GE WI Aktiengesellschaft

INNOVATIV, ÖKOLOGISCH, GEMEINSAM

System and Market Integration – The Perspective of a German Energy Trader

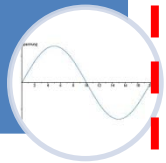
Berlin, 24th September 2015

The electricity sector is based on three pillars…

Focus of this presentation

- Is there sufficient electricity production to meet demand at any given time?

Electricity Generation (supply perspective)



- Can the electricity produced be transported to consumers (transmission and distribution)?

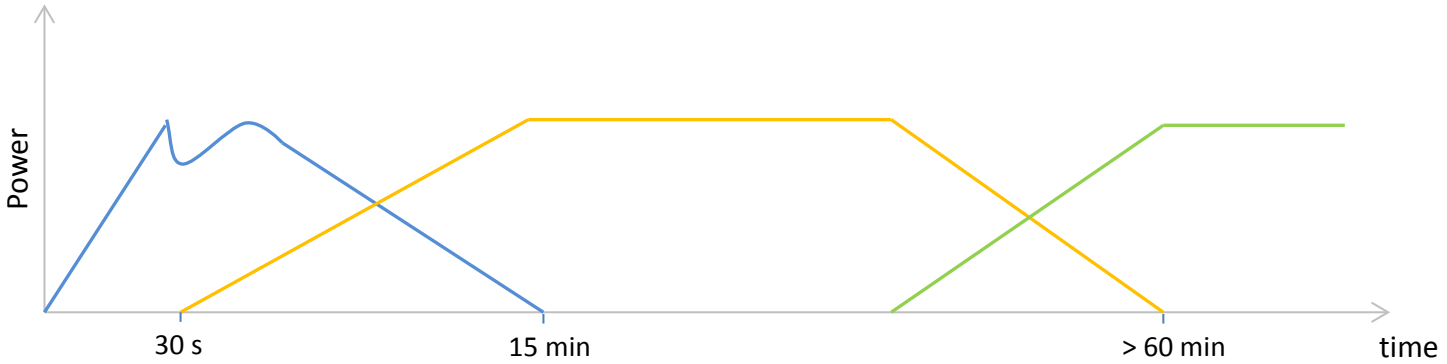
Electricity Distribution (grid perspective)

- Do market actors have access to produced electricity (liberalised market)?

Electricity sales/retail (market perspective)

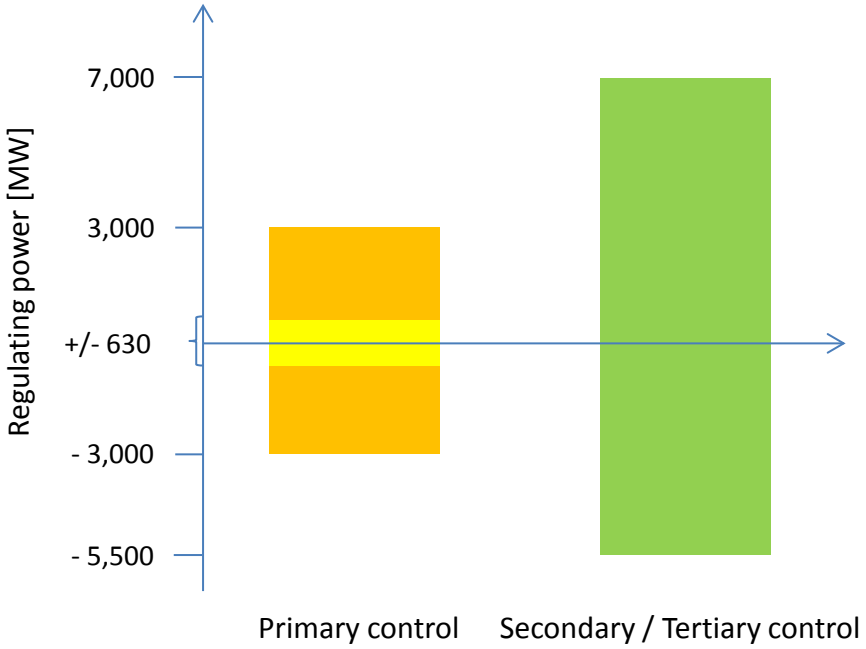
Balancing power

Illustrative



Type	Primary control	Secondary & tertiary control (minutes reserve)	"Bilanzkreis" (so-called balancing group)
Description	• Primary control/inertial response • Provided by all synchronously connected TSOs **Procurement:** • Automatic	• Procured by responsible TSO • Upward and downward regulation of power stations **Procurement:** • Secondary reserve: automatic • Tertiary control: manual	• Provided by respective balancing group • Purchased or sold at spot market or OTC market **Procurement:** • Manual

Overview of the Different Types of Balancing Power in Germany



Description

Primary control

- In the European transmission system (ENTSO-E) there is primary control reserve of +/- 3,000 MW

