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# Relevance of long-term power system planning towards high shares of RES

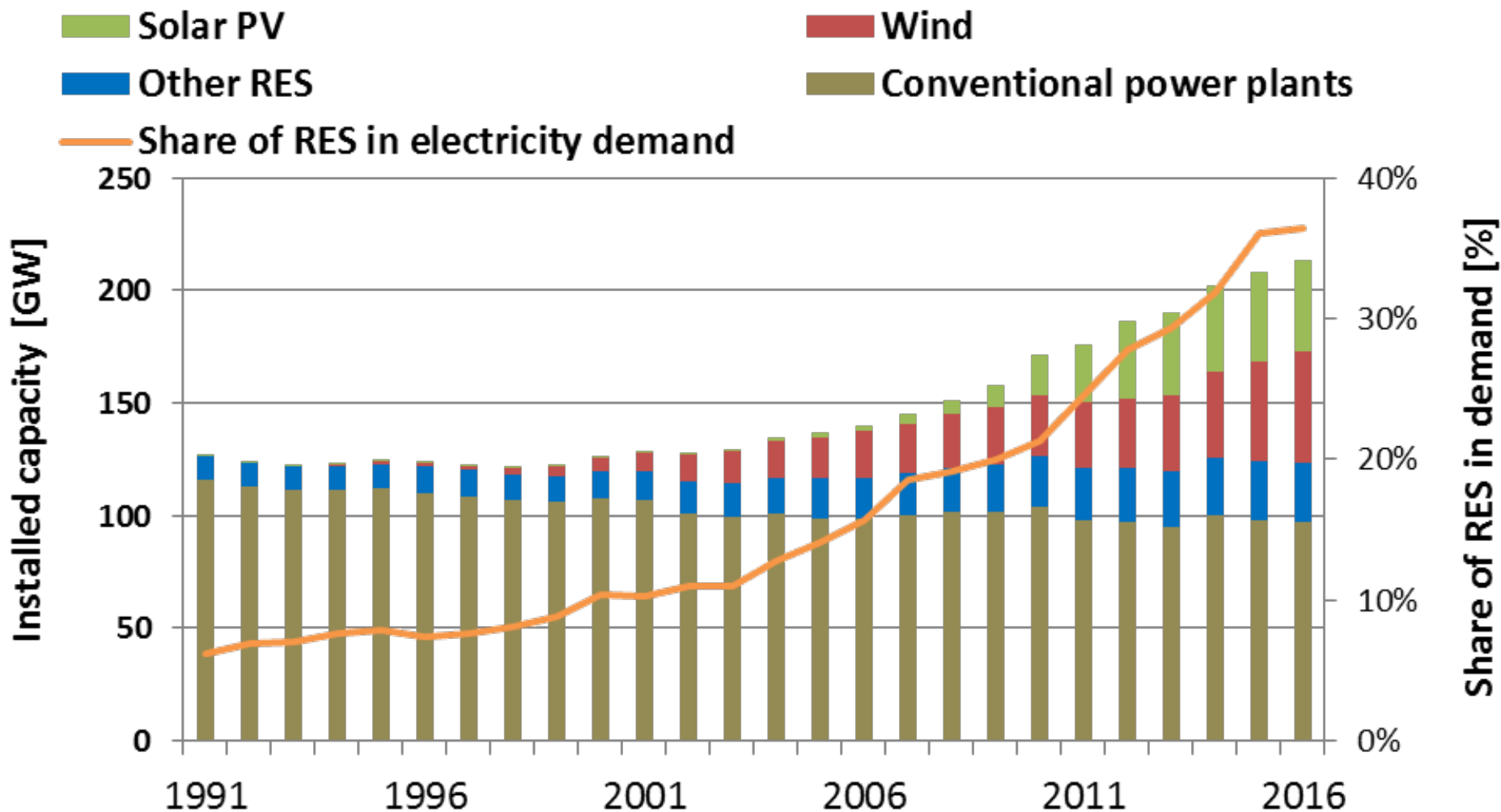
## Insights into the German Energiewende

Dennis Volk

*SEE Grid Integration Workshop – 7 Nov 18, Vienna*



[www.bundesnetzagentur.de](http://www.bundesnetzagentur.de)



**German Energiewende a long-term project; built on top a „mature system“; > 50% of generation under planned conditions**



- How did we get to where we are today?
  
  
  
  
  
  
  
  
  
  
- Where could we go from here?

**Planning measures used in the past; remain significant in the future**



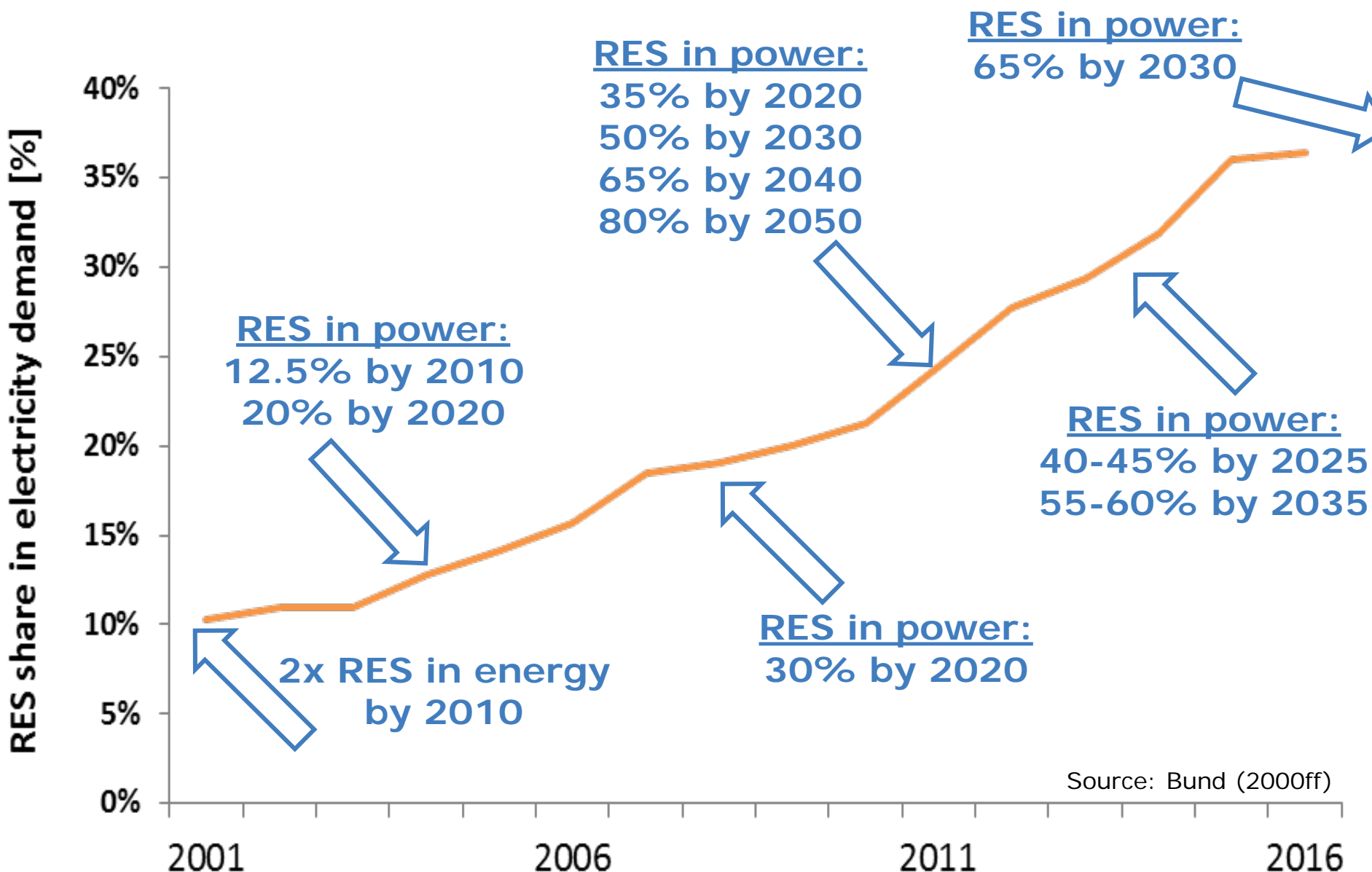
- Planning measures already in use
  - why they help,
  - how they are designed.



