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Market outcomes in flow-based market coupling: a model-based analysis of the fundamental parameters

ENERDAY 2021
Dresden, 9th April 2021

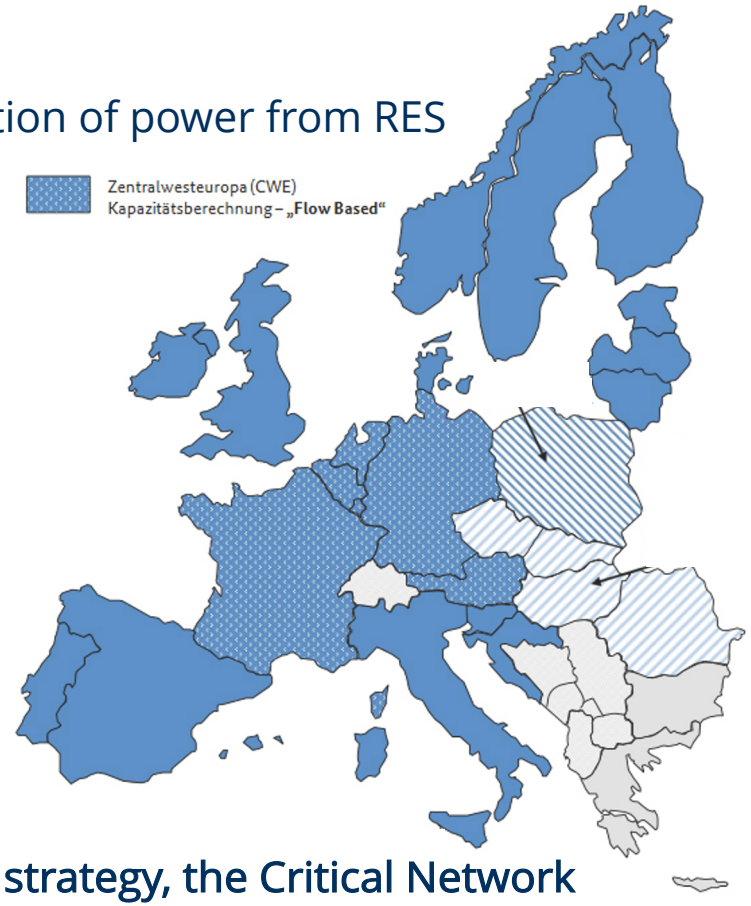
Agenda

1) Motivation & Introduction
2) Model Parameters
3) Modelled Generation Shift Key-Strategies
4) Impact of the Generation Shift Key-Strategy on the Number of Critical Network Elements
5) Computation of Trading Domains
6) Key Findings

1) Motivation

Internal electricity market:

- \+ increasing security of supply, competitive power prices, better integration of power from RES
- − physical restricted electricity grid
- **accurate capacity calculation**



→ Flow-based market coupling:

- Simultaneously with market coupling
- Considers actual power flows and physical grid restrictions
- Implemented in 2015 in Central Western Europe
- Soon to be expanded to Central Eastern Europe

Research question: „To what extent do the selection of the Generation Shift Key strategy, the Critical Network Elements and the CNE selection threshold influence the market results in flow-based market coupling?“

Source: BNetzA (2021)

