European Calculation of Transmission Benefits

Name: **Prof. Dr.-Ing. Albert Moser, ESIG Fall Tech Workshop, 28. October 2021**

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Agenda

- European Market for Electricity
- European Ten-Year Network Development Plan
- Bidding Zone Review
- German Grid Development Plan

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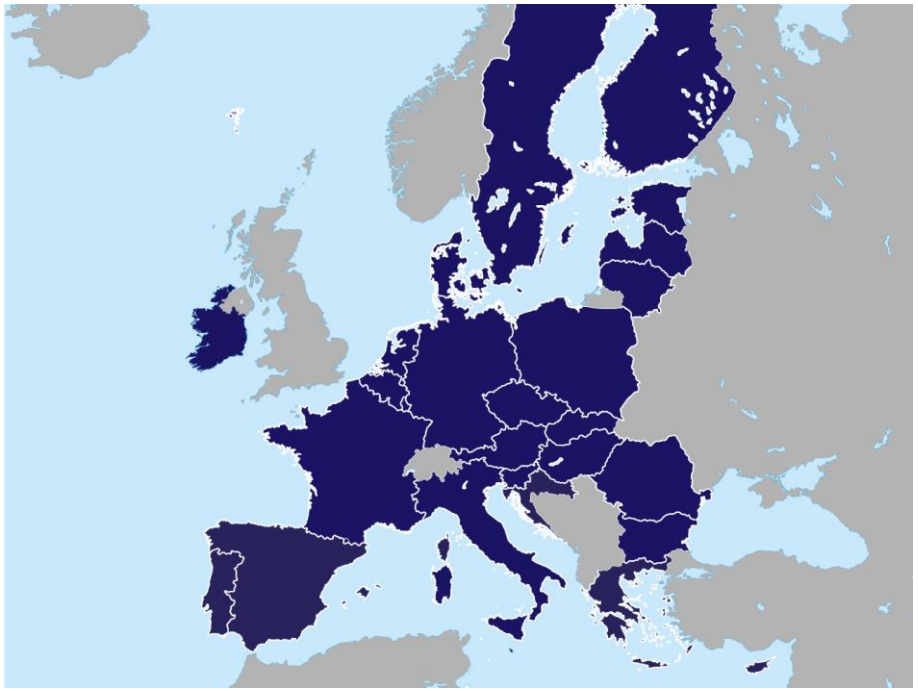
European Market for Electricity - Key Figures

Fuel	Production/Consumption in 2020	
Lignite	200 TWh	1020 TWh
Hard Coal	165 TWh	
Gas	545 TWh	
Other fossil	111 TWh	
Nuclear	685 TWh	685 TWh
Hydro	352 TWh	1054 TWh
Wind	396 TWh	
Bioenergy	155 TWh	
Solar	144 TWh	
Other renewables	7 TWh	
Imports	19 TWh	19 TWh
Demand	2778 TWh	2778 TWh

Source: Agora Energiewende, EMBER



Source: European Union Agency for Fundamental Rights

European Market for Electricity - Framework

REGULATION (EU) 2019/943 … on the internal market for electricity

⇨ Regulations for European and cross-border issues

Zonal market model
- Electricity trading
- Capacity allocation
- Congestion management
- **Bidding zone review ②**

Resource adequacy

Transmission system operation
- **Ten-year network development plan ①**

Distribution system operation

Network codes

REGULATION (EU) 347/2013 … on guidelines for trans-European energy infrastructure …

⇨ Regulations for energy infrastructure priority corridors and areas

Project of common interest
- **Energy system wide cost-benefit analysis (part of ①)**

DIRECTIVE (EU) 2019/944 … on common rules for the internal market for electricity …

⇨ Requirements for national law

Organisation of the Electricity sector

Consumer empowerment/protection

Distribution system operation

Transmission system operators
- **Network development plan ③**

Regulatory authorities

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Ten-Year Network Development Plan - Overview

Scenarios

National trend

- In line with national climate plans
- Bottom-up
- Up to 2040

Distributed energy

- In line with COP 21
- Top-down
- De-centralized innovation
- up to 2050

Global ambition

- In line with COP 21
- To-down
- Centralized innovation
- up to 2050

System needs

Show borders/areas where new solutions for electricity exchange is needed

Transmission capacities just to express the needs, not to express solutions

Focus on cross-border capacities

Based on national trend scenarios 2030 and 2040

Criteria: socio-economic welfare

European projects & PCI

European wide call for projects to reinforce the grid

Assessments of projects based on a pan-European CBA methodology

- Multi criteria assessment
- PINT & TOOT

Non-binding community-wide ten-year network development plan

TYNDP is the sole basis for the selection of projects of common interest (PCI).