- RES targets as cornerstone for development (IRENA, 2015)
  - spectrum,
  - sector(s),
  - design methodology.
  
- German RES targets
  - legally binding for electricity as target share,
  - non technology-specific,
  - anchor for „further measures“.

**German RES targets effective in combination w govt. investment guidance**

# Development of German RES electricity target

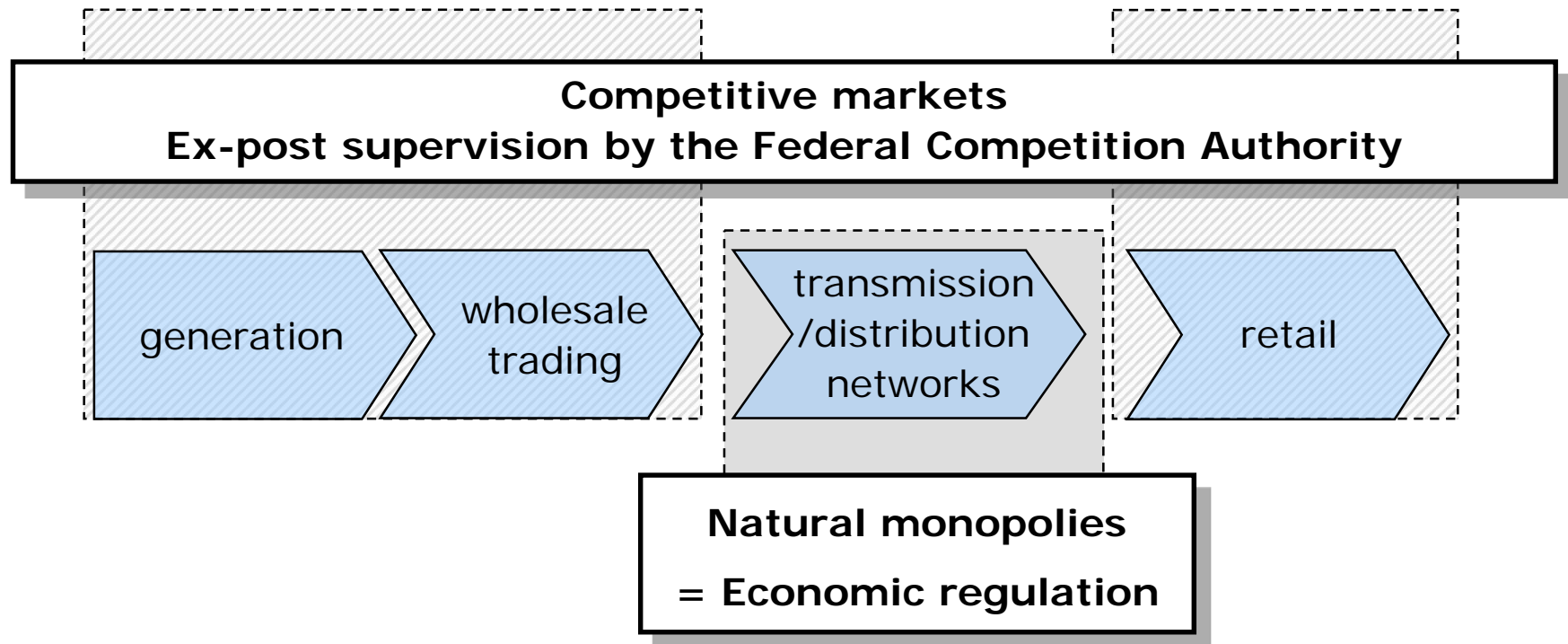


**RES targets growing w confidence; works w updates; „easy“ so far**



- „Energiekonzept“ @ 20%RES (BMWi, 2010)
  - Long-term energy/climate policy guidelines,
  - Scenarios to identify pathways for power, heat, transport,
  - RES as main energy source,
  - Energy efficiency, grids.
- Aiming towards market-based RES and larger shares
  - Reduced financial support,
  - Produce when required,
  - Provision of ancillary services.
- Incremental development since then; comprehensive revision possible

