ECN

Energy research Centre of the Netherlands

A Nodal Pricing Analysis of the Future German Electricity Market

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Motivation

Significant changes are expected to take place in German power market and its neighbouring countries until 2020:

- Expansion of new power generation capacities (e.g. coal, gas, and wind)
- Closures of old power plants (e.g. coal, nuclear)
- Expansion of interconnector capacities between national power markets and within German power grid
- Regulations in transmission system

  (e.g., unbundling of TSO's, integration of EU markets)

Methodology

Evaluation of the the impact of expected developments of new transmission and generation capacity in Germany and its neighboring countries on the future German power market in 2020 in terms of:

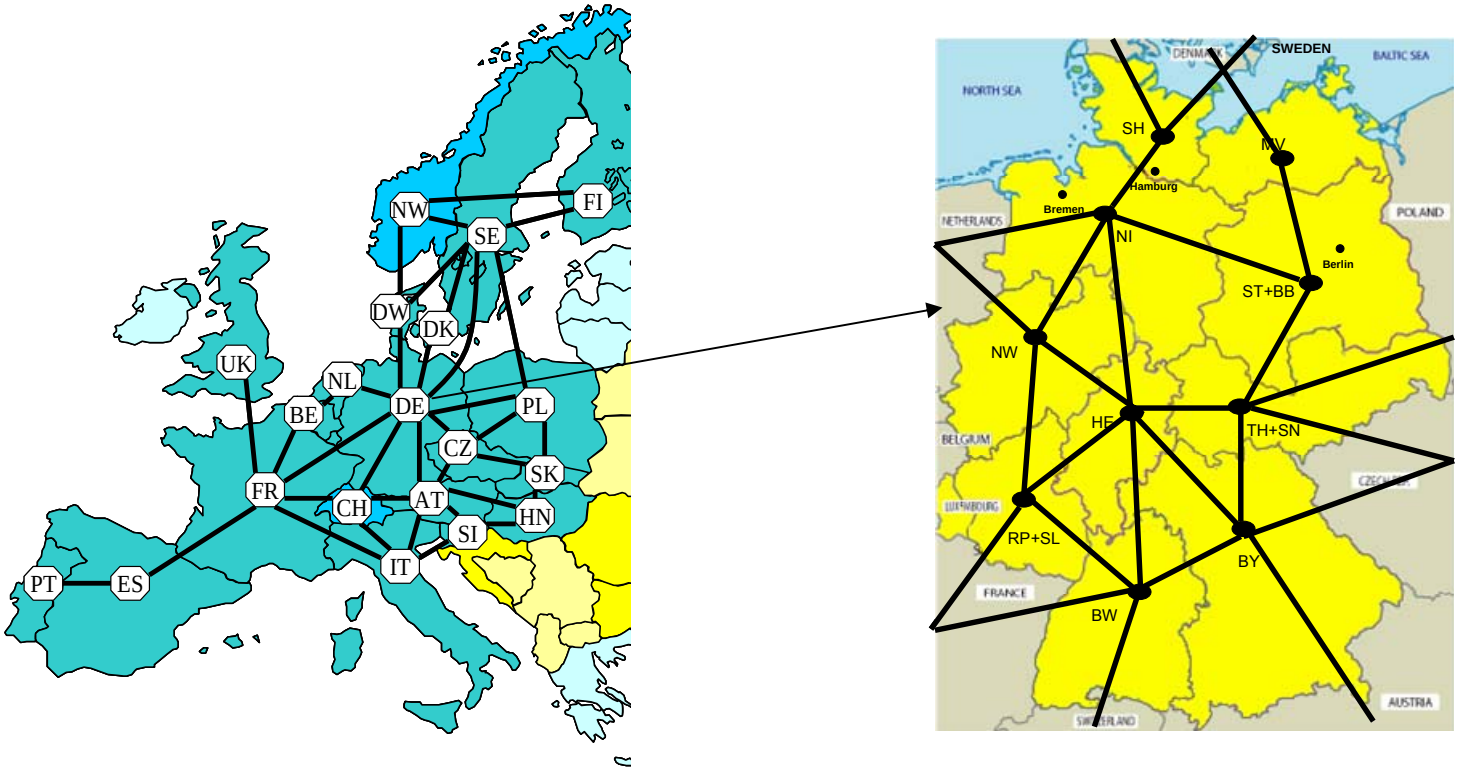
- Electricity market prices
- Congestion pattern and price differences within Germany
- Incentives of TSOs to invest in interconnection capacity