  ➔ For Germany: +/- 630 MW

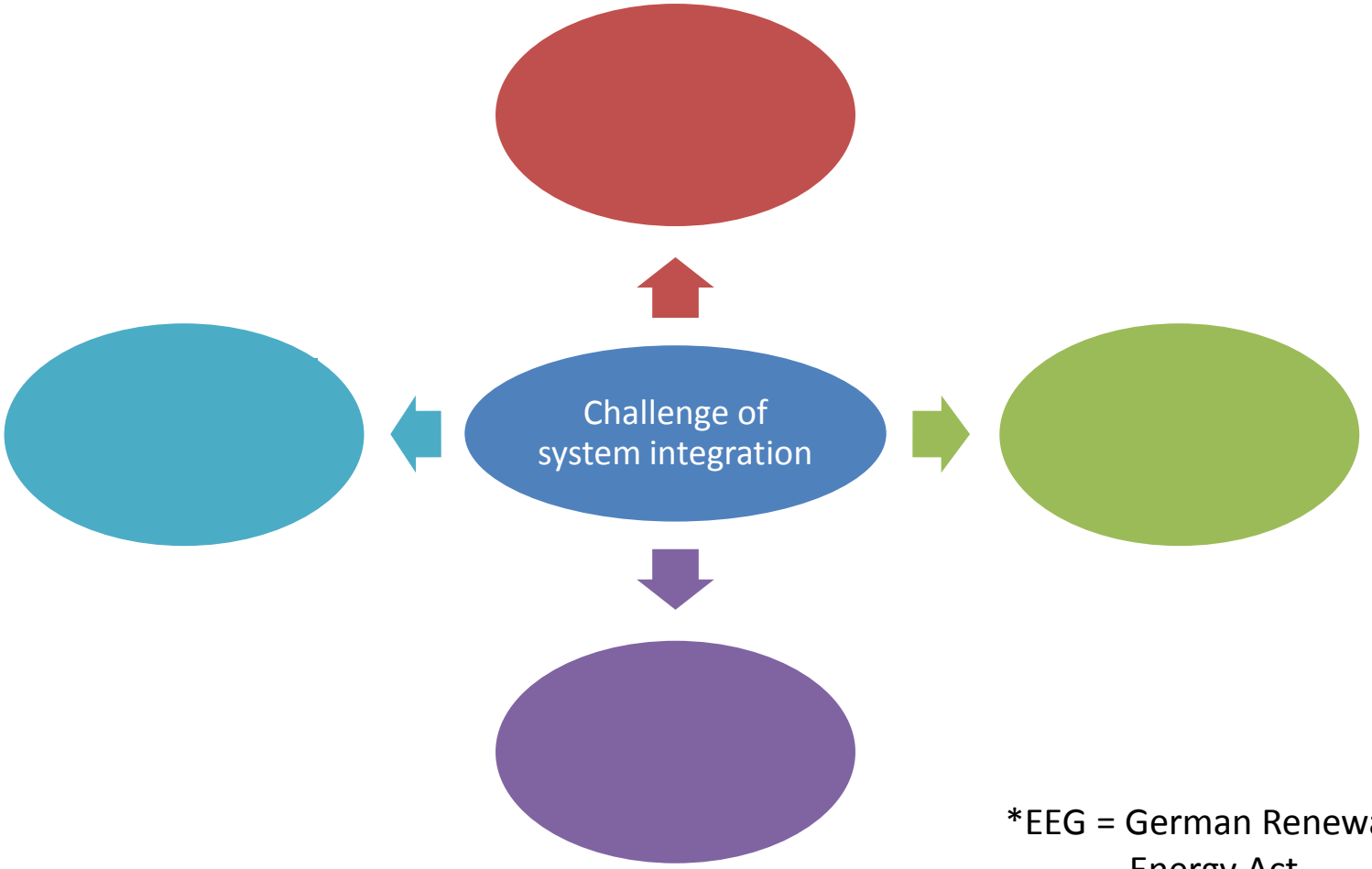
Secondary and tertiary control

- In the four control zones in Germany there is positive regulating power of approximately 7,000 MW and negative regulating power of around -5,500 MW

Objective

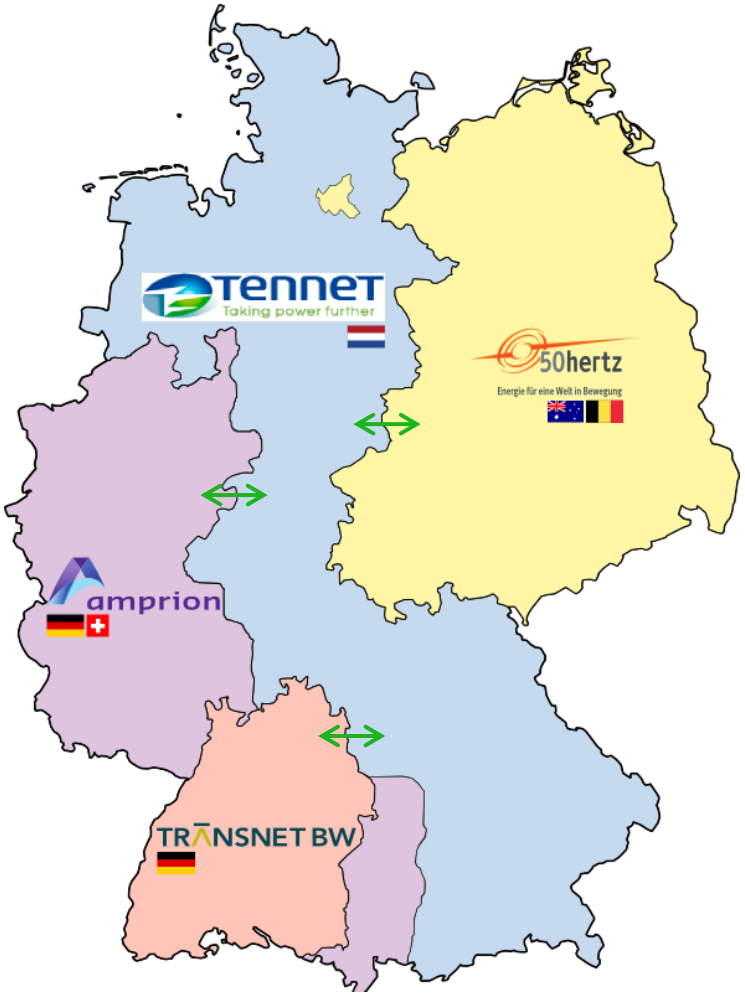
- Maintaining permanent balance between power generation and demand; balancing of deviations.