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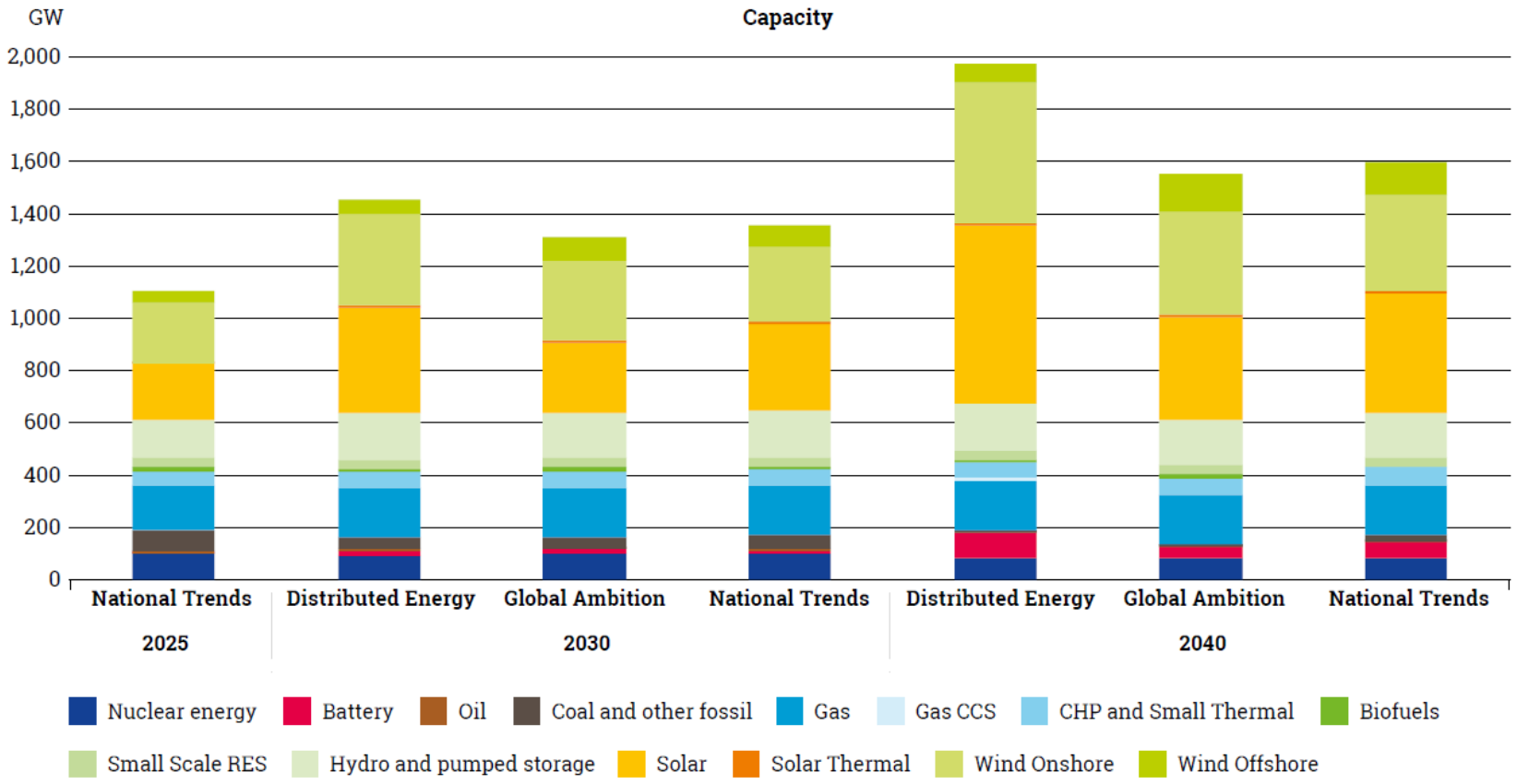
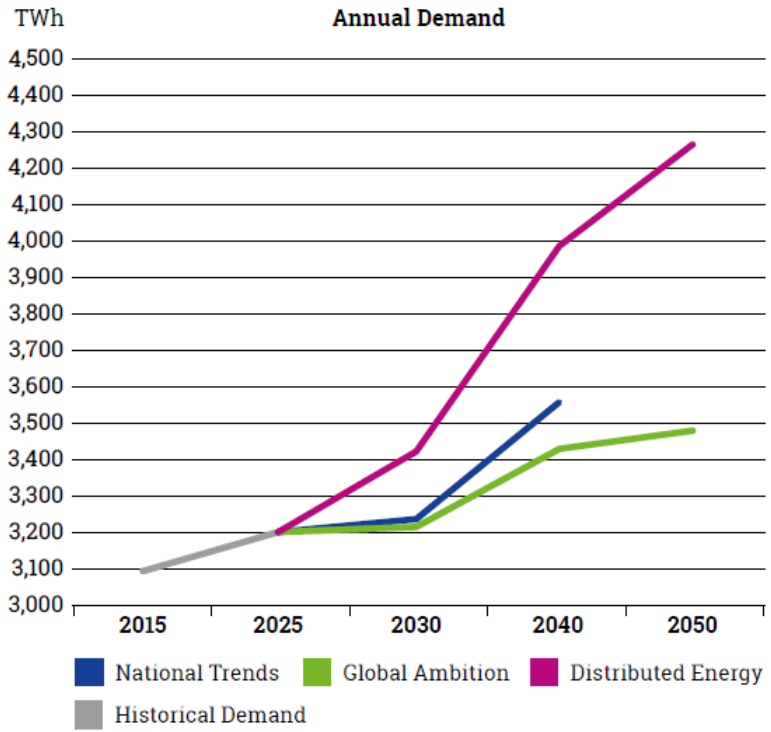
Ten-Year Network Development Plan - Szenarios