Tool: COMPETES Model

- Short-run equilibrium (static) model of a transmission-constrained EU power markets
- **Geographical coverage:** 20 EU countries
- **Production system:** individual power plants (ownership, fuel type, efficiency, availability, maximum output)
- **Temporal coverage:** 12 (demand) periods in a year
- **Transmission Network:** AC/DC lines and 3-Hub system (UCTE, Nordpool, and UK)
  - physical transmission system based on linearized DC load flows between nodes
  - auction-based transmission system between countries

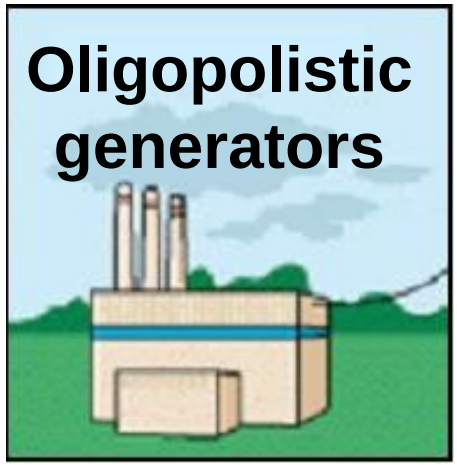
Transmission Network

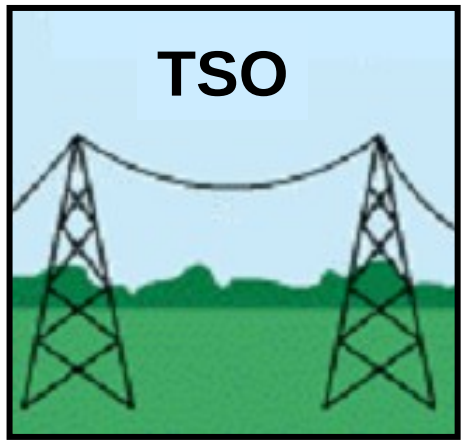
- Covers 20 EU countries; each country as a single node
- Germany is represented by 10 regions



Agents

- Generators aiming to maximize profits
- Arbitrageurs aiming to maximize profits
- TSO's aiming to maximize the value of transmission





