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Future storage demand under high uncertainties- a model-based sensitivity analysis

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Introduction

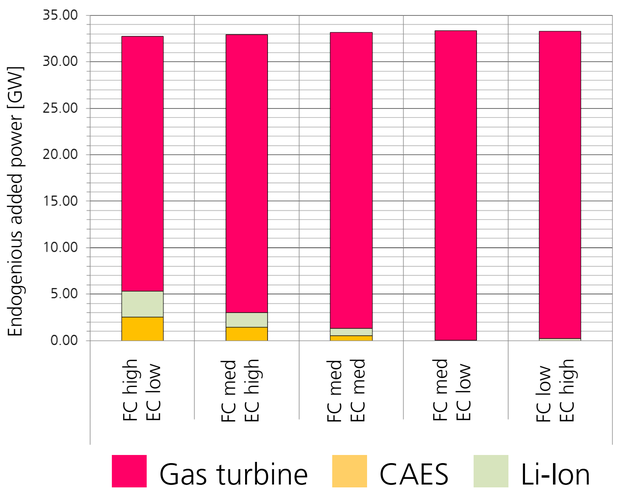
With growing shares of variable, renewable electricity generation in power systems, the supply of sufficient flexibility will most likely increase. This amount might be highly dependent on the scenario assumptions and a review of its robustness with regard to different cost assumptions yet has to be carried out. We therefore analyse model-endogenously derived storage- and gas turbine-expansion for the year 2050, varying the fuel- and emission costs as well as the underlying grid scenario.

Methodology

- Linear bottom-up optimization model REMix [1-4]
- Least cost dispatch and investment optimization for energy systems (electricity, heat, H_2, transport)
- High spatial and hourly temporal resolution
- Around 20 technology modules which enable different applications; e.g. short term capacity expansion, validation of balancing options, RE-integration
- 9 European and 20 German model regions
- 2 grid expansion scenarios (AC, DC): G+ and G-
- 3 curtailment scenarios: 100%, 10%, 3% shedding of annual electr. generation allowed (cur.100, cur.10, cur.3)
- 5 storages: adiabatic compressed air storage, hydrogen storage, lithium-ion battery, pumped storage, redox-flow battery
- Expansion options: storages and gas turbines

Results

I. Influence of cost assumptions



	Fuel costs (FC)	Emission costs (EC)
	low-med-high [€/MWh]	low-med-high [€/t CO_2]
Coal	14 - 21- 35	4 - 47 - 88
Lignite	8 - 9 - 10	4 - 47 - 88
Nat. Gas	33 - 48 - 73	4 - 47 - 88

