Bundesnetzagentur

VRE geospatial aspects in electricity system planning

the German regulators perspective

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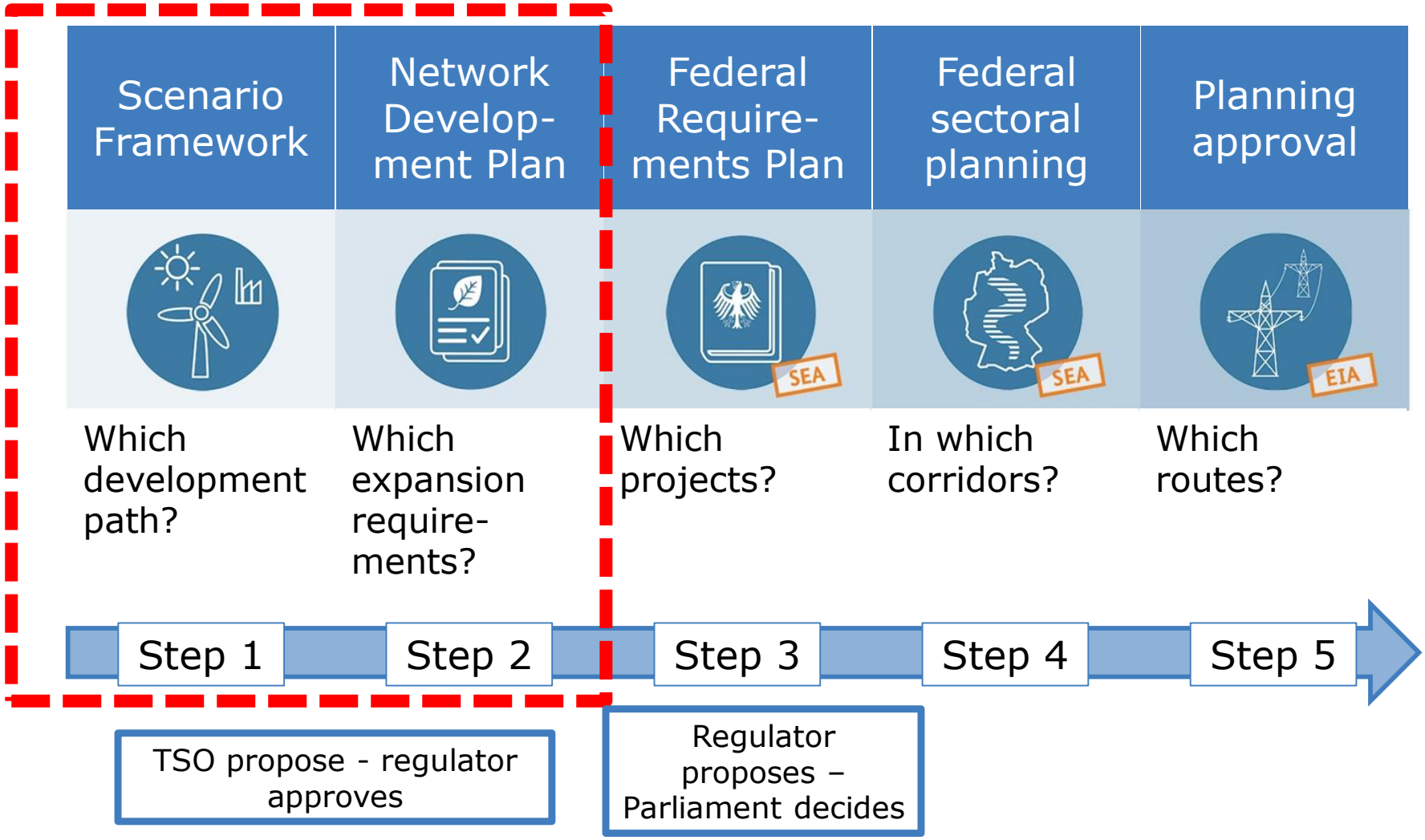
German regulator only involved in transmission planning (so far)

Main questions

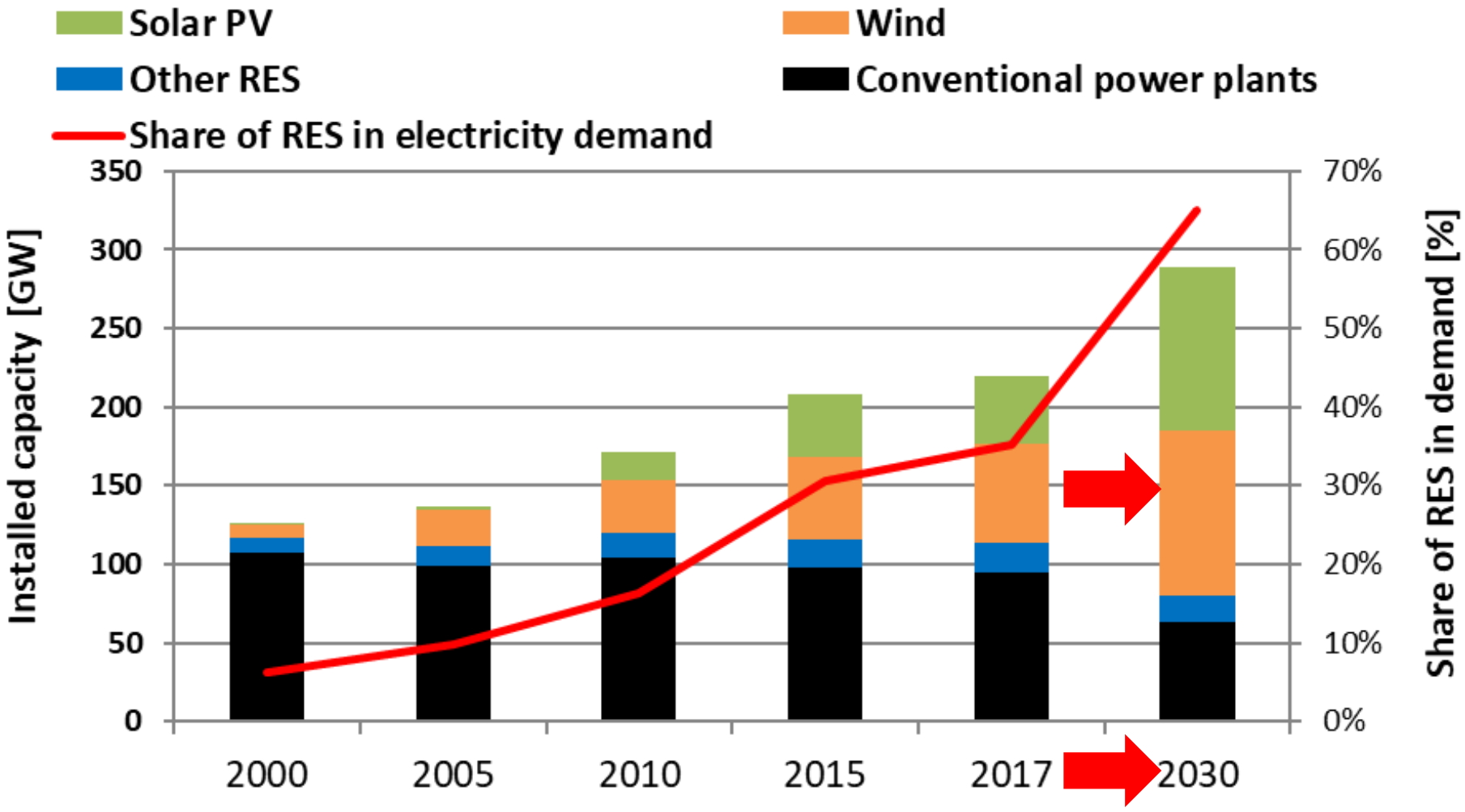
1. What are the roles of energy system modelling in long-term policymaking?
2. What methods are used to estimate and account for geospatial factors in long-term energy planning models? If applicable, how are capacity credit of VRE, transmission constraints and flexibility requirements addressed?
3. What kind of geospatial data resolutions, processing tools and widgets are used and how and where do you get your data from?
4. What are the challenges in representing long-term VRE impacts and limitations of current geo-spatial tools and long-term energy models to capture this?

