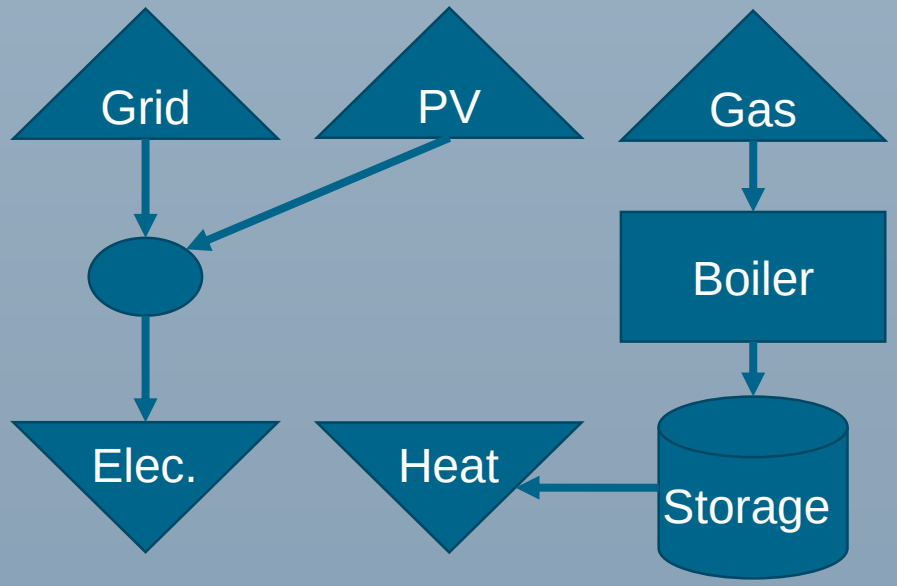
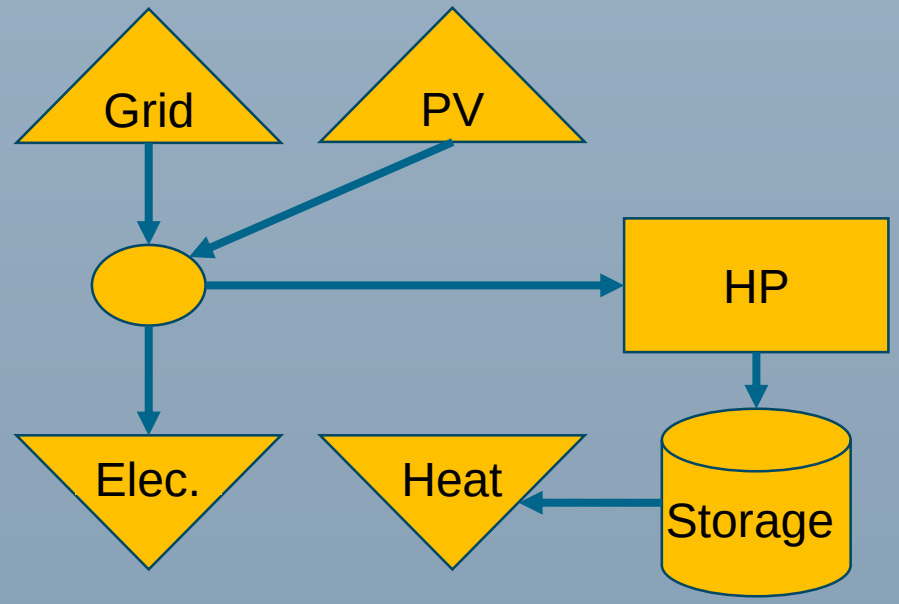
CONSIDERING UNCERTAINTY IN ENERGY SYSTEM OPTIMISATION

