On assessing the value of decentral flexibility given different flexibility deployment and TSO-DSO coordination

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ZellNetz2050

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What can we expect concerning Redispatch in a fully renewable based system?

- A net-zero emission system requires different system management
  - Infrastructure: e.g. capacity
  - Organization: e.g. processes and communication with more „smart“ units, …
- Decentral flexibility is seen as a key component in future congestion management (Redispatch 3.0)
- Yet, implications from a global system perspective and across voltage levels are unknown.

→ Which small-scale flexible technologies are beneficial from a system-perspective?
→ To what extent is decentral flexibility deployed for congestion management?
→ How does the varying deployment affect system operation?

Factors affecting future flexibility depolyment for redispatch

Possible sources of decentral flexibility in energy systems

- Novel flexibility options
  - *Electrification of heating and mobility sector*
- Currently in use
  - *Dispatchable generation*
  - *Renewable curtailment*
- Existing, but not in use so far
  - *Small units (Redispatch 3.0)*

Market context

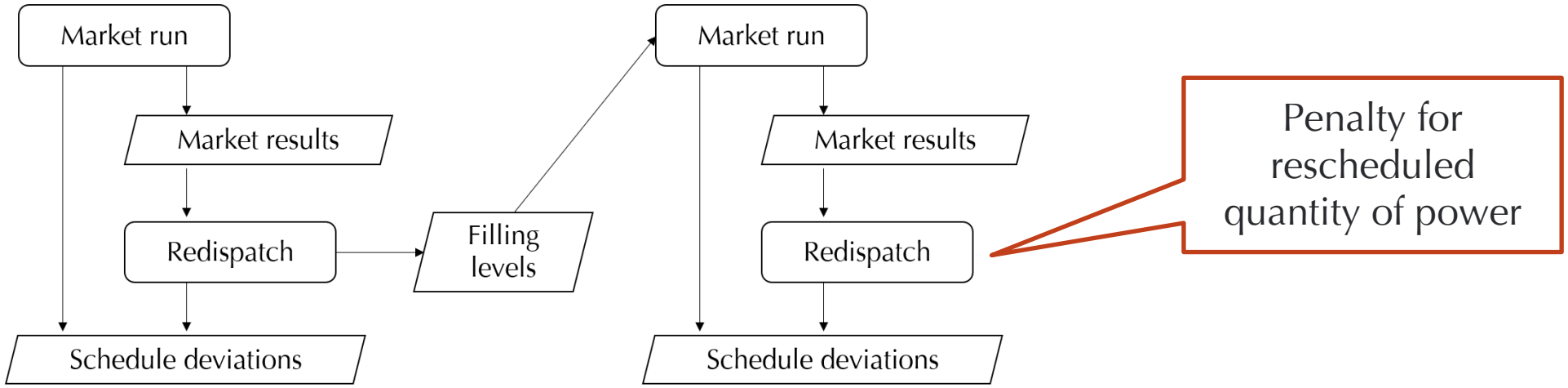
- Incentives/Rewards for flexibility
  - *Zonal vs. nodal markt design*
- Substitutes to decentral flexibility
  - *Central flexibility through power plants*

Influence of system operation (TSO, DSO)

- Operational system management
  - *Dispatch, system responsibility, billing*
- Grid planning principles
  - *Consideration of flexibility use as substitute to grid extension*

Methodology

- Underlying Model: Energy system model in Julia Language
  - Daily rolling planning of market clearing, then system operation run with „redispatch“
  - Decentral storage filling level from system model run is passed forward to next iteration



- Decentral units that participate in redispatch:
  - Heat pumps, battery storage, power-to-gas, dispatchable power plants

Net-zero emission study case for Germany in 2050

- Distribution network region Schleswig-Holstein (110 kV, 20 kV, 0.4 kV)
- Model run for calendar week 9 (first week in March)
  - Winter season: October and March
  - Low residual load (high wind infeed, low local demand)
- Here: Focus on battery storage deployment as sensitivity
  1. Amount of battery units is altered while heat pumps are „dumb“
  2. Amount of battery units is altered while heat pumps are „smart“