Transmission approval – today's process



Investment facilitation: > 90bn EUR until 2030

Scenarios – greater shares of vRES



Scenarios – beyond vRES

Energieträger	Referenz 2017	Szenario A 2030	Szenario B 2030	Szenario C 2030	Szenario B 2025	Szenario B 2035
Installierte Leistung [GW]						
Kernenergie	9,5	0,0	0,0	0,0	0,0	0,0
Braunkohle	21,2	9,4	9,3	9,0	9,4	9,0
Steinkohle	25,0	13,5	9,8	8,1	13,5	8,1
Erdgas	29,6	32,8	35,2	33,4	32,5	36,9
Öl	4,4	1,3	1,2	0,9	1,3	0,9
Pumpspeicher	9,5	11,6	11,6	11,6	11,6	11,8
sonstige konv. Erzeugung	4,3	4,1	4,1	4,1	4,1	4,1
Kapazitätsreserve	0,0	2,0	2,0	2,0	2,0	2,0
Summe konv. Erzeugung	**103,5**	**74,7**	**73,2**	**69,1**	**74,4**	**72,8**
Wind Onshore	50,5	74,3	81,5	85,5	70,5	90,8
Wind Offshore	5,4	20,0	17,0	17,0	10,8	23,2
Photovoltaik	42,4	72,9	91,3	104,5	73,3	97,4
Biomasse	7,6	6,0	6,0	6,0	7,3	4,6
Wasserkraft	5,6	5,6	5,6	5,6	5,6	5,6
sonstige reg. Erzeugung	1,3	1,3	1,3	1,3	1,3	1,3
Summe reg. Erzeugung	**112,8**	**180,1**	**202,7**	**219,9**	**168,8**	**222,9**
Summe Erzeugung	**216,3**	**254,8**	**275,9**	**289,0**	**243,2**	**295,7**
Nettostromverbrauch [TWh]						
Nettostromverbrauch[1)]	530,1	512,3	543,9	576,5	528,4	549,4
Treiber Sektorenkopplung [Anzahl in Mio.]						
Haushaltswärmepumpen	0,7	1,1	2,6	4,1	1,7	2,9
Elektroautos	0,1	1,0	6,0	10,0	2,0	8,0
Flexibilitätsoptionen und Speicher [GW]						
Power-to-Gas	---	1,0	2,0	3,0	0,5	3,0
PV-Batteriespeicher	0,3	6,5	8,0	10,1	3,2	12,3
Großbatteriespeicher	0,1	1,5	2,0	2,4	1,2	3,4
DSM (Industrie und GHD)	1,5	2,0	4,0	6,0	3,0	5,0
Marktmodellierung						
CO_2-Vorgabe zur Markt-modellierung [Mio. t CO_2]	---	max. 184	max. 184	max. 184	max. 240	max. 127

1) Inklusive der Summe der Netzverluste in TWh im Verteilnetz.

Installed capacity in GW by 2030 and 2035 (plus: 2025)

Annual electricity consumption (TWh)

Sector coupling

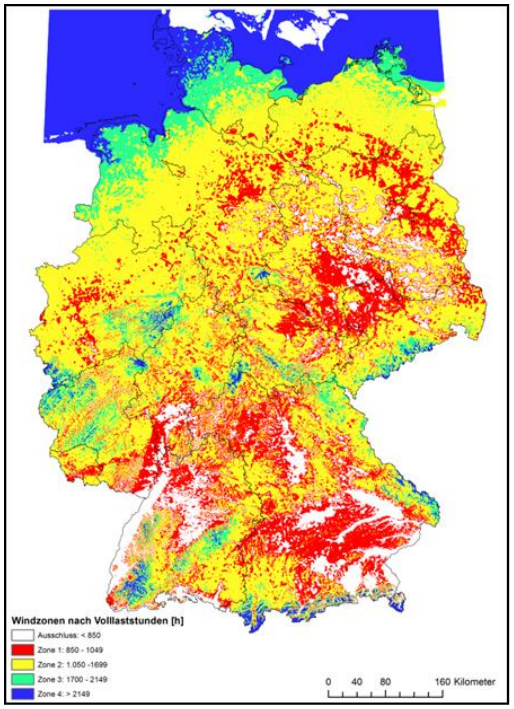
Flex and storage

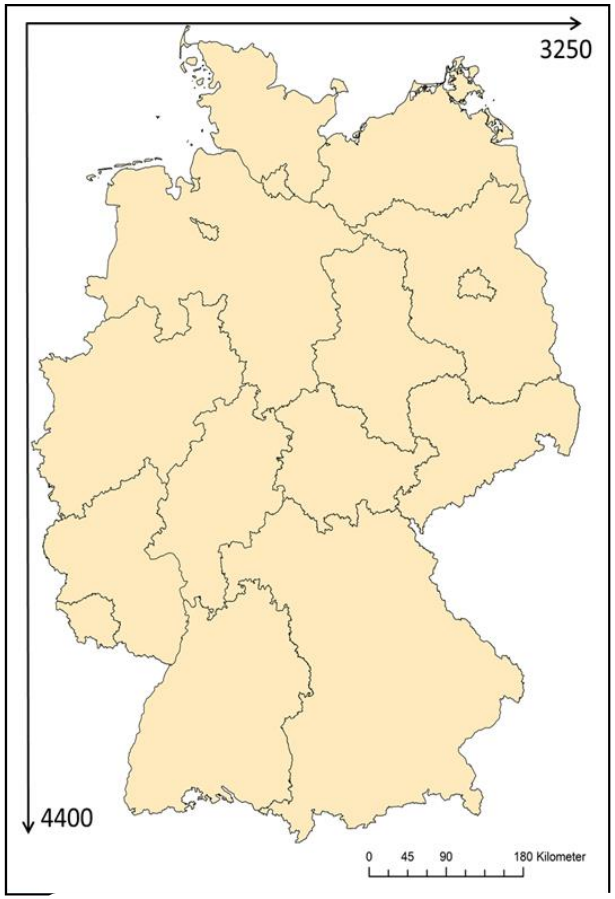
Source: https://www.netzausbau.de/bedarfsermittlung/2030_2019/szenariorahmen2019-2030/de.html