Patrik Schönfeldt, Carlos Munoz, Elif Turhan

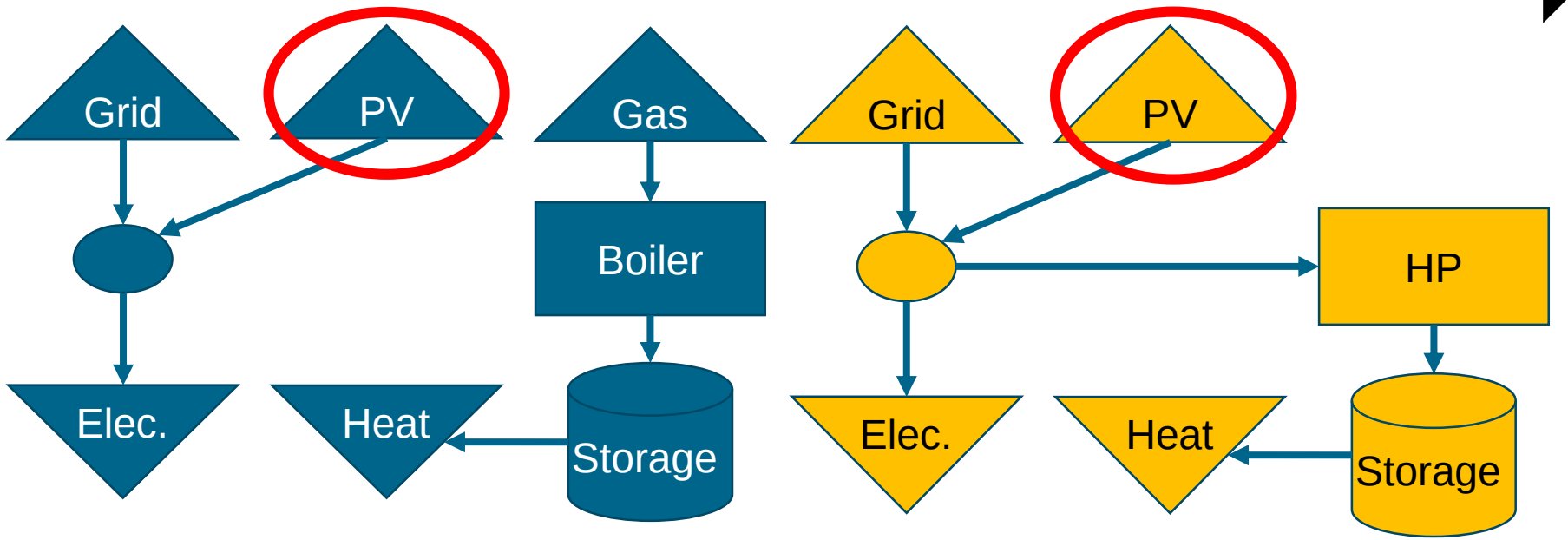


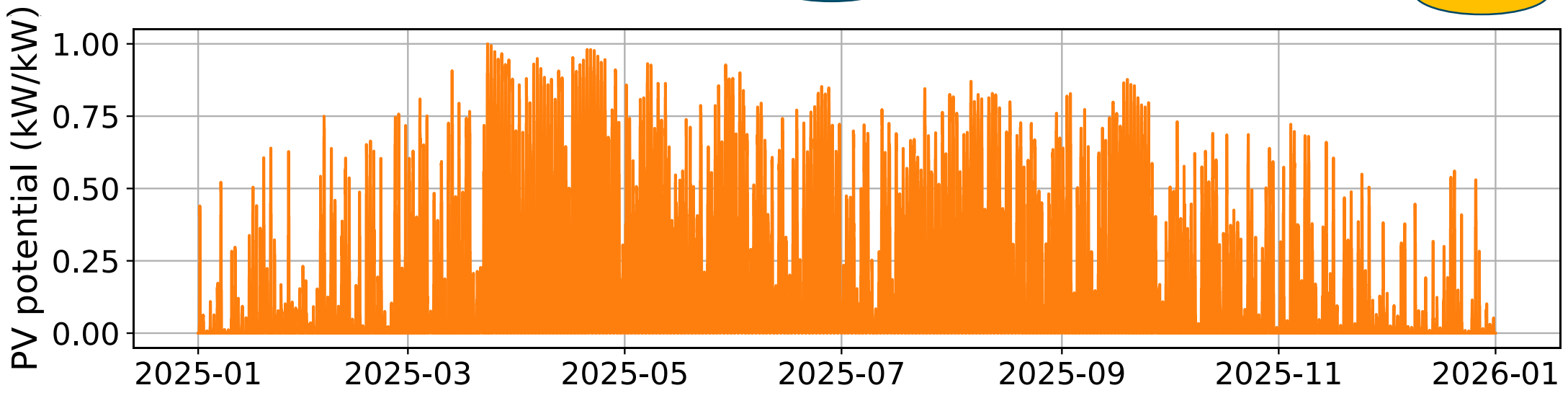


LOW NUMBER OF SCENARIOS

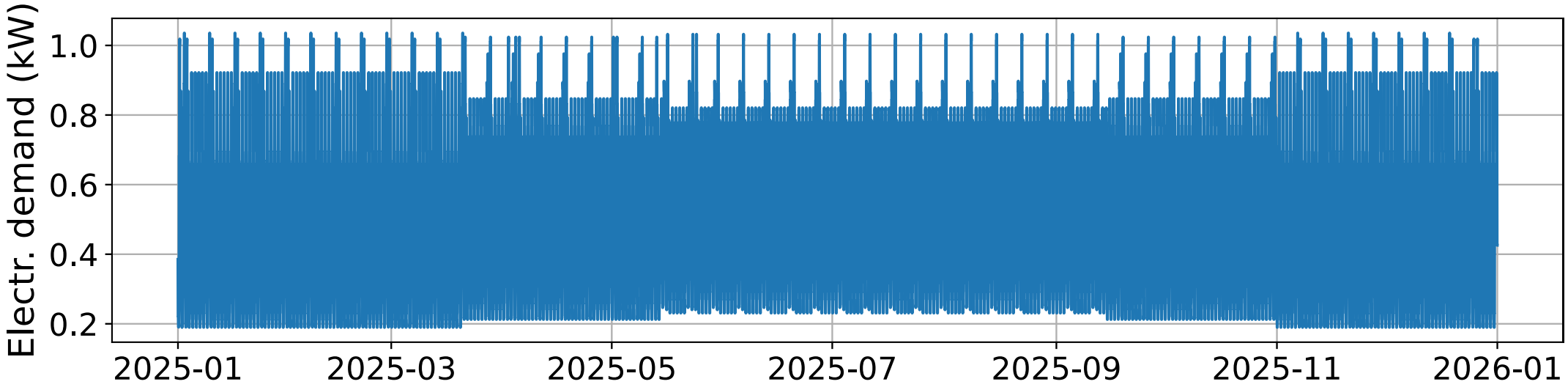
Energy System Topologies

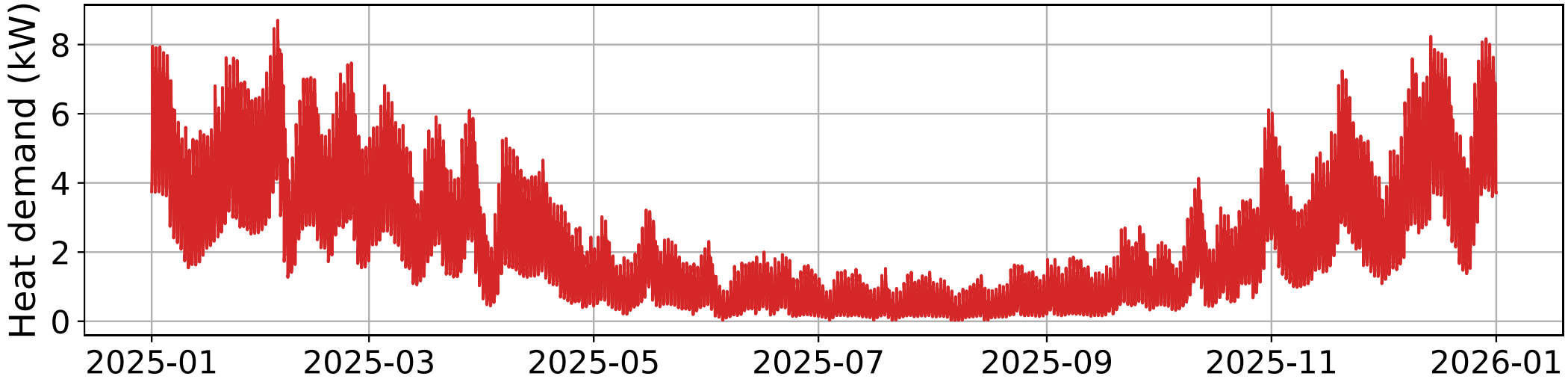
- Optimize size of PV panels
- Heating technology undecided, yet
- Gas: 10.2 ct/kWh
- Electricity
  - 33.5 ct/kWh
  - No feed-in



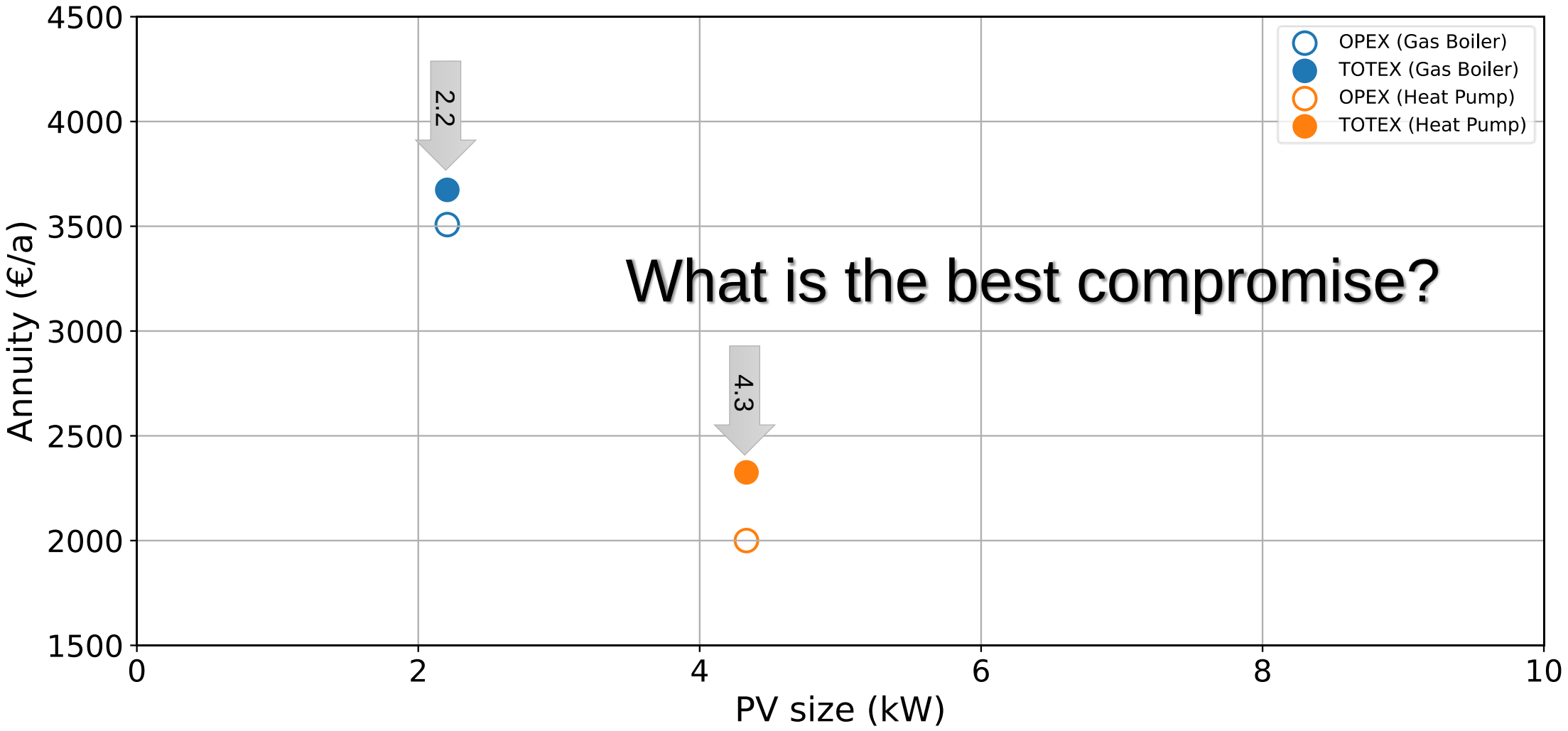


Demand Data (SLP from demandlib)

