A Monte-Carlo assessment of the effects of long-term changes on residential energy supply systems

Elif Turhan

15 March 2022

DPG spring meeting

DLR Institute of Networked Energy Systems

Gefördert durch:
Bundesministerium für Wirtschaft und Klimaschutz
aufgrund eines Beschlusses des Deutschen Bundestages

Gefördert durch:
Bundesministerium für Bildung und Forschung
aufgrund eines Beschlusses des Deutschen Bundestages

grant number 03SBE111

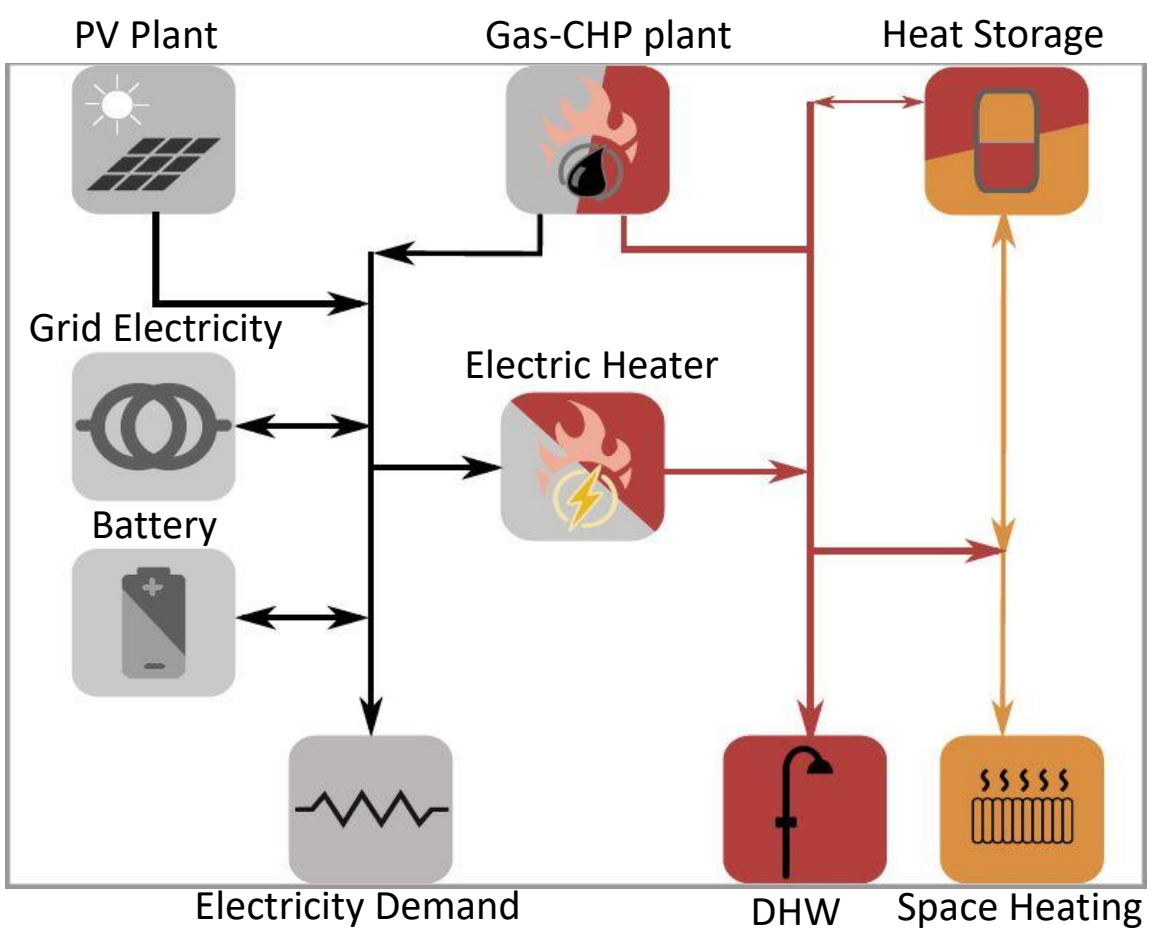
Context: Energetic Neighbourhood Fliegerhorst Oldenburg