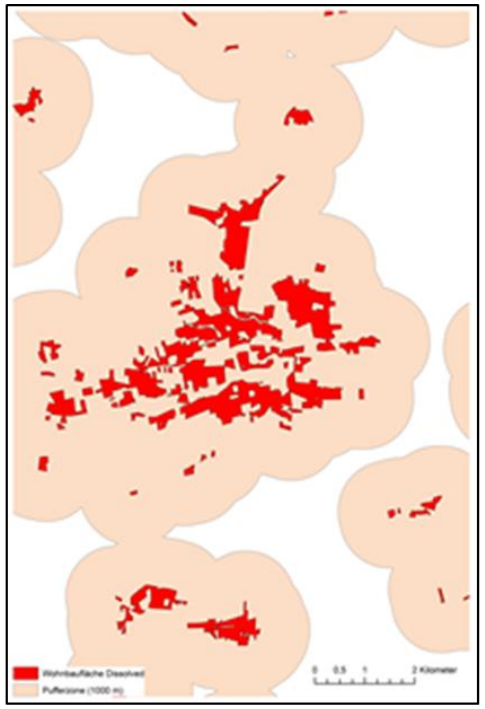
Modelling steps for transmission approval

- **Regionalisation (around 450 nodes)**
- **Hourly market modelling**
- **Hourly load flow identification**
- **Load flow impact assessment**
- **Transmission needs assessment**

vRES regionalisation – onshore wind







Weather Utilisation

Area assessment

Location Max. capacity

Final regionalisation

Staffing / expertise, available time and translating complexities

Planning staff of around 20

- 1 manager
- 2 lawyers
- 8 electrical engineers
- 9 miscellaneous

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Thank you for your attention!

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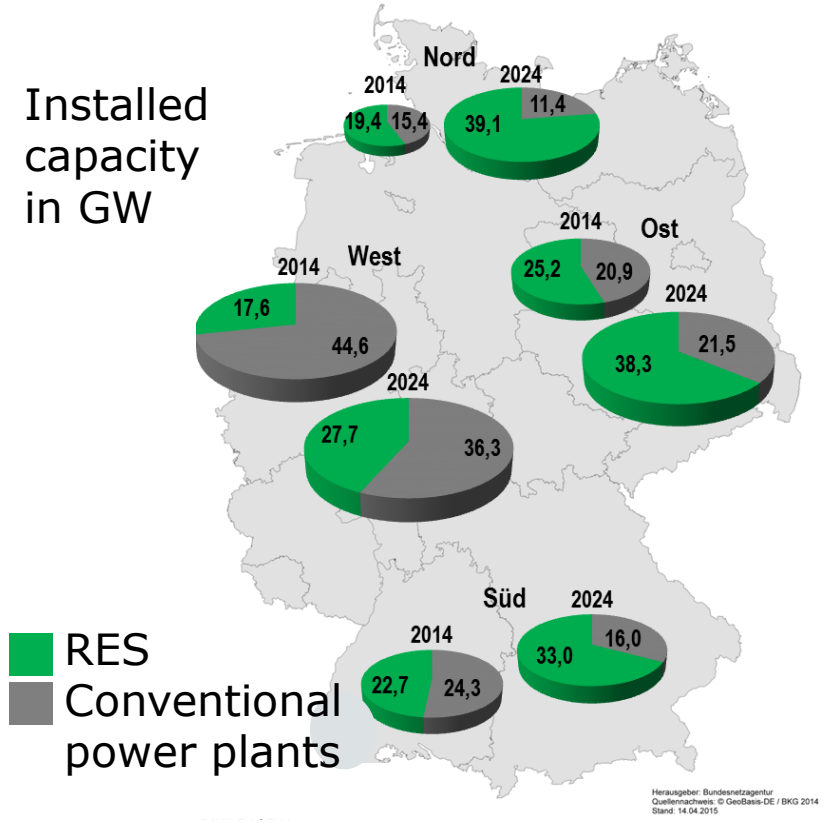
Back up

Regionalization

The NDP 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.

Generation by region - NEP 2024

NDP - Market modelling

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

Approach:

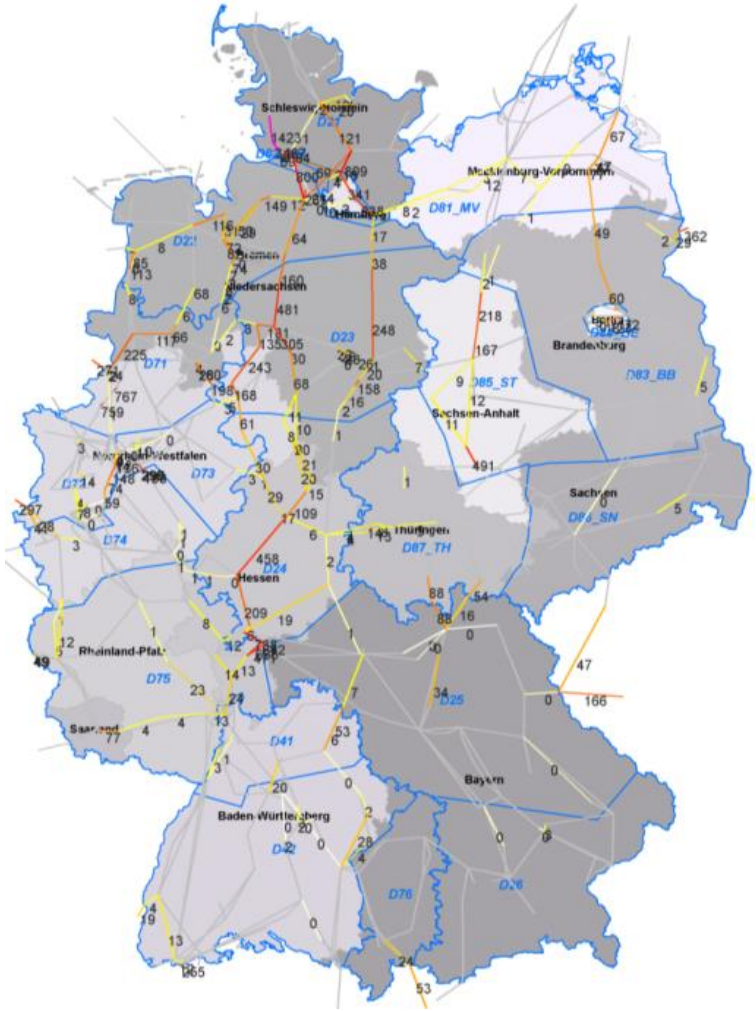
- Internal network as “copper plate”
- Economic priority to renewables
- Consideration of “must-run” plants
- Net load covered by conventional power plants