**Whole-of-system plans as checkpoints for policy adjustments**

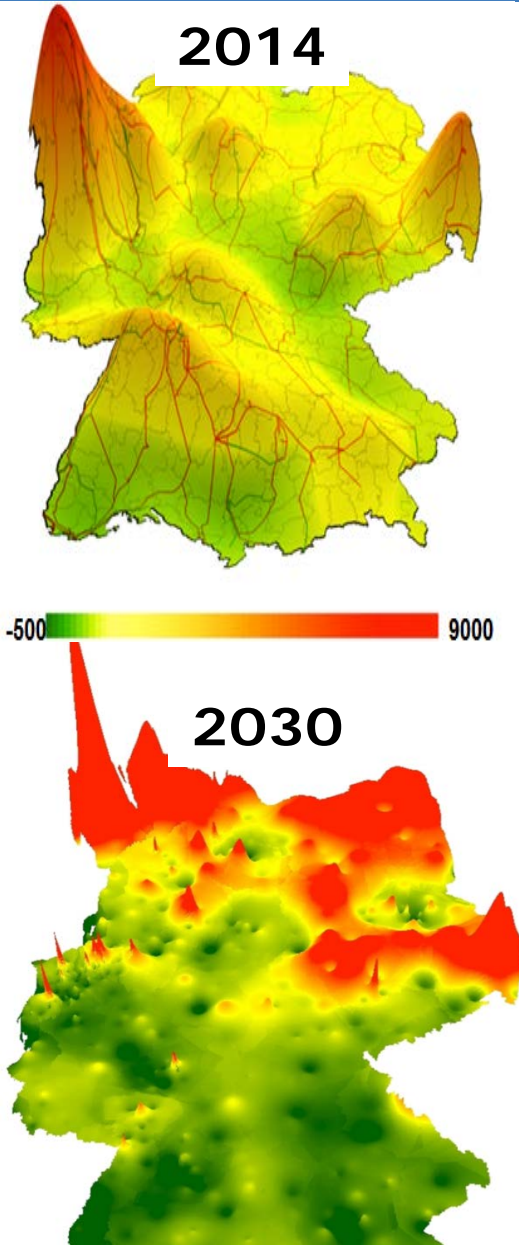


**Govt. Investment planning in Germany roughly along the lines of competitive market design structures**



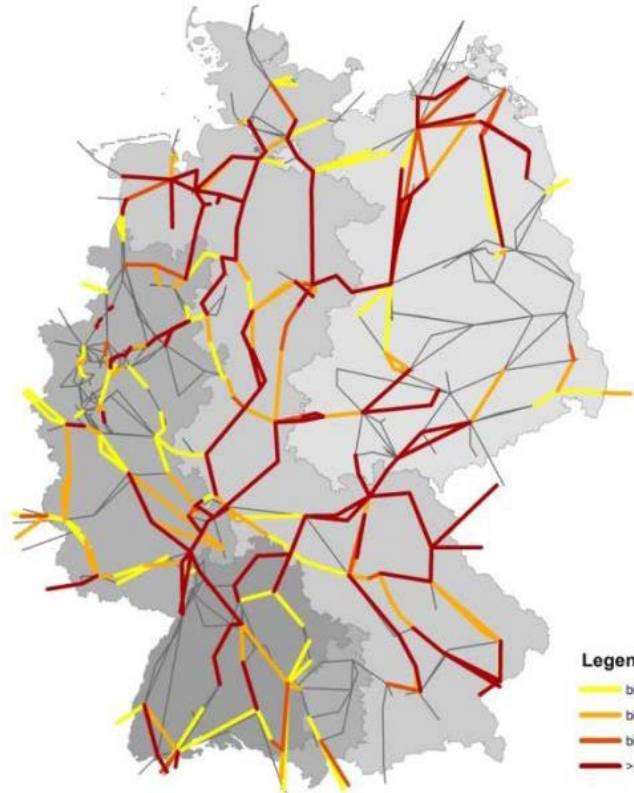


Electricity account balance [MW]



Current grid:

35k km of electric circuits



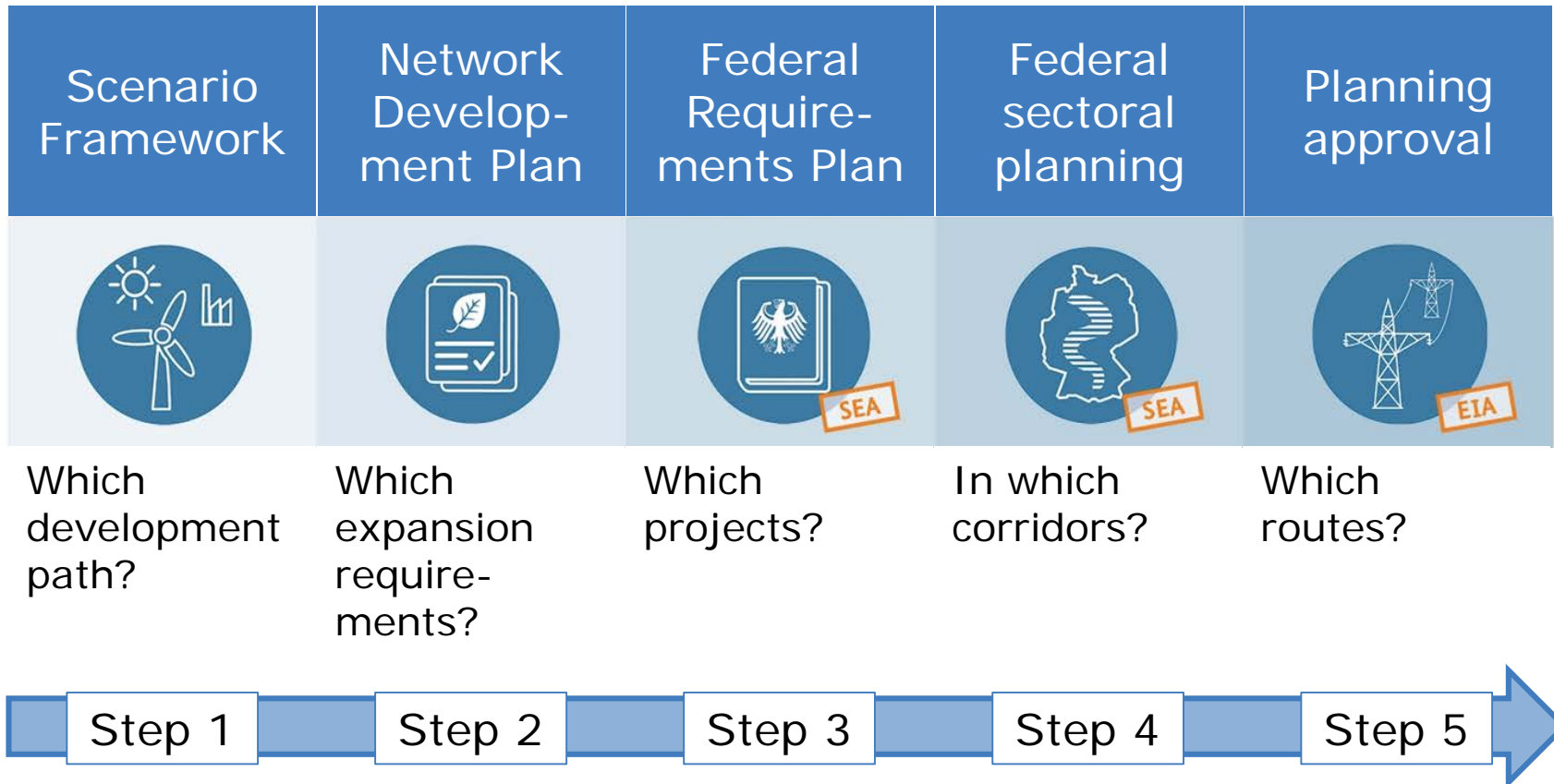
Future grid:

42k km of electric circuits,

incl. 5 HVDC lines

**20% more grid makes a plan valuable**

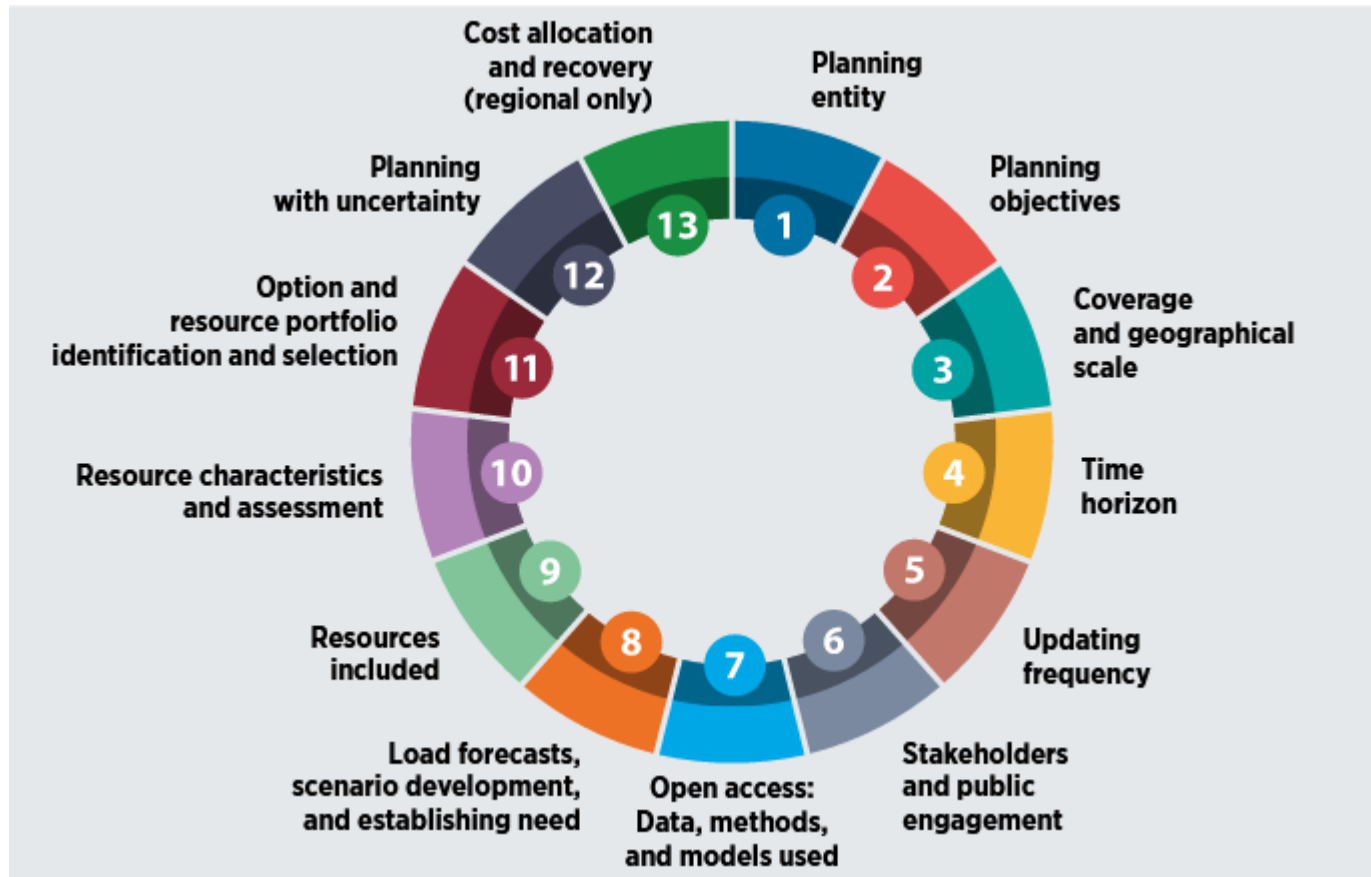
# German electricity sector investment planning – transmission expansion