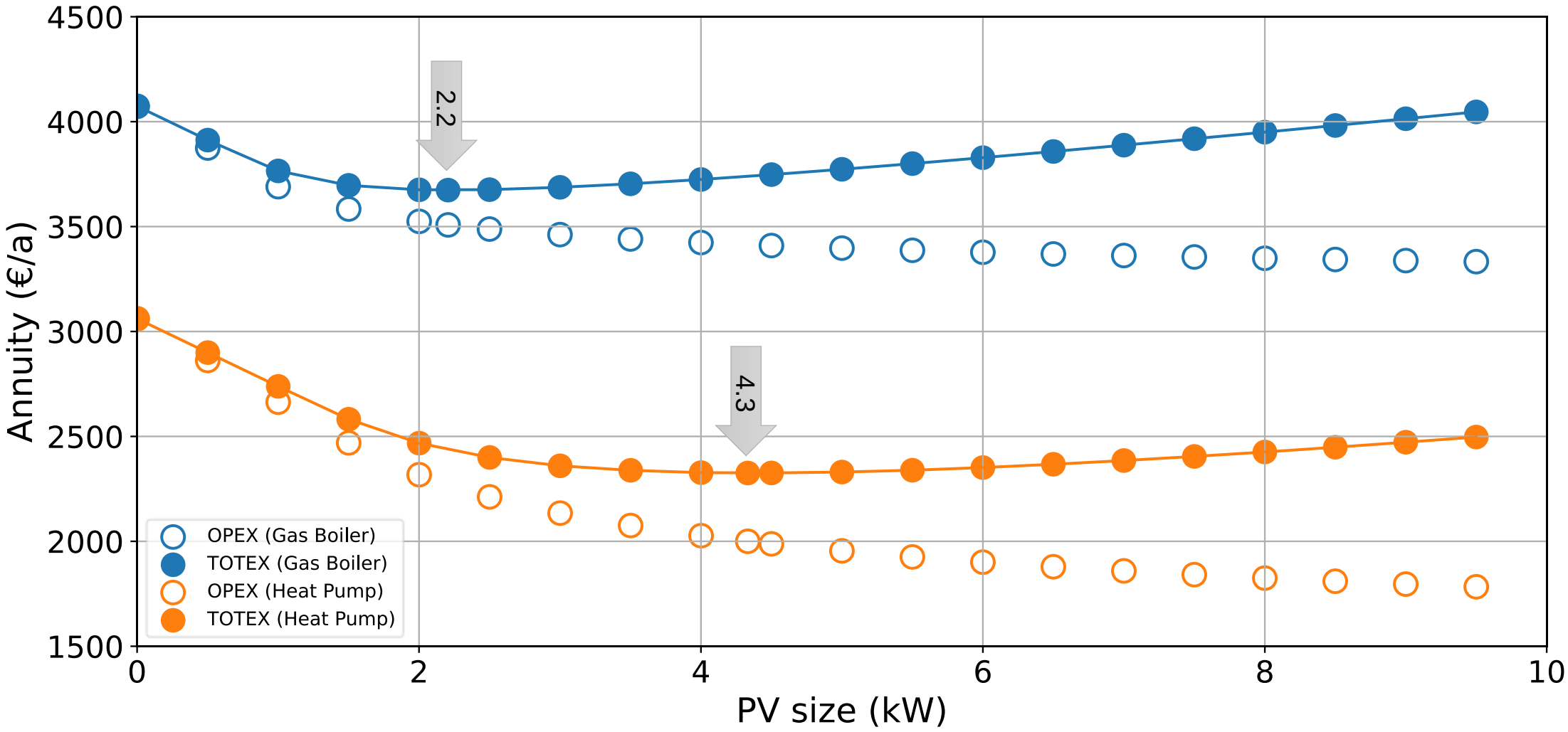




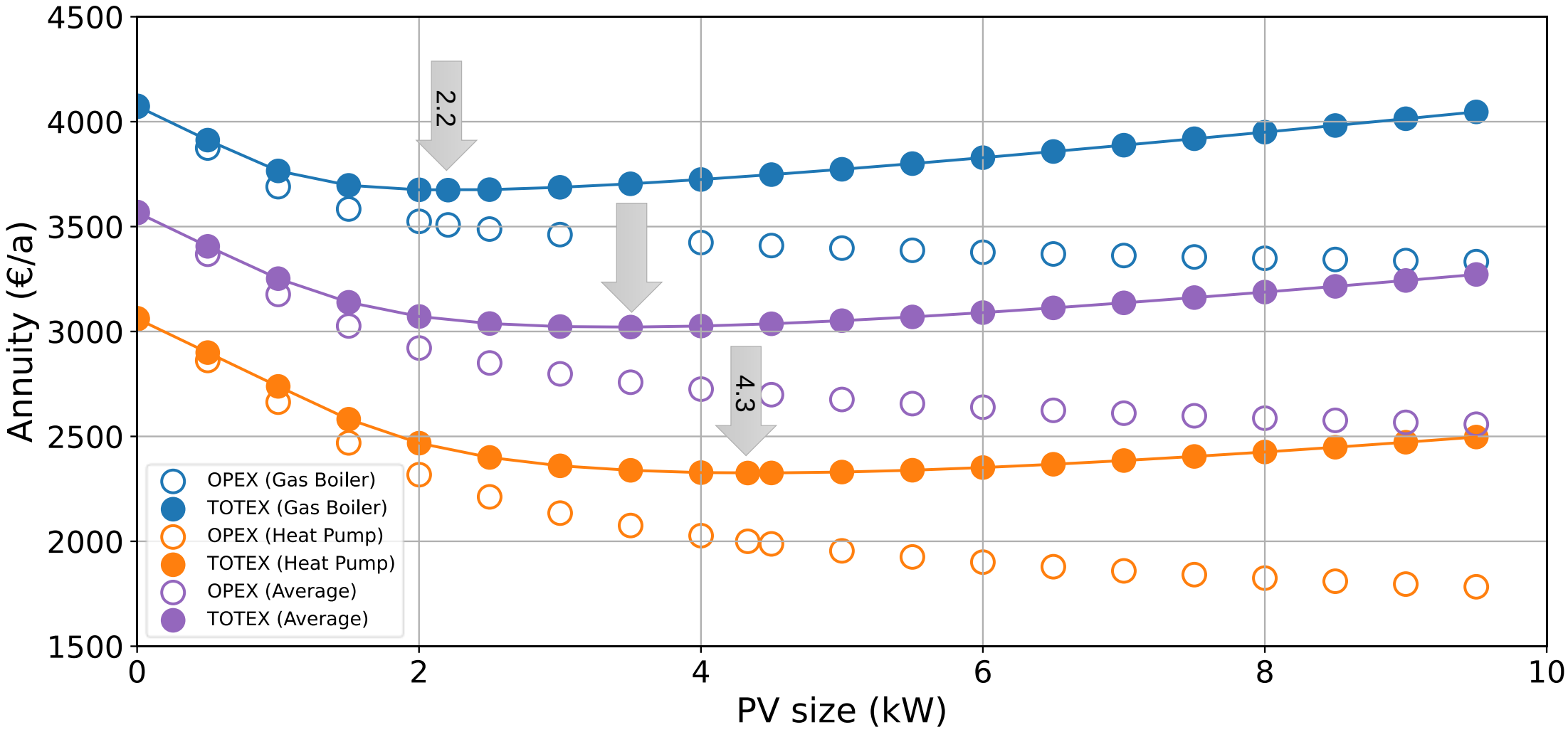
Results of Independent PV Size Optimisation