Result:

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

NDP – Load flow impact assessment

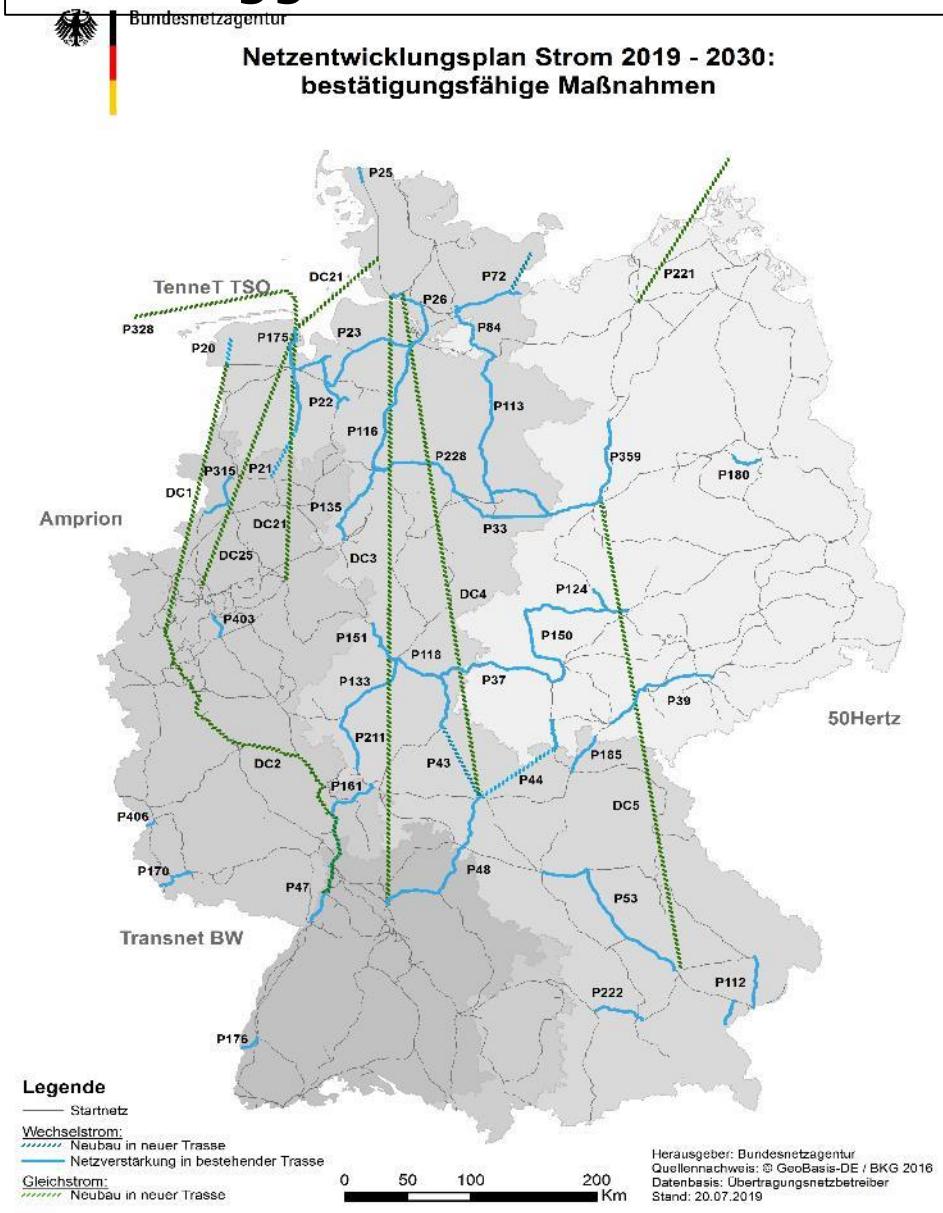
The load flows' impact on the existing transmission infrastructure is simulated for every hour of the target year.



- Values represent scope and level of transmission overloading
- Summarised in annual energy not transmitted
- Annual energy not transmitted could rise to 25,9 TWh by 2030

NDP – Transmission needs assessment

TSO suggest measures to overcome identified bottlenecks



- Existing grid
  - Around 35,000 km length of electric circuit
- Already approved
  - Around 6,350 km restructuring or new-built, incl. 2.250 km DC
- Under consideration
  - Around 7,450 km restructuring or new-built, incl. 3.100 km DC

TSO applied for 10,200 km

Approval criteria for domestic projects

Based on different criteria the regulator analyses the projects.

Effectiveness (n-1)

Does the project resolve or reduce an overload?

&

Necessity

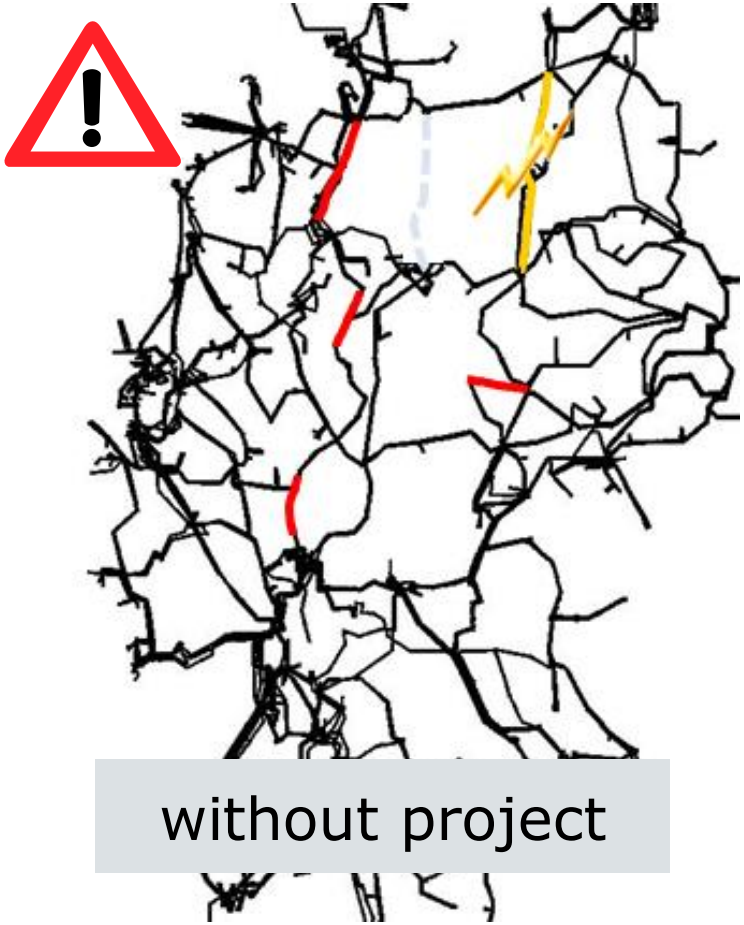
Is the utilisation rate above 20%?