Fliegerhorst Oldenburg before the project

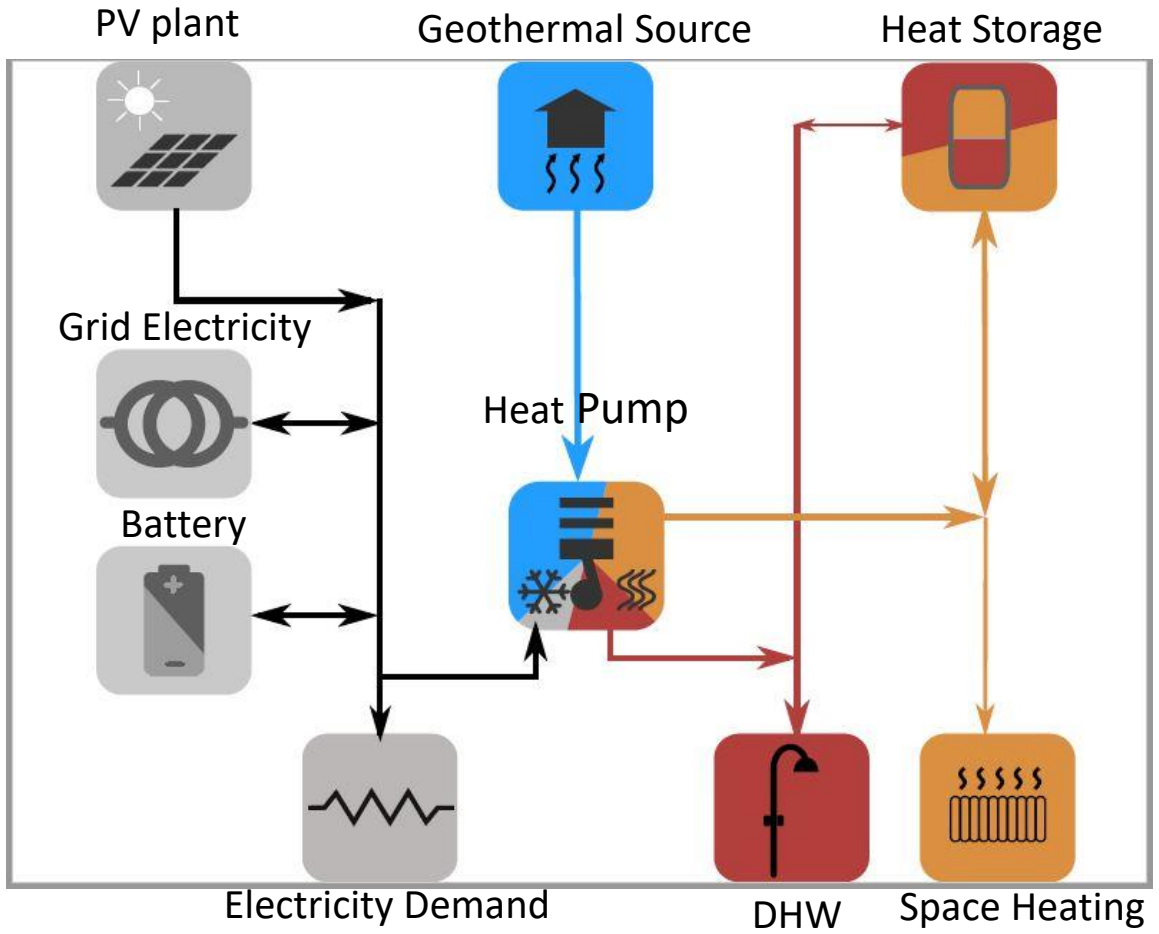
https://www.enaq-fliegerhorst.de/

- Key aspect: Cover most of its energy needs from locally generated energy
- Key Performance Indicators (KPIs):
  - Low operational costs
  - Low CO_2 emissions
- Two energy system designs analysed
- Operational optimisation with *Model Template for Residential Energy Supply Systems* (MTRESS) for 2030

Energy System Design



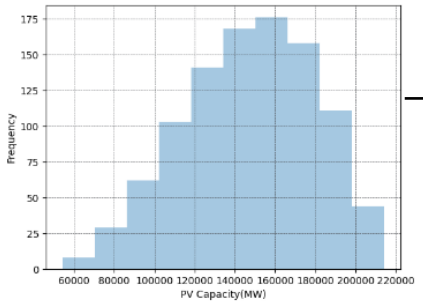
Combined Heat and Power (CHP) based energy system design