Challenges of System Integration of Renewable Energy



*EEG = German Renewable Energy Act

Challenge I: Bottlenecks/congestion due to lack of sufficient exchange capacity between the 4 control areas in the German grid



Description

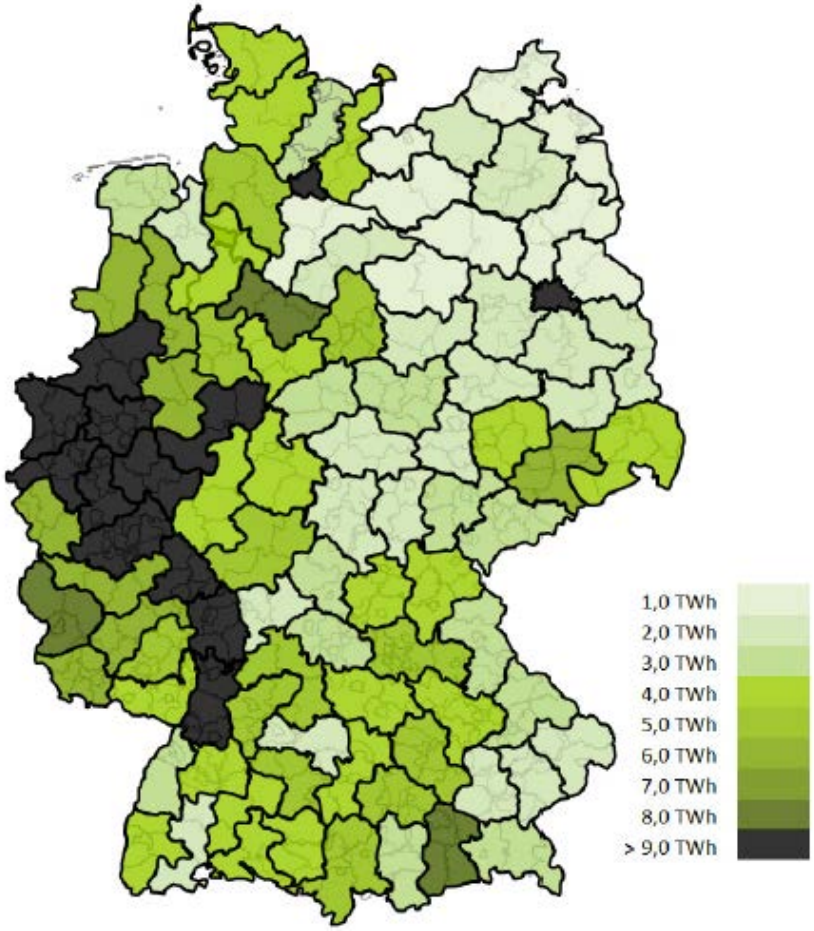
"Interconnectors" between the 4 German control areas

- Balancing across the 4 control areas in order to minimise the procurement of balancing power
  - ➔ However, this is restricted by the available capacity for power exchange between the 4 control areas
  - ➔ Strong fluctuations (e.g. induced by renewable energy feed-in) may become challenging, sooner or later, in the 4 control areas…

Solution approach

- Expansion of transmission lines between control areas, implementation of storage projects and – possibly – increased geographical distribution of RE production

Grid congestion and problems can lead to interference on the market



Source: PhD thesis M.Stark

Description

Challenge power transmission

- High production levels by wind and solar PV in South Eastern and Eastern Germany
  - ➔ Low electricity demand in these areas leads to high need for electricity transport
  - ➔ There are only limited possibilities for power transmission between the 4 control areas in Germany

Consequences

§14 EEG – Reimbursement for curtailment (system integration is lower as not all power that could be generated in certain periods can be fed into the grid)

- A portion of renewable power feed-in cannot be realised due to grid congestion.