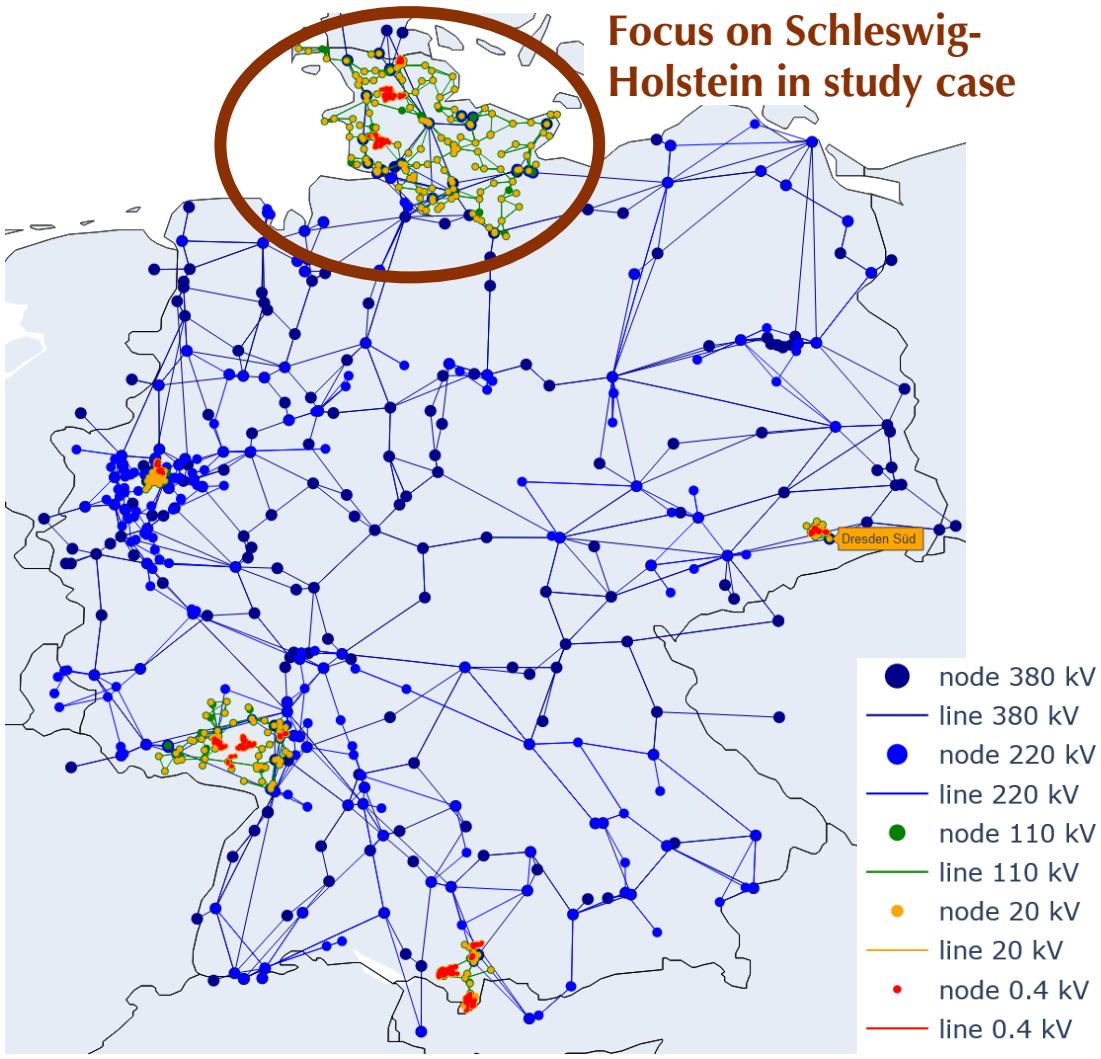
No market-oriented heat pump flexibility
- No deployment of decentral storage units in medium and low voltage grid
- deployment „market-oriented“ decentral storage units in medium and low voltage grid