Results of PV Size Scan

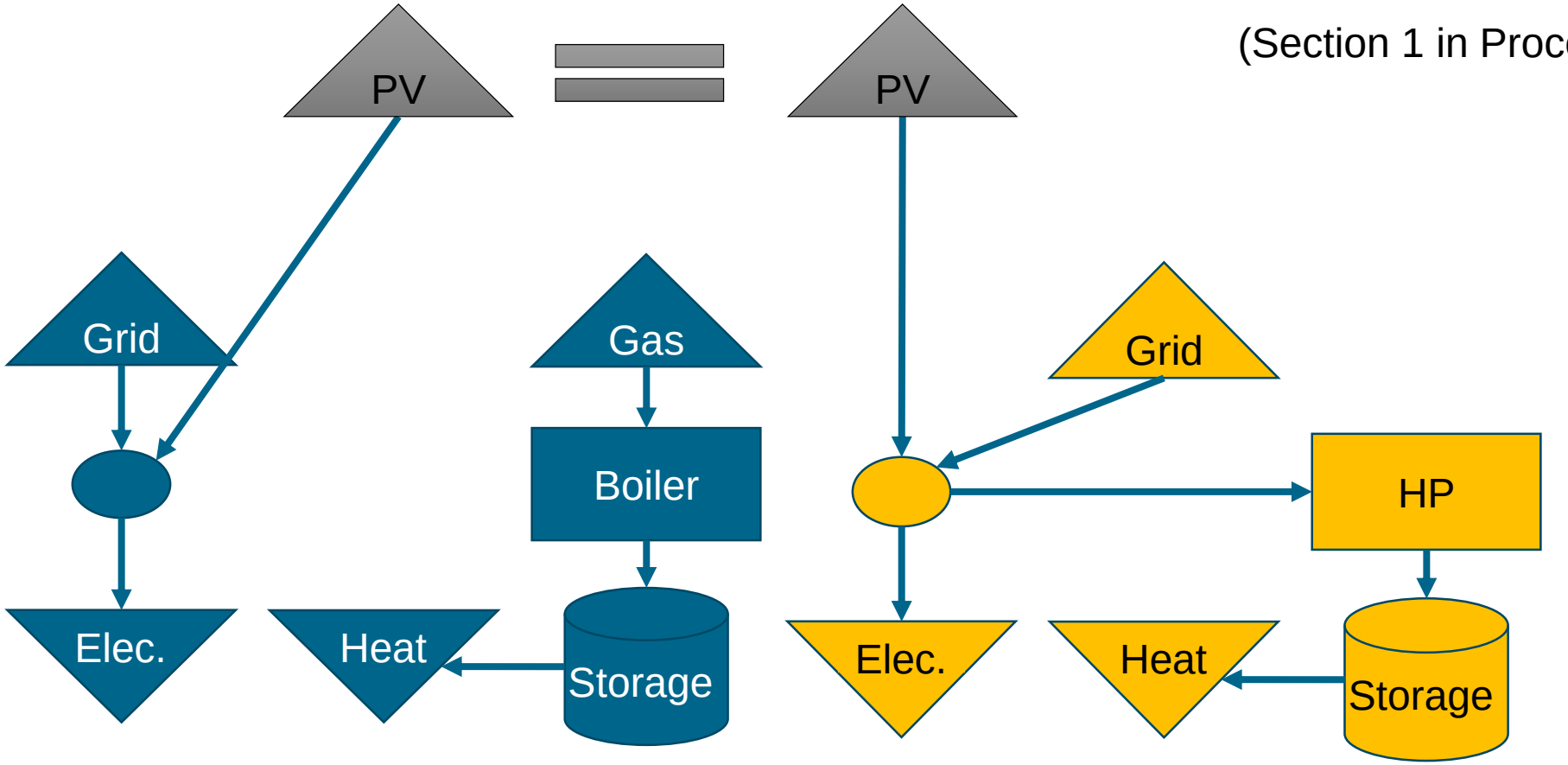


Results of PV Size Scan

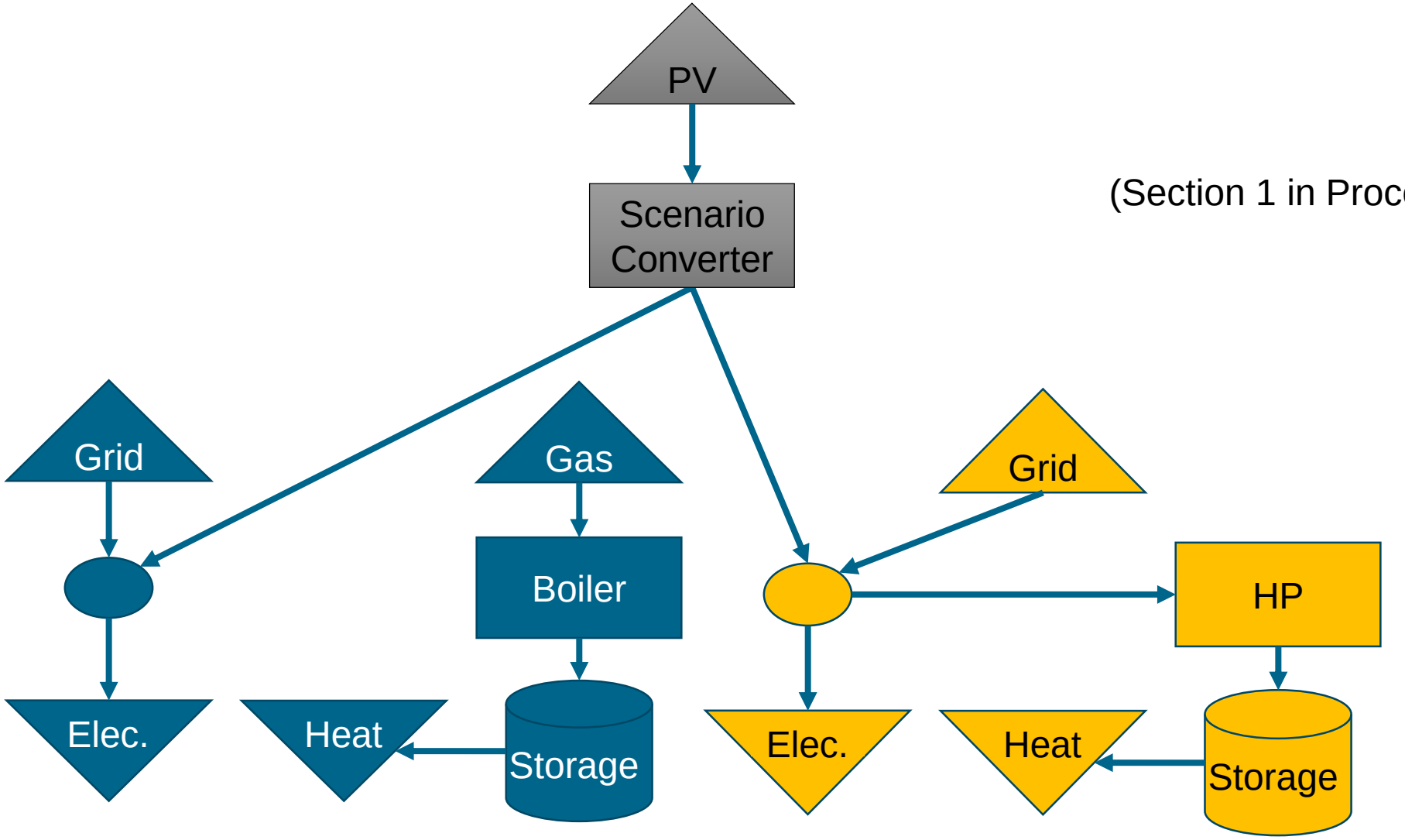


Global Energy System Optimisation

(Section 1 in Proceedings)