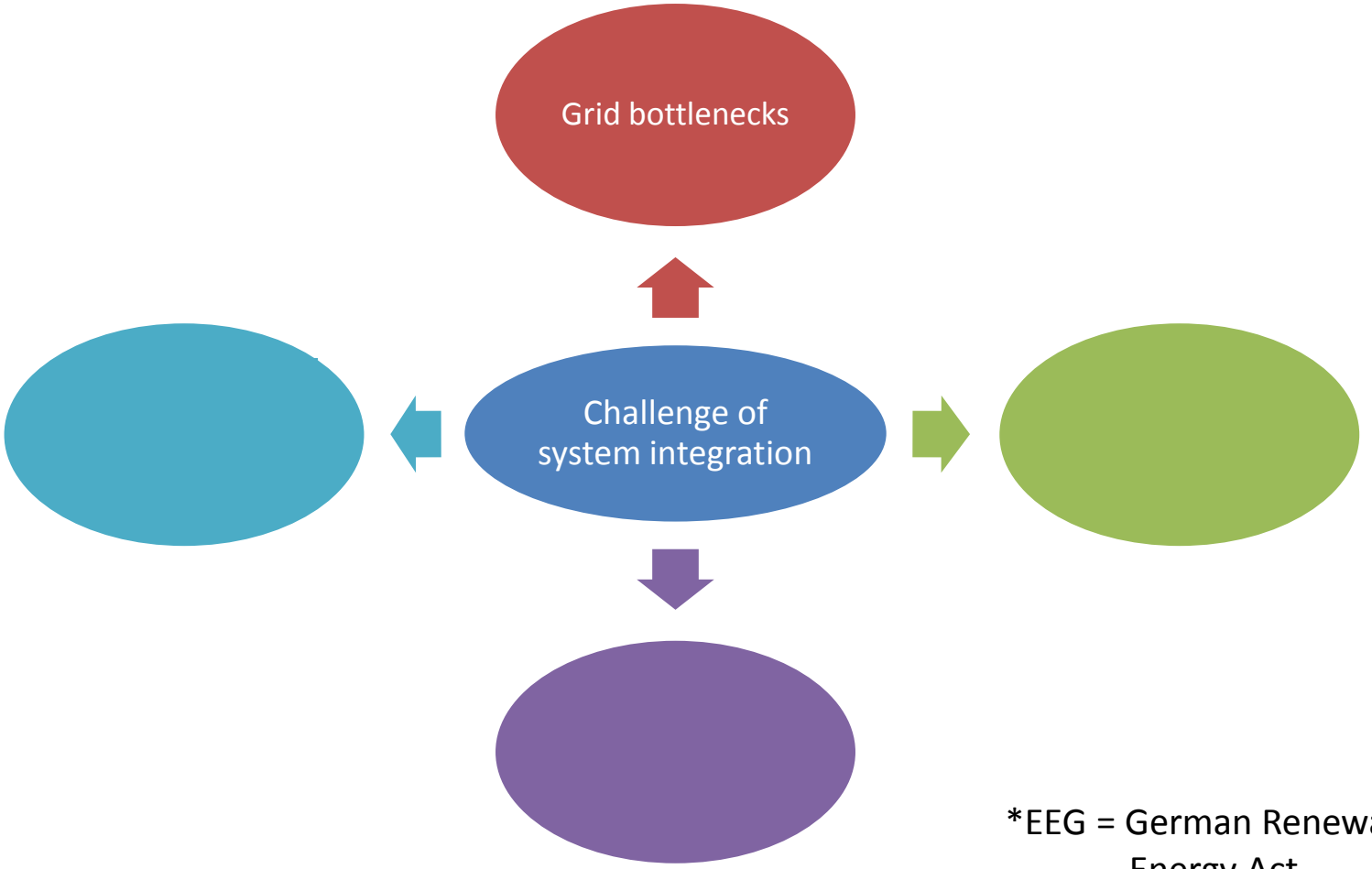
§13.1 EnWG (German Energy Act)

- Already today the TSO interferes by means of redispatch measures in the market (in the 50Hertz control area).

§13.2 EnWG (German Energy Act)

- If there are increasing grid constraints, this has a detrimental impact on the market (suspension).

Challenges of System Integration of Renewable Energy



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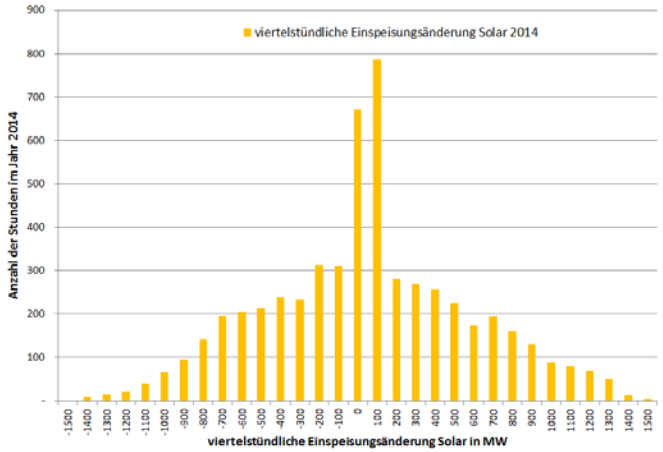
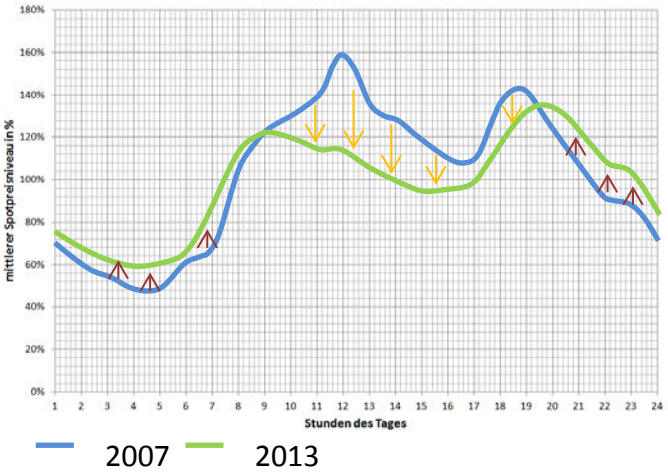
Challenge II: High ramp rates of variable energy feed-in have consequences – both from a grid and market perspective