Other considerations

Are there other reasons to justify a project?

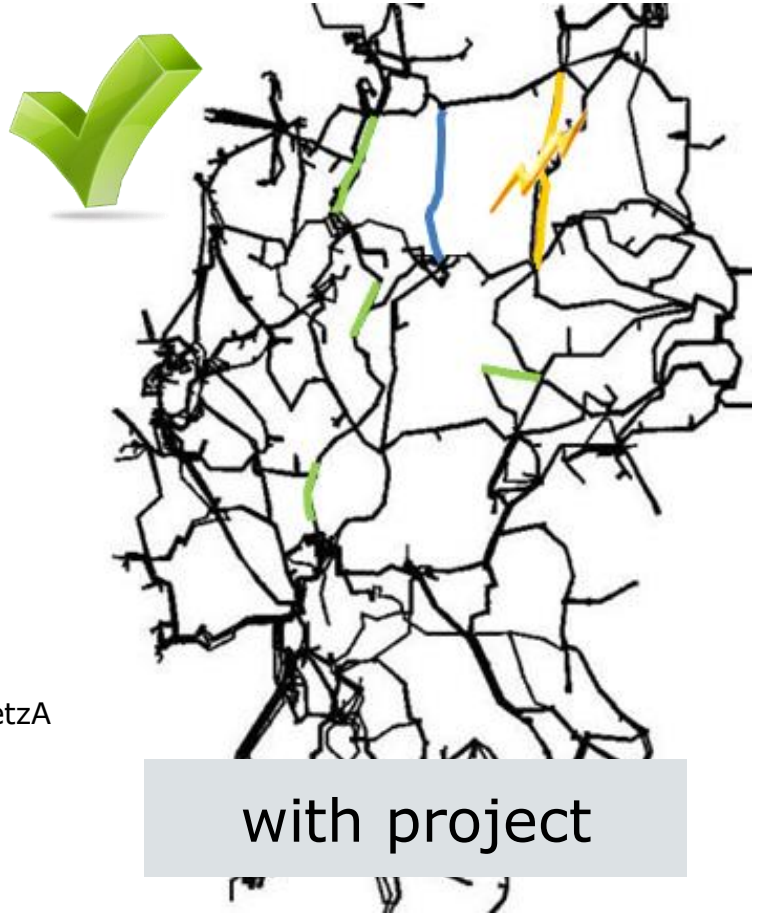
Effectiveness

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



without project

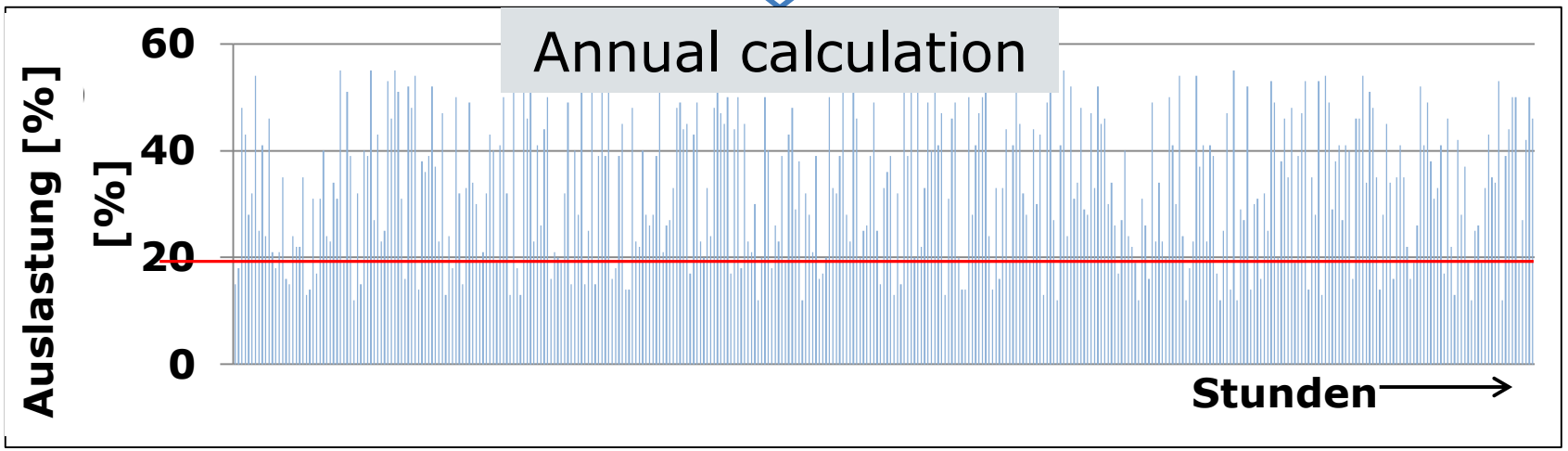
Source: BNetzA



with project

Necessity

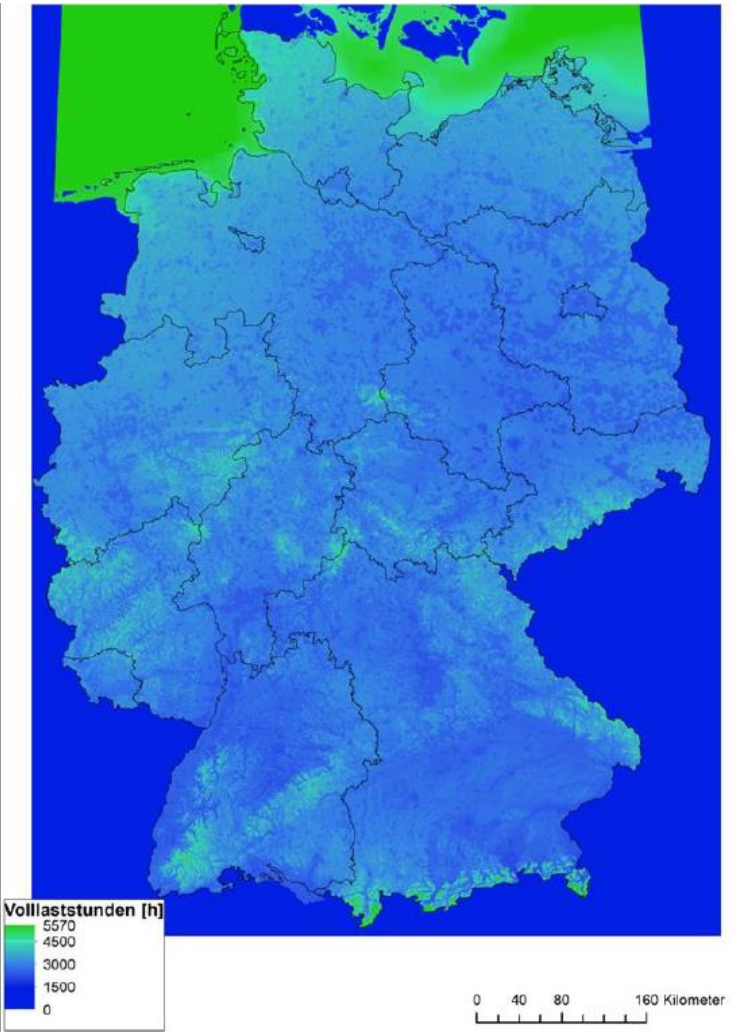
Verification of maximum capacity utilization



Maximum capacity utilization > 20%

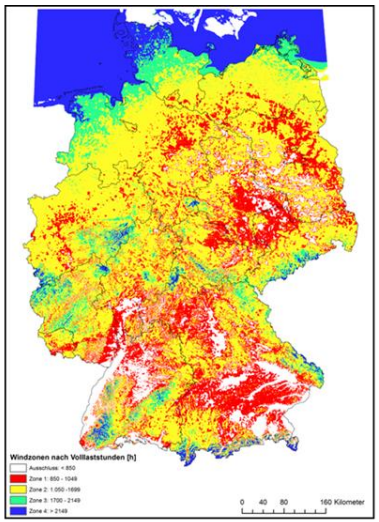
Necessity confirmed

RES regionalisation – spatial wind data



- Weather data openly available with hourly resolution (DWD)