Simulation runs for 2020

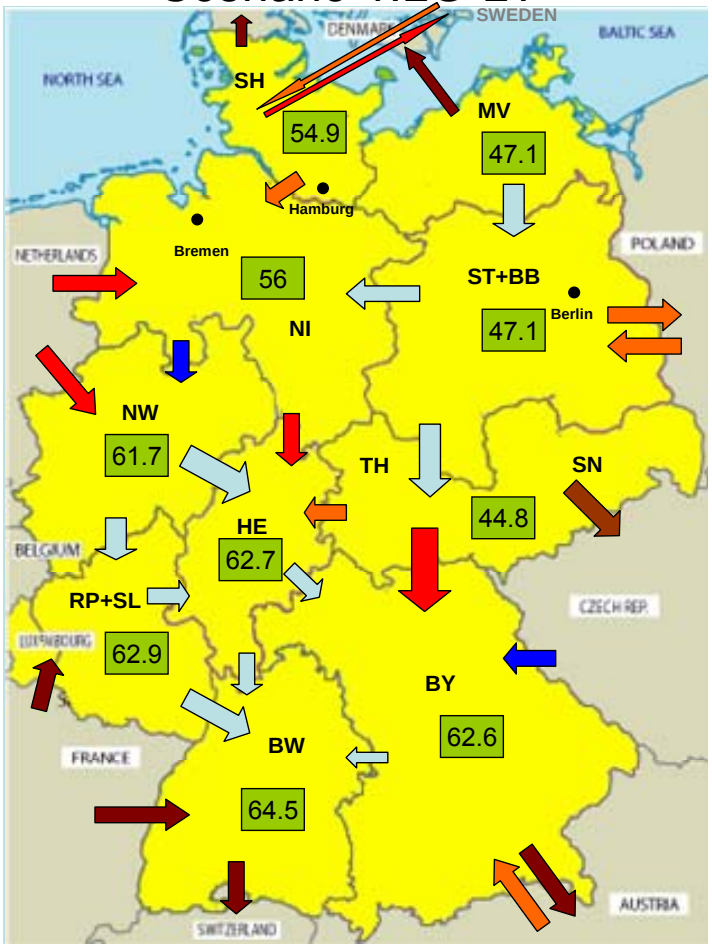
- Country specific scenarios for Germany and neighboring countries on expansion of generation capacity
- Scenarios on expansion of transmission capacity
  - EU interconnector expansion scenario by CESI study (2005)
  - German network capacity expansion scenario by DENA study (2008)
- Fuel prices: Global Economy High Oil Price (GEHP) scenario (National scenario of the Netherlands)
- CO2 price: 20 Euro/tonne

Overview of Scenarios

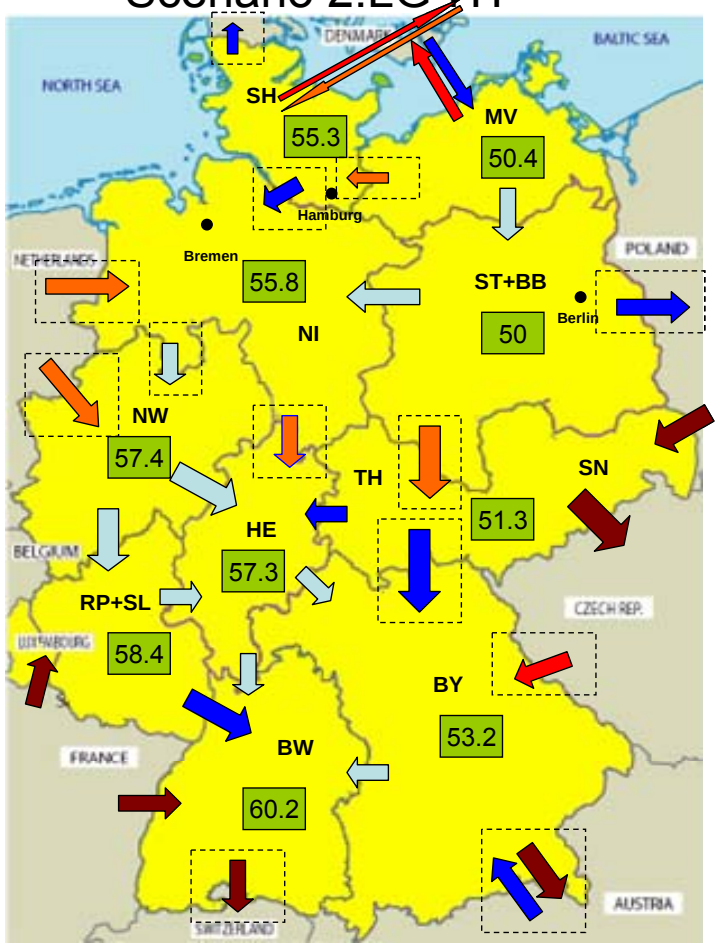
Low generation capacity in DE -14 GW wind turbines in North -16 GW nuclear is decommissioned	No transmission capacity built in DE	Scenario 1
	Expected transmission capacity built in DE (by DENA)	Scenario 2
High generation capacity in DE -26 GW wind turbines in North -Nuclear is not decommissioned	No transmission capacity built in DE	Scenario 3
	Expected transmission capacity built in DE (by DENA)	Scenario 4