Description

Challenge of high ramp rates

- Renewable power feed-in with high variability, especially solar PV (high ramp rates), needs to be ensured also in the future.
  - ➔ The installation of solar PV capacity increases
  - ➔ Capacity of conventional power plants decreases

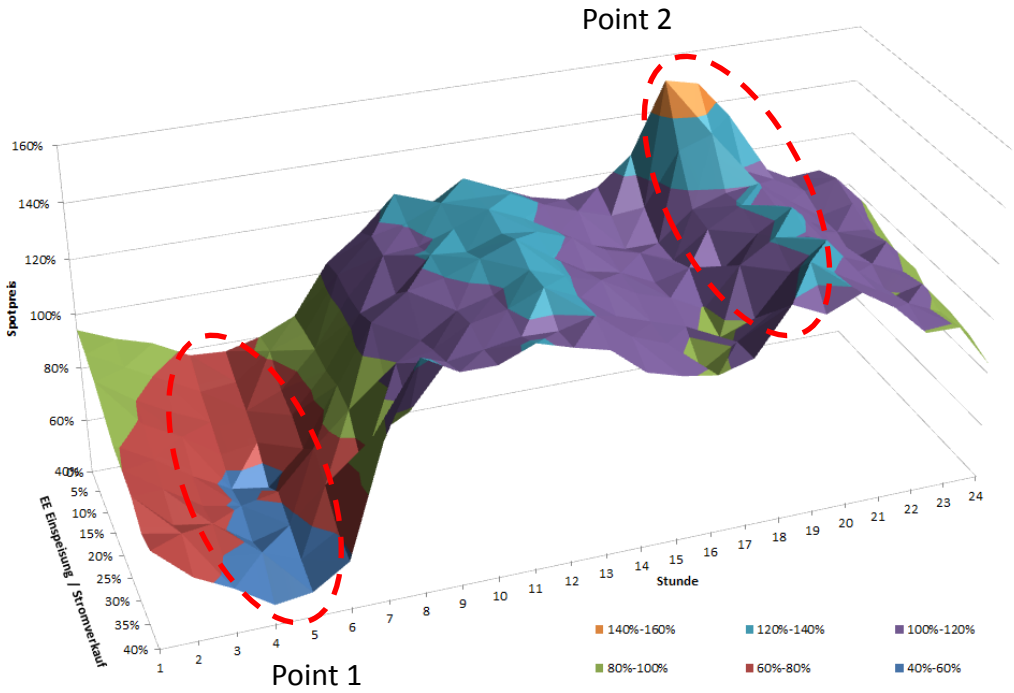
Consequences / Impacts

- In certain regions, the power produced may partially not be fed in.
  - ➔ Challenge especially regarding solar PV rooftop panels without possibility for remote steering
- Effect on spot price (“merit order effect“)

Solution Approach

- Installation of PV (East-West), stronger regional distribution and usage of decentralised storage in case of high RE feed-in (high ramps)

Merit Order Effect depending on the daily power feed-in by renewable energy production