Source: ENTSO-E

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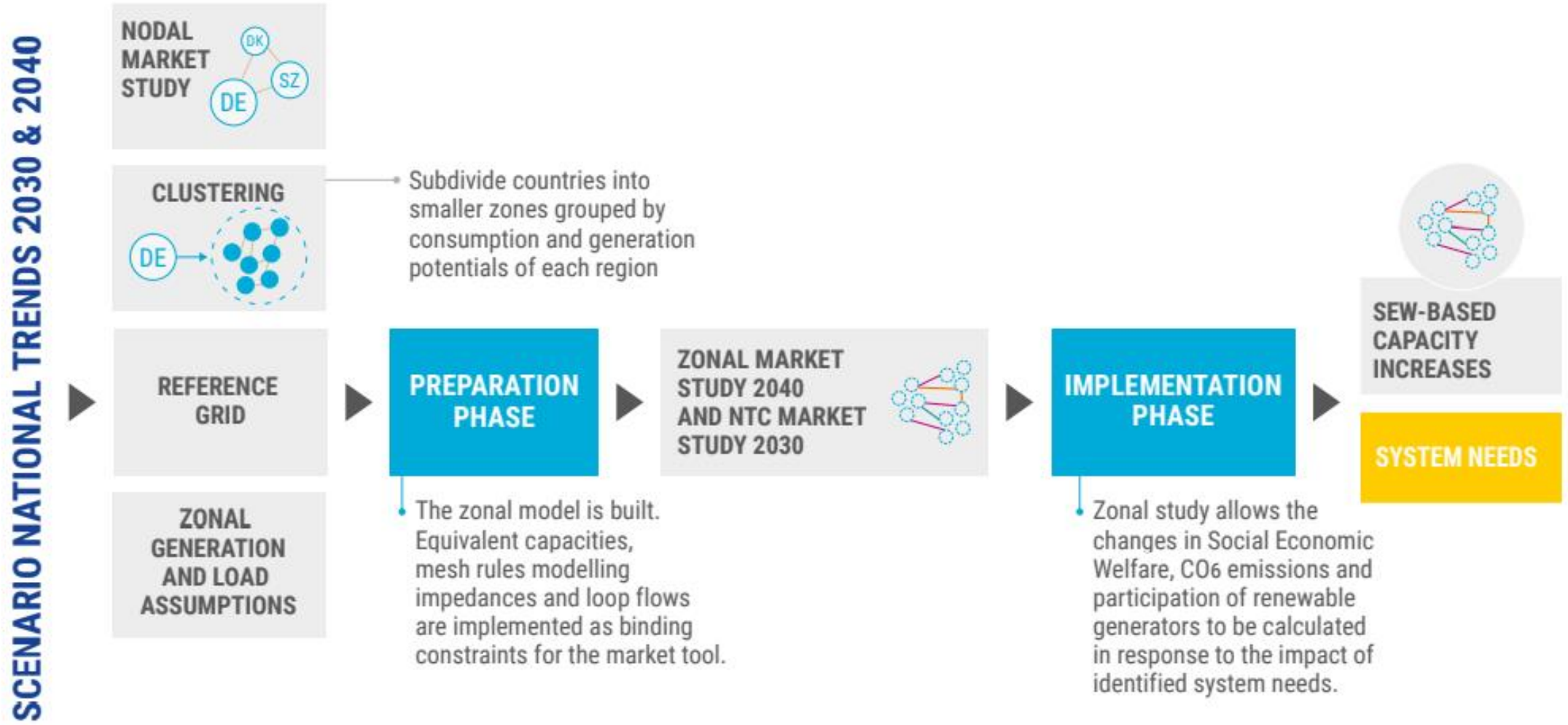
Ten-Year Network Development Plan - Identification of System Need Methodology



Source: ENTSO-E

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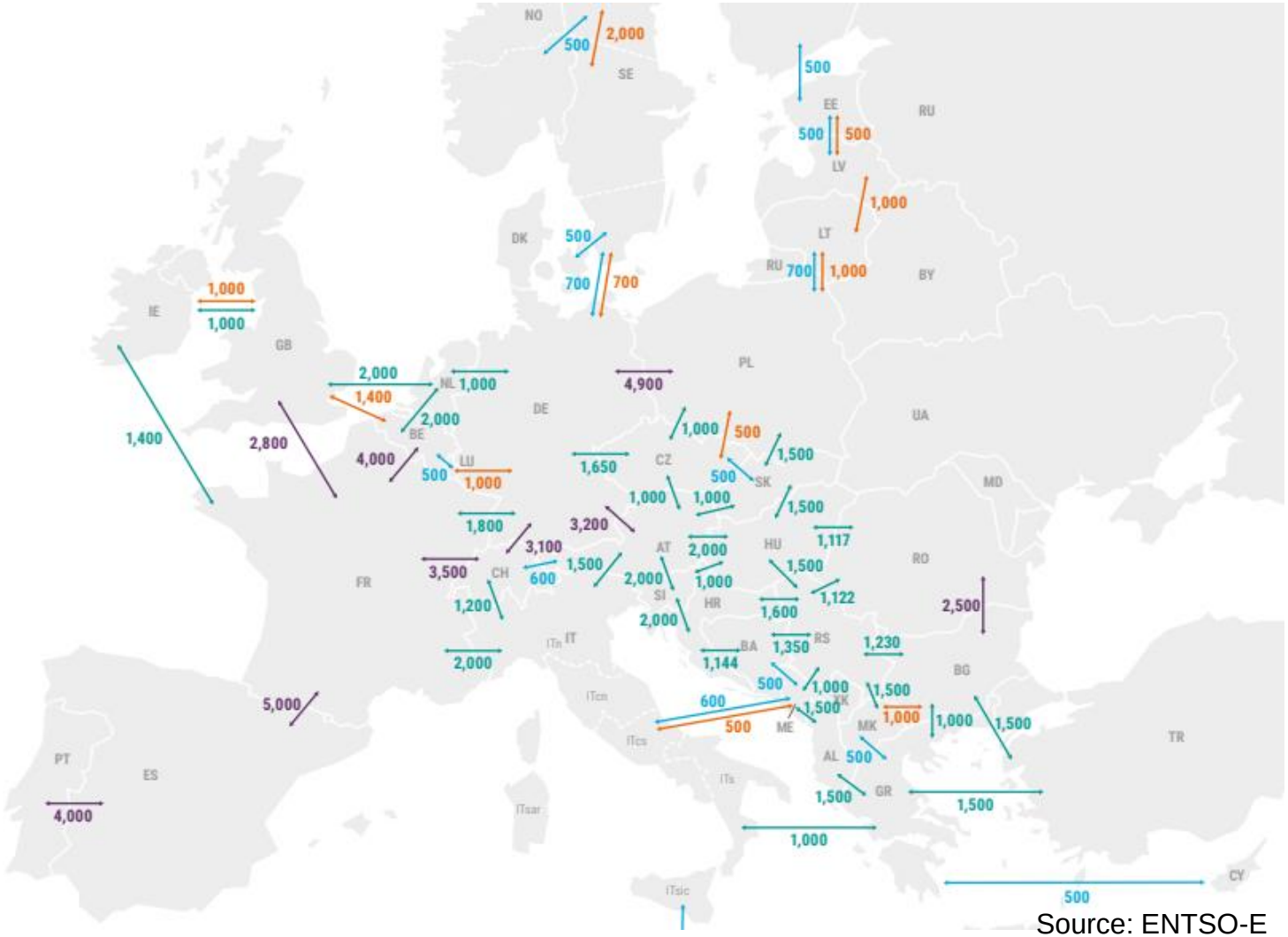
Ten-Year Network Development Plan - System Needs