Impact of wind turbine installations in the North: Low generation capacity scenarios

Scenario 1:LG-LT

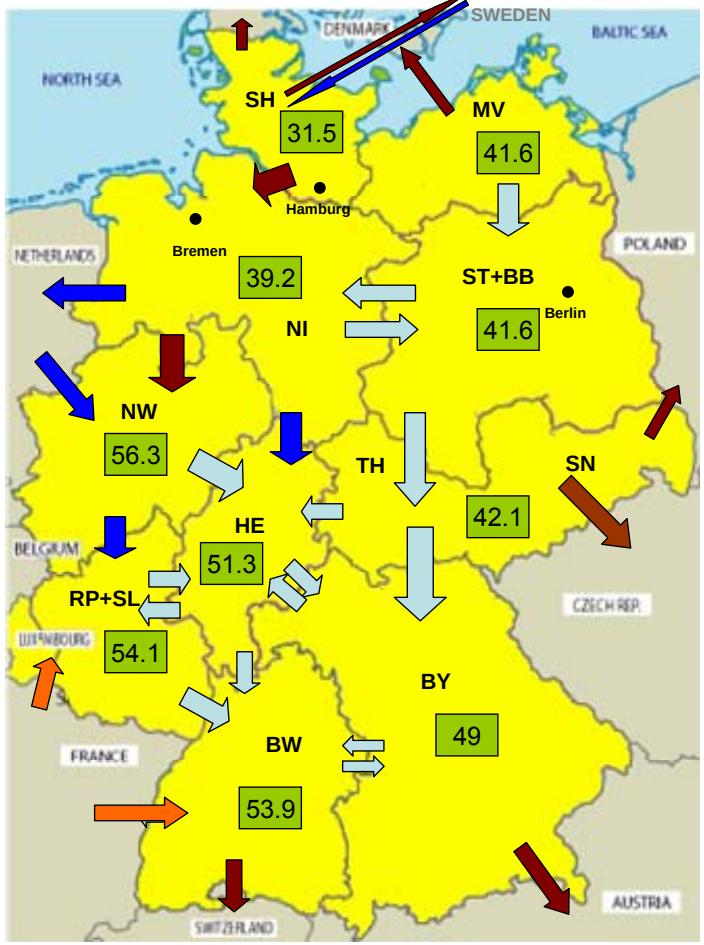


Scenario 2:LG-HT

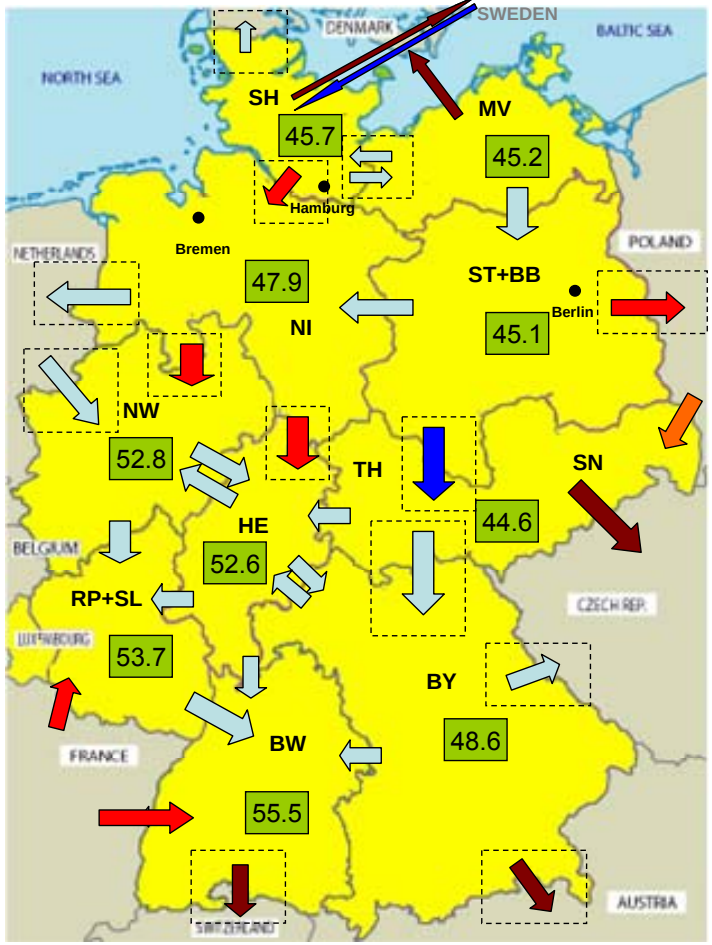


Impact of wind turbine installations in the North: High generation capacity scenarios