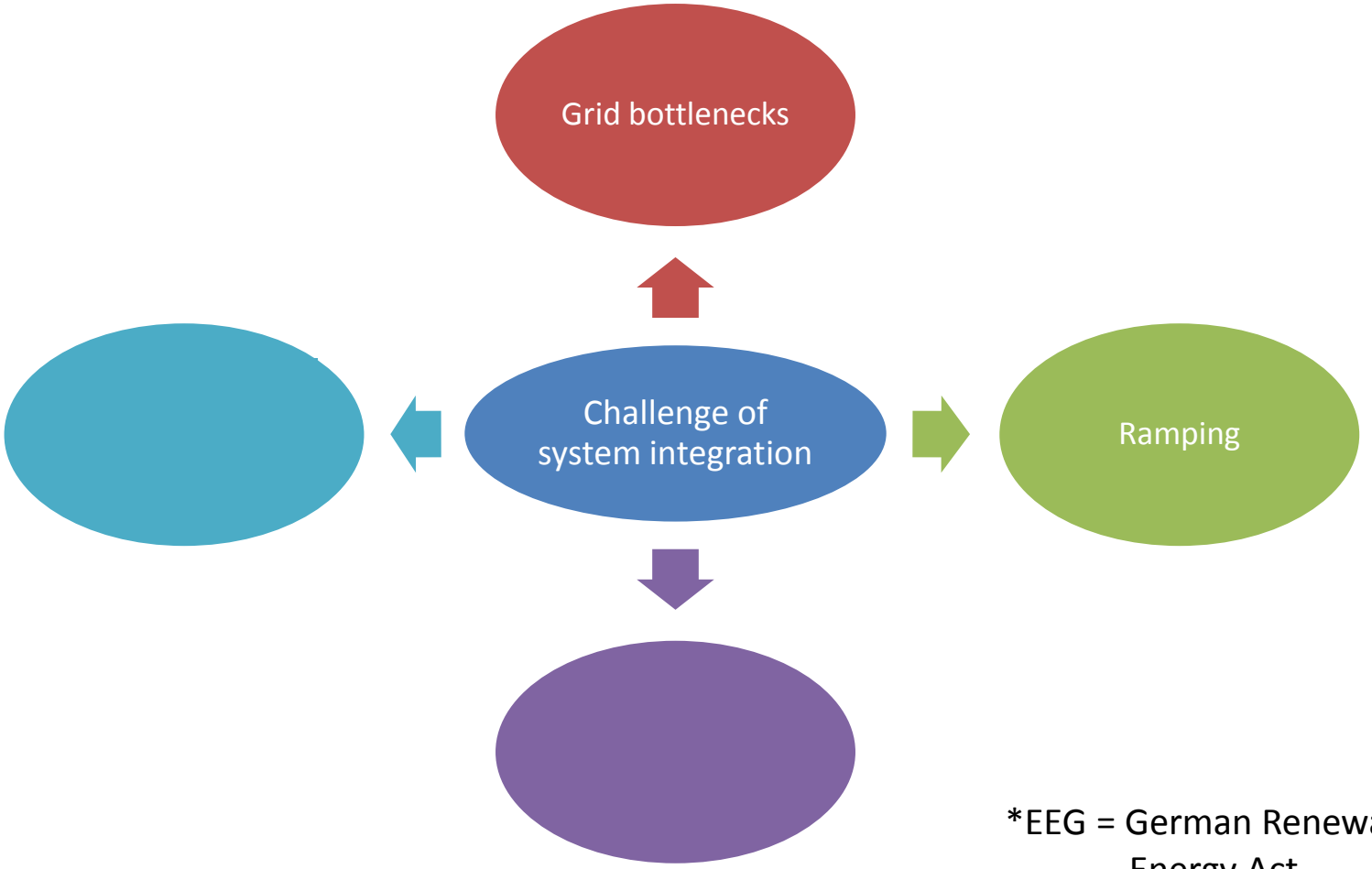
Description

- With increasing penetration of renewables, prices decrease on the spot market.
- This effect is **not** the same effect during an entire day.
  - ➔ During periods with low demand there are negative prices induced by high renewable power feed-in.

    ("Entsorgungsprämie", Point 1)
  - ➔ During periods with high electricity demand some technologies may be "pushed out" of the merit order due to high renewable power feed-in.

    (e.g., gas turbines, Point 2)

Challenges of System Integration of Renewable Energy



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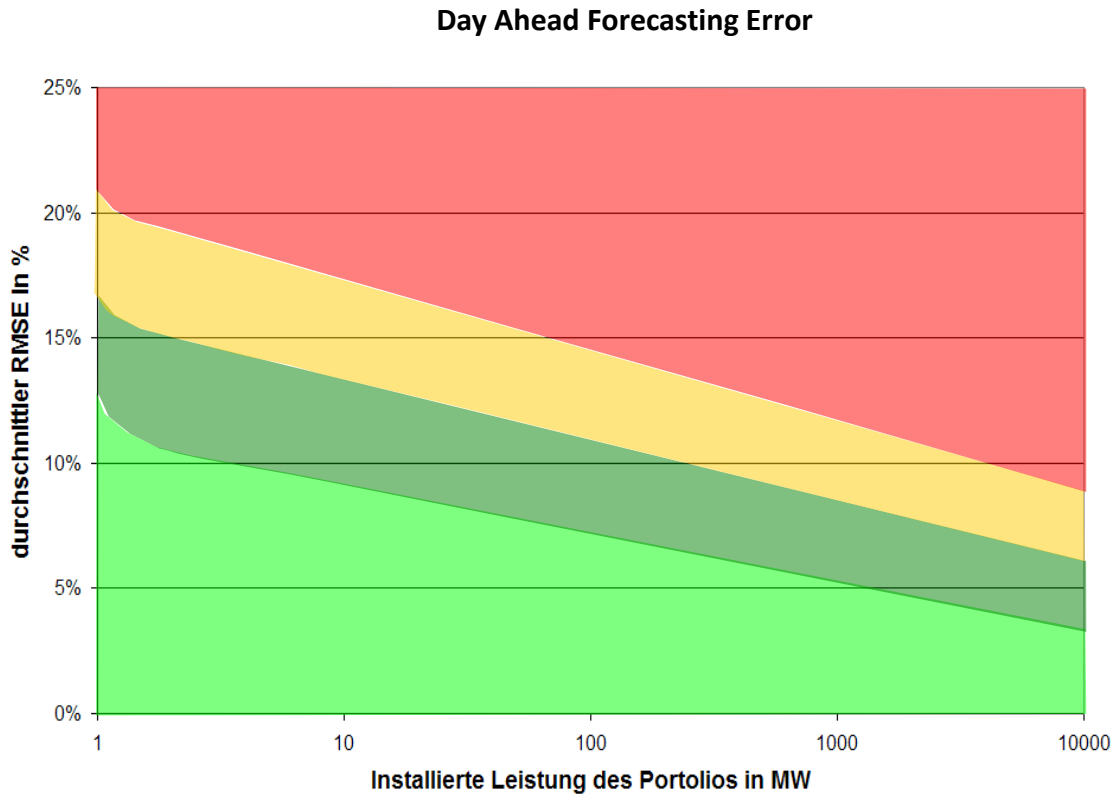
Challenge III:
Forecasting errors increase the procurement of balancing power



Description

- A larger portfolio increases substantially forecasting quality.