NEEDS < 700 MW

NEEDS 700 → 2,000 MW

NEEDS > 2,000 MW

ADDITIONAL CAPACITY INCREASES THAT, WHEN ADDED ONE AT A TIME TO THE SEW-BASED NEEDS, DELIVER SIMILAR OVERALL BENEFITS



Source: ENTSO-E

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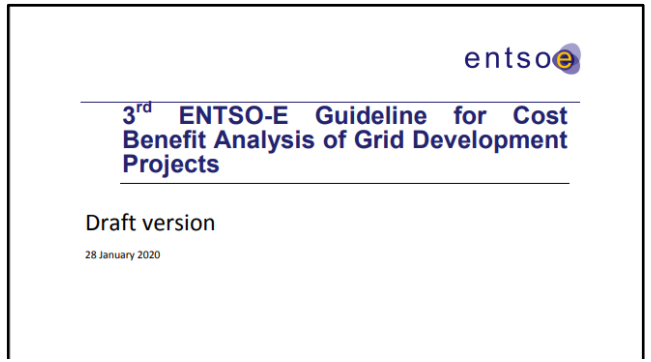
Ten-Year Network Development Plan - Cost Benefit Analyses

Key benefits being considered

1. Reduction of overall generation cost by dispatch and re-dispatch
2. Monetized CO_2 emissions resulting from the new exchange and the evolution of losses.
3. The change in the curtailed energy volume induced by the project.
4. The evolution of emissions of several polluting gas induced by the generation mix (NOX, NH3, SO2, particulate matter, …)
5. The evolution of the volume and the cost of electric losses on the grid.
6. The support to adequacy by reducing the loss of load expectancy and decreasing the need of generation capacity

… Balancing energy/capacity exchange, stability, avoidance of renewal/replacement costs, redispatch reserves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3rd ENTSO-E Guideline for Cost Benefit Analysis of Grid Development Projects

Draft version

28 January 2020

	National Trends 2025	National Trends 2030	Global Ambition 2030	Distributed Energy 2030
B1 – Socio-economic welfare	✔	✔	✔	✔
B2 – CO_2 emission	✔	✔	Partially	Partially
B3 – RES integration	✔	✔	✔	✔
B4 – Non Direct Greenhouse Emission	✔	✔	✘	✘
B5 – Losses	✔	✔	✘	✘
B6 – Adequacy	✘	✔	✘	✘