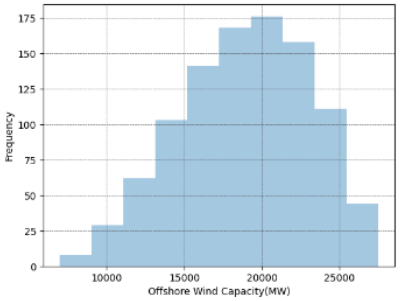


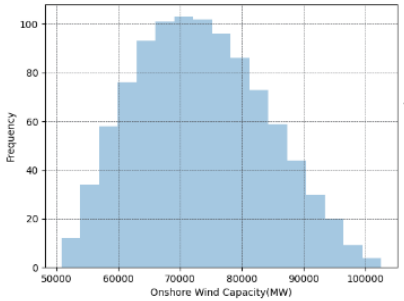
Heat pump (HP) based energy system design

Monte Carlo Simulations

Input Distributions

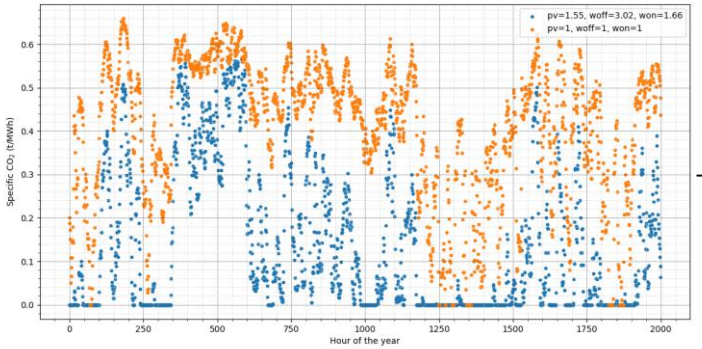


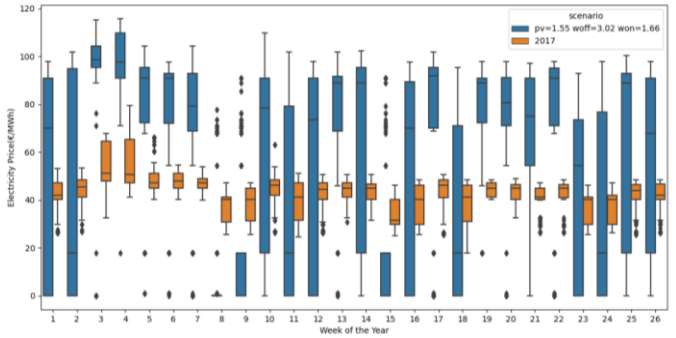