BUT:

- Despite a percentual reduction of the RMSE error with a larger portfolio , the maximum error may also increase

➔ Increased procurement of regulating power

Legend

Good

Poor

Very good

Medium

* Referring to a medium utilisation of 1.800 h/a. With lower utilisation => higher RMSE

Source: own calculations

Overview of maximum error in different portfolios

Type	Rated power	RMSE	Max. abs. error (in relation to rated power)	Reason of max. error
Wind farm	4 – 40 MW	6.9% - 14.3%	64% - 97%	Shut down of wind turbine or parks
Kleiner Verbund (RZ)	Ca. 100 MW	5.1% - 8.3%	32% - 60%	Icing, storm, prognosis
Größerer Verbund (D)	Ca. 300 MW	4% - 5%	25% - 30%	
Total installation D	Ca. 32,000 MW	3,19%	Ca. 10%	Prognosis

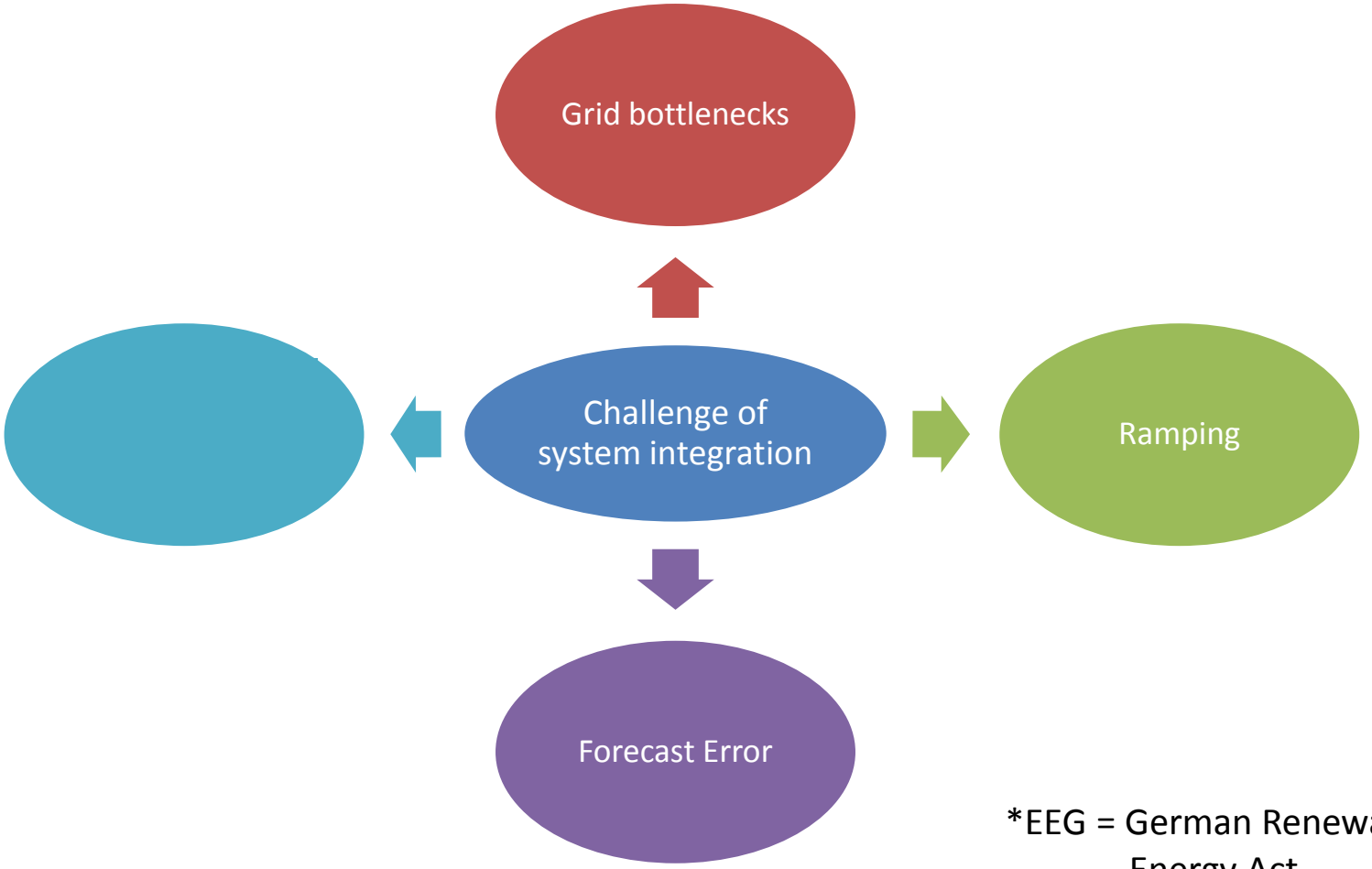
Beschreibung

- A larger portfolio reduces the direct impact of outages or shut downs of individual wind turbines or parks.
- However, also when a larger portfolio is applied there may still be day-ahead errors of 25%.