- Spatial resolution: 200 x 200 m
- Utilisation (h/a) based on Weibull distribution

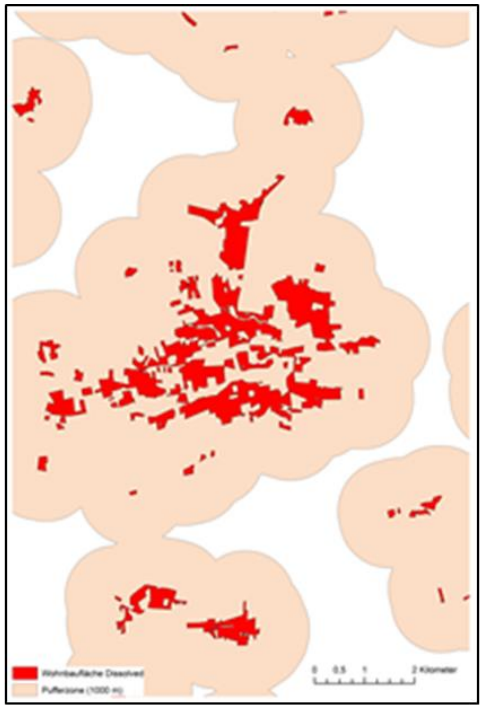
- Four wind zones w different turbines
- „Standard year“ approach to ensure transparency and robust results



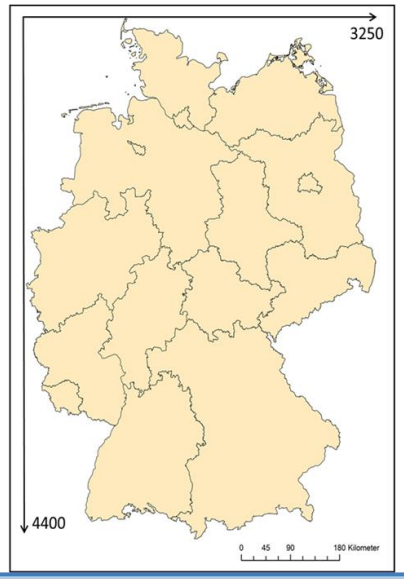
Wind data Utilisation

RES regionalisation – available area for wind

- Spatial data openly available from state level statistics offices
- Available area @ 8% from total
  - Housing as main factor; different distances apply



Area assessment



Resolution: 4400 x 4350 = 14,3 Mn.