**Grid planning process established in 2011 (@ 24% RES share) as response to growing needs**



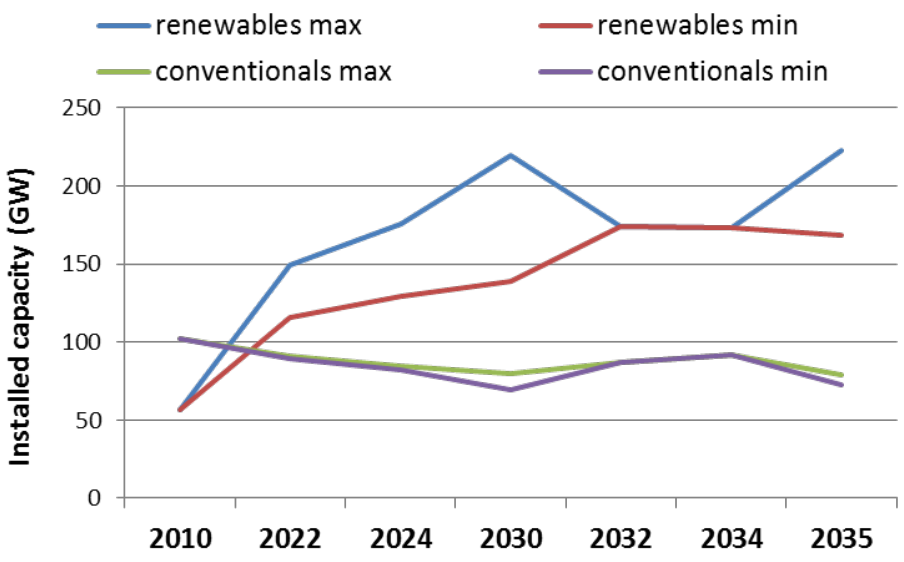
- Transmission planning follows a comprehensive approach (IRENA, 2018)



**Process delivers transparent, least-cost, policy-adjusted transmission plan to achieve timely and efficient infrastructure**

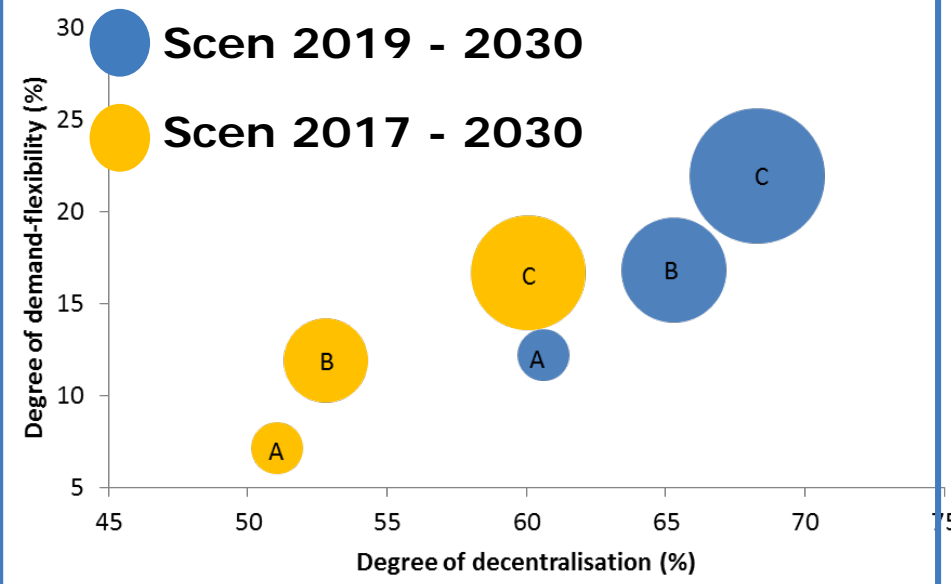


## Generation capacity development



- RES capacity growing significantly in all scenarios
- Large RES bandwidth induces uncertainty
- Conventionals decline slowly
- Low uncertainty largely driven by retirement decisions