Source: ENTSO-E

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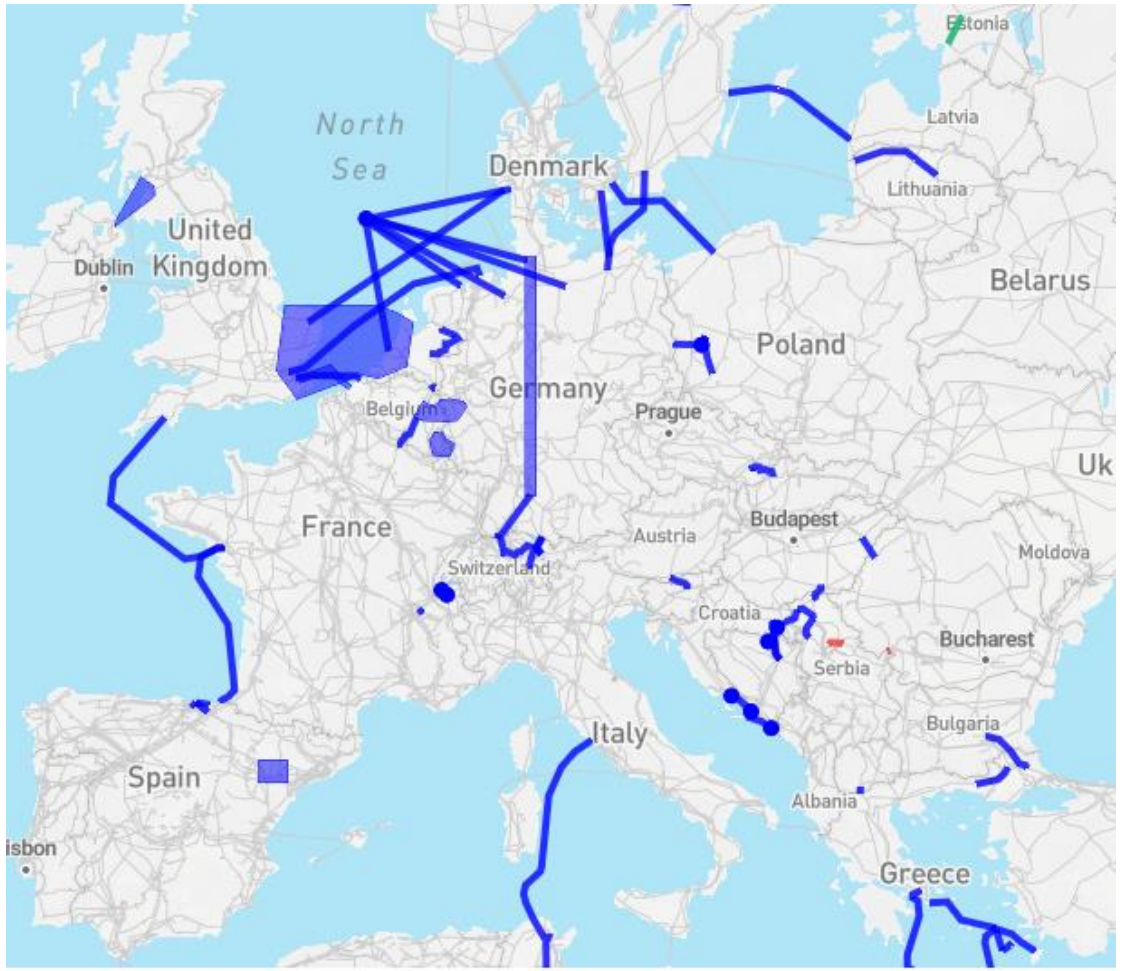
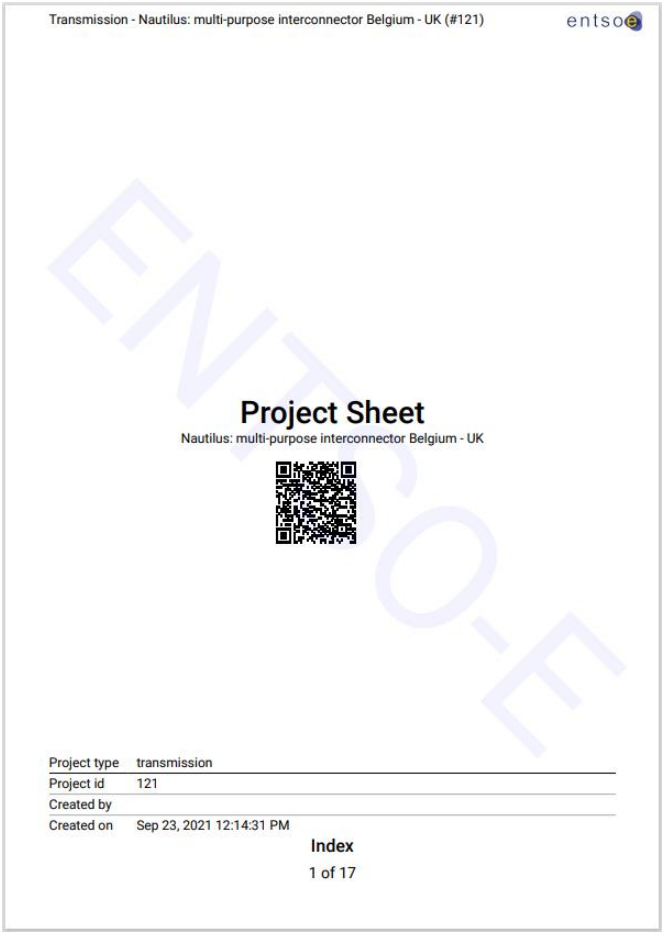
Ten-Year Network Development Plan - Transmission Projects (under Consideration)





Transmission - Nautilus: multi-purpose interconnector Belgium - UK (#121)

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Project Sheet

Nautilus: multi-purpose interconnector Belgium - UK

Project type	transmission
Project id	121
Created by	
Created on	Sep 23, 2021 12:14:31 PM

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Source: ENTSO-E

Ten-Year Network Development Plan – Example: Nautilus (Interconnector Belgium – UK)

Increase in socio-economic welfare

B1 Annual Socio-Economic Welfare (SEW) increase (M € / year)	max average min	12 11 9	39 37 36
B1_CO2 Annual Socio-Economic Welfare increase resulting from CO2 emissions reduction	max average min	3 3 2	15 13 12
B1_RES Annual Socio-Economic Welfare increase resulting from RES integration	max average min	1 1 0	7 5 4

Reduction of CO2 and GHG emissions

B2a Annual CO2 variation from market simulation (ktonnes / year)		max average min	-99 -114 -134	-428 -479 -548
B2a_€ Annual Societal cost variation resulting from CO2 variation from market simulation monetised (M € / year)	CO2 price	60€/ ton 100€/ ton 189€/ ton	4 9 19	15 34 77
B2b Annual CO2 variation due to network losses (ktonnes / year)		average	-66	443
B2b_€ Annual Societal cost variation resulting from CO2 variation from network simulation monetised (M € / year)	CO2 price	60€/ ton 100€/ ton 189€/ ton	6 5 11	-14 -32 -71

Integration of renewable energy sources

B3 Annual avoided curtailment (RES integration) (GWh / year)	max average min	22 14 7	200 139 105