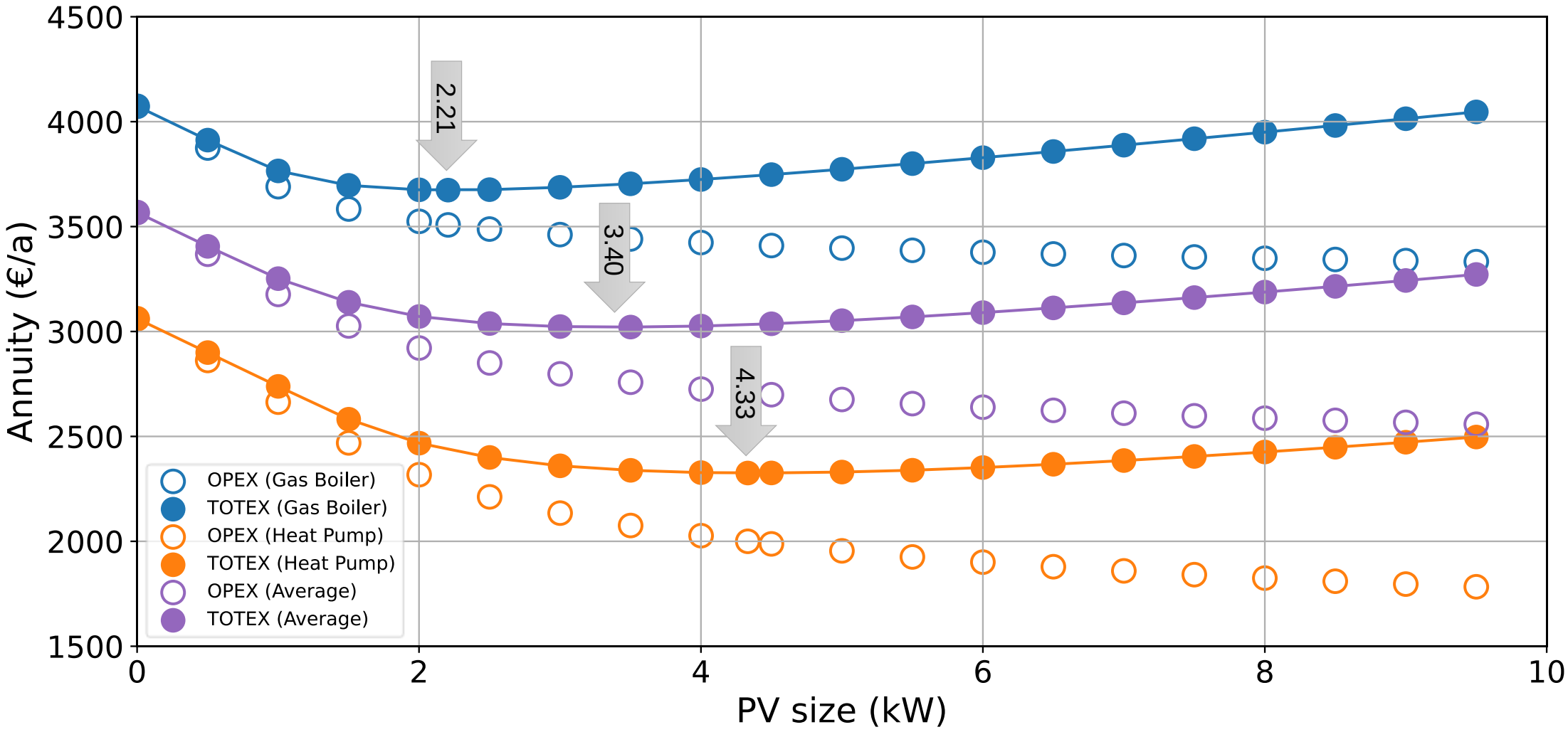


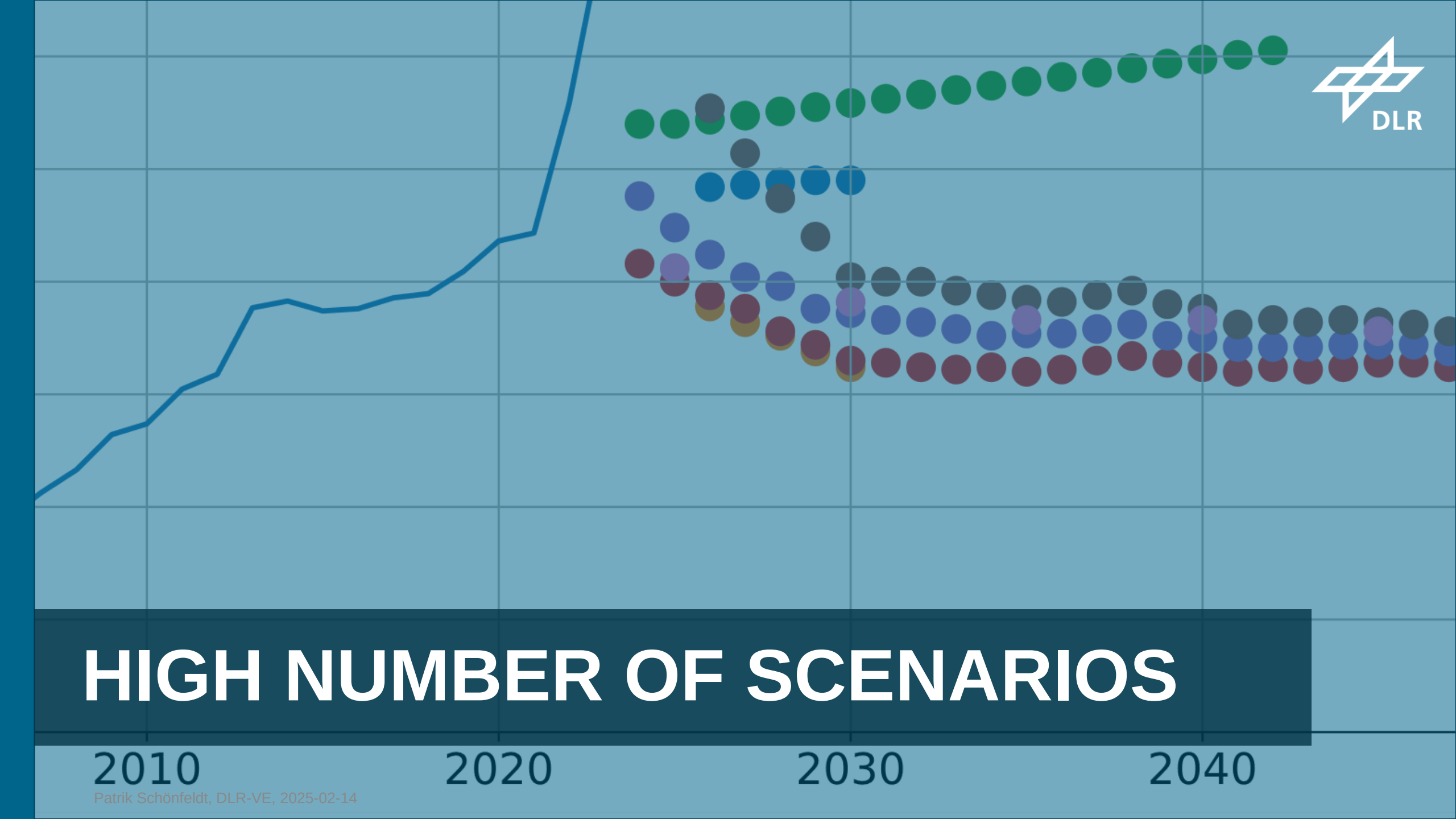
Global Energy System Optimisation



(Section 1 in Proceedings)