## Sector coupling, flex and decentral

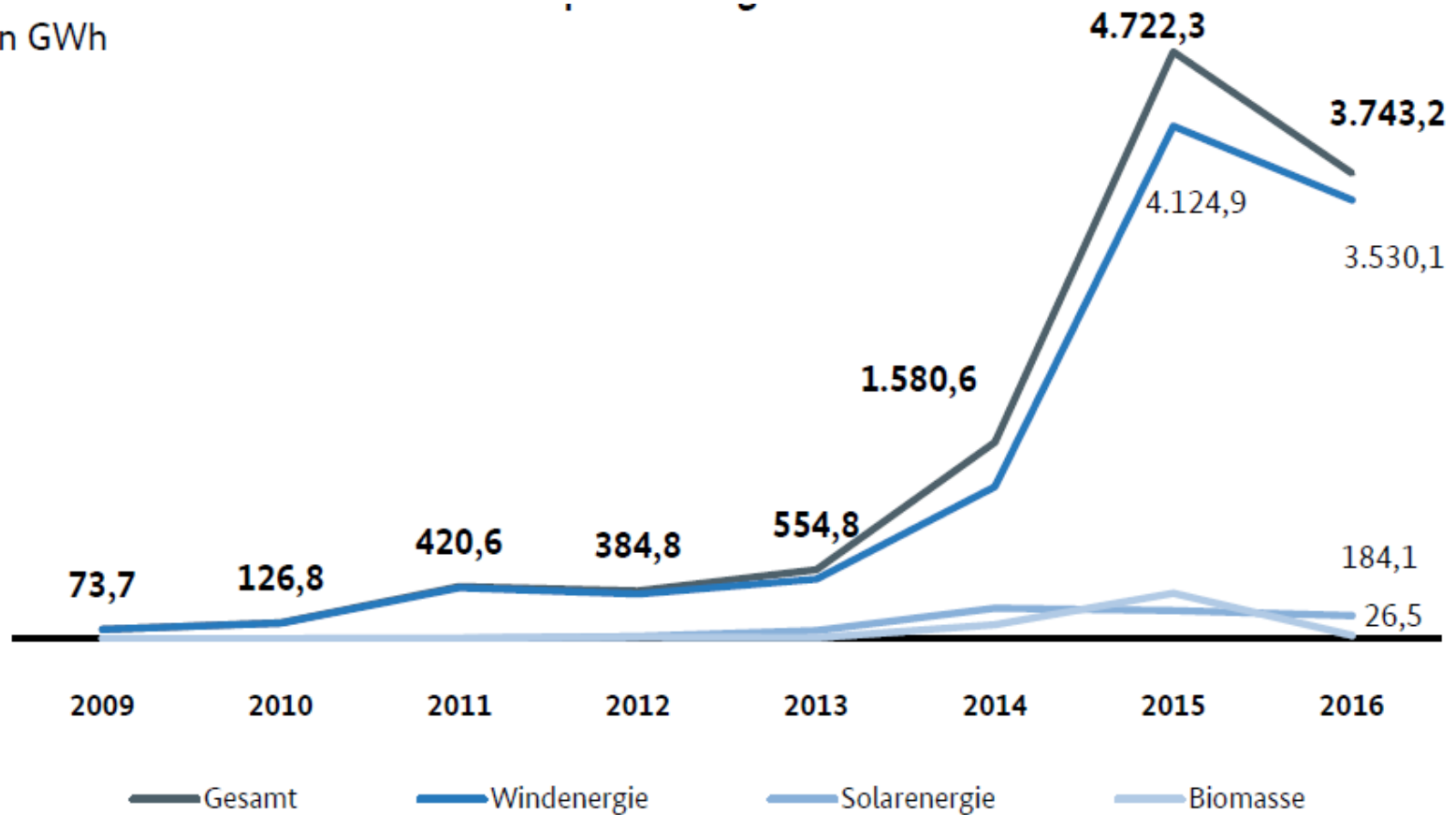


- Sector coupling as „new“ feature to the scenarios
- Decentralisation above 50% in all scenarios
- Large bandwidth driven by RES
- Demand flexibility @17% max; harder to reach in the market<sub>12</sub>



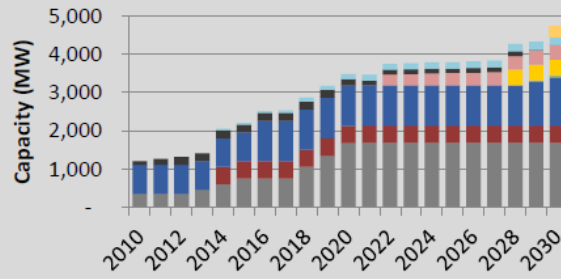
- Security constraints more often binding
  - Redispatch (11 TWh and 220mEUR)
  - Renewables curtailment (82mEUR; 314; 643)

in GWh





## Power sector planning: Planning scopes for techno-economic analysis



### Generation expansion

- Ministry of Energy
- Planning agency
- Utility

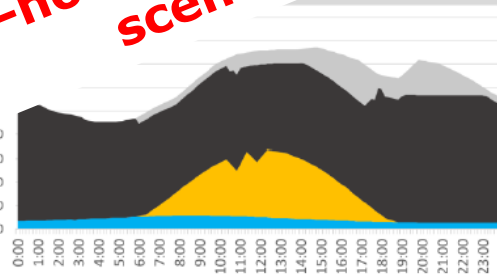
**Regulatory simulation of;**  
**scenario-based**



### Dispatch simulation

- Utility
- Regulator
- TSO

**In-house; based upon**  
**scenarios**



### Geo-spatial planning

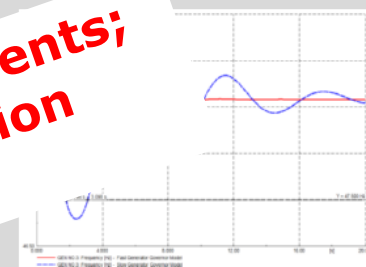
- Ministry of Energy
- Planning agency
- Utility
- TSO

**In-house; based upon**  
**scenarios**



### Technical network studies

**Load flow assessments;**  
**portfolio selection**  
**criteria**





- Enhanced transmission planning
  - stability assessments,
  - automated network operation,
  - storage for grid services,
  - other complements to the grid
- Distribution level planning
- Generation planning
  - nation-wide adequacy and flexibility
- Energy sector planning

**All items are speculation; some could also be solved by „the market“.**



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Thank you for your attention!

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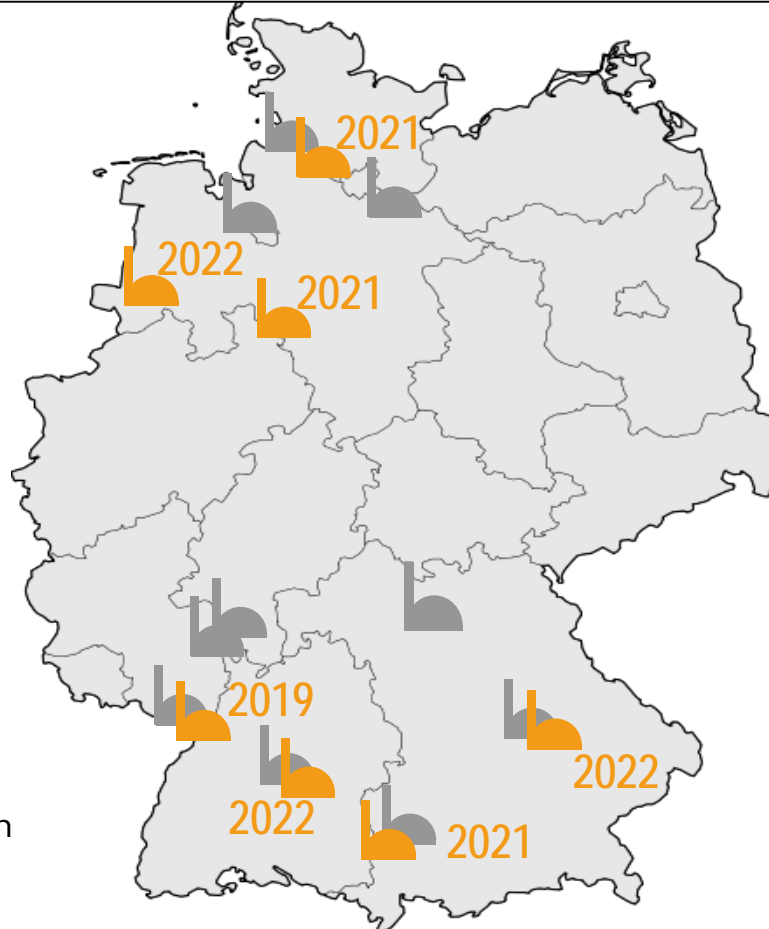
The big north-south divide of generation and load results in challenges for the transmission grid.

### Wind offshore

Status 2017: 5,4 GW  
2030: 10-23 GW

### Wind onshore

Status 2017: 50,5 GW  
2030: 70-90 GW



### Photovoltaics

Status 2017: 42,4 GW  
2030: 73-105 GW

- Planned decommission
- Decommissioned

Source: BNetzA

The TSOs set the extent of the network expansion by applying the NOVA-principle.