Impact on grid losses

B5 Variation of network losses (GWh / year)	average	-13	901
B5_€ Variation of network losses monetised (M€ / year)	average	-1	31

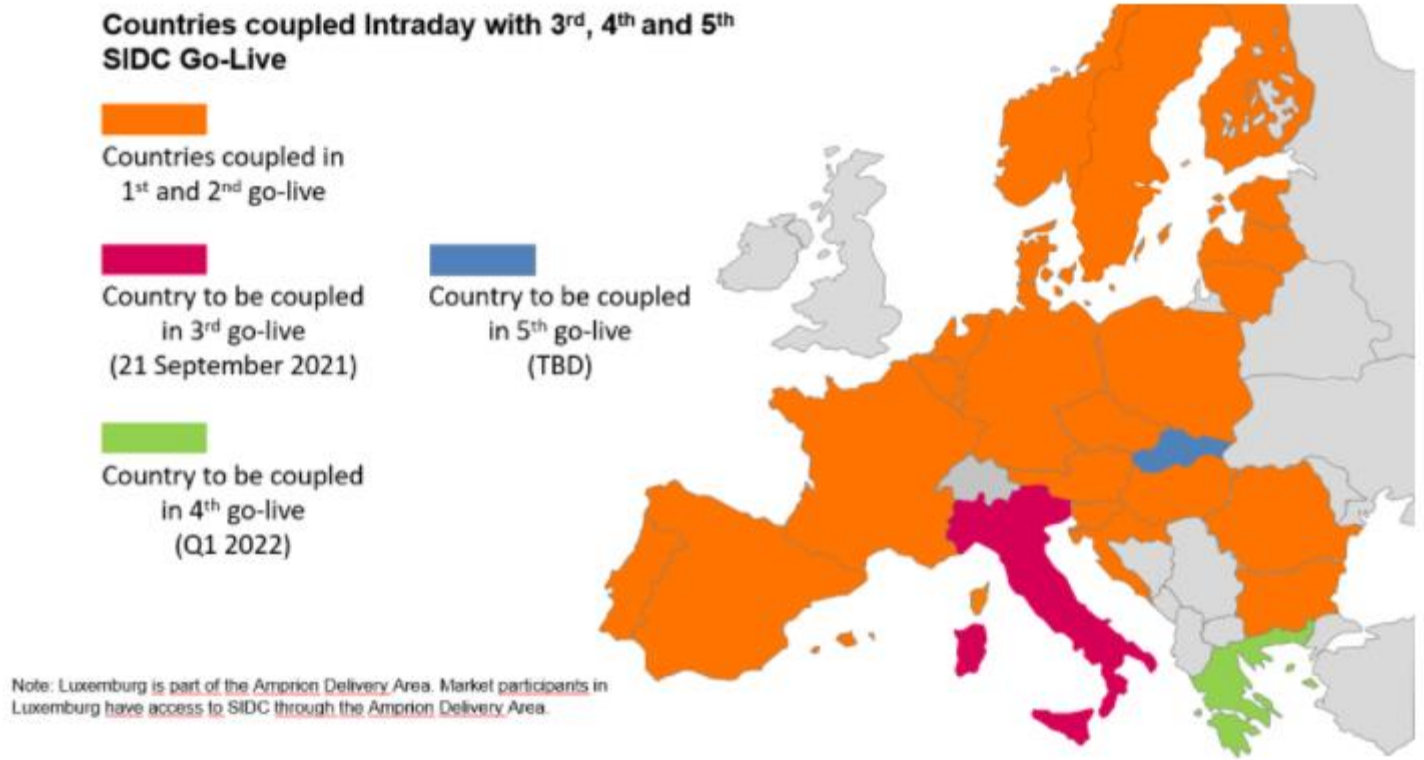
Security of supply

B6 Annual reduction in Energy Not Served (MWh / year)	max average min		3200
B6_€ Annual Socio-Economic Welfare increase resulting from reduction in Energy Not Served monetised (M€ / year)	average	n/a	32

Source: ENTSO-E

Bidding Zone Review - Day-Ahead & Intraday Market Coupling of European Electricity Markets