Figure 1: Gas turbine- and storage expansion

II. Storage expansion

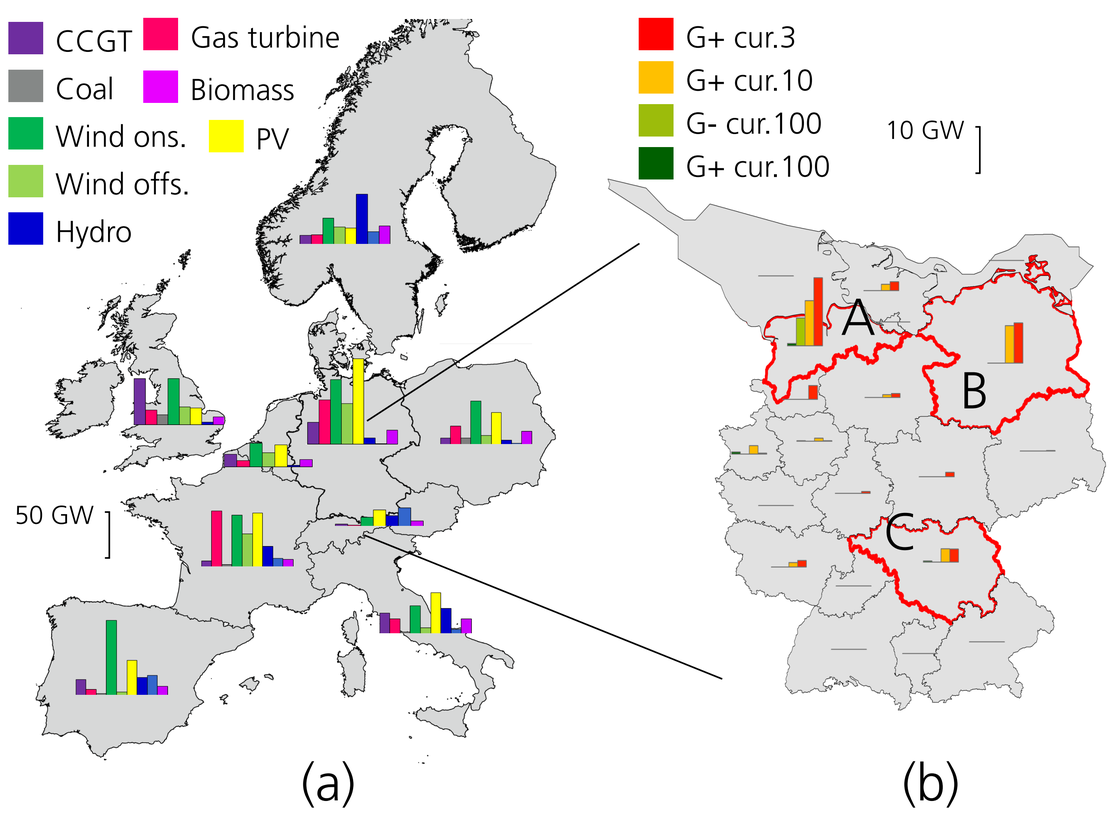


Figure 2: Capacities (a) [5] and spatial distribution of storage expansion (b)

III. Storage utilisation

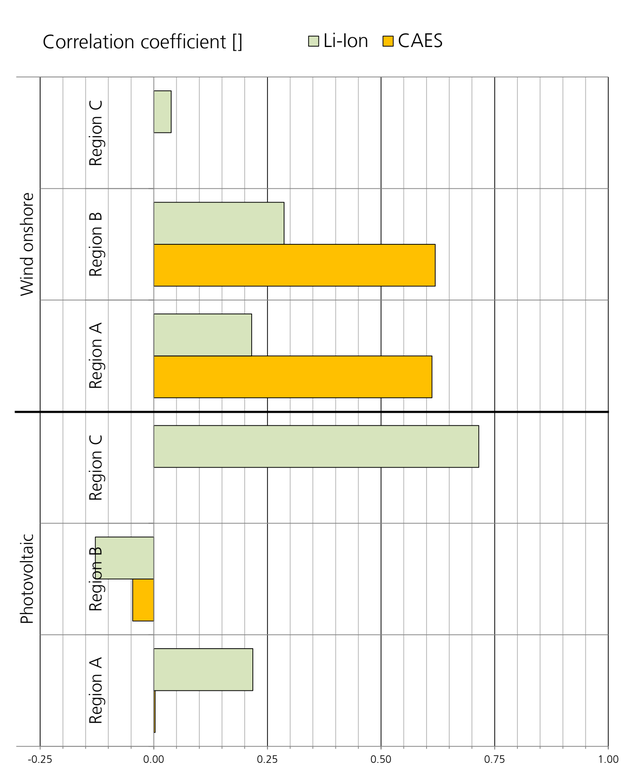


Figure 3: Selected correlation coefficients

- High fuel costs can quadruple the added storage power, while high emission costs only increase the model endogenous expansion by factor 2 (I.)
- With lower FC- and EC costs storages are substituted by gas turbines (I.)
- However, storage expansion is mainly influenced by the grid scenario and restrictions regarding the curtailment (II. (b))
- Storage operation is mainly used for balancing wind power (region A, B), apart from model region C where high PV potentials foster the storage capacity expansion (III.)

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German Aerospace Center

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