<b>N</b>	<b>Grid...</b>	
<b>O</b>	<b>optimization</b>	<ul style="list-style-type: none"><li>• Topology measure</li><li>• Transmission line monitoring</li></ul>
<b>V</b>	<b>strengthening</b>	<ul style="list-style-type: none"><li>• Voltage increase</li><li>• New lines in existing corridors</li></ul>
<b>A</b>	<b>extension</b>	<ul style="list-style-type: none"><li>• New 380 kV-lines</li><li>• New substations</li></ul>

Source: BNetzA

Based on different check criteria the BNetzA analyses the projects.

## Effectiveness (n-1)

Does the project resolve or reduce an overload?

&

## Necessity

Does the use of capacity of the new project is at least 20%?

## Other considerations

Are there special reasons to justify the confirmation or disaffirmation of a project?

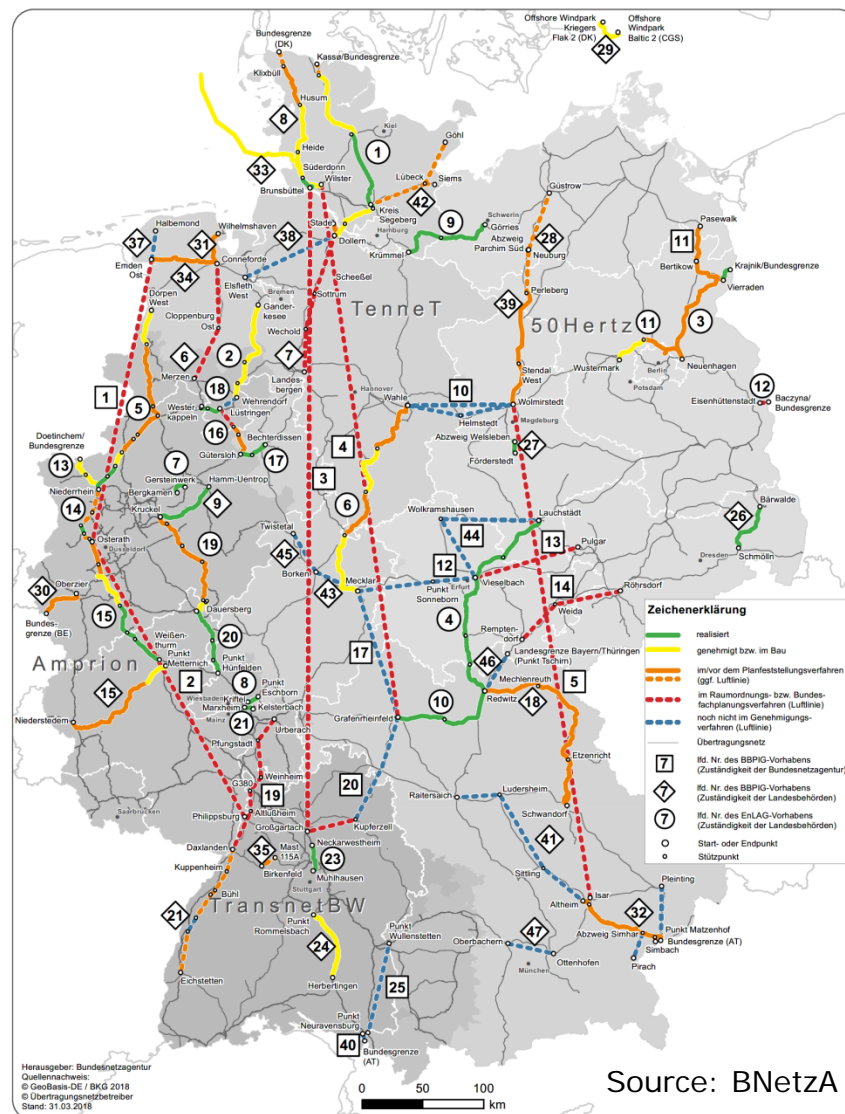


## Projects of Federal Requirements Plan (BBPG)

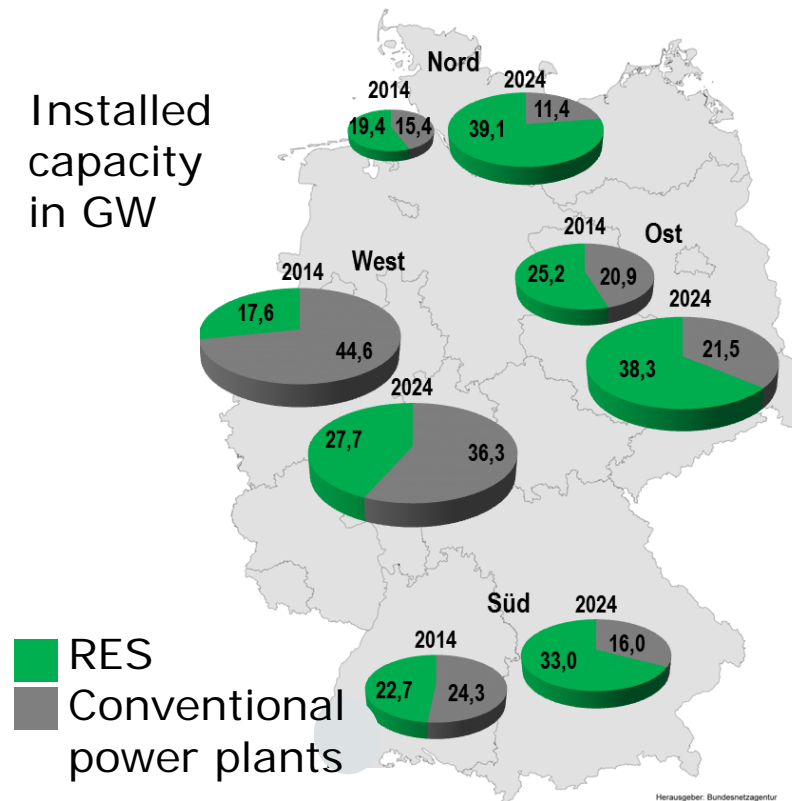
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## Projects of Power Grid Expansion Act (EnLAG)

- realized
- allowed / under construction
- Planning approval
- - - Federal sectoral planning
- - - Not yet in approval procedure
- Transmission system



The NEP contains a method for the allocation of producers of renewable energy and the loads.



Allocation of:

- Renewable Energies
- conventional power plants
- loads

to one of approximately 450 nodes of the transmission network.

RES distribution - NEP 2024

Herausgeber: Bundesnetzagentur  
Quellenangabe: © GeoData-DE / BKG 2014  
Stand: 14.04.2015



The electricity market is simulated for every hour of the target year.