Source: ENTSO-E



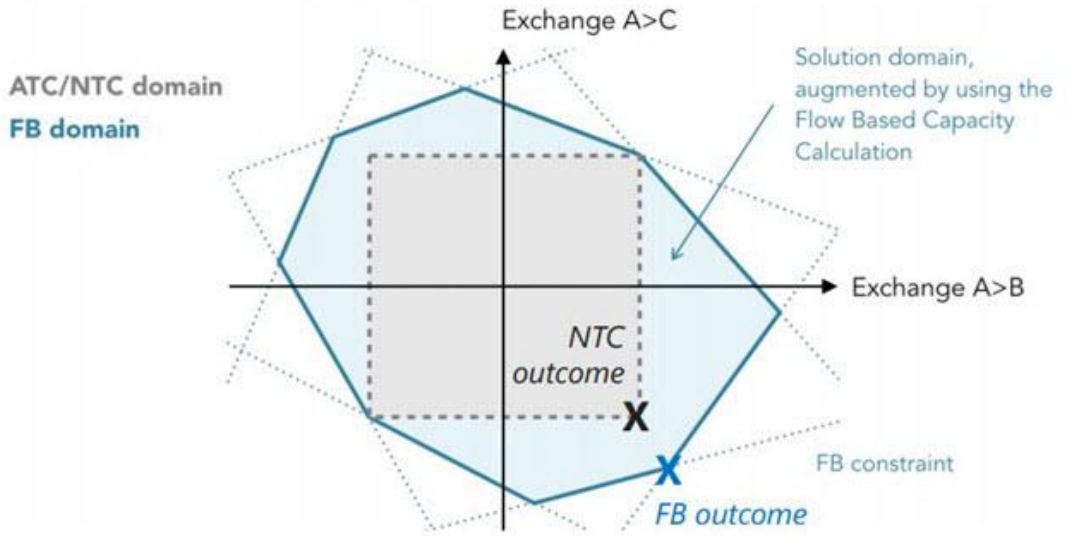
Source: ENTSO-E

Bidding Zone Review - Bidding Zones and Cross-Bidding Zone Capacity Allocation

Today's bidding zones

Source: Florence School of Regulation

NTC vs. flow based capacity allocation



Source: Elia International

CORE region applying flow based approach

Source: Joint Allocation Office

Bidding Zone Review – Evaluation Criteria

Market efficiency

- Economic efficiency
- Firmness costs
- Market liquidity
- Market concentration and market power
- Effective competition
- Price signals for building infrastructure
- Accuracy and robustness of price signals
- Transition and transaction costs
- Infrastructure costs
- Market outcomes in comparison to corrective measures
- Adverse effects of internal transactions on other bidding zones
- Impact on the operation and efficiency of the balancing mechanisms and imbalance settlement processes

Network security

- Operational security
- Security of supply
- Degree of uncertainty in cross-zonal capacity calculation

Stability and robustness of bidding zones

- Stability and robustness of bidding zones
- Consistency across capacity calculation time frames
- Assignment of generation and load units to bidding zones
- Location and frequency of congestion (market and grid)

Energy transition

- RES integration

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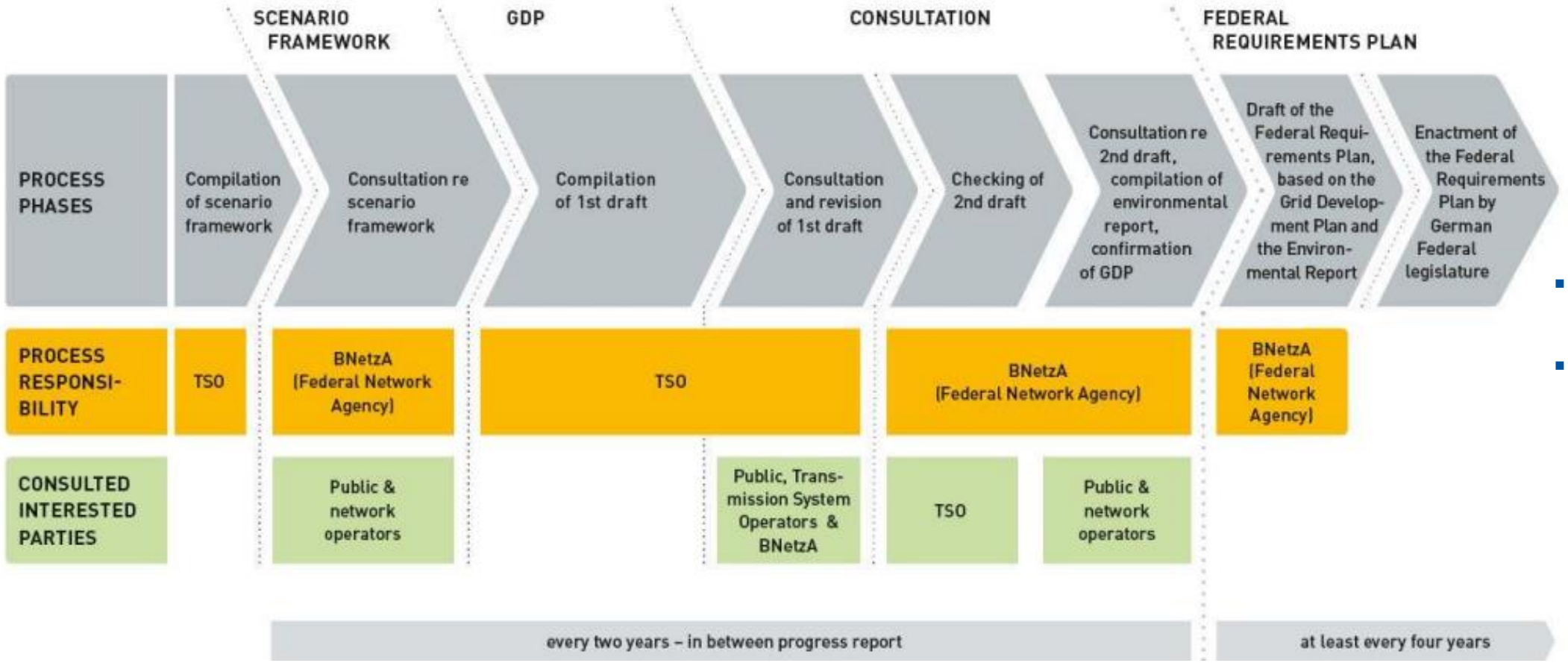
German Grid Development Plan - Overview



- Two time horizon: 10 & 15 years
- Scenarios: A, B and C (different advances in energy transition according national energy policy)

Source: German TSOs

German Grid Development Plan - Evaluation Criteria

- Cost benefit analysis for cross-border interconnectors similar to European TYNDP
  - by TSOs during grid planning
  - by German regulator during conformation process
- Planning rules of German TSO for national lines
  - (n-1) criterion
  - NOVA principle (network optimization before network reinforcement before network expansion)
- Confirmation rules of German national regulator for national lines
  - Effectiveness = reduction of Germany-wide non-transferable electricity across all lines (congestion index).
  - Necessity = observed utilization of a new line of at least 20%.
    (extension of 110 kV distribution grid to be preferred otherwise)
- Cost benefit analysis by TSOs and national regulator for ad-hoc measures (PST, …)
  - Savings in redispatch for 3 … 5 years exceed investment costs.