Results of PV Size Scan





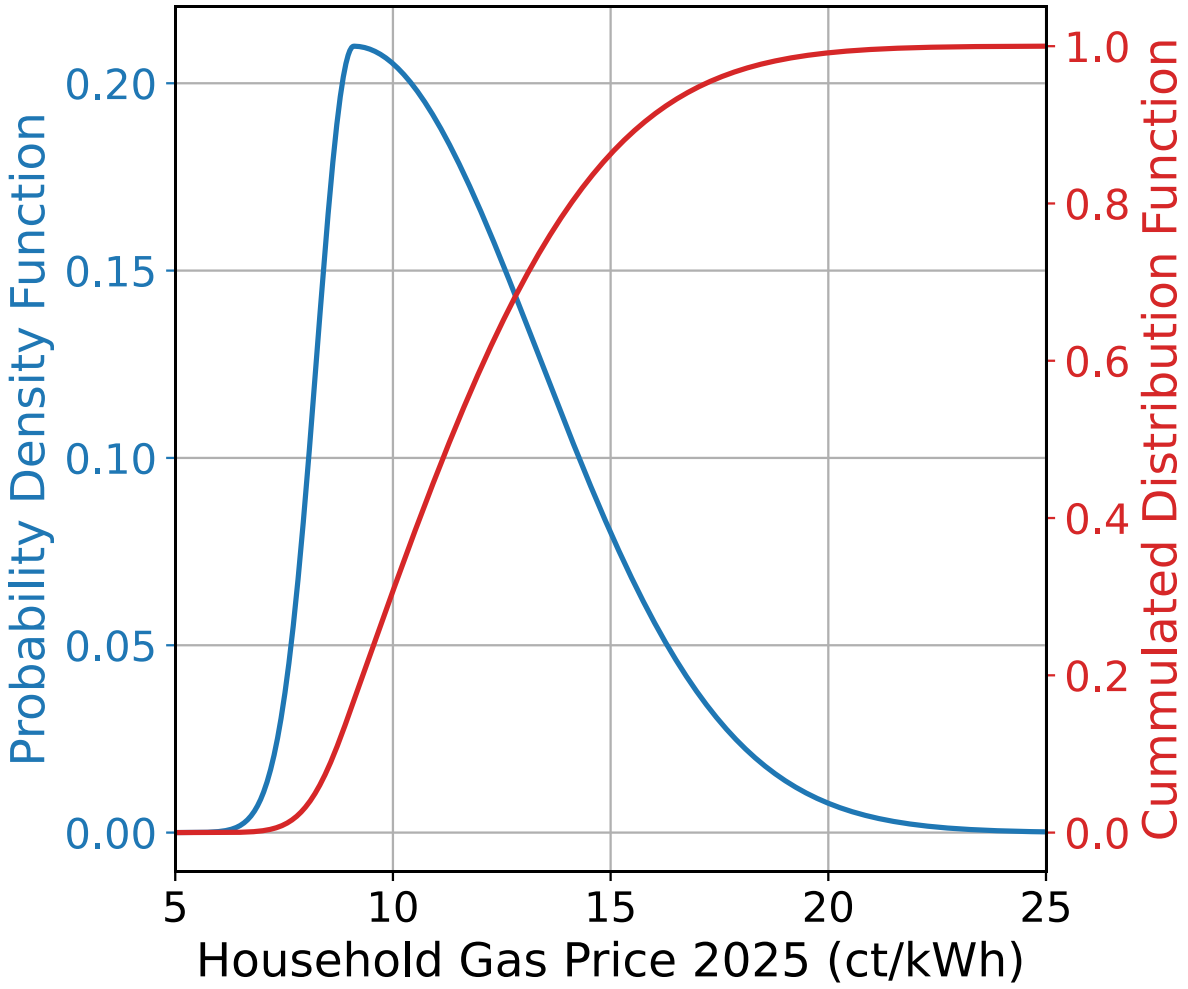
HIGH NUMBER OF SCENARIOS

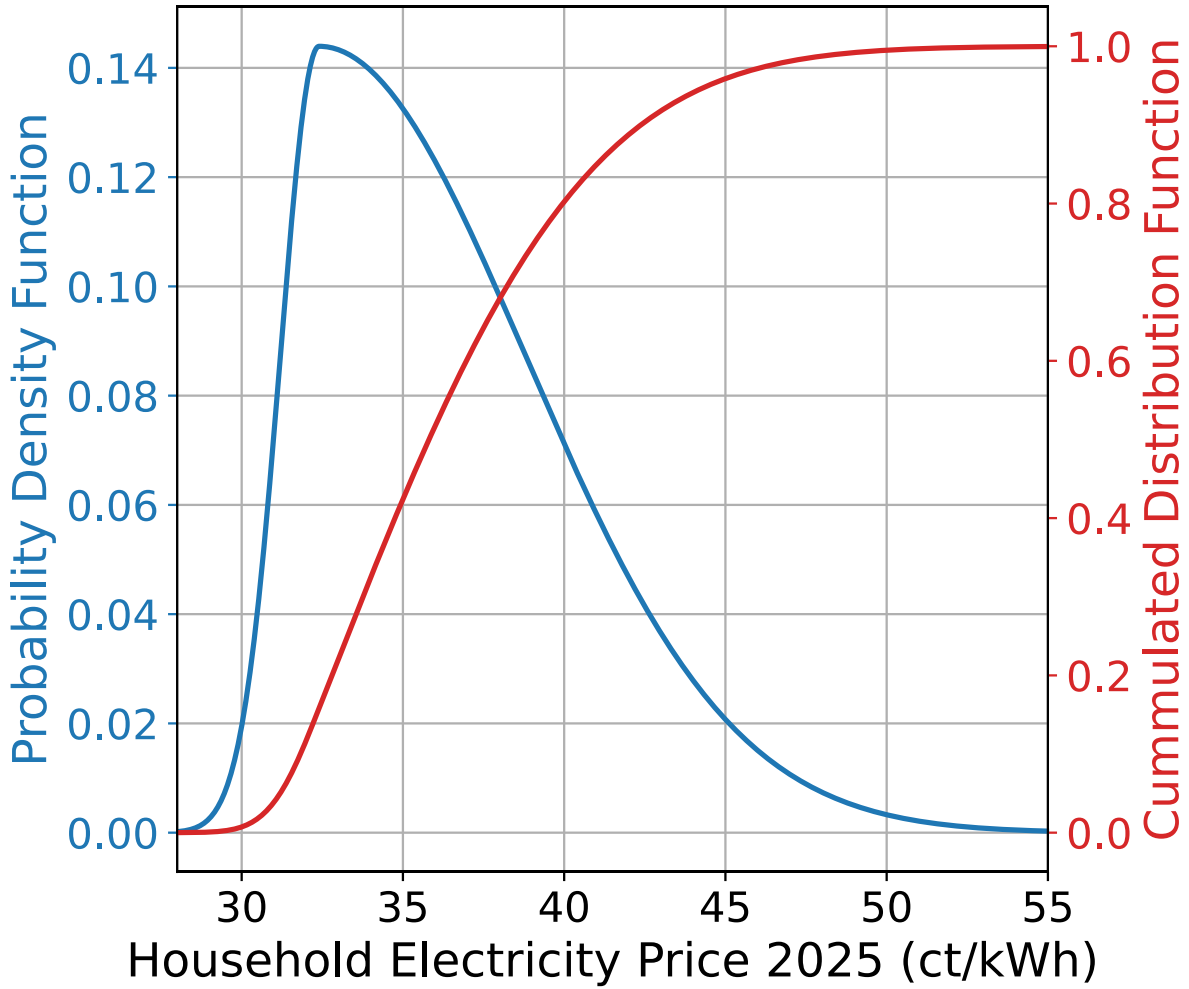
Why Monte-Carlo

- Global (stochastic) optimisation fast for low number of scenarios
- Number of scenarios grows polynomial with number of uncertain parameters
- Complexity of global optimisation grows exponential
- Complexity of parameter scan just grows linear
- For two or more dimensions (parameters), Monte-Carlo more robust than stepping scan

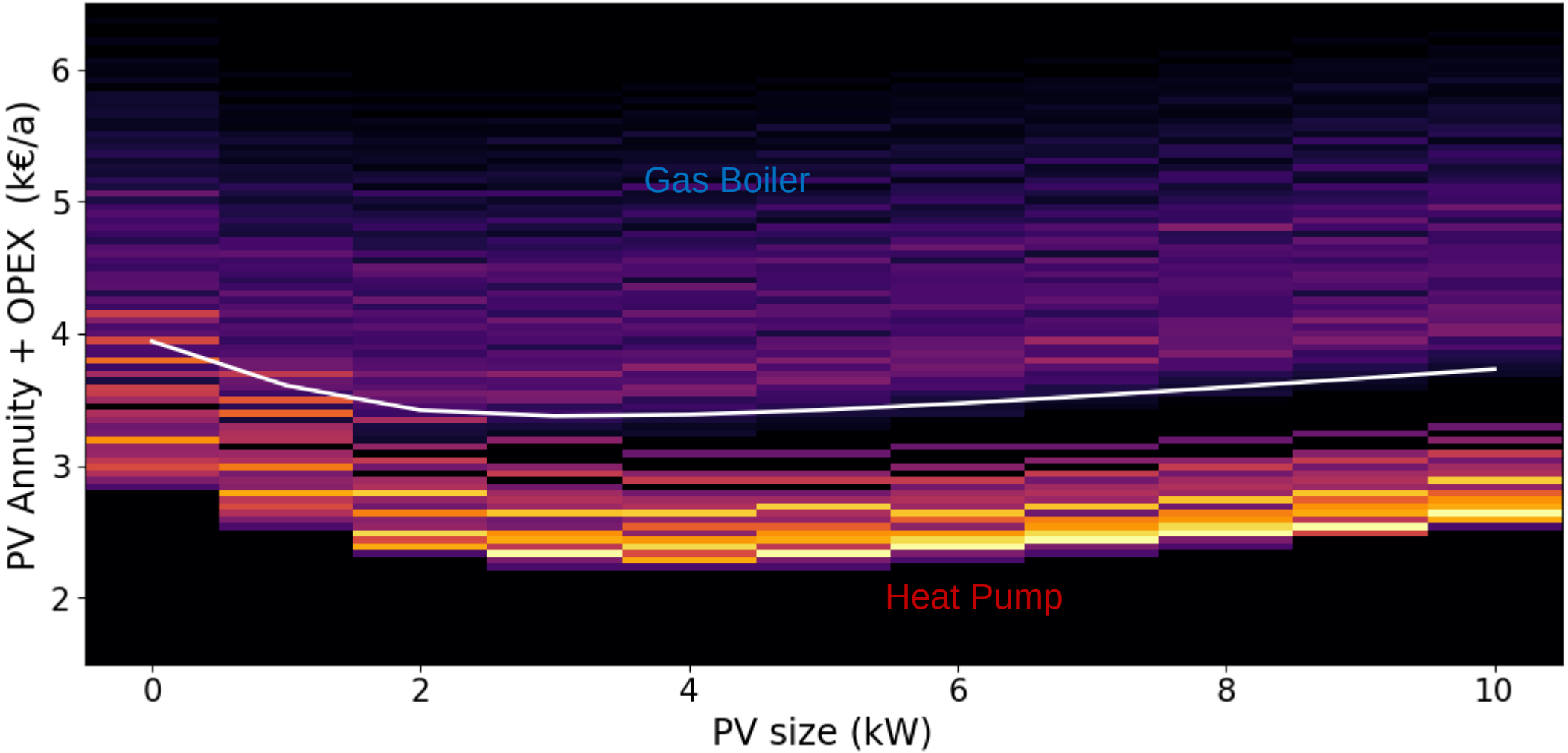
Energy Price Probabilities

based on VBW Strompreisprognose 2023 (high, mid, low)