2) Fundamental model parameters of flow-based market coupling

1) **Generation Shift Keys (GSK)**

→ Convert nodal information into zonal information

2) **Critical Network Elements (CNE)**

→ Decisively affected transmission line

3) **Critical Network Element selection threshold**

→ Threshold above which transmission lines are considered as „critical“

4) **Flow Reliability Margin (FRM)**

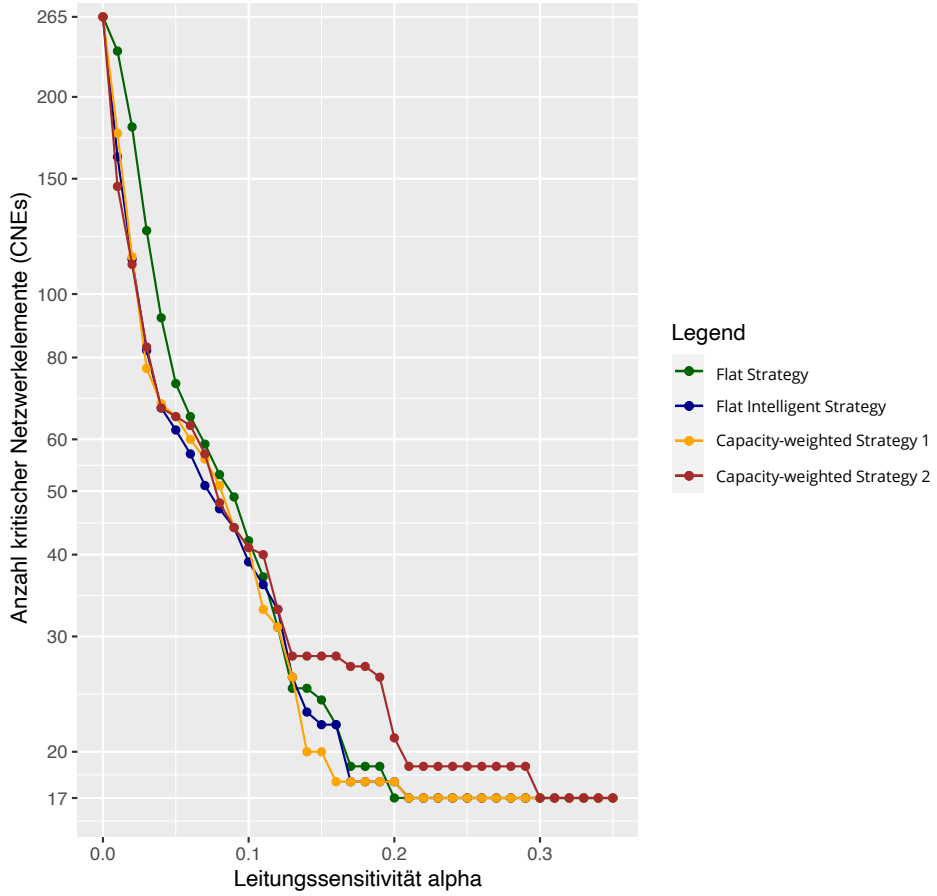
→ Security margin

3) Modelled Generation Shift Key-strategies

	„Flat“	„Flat Intelligent“	„Capacity-weighted Strategy 1“	„Capacity-weighted Strategy 2“
Considered power plant types	– all	– only **conventional** power plants	– only **conventional** power plants	– only **hard coal and gas** power plants
Weighting method	– **Equal** weighting within a zone	– **Equal** weighting within a zone	– Weighting according to the maximum capacity of each power plant (P_{max})	– Weighting according to the maximum capacity of each power plant (P_{max})

4) Impact of the Generation Shift Key-strategy on the number of Critical Network Elements

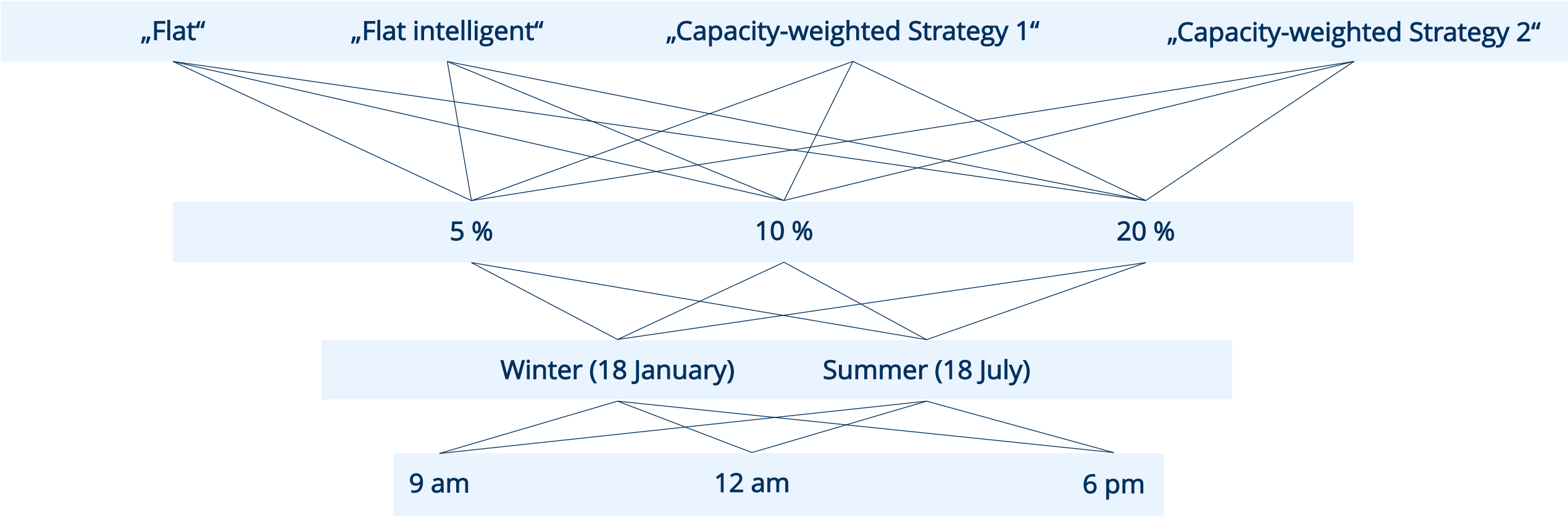
Number of Critical Network Elements (CNEs) depending on Generation Shift Key-strategies