## Approach:

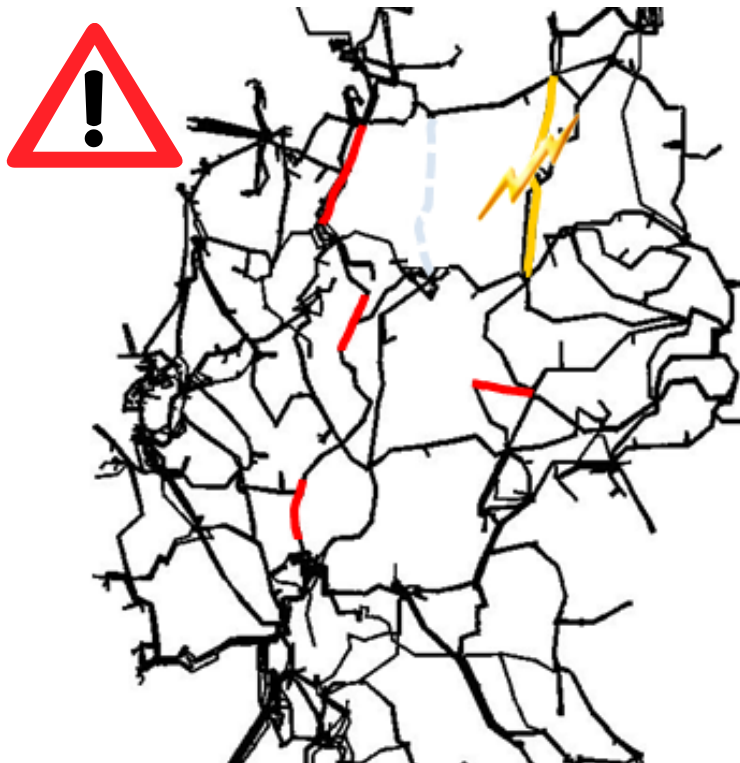
- Internal network is “copper plate”
- Economical priority of Renewable Energies
- Must-run plants
- Load, that cannot be served by Renewables, is covered by conventional power plants

## Result:

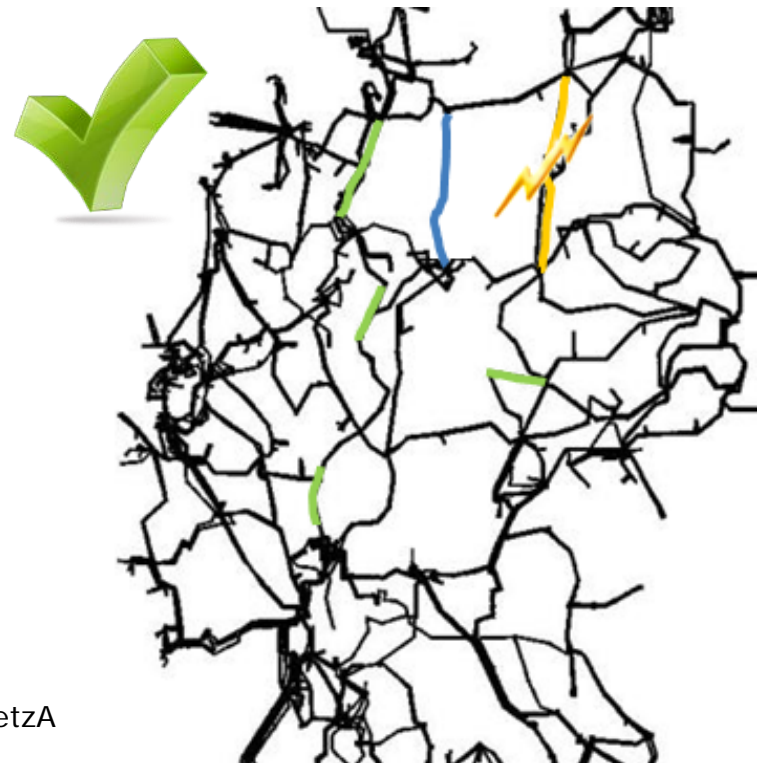
- Hourly forecast of the power plant utilization
- Hourly load and feed-in for every node



The (n-1)-security is considered by outage calculations using a calculation software.



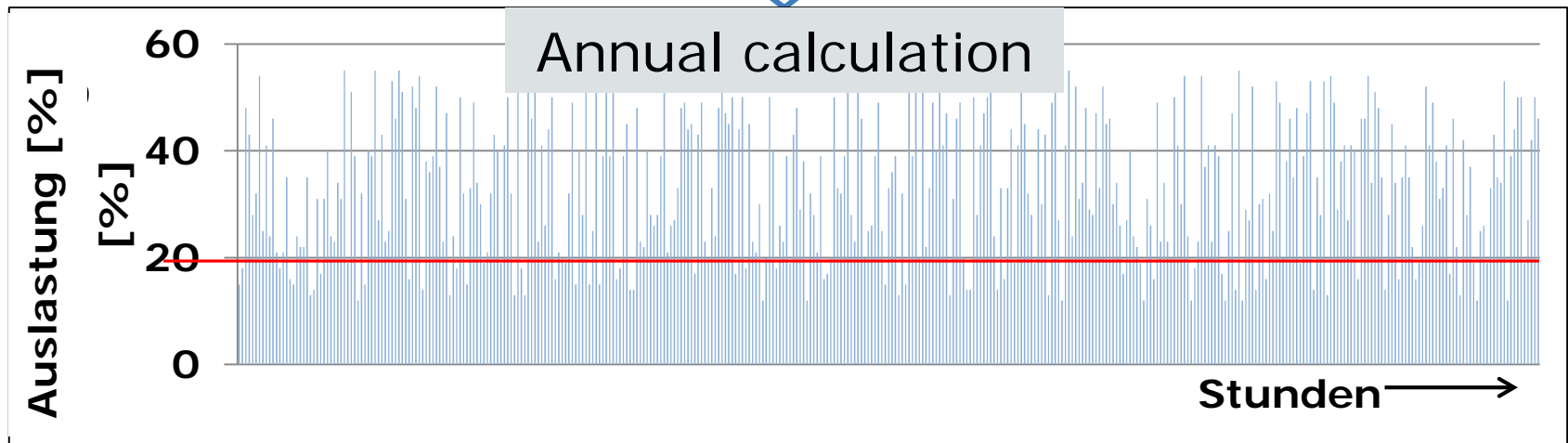
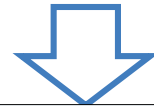
without project



with project

Source: BNetzA

Verification of maximum capacity utilization



Maximum capacity utilization > 20%



Necessity confirmed



(n-1)-secure means, that with ONE line failure the grid can still work safely and reliably.

Further reasons for the efficiency of a project are, that the project...

- avoids disproportional effort for establishing (n-1)-security in subordinate grids
- leads to an intended increase of transport capacity across borders
- reduces undesired loop-flows over foreign countries significantly



## Federal Requirements Plan (“BBP”)

- Projects in the Federal Requirements Plan are necessary for the energy system and have “priority need” for implementation
- The Federal Requirements Plan defines start and end point of each project
- Legal Basis for the next steps: the planning of corridors and final routes
- The law was passed in 2009
- The first Federal Requirements Plan was issued in 2013 on the basis of the NEP 2012



Source: BNetzA



## Federal Sectoral Planning:

- Definition of corridors which have the least impact on people and environment
- Strategic Environmental assessment
- Cross-border projects: BNetzA (NABEG) is responsible