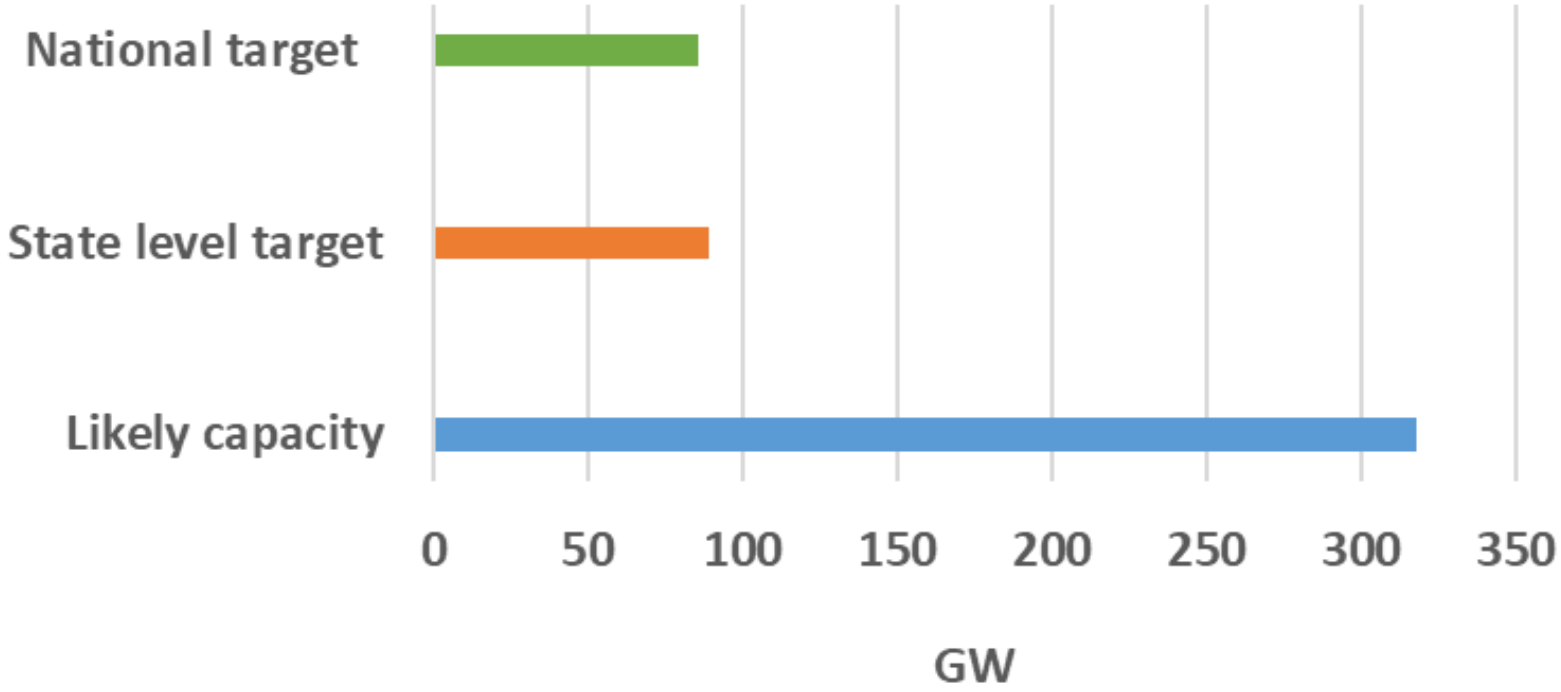
Location
Max. capacity

- Capacity in availabale area exceeds national target (588 GW)
- Likely capacity in available areas exceeds national target (317 GW)
- Prime locations based on economics

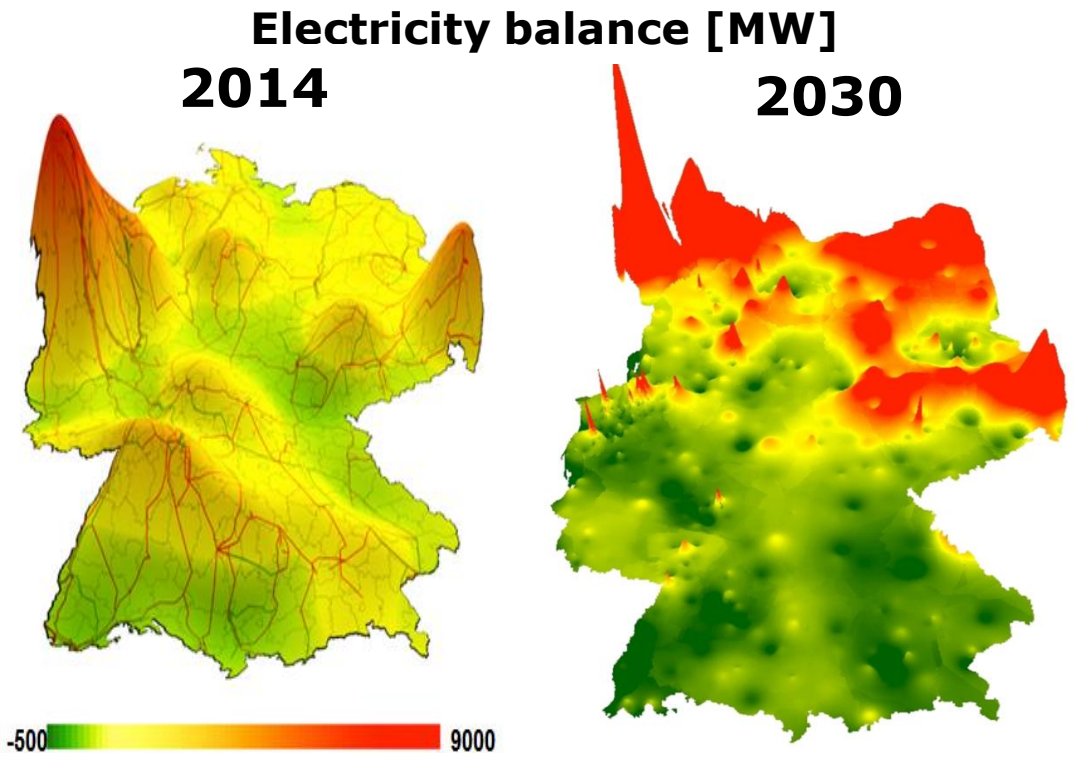
RES regionalisation – adjustment to targets

- 4 GW surplus between state level and national target
- Reduction of surplus relative to each states‘ target