⇔

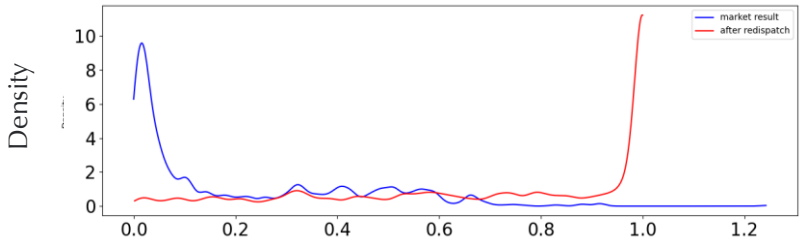
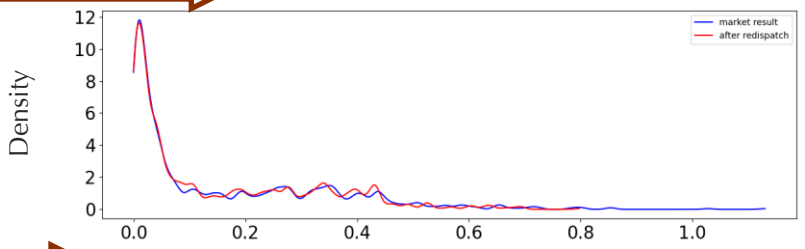
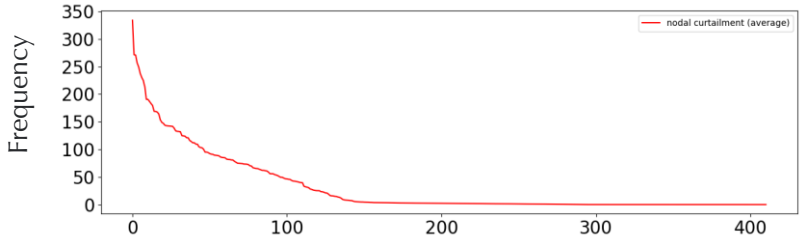
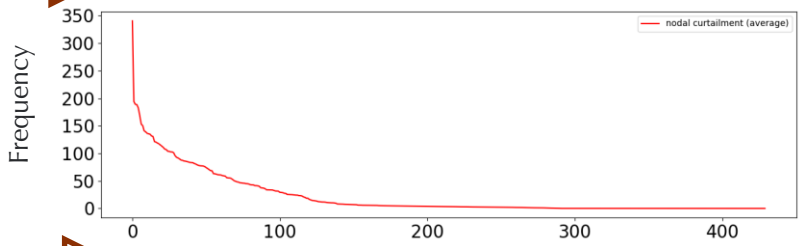
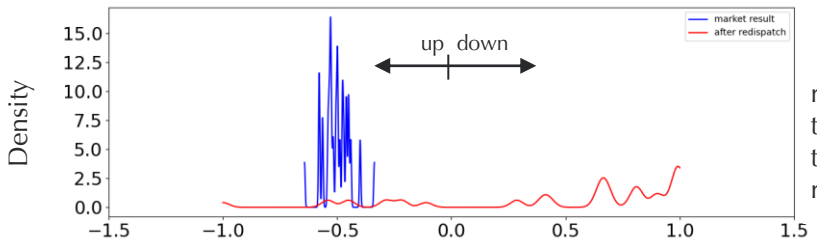
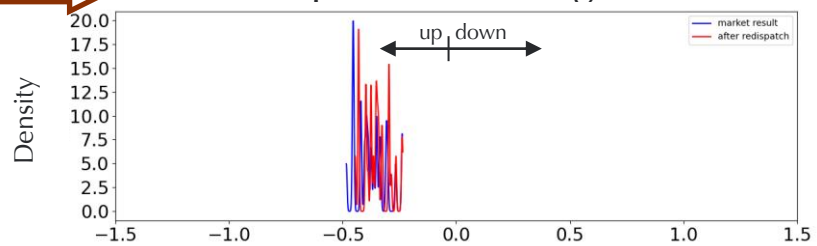
Heat pump units are integrated **market-oriented**
- No deployment of decentral storage units in medium and voltage grid
- deployment „market-oriented“ decentral storage units in medium and low voltage grid