Scenario 3:HG-LT

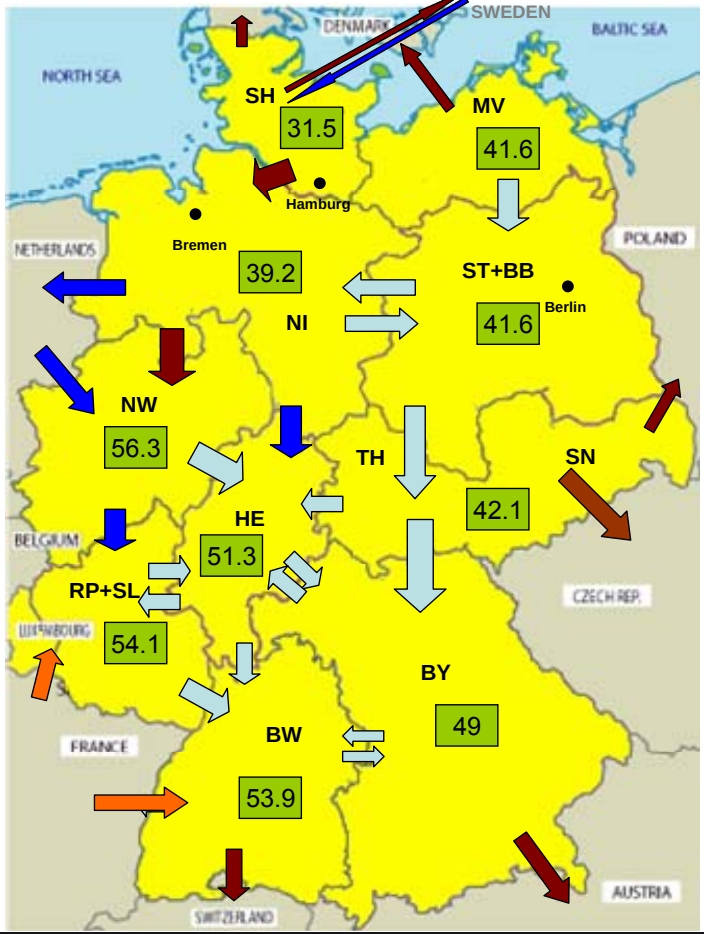


Scenario 4:HG-HT

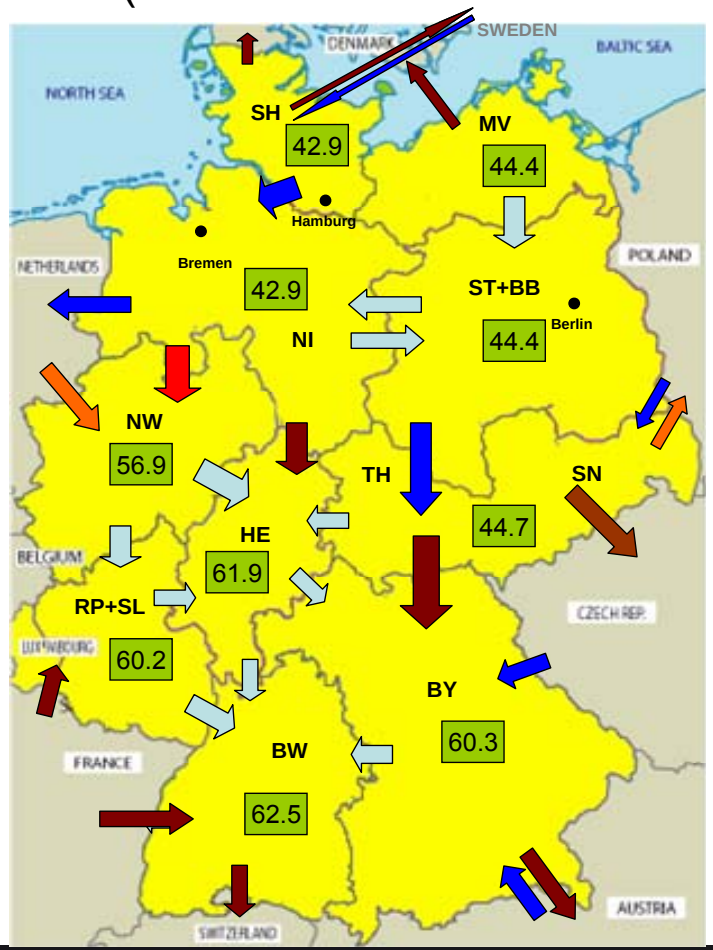