DEFLEX

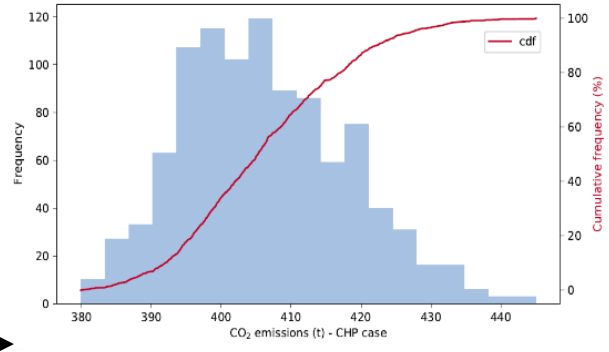
Intermediate Time Series

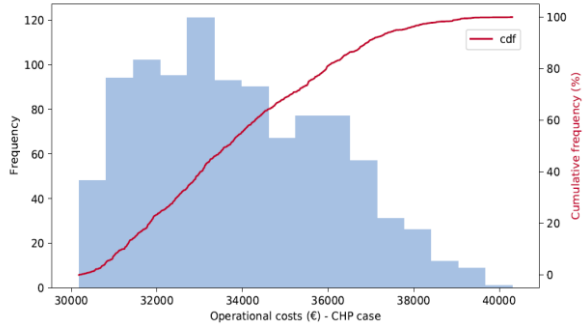




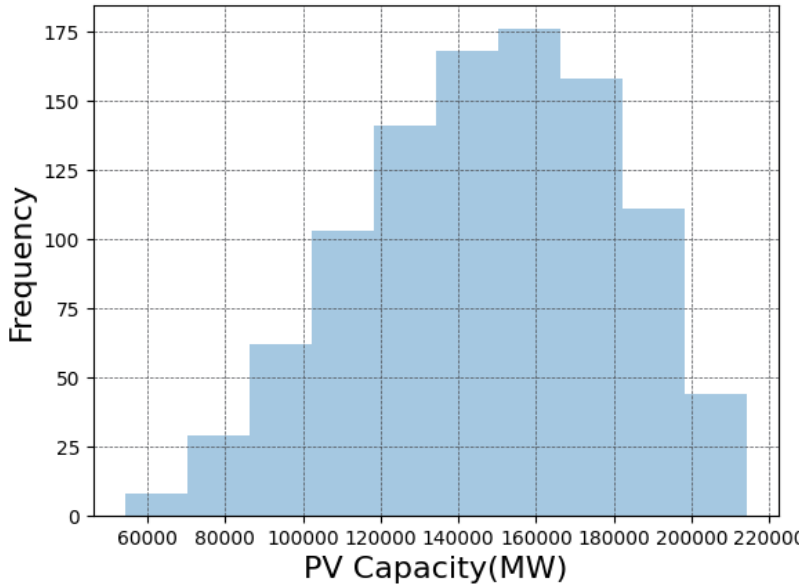
MTRESS Simulation

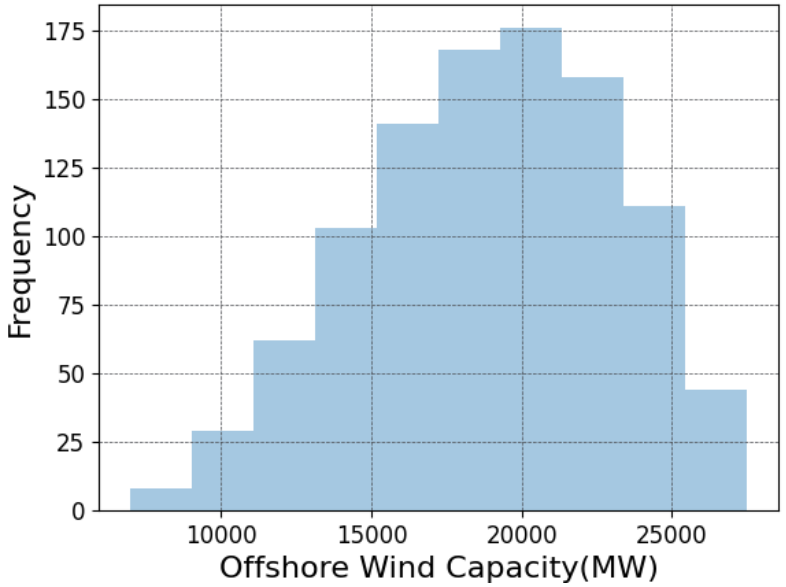