Findings:

- Number of Critical Network Elements decreases with increasing selection threshold
- A minimum number of CNEs of 17 (cross-border transmission lines)
- Similar number of CNEs for ”Flat Intelligent”, “Capacity-weighted Strategy 1” and “ Capacity-weighted Strategy 2” for a selection threshold < 12 %
- “Flat Strategy” has slightly increased number of CNEs

5) Computation of Trading Domains



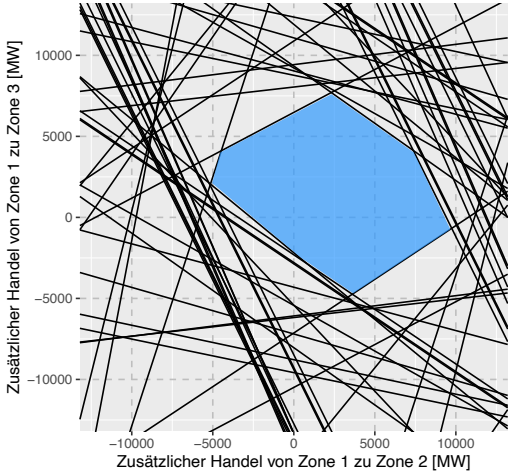
→ 72 trading domains to analyze the impact of:

1) GSK-strategy 2) CNE selection threshold 3) season / load profile 4) Time

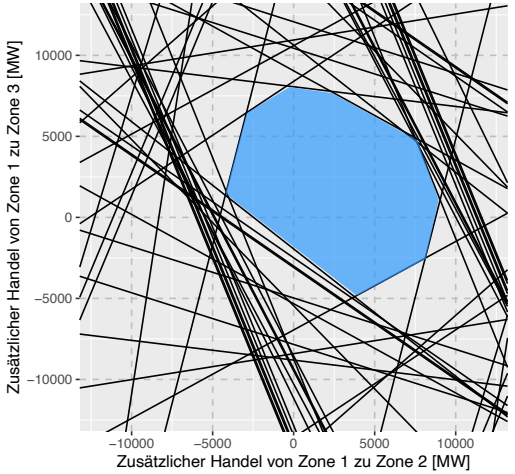
5) Computation of Trading Domains:

18th January, 9 am, α = 10 %

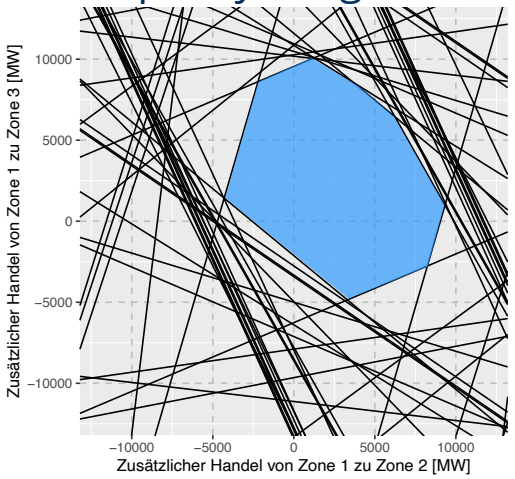
Flat



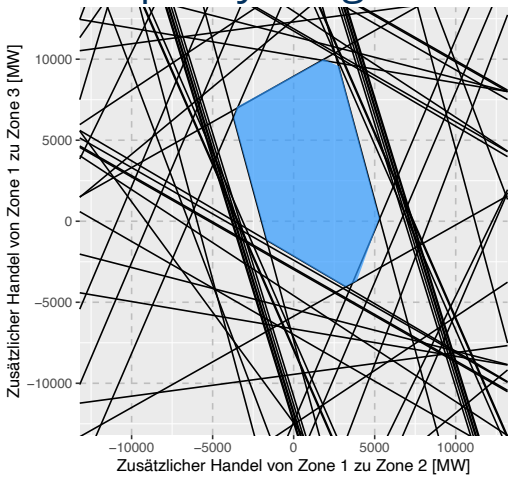
Flat Intelligent



Capacity-weighted 1



Capacity-weighted 2



Findings:

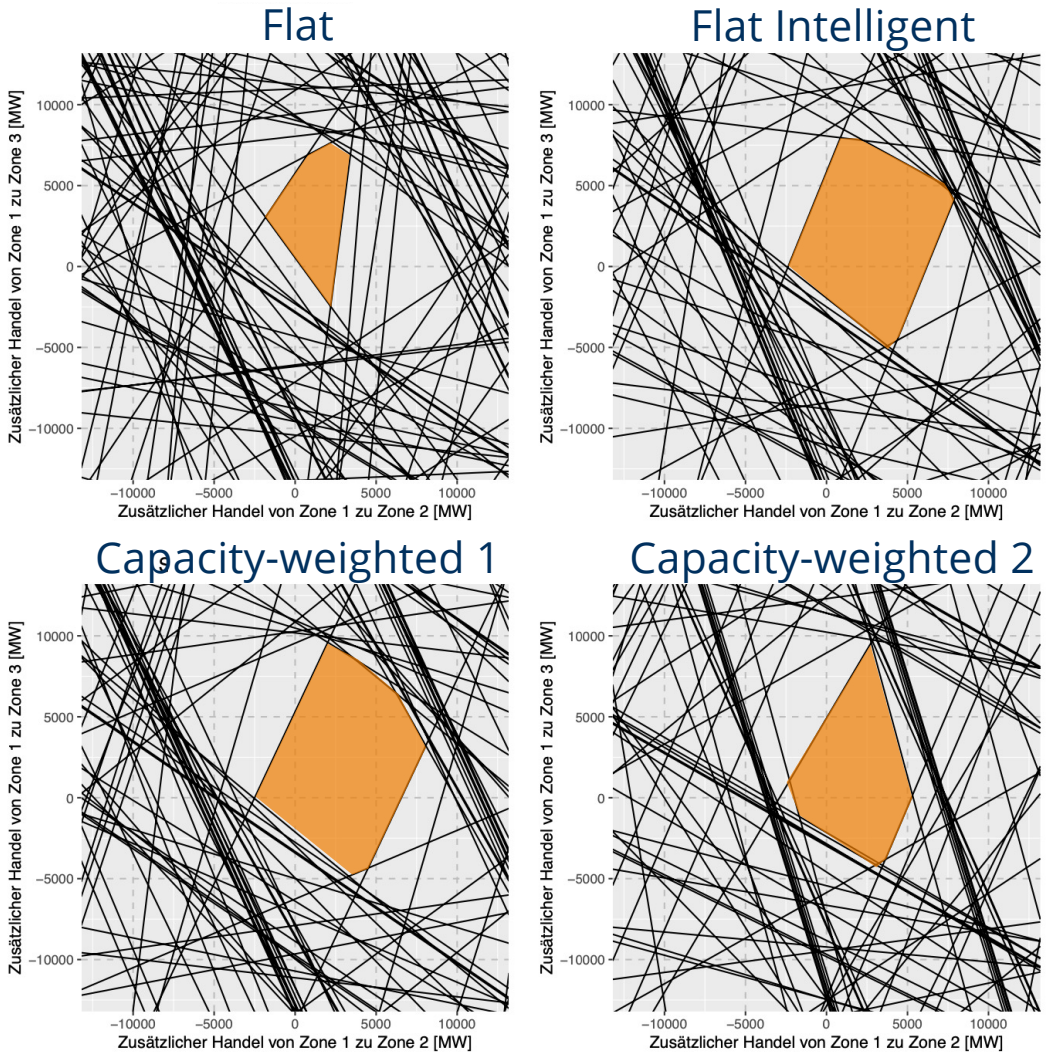
- Selection of Generation Shift Key-strategy significantly affect the trading domains and the allowed trading capacity
- Number of restricting Critical Network Elements differ between the single Generation Shift Key-strategies
- Trading domains (blue) of “Flat”, “Flat Intelligent” and “Capacity-weighted Strategy 1” similar
- Trading domain (blue) of “Capacity-weighted Strategy 2” more restricted