Impact of nuclear decommissioning in the South (1)

Scenario 3:HG-LT

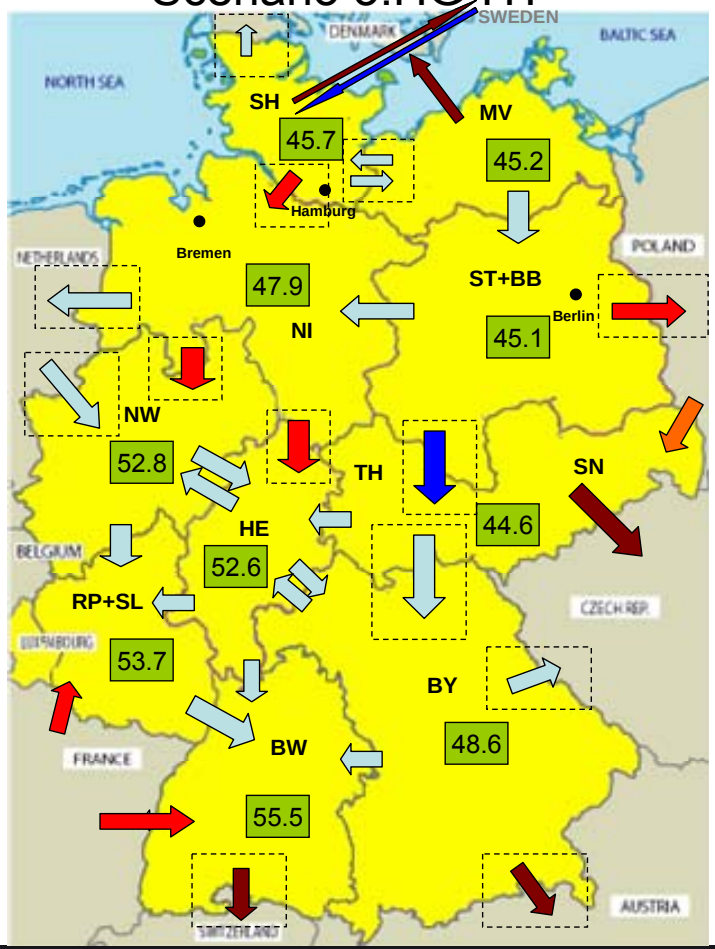


HG-LT (Nuclear is decommissioned)