KPI Distributions

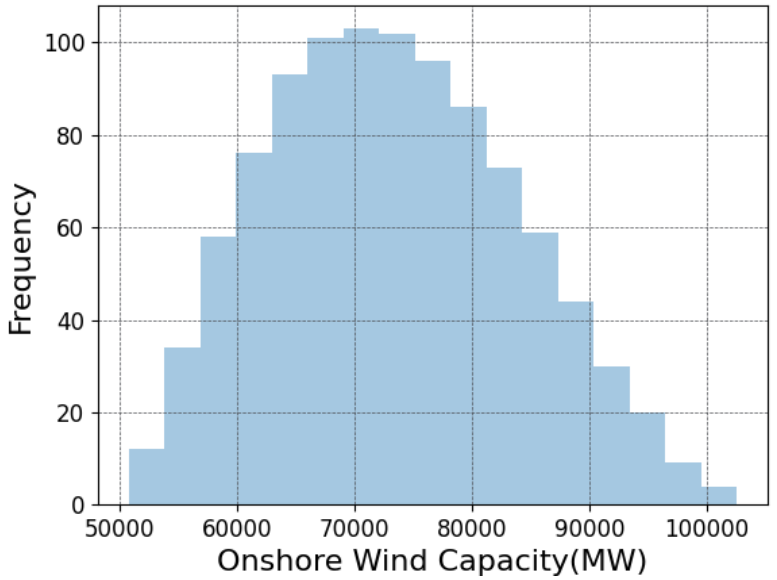




Monte Carlo Simulation Input Parameters





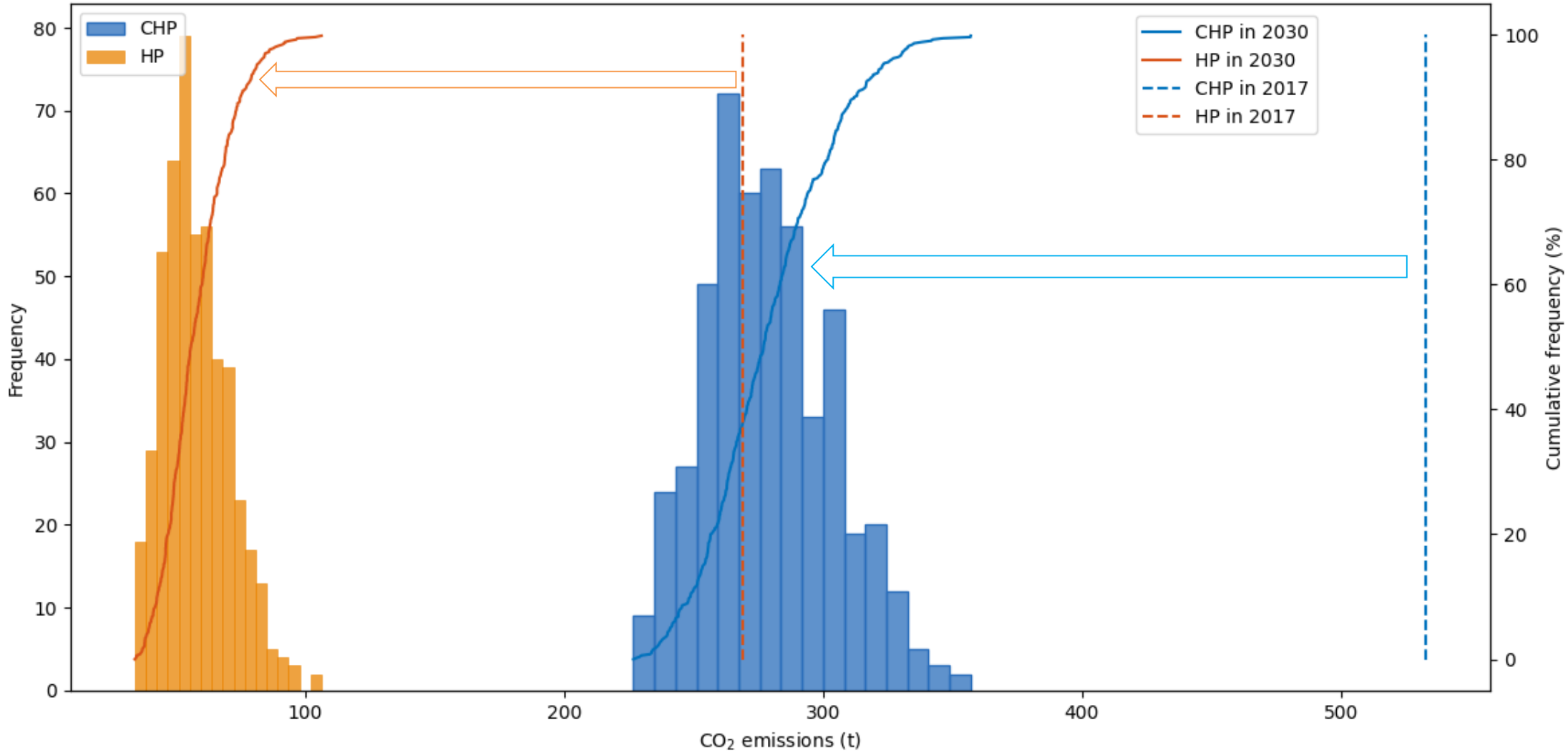


Installed PV Capacity
Lower bound: 42293 MW
Peak: 98000 MW
Upper bound: 200000 MW