5) Computation of Trading Domains:

Findings:

- Lower CNE selection threshold leads to more Critical Network Elements (= lines)
- Smaller resulting trading area
- Major differences in size and shape of the trading domains (orange) between the GSK-strategies
- Trading domains (orange) of “Flat Intelligent” and “Capacity-weighted Strategy 1” are again very similar

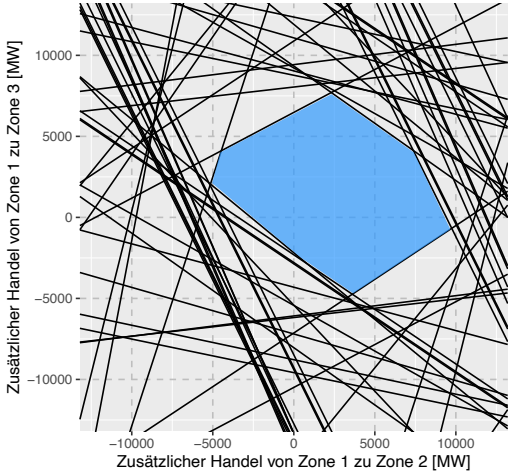
18th January, 9 am, α = 5 %



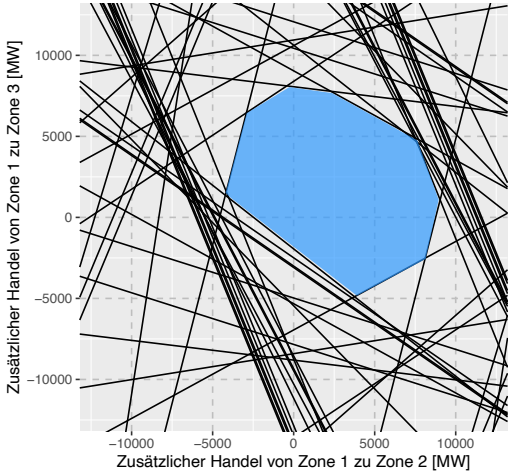
5) Comparison of Trading Domains:

18th January, 9 am, α = 10 %

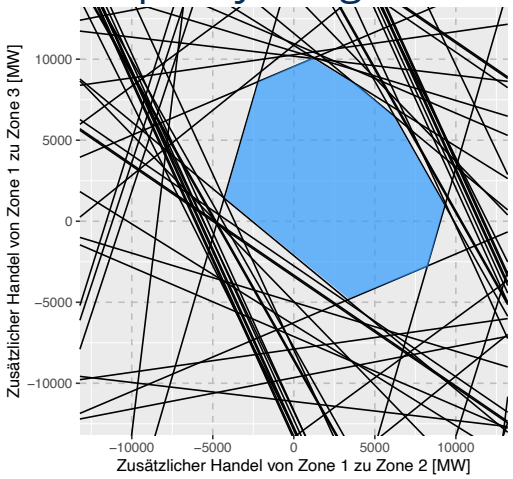
Flat



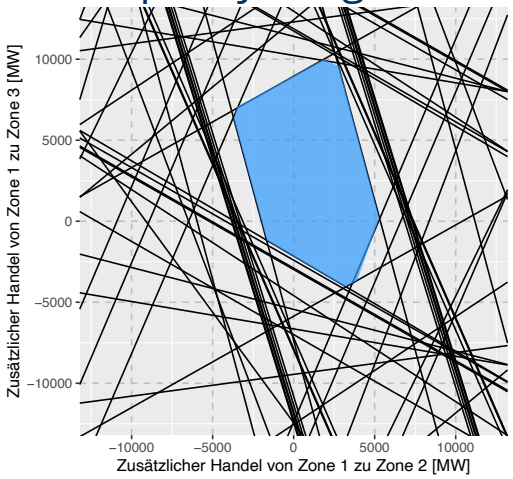
Flat Intelligent



Capacity-weighted 1

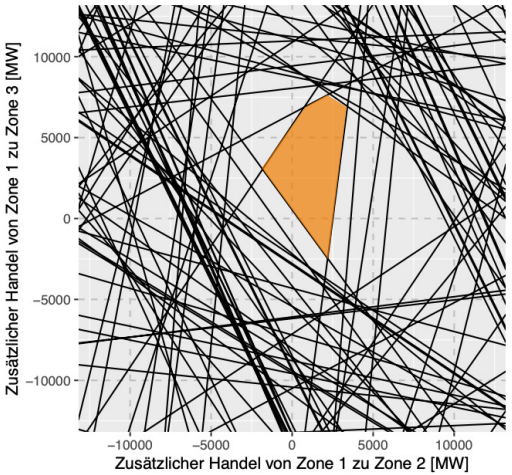


Capacity-weighted 2

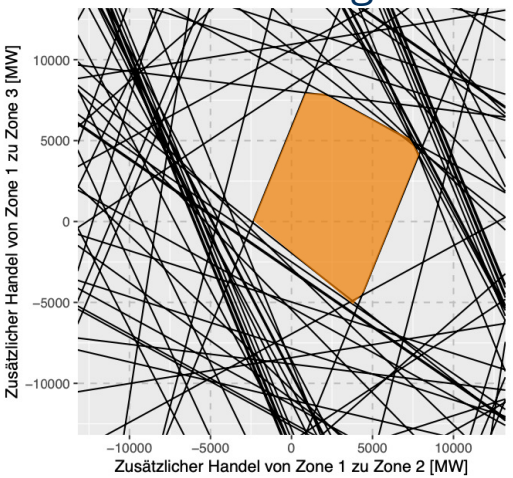


18th January, 9 am, α = 5 %

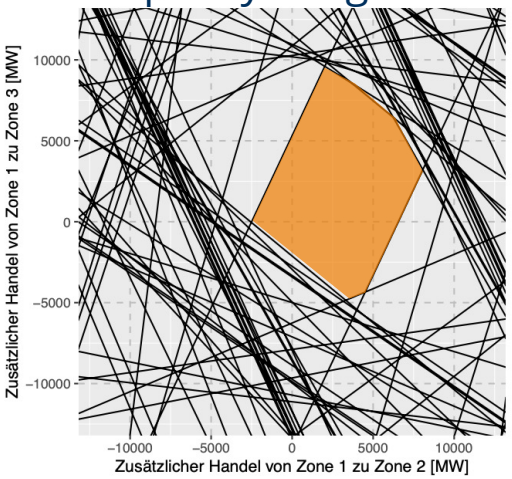
Flat



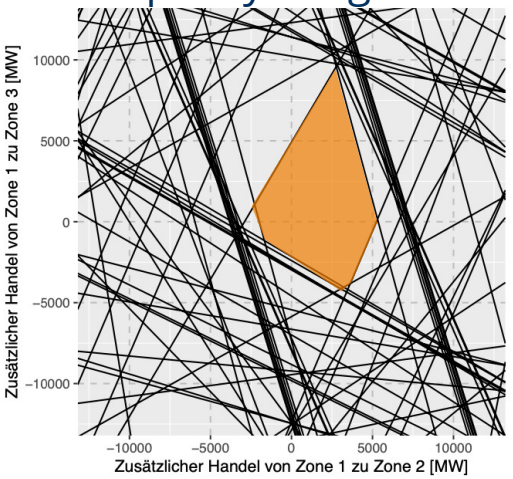
Flat Intelligent



Capacity-weighted 1



Capacity-weighted 2



6) Key Findings

- Flow-based market coupling will gain importance in Europe during the next years.
- Model accuracy highly depends on the parameter design.
- Number of Critical Network Elements decreases with increasing selection threshold.
- Market domains of „Flat Intelligent“ and „Capacity-weighted Strategy 1“ differ only slightly for all CNE selection thresholds and timestamps in all scenarios.
- The smaller the CNE selection threshold, the more trading restrictions.
- The CNE selection threshold-parameter has the greatest impact on the trading domains using the „Flat Strategy“.
- Major differences between the trading domains of a CNE selection threshold of 5 % and 10 %. Minor differences between 10 % and 20 %.

Thank you for your attention!

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Picture Sources:

- **Slide 3:**
  https://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/HandelundVertrieb/EuropMarktkopplung/MarketCoupling.html