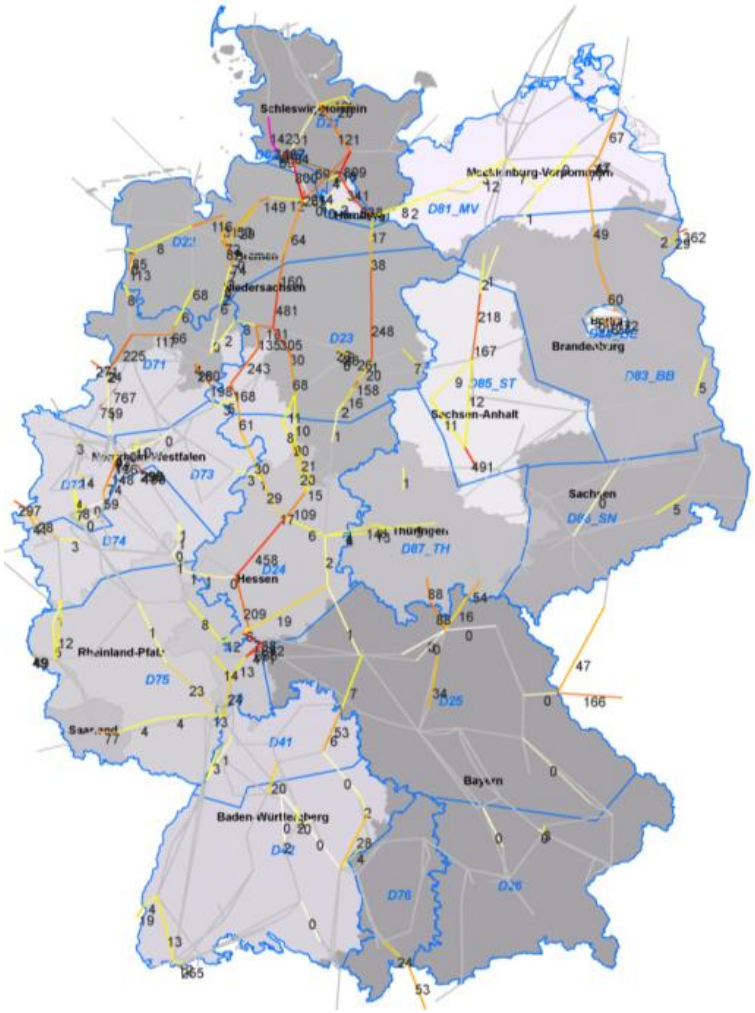
→ Final regionalisation



Results and impacts with todays‘ grid

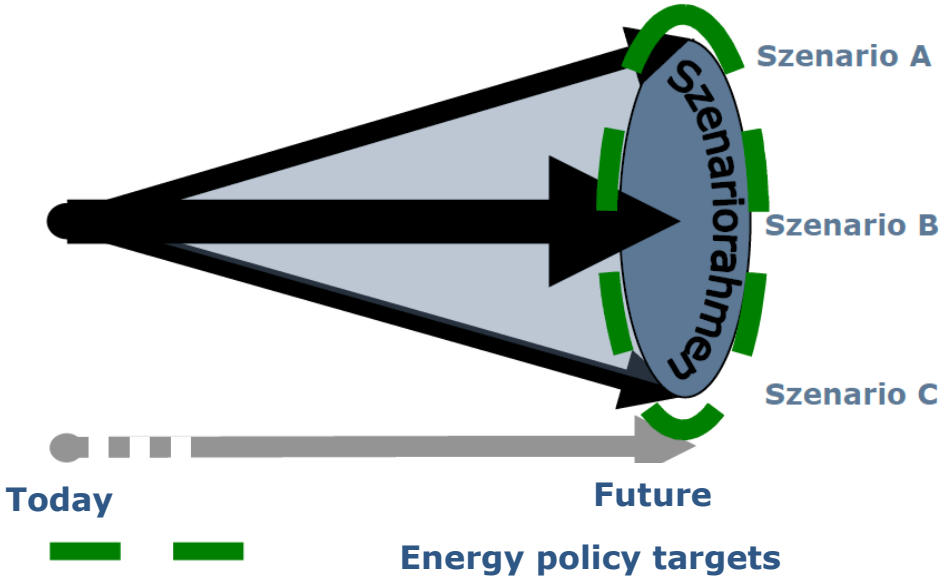


Growing regional imbalances between North and South

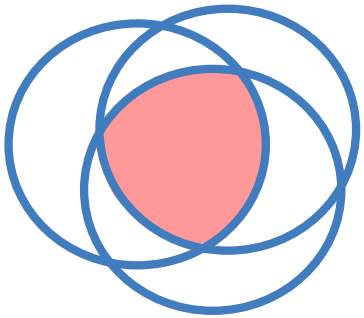


Annual energy not transmitted @25,9 TWh by 2030

Selecting proposals from all likely scenarios



- Energy policy targets define the scenario frame
- Targets at technology-level (e.g. 20 GW offshore wind)

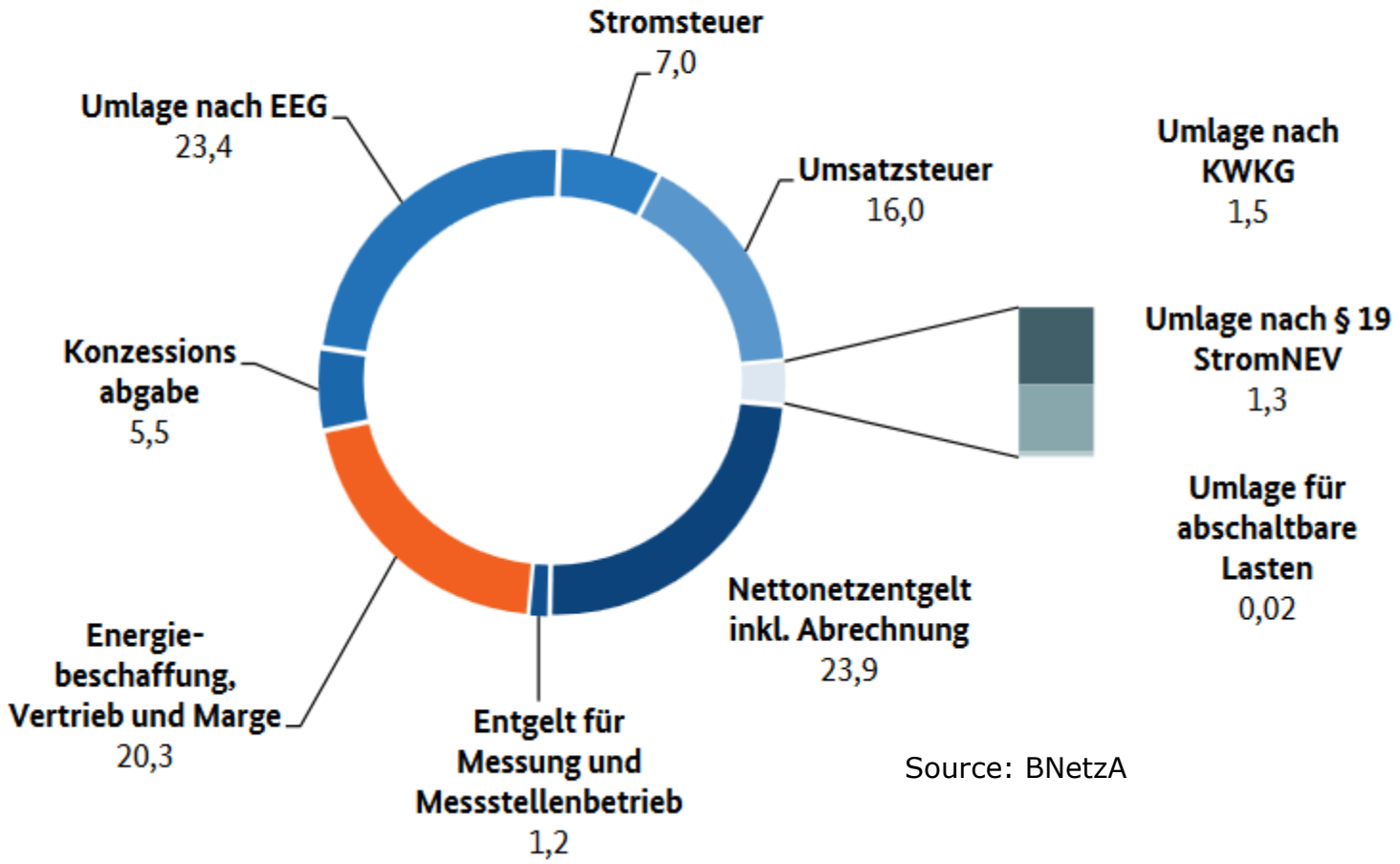


- Transmission proposals developed for all scenarios
- Proposals need to be valid in each scenario (intersection)

Conservative strategy reflects the plans' need to be relevant

Electricity tariff for private customers

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