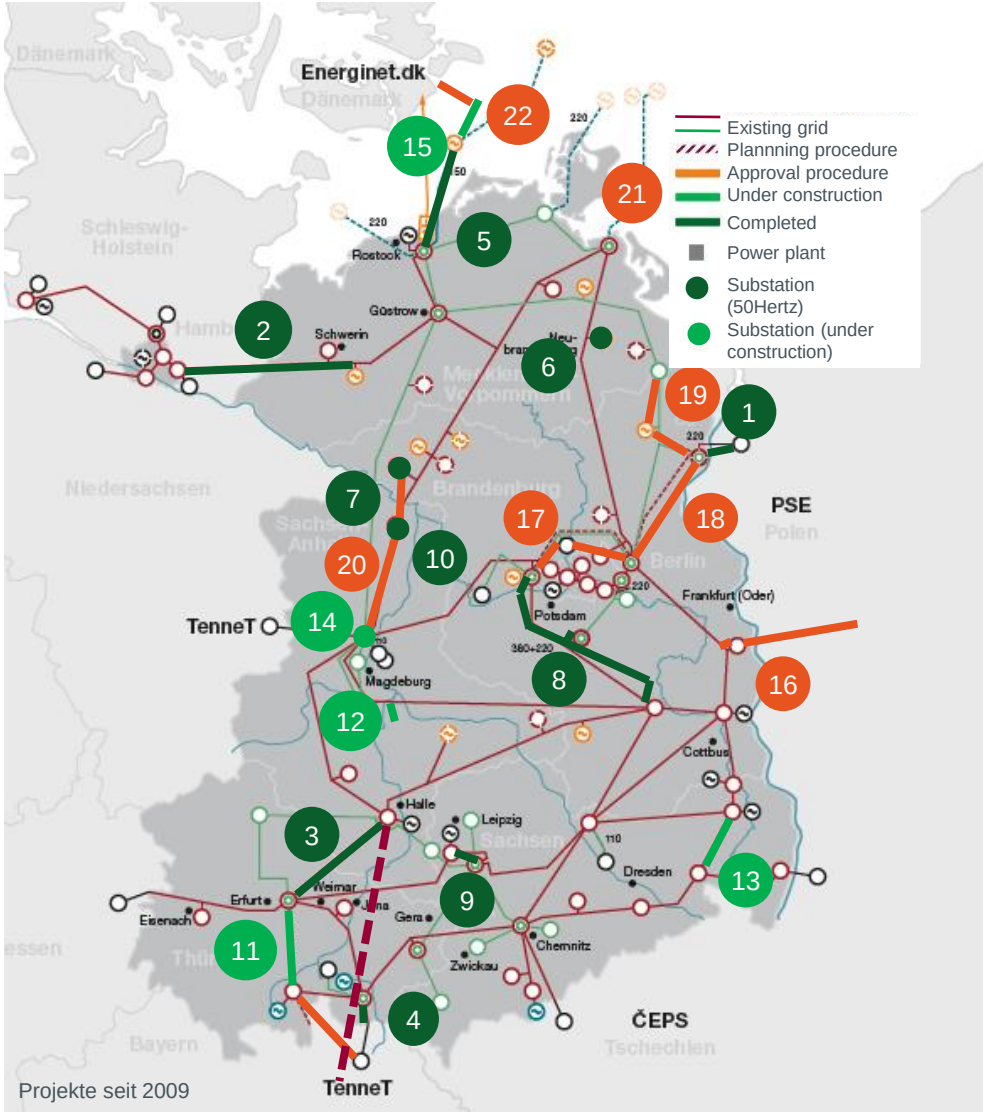
The Federal Requirement Plan as Foundation for the Grid Expansion



2012 Federal Requirement Plan Act adopted by German Bundestag in June 2013

- Basis: 2012 Grid Development Plan of the TSOs
- 36 projects confirmed
- 3 HVDC corridors
- Current Grid Development Plan confirms FRP
- Law of FRP about to be updated in 2015 and 2018