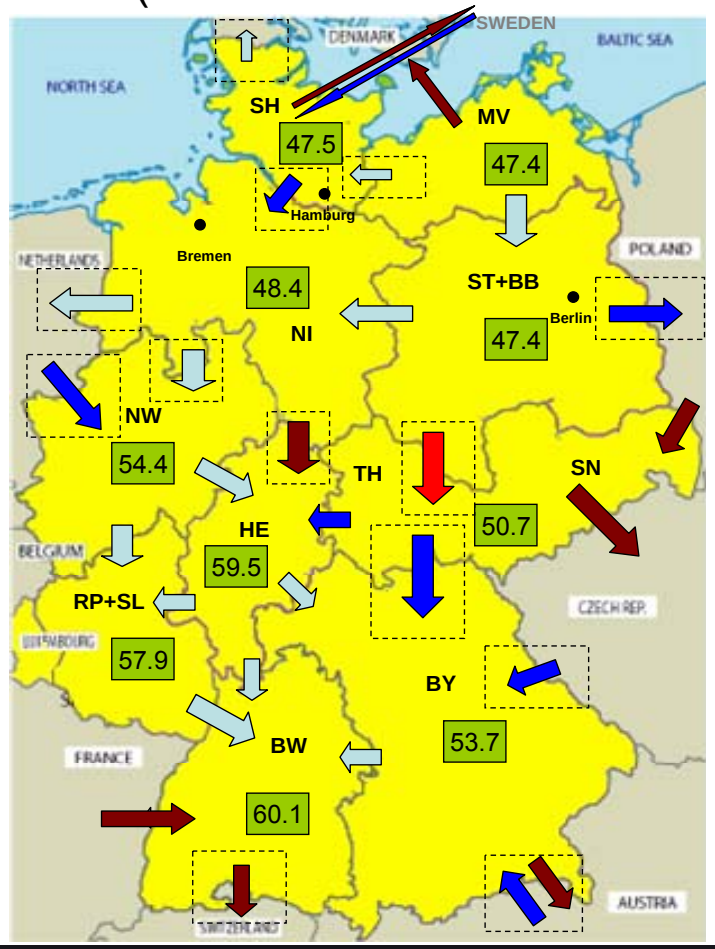


Impact of nuclear decommissioning in the South (2)

Scenario 3:HG-HT



HG-HT (Nuclear is decommissioned)



Vertically Integrated Utilities vs Unbundled TSOs

Assumptions for investment incentives: Congestion revenues (transmission surplus) are ring fenced to network investments.

- *VIU:* maximize its production surplus only
- *Unbundled TSO:* network charges would be regulated such that TSOs would be incented to make investments that increase overall market efficiency, no matter who benefits. (e.g., higher net surplus)

Investment Incentives

Overview of Producer, Consumer, and Transmission Surplus (in MEuros)

	Scenario 1			Scenario 2		
	PS	CS	TS	ΔPS	ΔCS	Δ(PS+CS+TS)
DE	13805	80398	855	-1187	2027	91
EU 20 (excl. DE)	90919	442756	2825	-727	874	357
	Scenario 3			Scenario 4		
	PS	CS	TS	ΔPS	ΔCS	Δ(PS+CS+TS)
DE	14358	86474	1677	1864	-779	1222
EU 20 (excl. DE)	88680	445050	2311	-2251	2545	-475

Conclusions

Future German power market:

- Congestion and nodal price differences may arise due to high wind turbine installations in the North
- Nuclear decommissioning in the South has an enhancing effect on congestion
- Single zone pricing may not be justifiable
- Unbundling is likely to stimulate investments in cross-border transmission capacity (if regulation ensures).
- In case Germany remains an export country, VIU's may also be incented to invest in cross-border transmission capacity.

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