

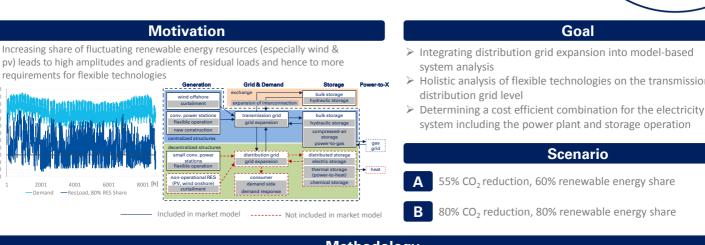
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Use of Energy (IER)

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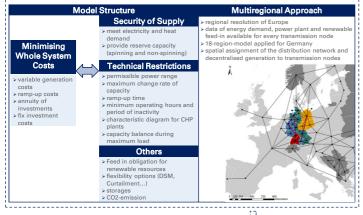
A METHODOLOGY TO INTEGRATE DISTRIBUTION GRID EFFECTS AND DISTRIBUTED FLEXIBLE TECHNOLOGIES INTO MODEL-**BASED SYSTEM ANALYSIS OF ELECTRICITY MARKETS**



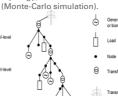
Methodology

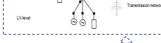
specific costs for distributed

- flexible options
- Stochastic European Electricity Market Model (E2M2s)
- > stochastic mixed integer linear electricity market model
- > investments in power plants, storages, other flexibility options and grids during
- simultaneous modelling of power plant operation
- > myopic optimization of power plant planning and investments on yearly basis with time resolution of up to 8760 hours
- > inter-temporal power plant restrictions, optimal provision of reserve capacity, DC-Loadflow, consideration of environmental concerns like CO2-emission



- Distribution-Network-Assessment-Tool (DNA-Tool) ▶ simulation of distribution grid expansion requirements
- > the average amount of exceedance of the voltage range and current rating, as well as the length of the line expansion in the region in every network level, can be simulated.
- high voltage grids with attached medium and low voltage grids are simulated for every region
- > in every simulation run, the topology of the grid, the electricity demand/supply and the necessary line expansion are simulated.
- > to reduce the dependence on a specific topology, several runs are executed





hourly load operation curve of distributed flexible options

Costs for Distribution Grid Line Expansion MV ົອ

Conclusion

Iteration of

simulation (Monte

Carlo Simulation)

- gas power plants and CCS become major technologies in the Germa power plant mix due to strict CO₂ reduction targets
- importance and utilization of flexible technologies increase with higher renewable share, especially storage, DSM and Power-To-Heat 8

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flexible technologies can help to reduce costs for distribution grid line expansion

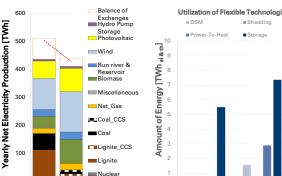
References

- Bothor et al., Bedarf und Bedeutung von Integrations- und Flexibilisierungsoptionen in Elektrizitätssystemen mit steigendem Anteil erneuerbarer Energien, 9. IEWT 2015
- (2) Eberl et al., Kosten des Verteilnetzausbaus aufgrund dezentraler Elektrizitätserzeugung – eine simulationsgestützte Betrachtung an Beispiel Baden-Württembergs, Bundesnetzagentur 2013

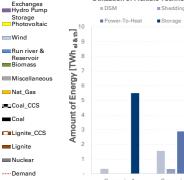
Acknowledgements

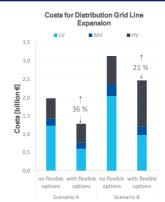
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Modelling Results



Scenario Scenario





- Holistic analysis of flexible technologies on the transmission and

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scenarios

system including the power plant and storage operation