Net-zero emission study case for Germany in 2050

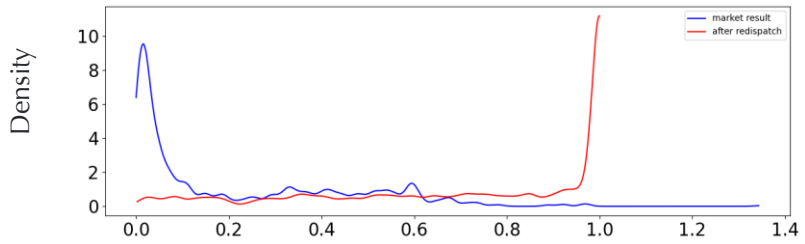
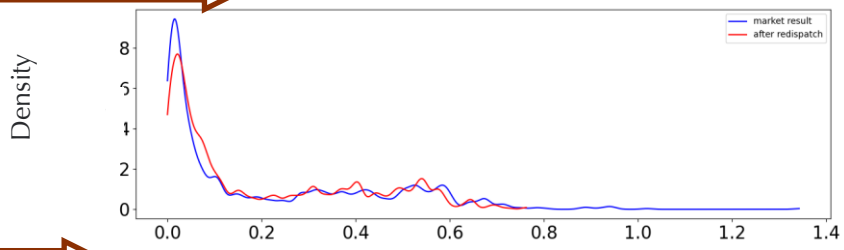
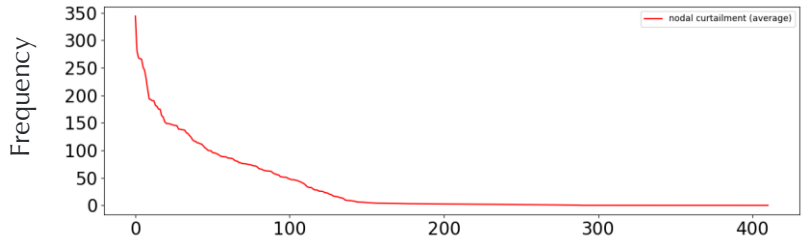
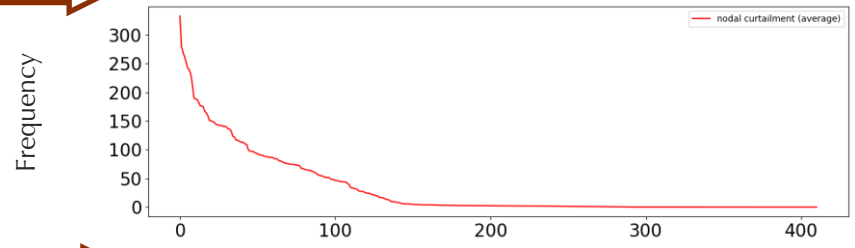
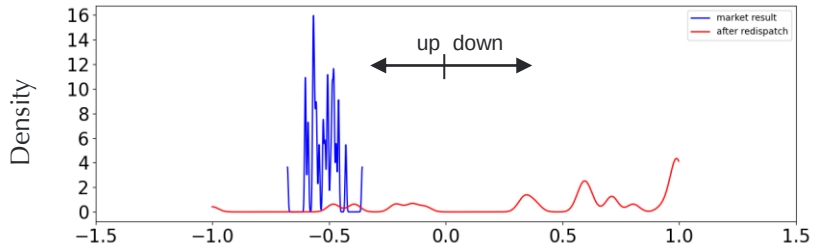
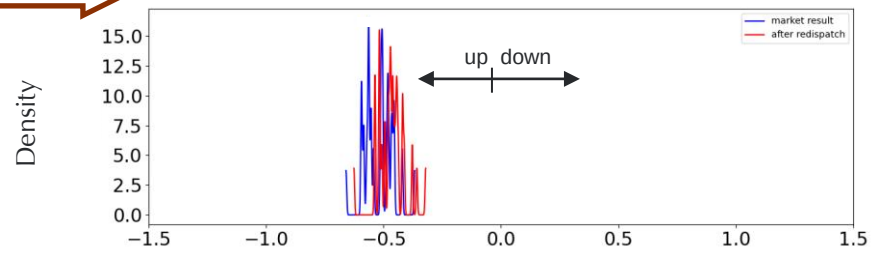
	Germany	Schleswig-Holstein
Conventional Load	648 TWh 115 GWp	6.6 TWh 1.4 GWp
Photovoltaik (after self-consumption)	60 TWh 62 GWp	6 TWh 4.7 GWp
Wind (onshore and offshore)	585 TWh 154 GWp	77 TWh 19 GWp
E-Mobility (residential)	50 TWh 20 GWp	1.6 TWh 0.6 GWp
Heat pumps	45 GW	2 GW
Battery units	20 GW 22 GWh	1 GW 1 GWh
Power-to-Gas	53 GW	1,9 GW
Network nodes	543 (TSO) 4775 (DSO)	897 (DSO)



Preliminary results for Schleswig-Holstein

Heat pump flexibility	Storage flexibility: No storage	Storage flexibility: Decentral battery storage on DSO level
not market-oriented	Average line loading	Average line loading
		
	reduced line loading on DSO level	
	Nodal renewable curtailment	Nodal renewable curtailment
		
	minor reduction	
	Total power exchange TSO/DSO	Total power exchange TSO/DSO
		
	always upwards	

Preliminary results for Schleswig-Holstein

Heat pump flexibility	Storage flexibility: No storage	Storage flexibility: Decentral battery storage on DSO level
market-oriented	Average line loading	Average line loading
		
	Nodal renewable curtailment	Nodal renewable curtailment
		
	Total power exchange TSO/DSO	Total power exchange TSO/DSO
		

reduced line loading on DSO level

about the same

always upwards

Preliminary Conclusion and Outlook

- Battery storage units in lower voltage level support the grid
  - Line loading is decreased on average (compared to line loading after redispatch)
  - Decentral storage units reduce the amount of power required for redispatch

- Curtailment of renewable energy sources remains similar even though different flexibility technologies are used in the distribution system
  - Congestions in this study case cannot be solved by temporal or geographical flexiblity
  - Further assessment of implausible grid representation is necessary

- Power exchange of transformers is affected if decentral flexibility is applied.
  - Redispatch in the downward direction is required
  - Decentral storage units reduce the deviation between market run and system operation schedules

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Thank you for your attention.

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