  ➔ Forecasting errors may have consequences on the spot market.
- Even when taking the entire wind production portfolio of Germany as a basis, the maximum absolute error cannot be reduced below 10 %.

Source: own calculation

Challenges of System Integration of Renewable Energy



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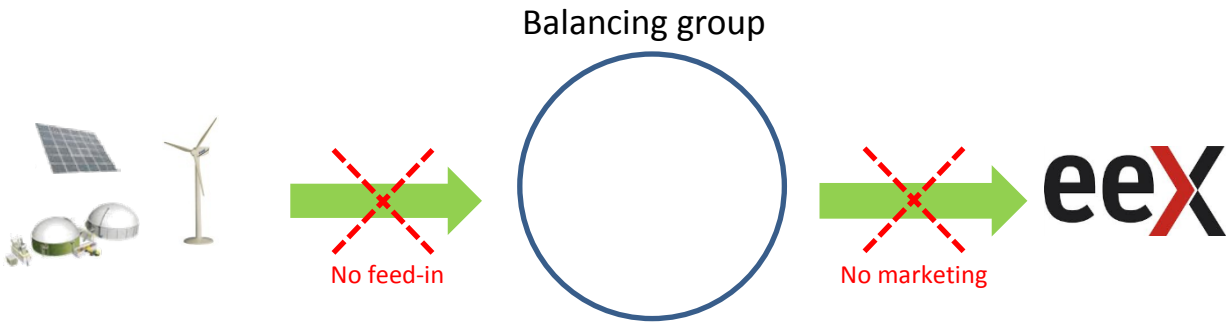
„Challenge“ IV:
Political intervention by §24 EEG 2014

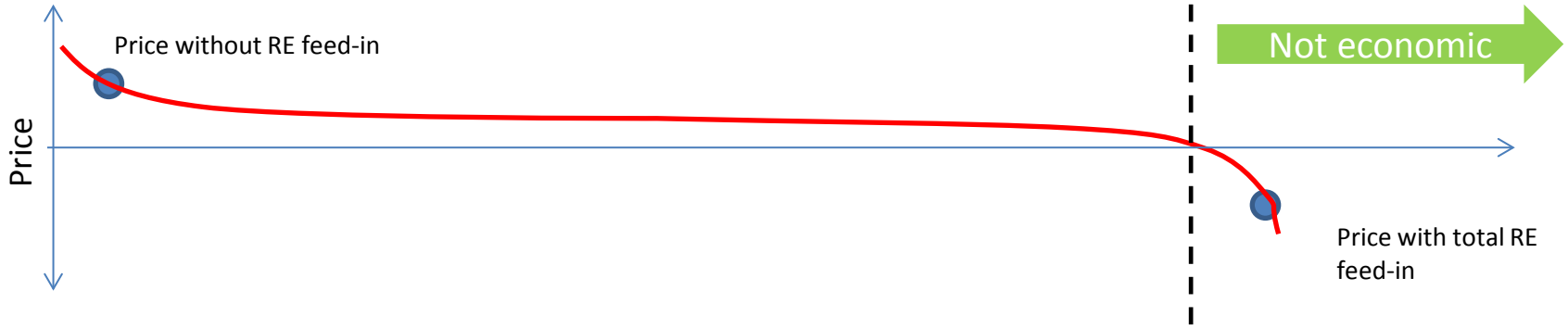
If there are (at least) 6 negativ price consecutive hours on the spot market, then renewable power produced (and falling under §24 EEG 2014) receives a feed-in tariff of “zero“ during this period.



Consequences of §24 on grid reliability

- In the absence of any possibility of marketing, the electricity feed in may not be in the balancing group
  - ➔ Curtailment
- Already in 2017, approximately more than 3,000 MW of new renewable installations will be subject to §24 EEG 2014.
  - ➔ Curtailment of these renewable power installations will happen nearly at the same time.
  - ➔ Hence, the “n-1“ criteria is no longer the largest classical power station, but the “virtual power station „ consisting of renewables.

§24 EEG induces higher marketing costs for traders



Possibility A:
Interfernce by various traders leads to **positive prices**

- Due to reduction in supply on the spot market there are *positive* market prices

Consequence:

- No §24 EEG 2014 case exists.

Cosnequences for traders

a) Traders that have not traded all quantities have to sell quantities on the intraday market at potential losses

b) Trader that have traded all quantities incur no losses

Possibility B:
Interfernce by various traders leads – neverthelsess -to negative prices

- Despite reduction in supply on the spot market there are *negative* market prices

Consequence:

- §24 EEG 2014 case potentially exists.

Consequences for traders

a) Traders that have not submitted any bids can protect themselves from losses by means of potential curtailment

b) Trader that have traded all quantities, but where there still is curtailment need to trade on the intraday market (potentially incurring losses as compared to spot market)

Thank you for your attention

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