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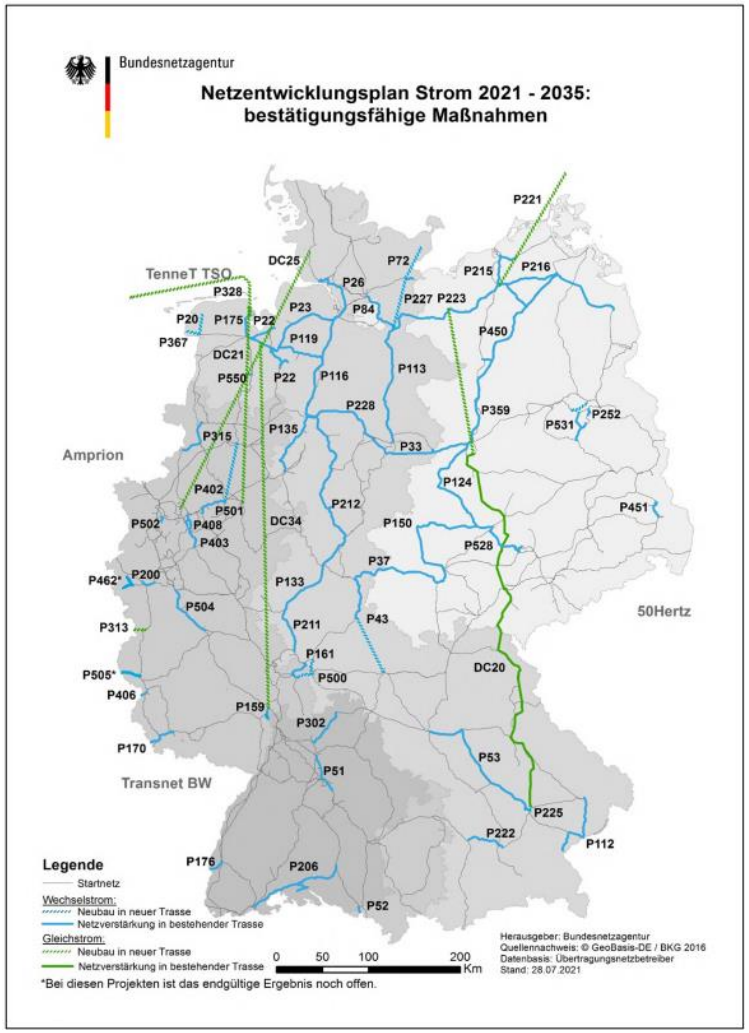
German Grid Development Plan – Confirmed Lines and Ad-hoc Measures



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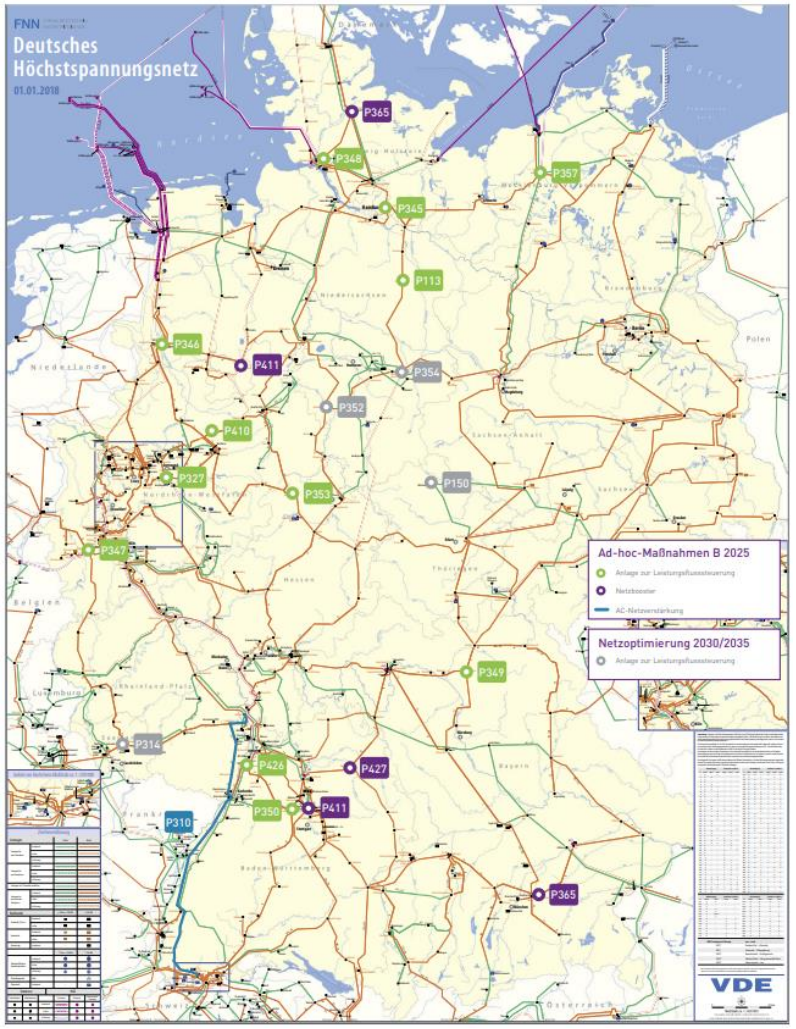

Source:
German TSOs