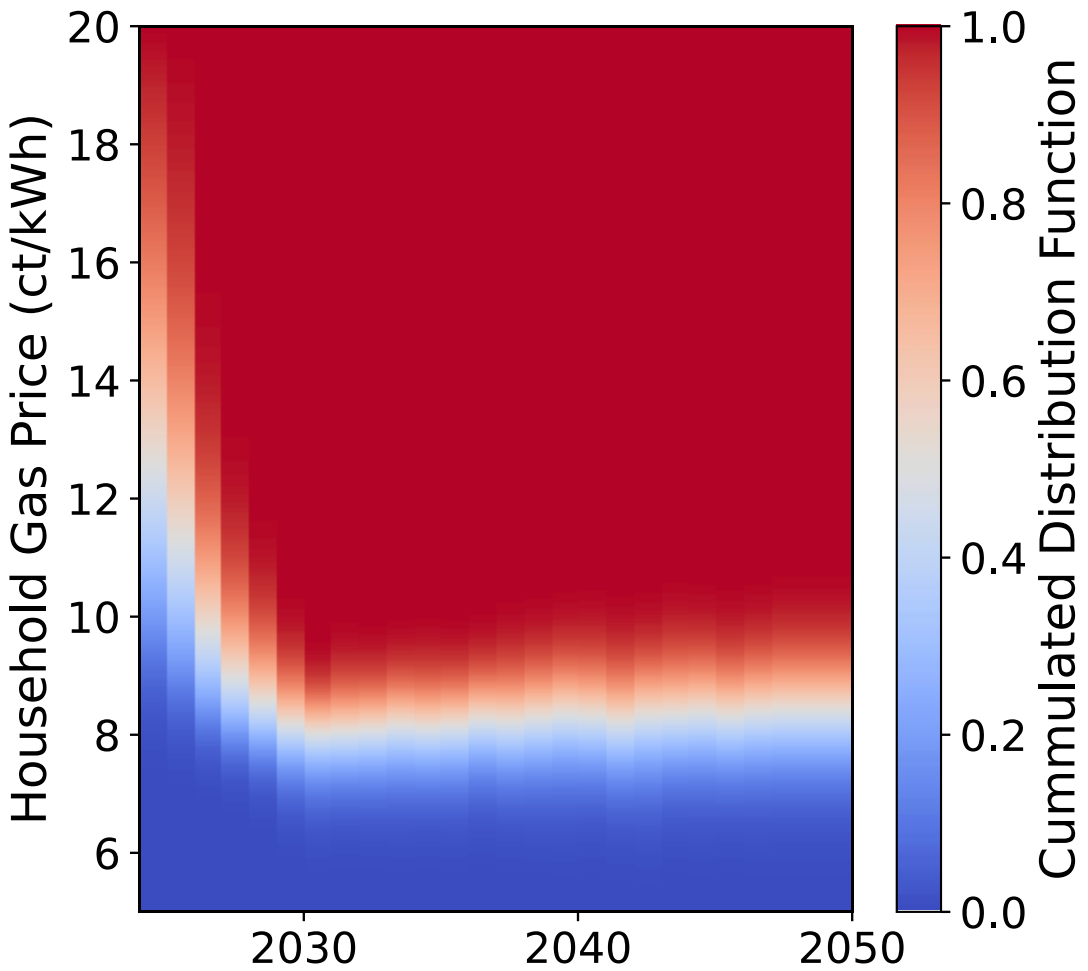


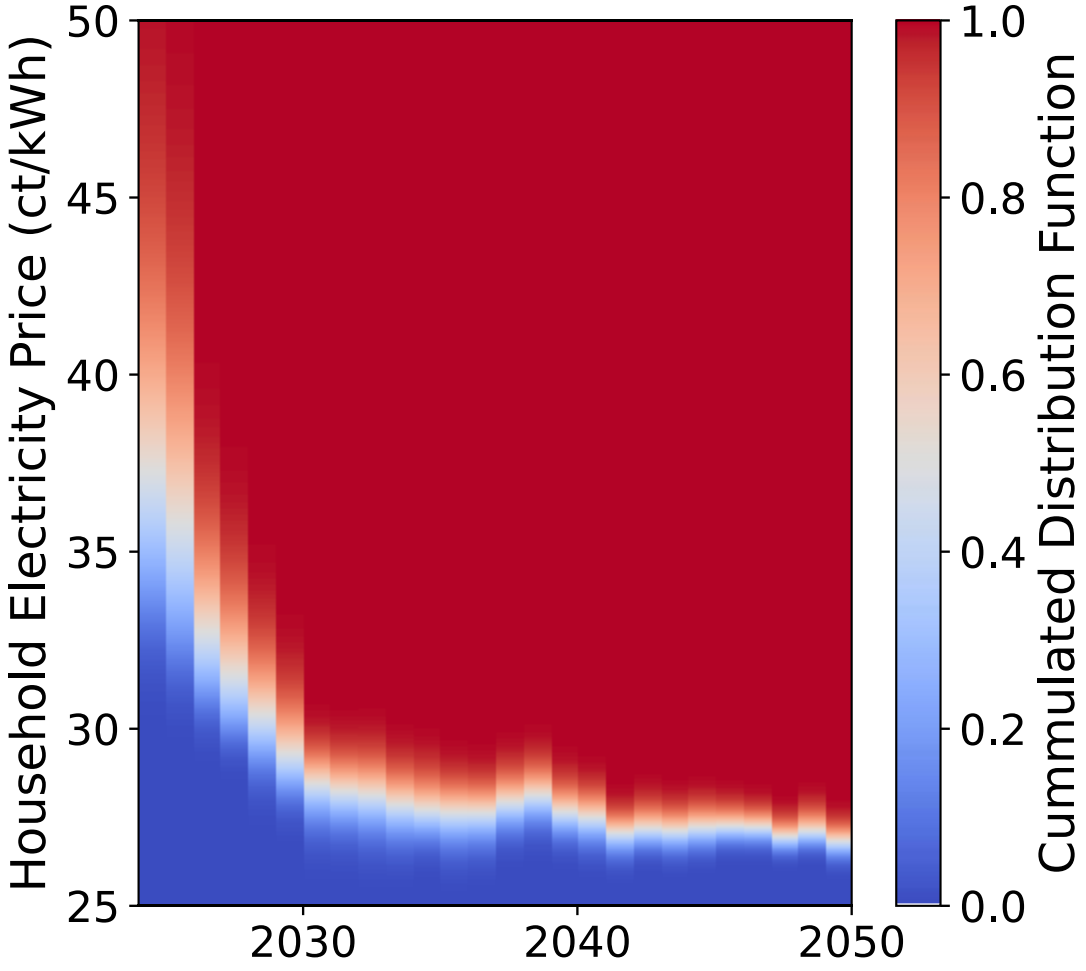
Costs of 2025 Scenarios



Energy Price Development Probability

based on VBW Strompreisprognose 2023 (high, mid, low)