Source: BNetzA

## Planning approval:

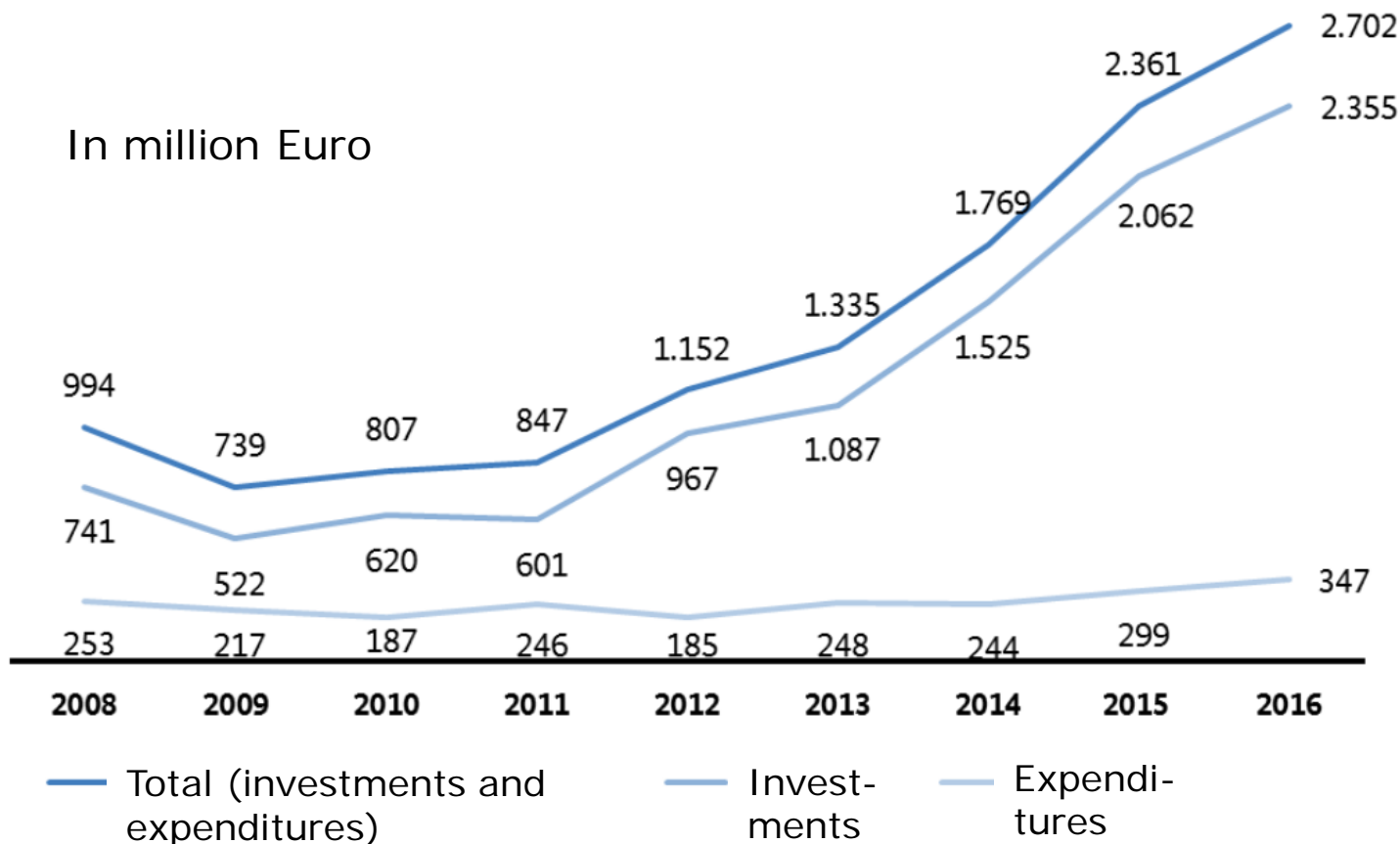
- Final decision on the route (location of masts etc.)
- Environmental assessment
- Cross-border projects: BNetzA (NABEG) is responsible



Source: BNetzA



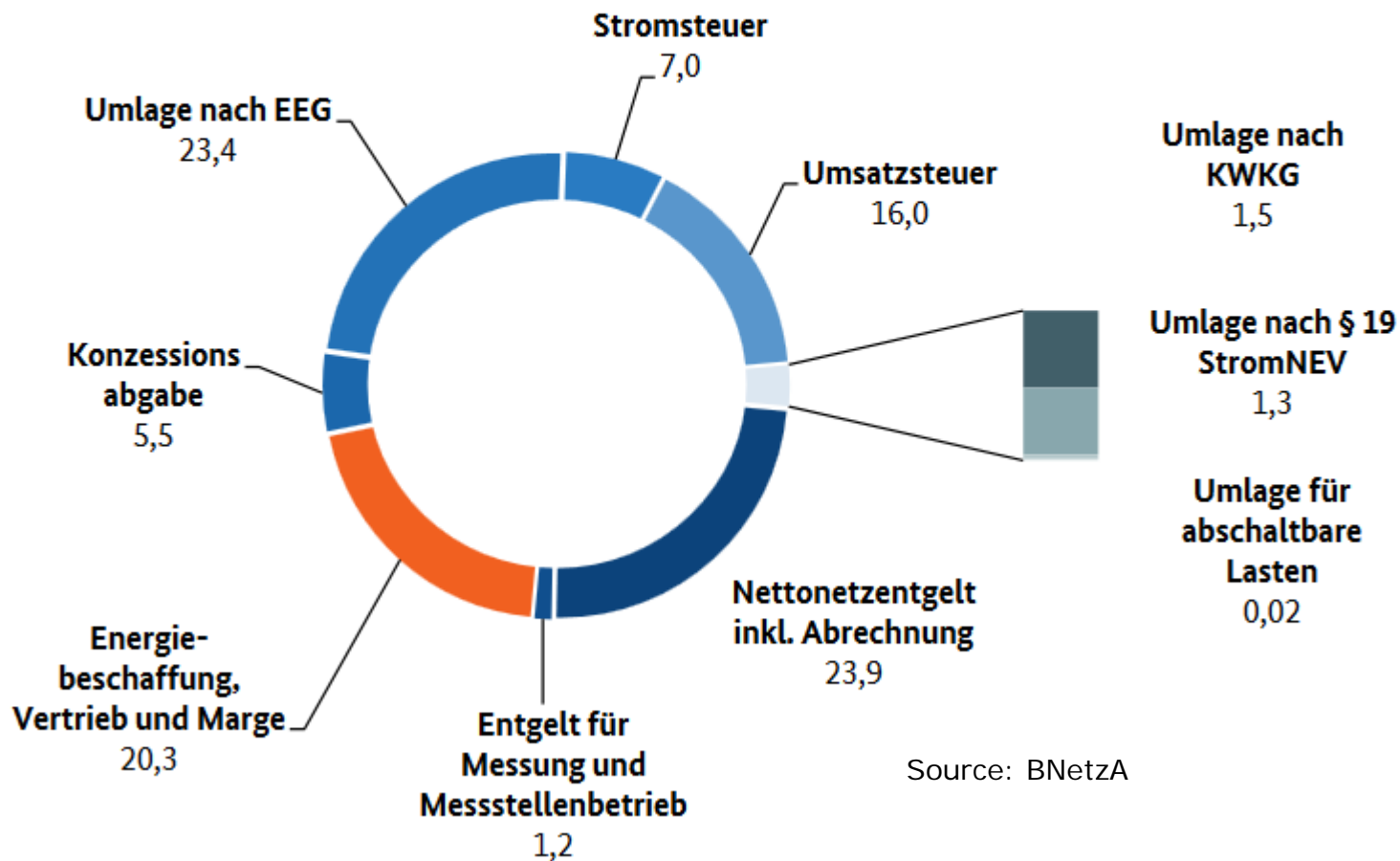
## Investments and expenditures in grid infrastructure by the TSOs



Source: BNetzA



**Aufteilung der Einzelpreisbestandteile für Haushaltskunden für das Abnahmeband zwischen 2.500 kWh und 5.000 kWh (DC) im Jahr für Ökostrom, Preisstand 1. April 2017**  
in Prozent



Source: BNetzA