Grid Extension Projects at 50Hertz



1. Interconnector Vierraden – Krajnik
2. Northerin line Hamburg – Schwerin
3. Southwest-interconnector 1 Lauchstädt – Vieselbach
4. High-temperature line Remptendorf – Redwitz
5. Baltic 1
6. Grid connection substation Altentreptow Nord
7. Capacity expansion substation Perleberg
8. Transition 220-kV to 380-kV Ragow – Thyrow and Ragow – Wustermark
9. Rebuilding Eula – Großdalzig for Mining Schlehnhain
10. Grid connection substation Stendal West
11. Southwest-interconnector 2 Vieselbach – Altenfeld
12. Grid connection substation Förderstedt
13. 380-kV-line Bärwalde-Schmölln
14. Substation Wolmirstedt
15. Baltic 2
16. 3. Interconnector to Poland
17. 380-kV-Ring Berlin
18. Uckermark-Line Neuenhagen – Bertikow
19. Bertikow – Pasewalk
20. Wolmirstedt – Perleberg
21. Offshore connections Baltic Sea
22. Combined Grid Solution

Role of Storages
General Types

Short-term Storages (STS)

Technologies:

- Pumped Storage
- Batteries
- Compressed Air

efficiency factor: ~ 80%

capacity / power: ~5 Wh/W

Long-term Storages (LTS)

Technology:

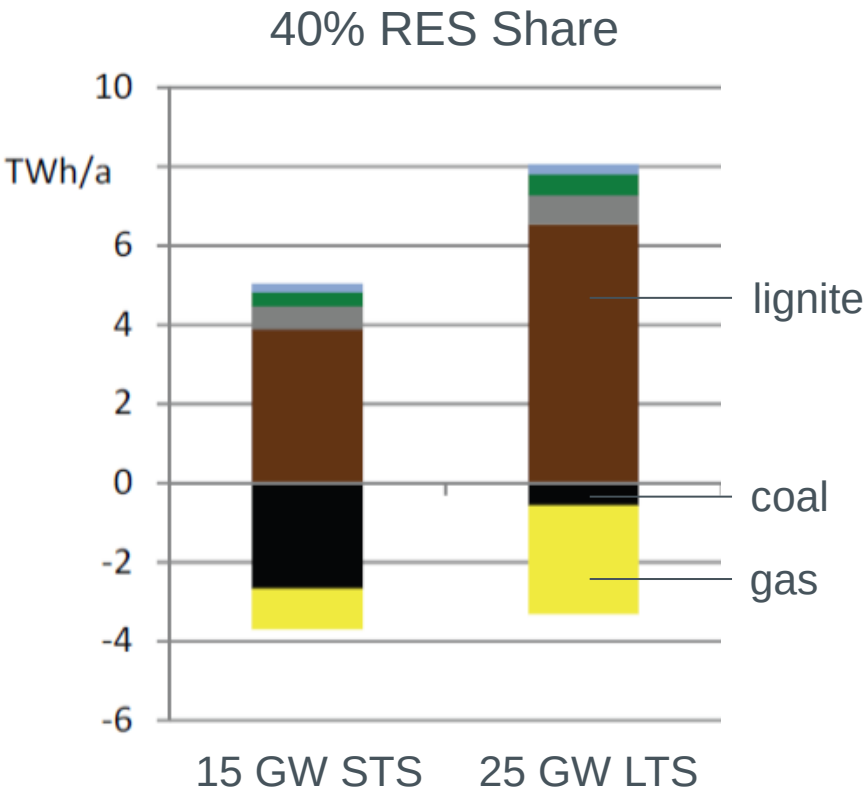
- Power to Gas

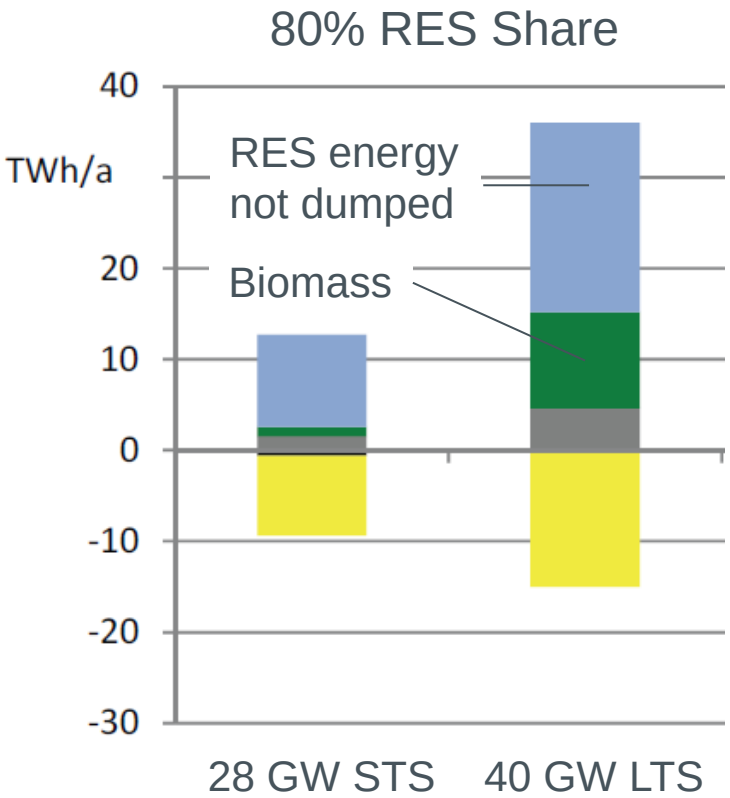
efficiency factor: ~ 40%

capacity / power: unlimited

Role of Storages
Influence on Generation

Source: VDE Studie „Energiespeicher für die Energiewende“, 2012





- No short term needs for storages in the energy only market
- Storages are mainly needed for provision of ancillary services

Balancing of volatile Generation and Load
Conclusions

Lessons Learned

- In Germany grid extension is the cheapest way to balance consumption and RES production efficiently
- To realize grid extensions new processes with intensive involvement of the public are needed; these processes have been set up now
- Large storages are not needed at least until 2020 for integration of RES and are currently economically unviable; with the large share of lignite in the German energy mix they would even increase CO2-emissions in the next years

Future Challenges

- Ensure security of supply and give incentives for sufficient new conventional generation at the right places
- Optimize redispatch process

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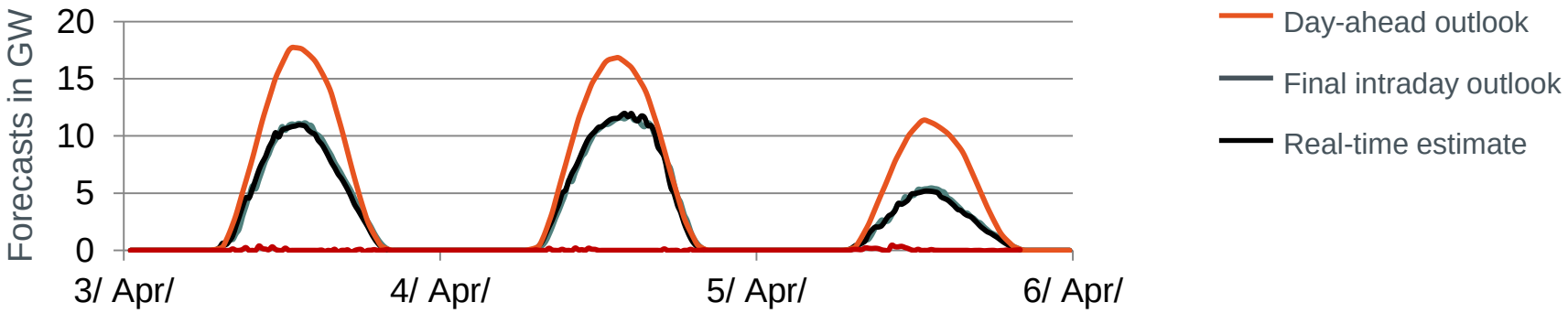
Key Challenge 3:

Dealing with inaccurate Forecasts

Operational Challenges due to Forecast Inaccuracy

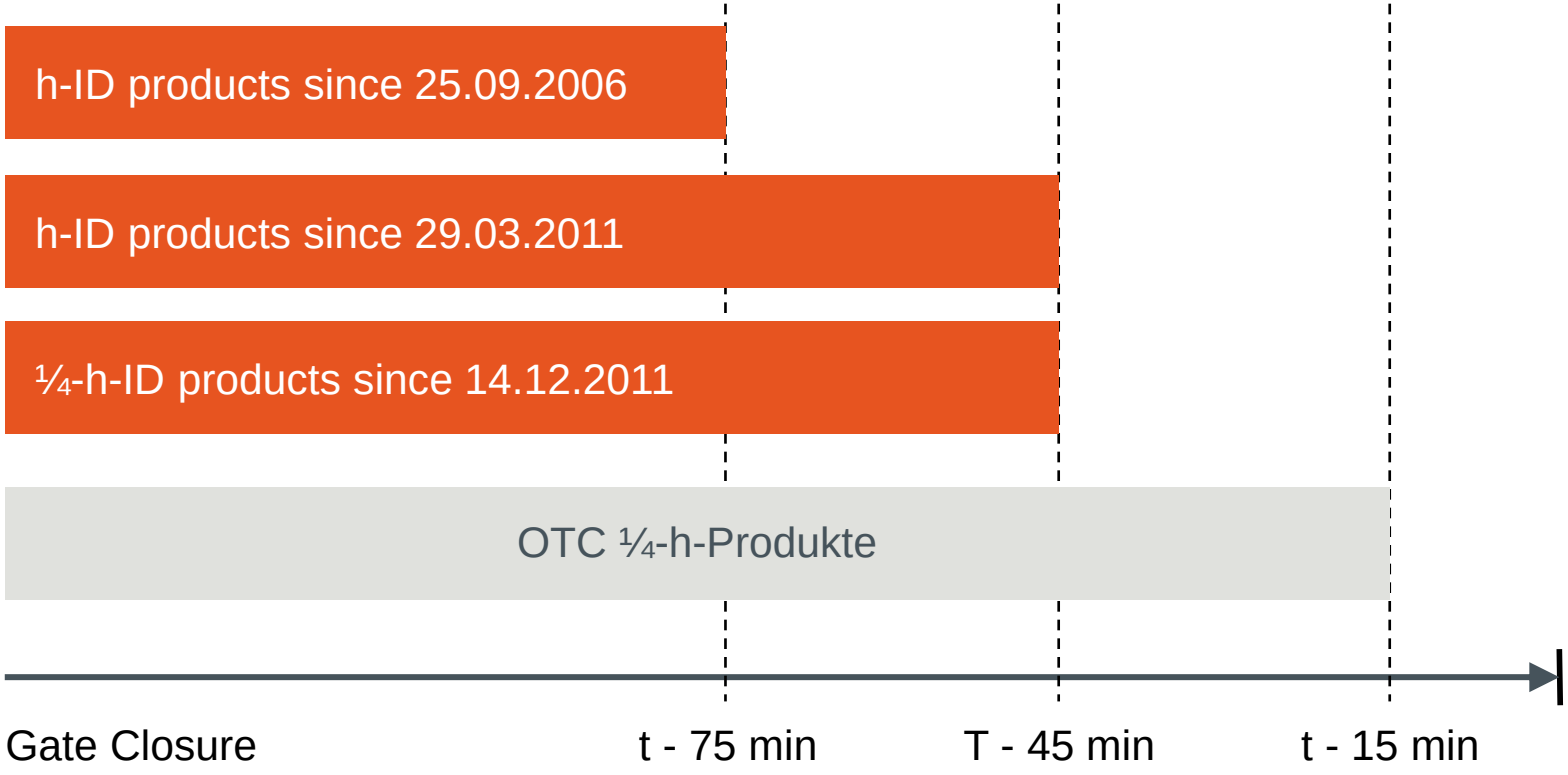
PV forecasts for Germany, April 2013

- Dramatic forecast errors of up to 8800 MW in the day-ahead forecast
- Intraday forecasts clearly better in comparison, closer match with actual feed-in



Need for large amount of flexible generation in special situations

Intraday (ID) Market in Germany



Dealing with inaccurate Forecasts
Conclusions

Lessons Learned

- Liquid intraday markets are key success factor for dealing with inaccurate forecasts of RES

Future Challenges

- Source control power also from volatile RES
- Provide market design that gives sufficient incentives for investments in flexibility

Many thanks for your attention!

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