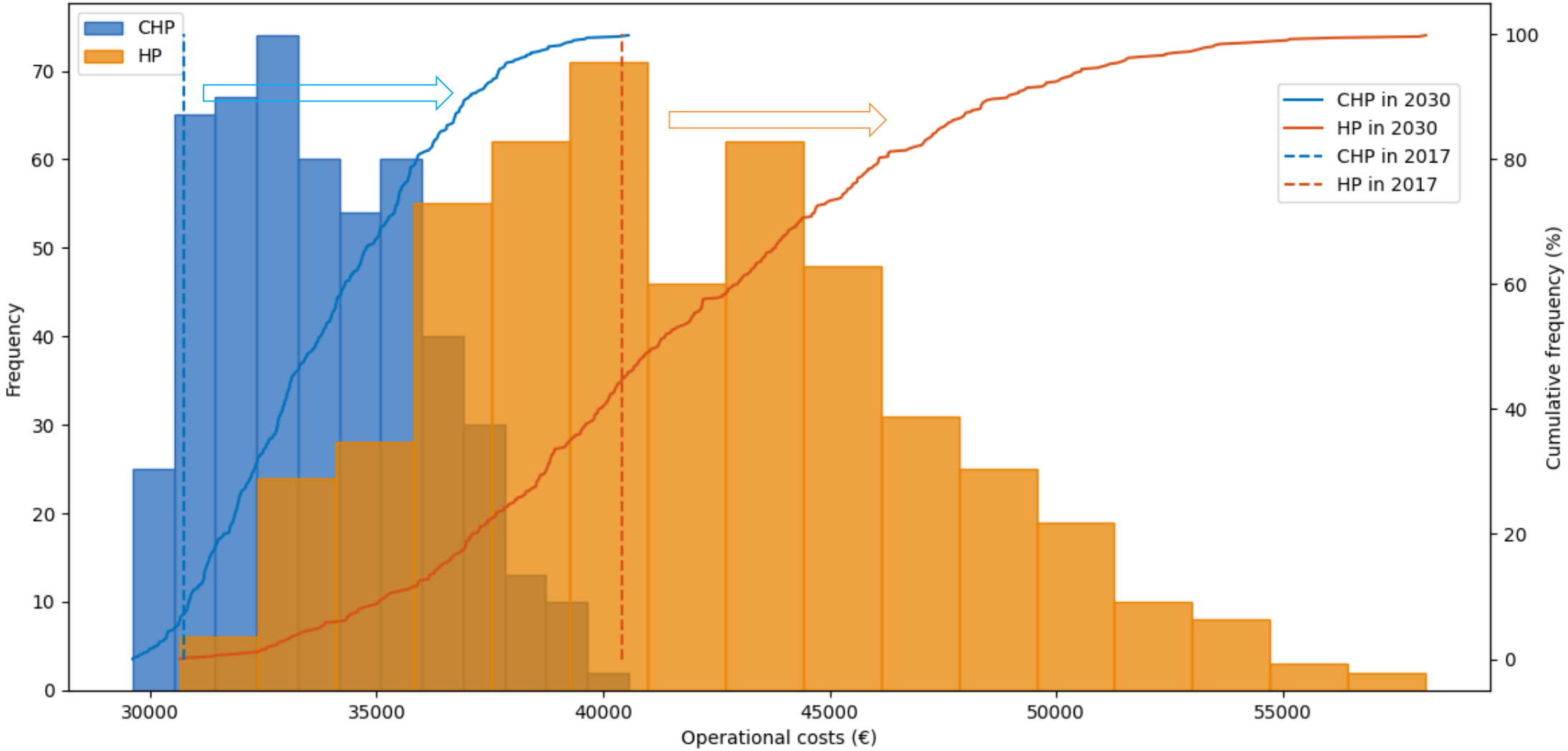
Installed Offshore Wind Capacity
Lower bound: 5427 MW
Peak: 20000 MW
Upper bound: 28000 MW

Installed Onshore Wind Capacity
Lower bound: 50292 MW
Peak: 71000 MW
Upper bound:106029 MW

Monte Carlo Simulations – CO_2 Emissions



Monte Carlo Simulations – Operational Costs



*Fossil fuel prices were assumed to be constant.

Conclusions

- The distributions of CO_2 emissions did not even overlap when comparing the CHP case and HP case.
- CO_2 emissions were higher in the CHP case.
- Lower operational costs were likely in the CHP system.
- Further investigation planned: A more sophisticated model of the future German grid
  - Energy storage, energy demand, electricity export and import, transportation losses

Thank you for your attention!

Contact info: elif.turhan@dlr.de

Backup

Typical operation of CHP and HP