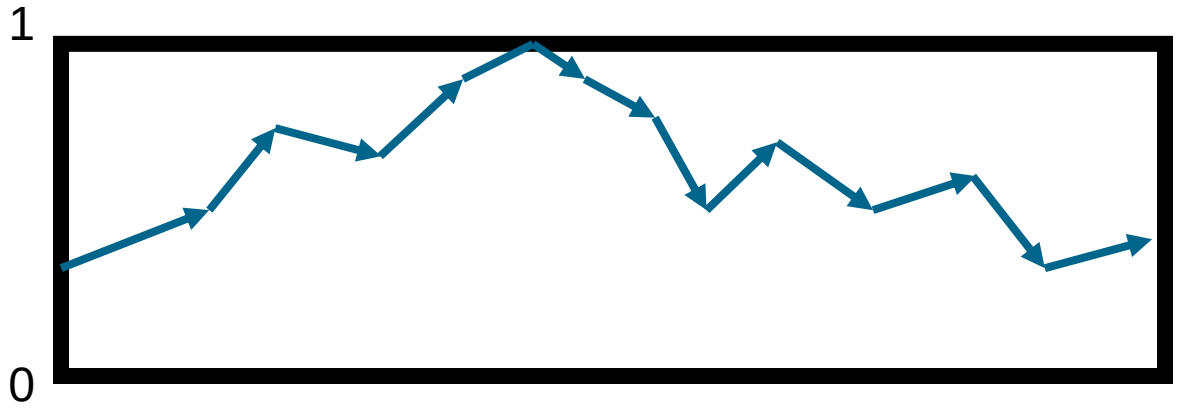


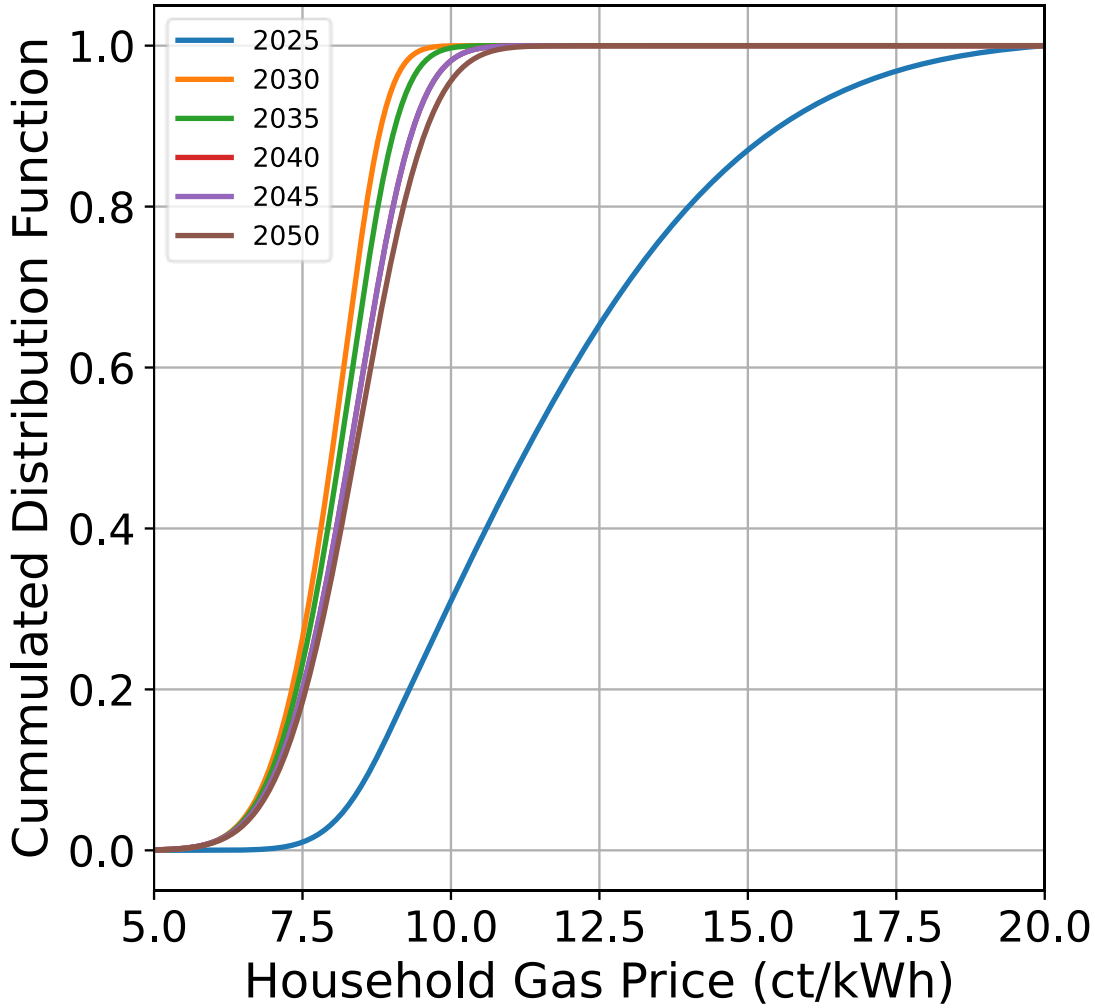


Scenario Generation using Markov Chain

(Section 2 in Proceedings)

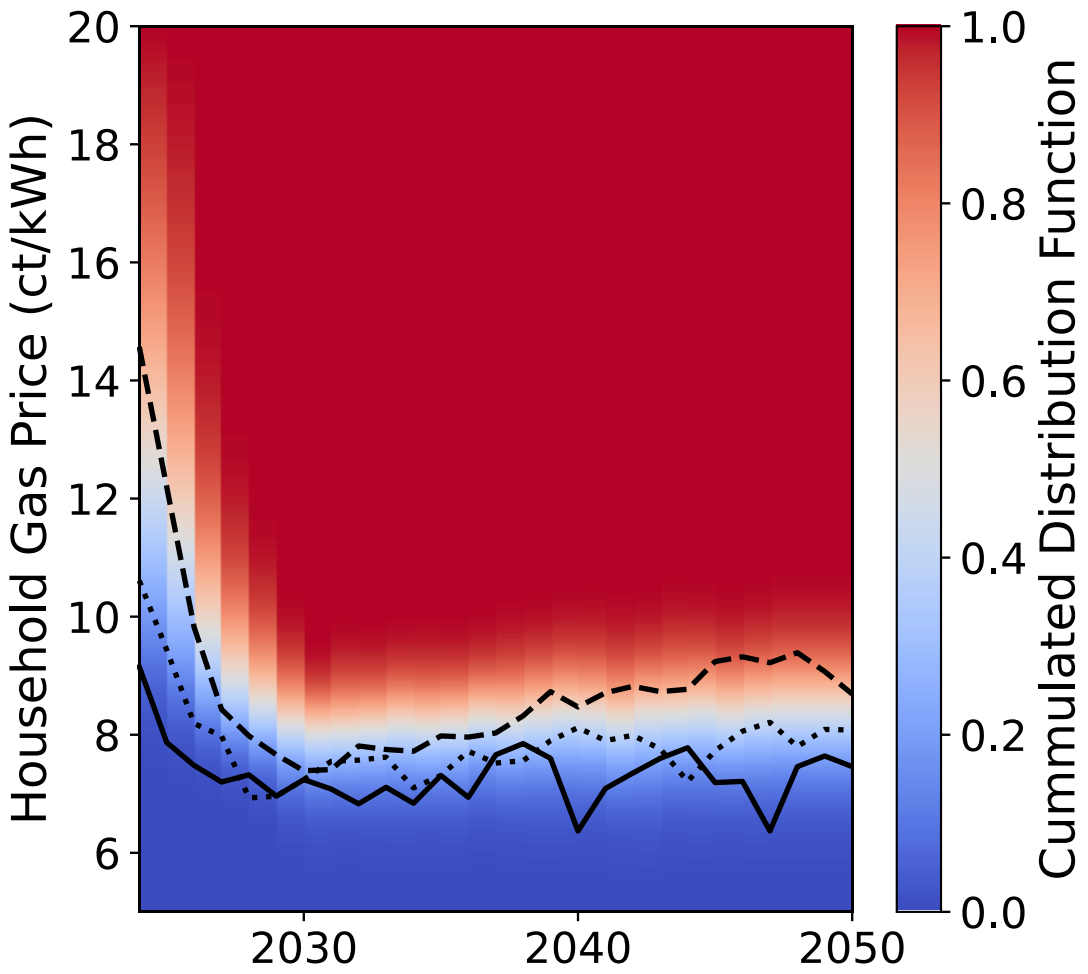
- Step probability expressed in “percentile change”
- Constrained random walk in “percentile space” [0:1]
- Map to prices in €/kWh using the CDF

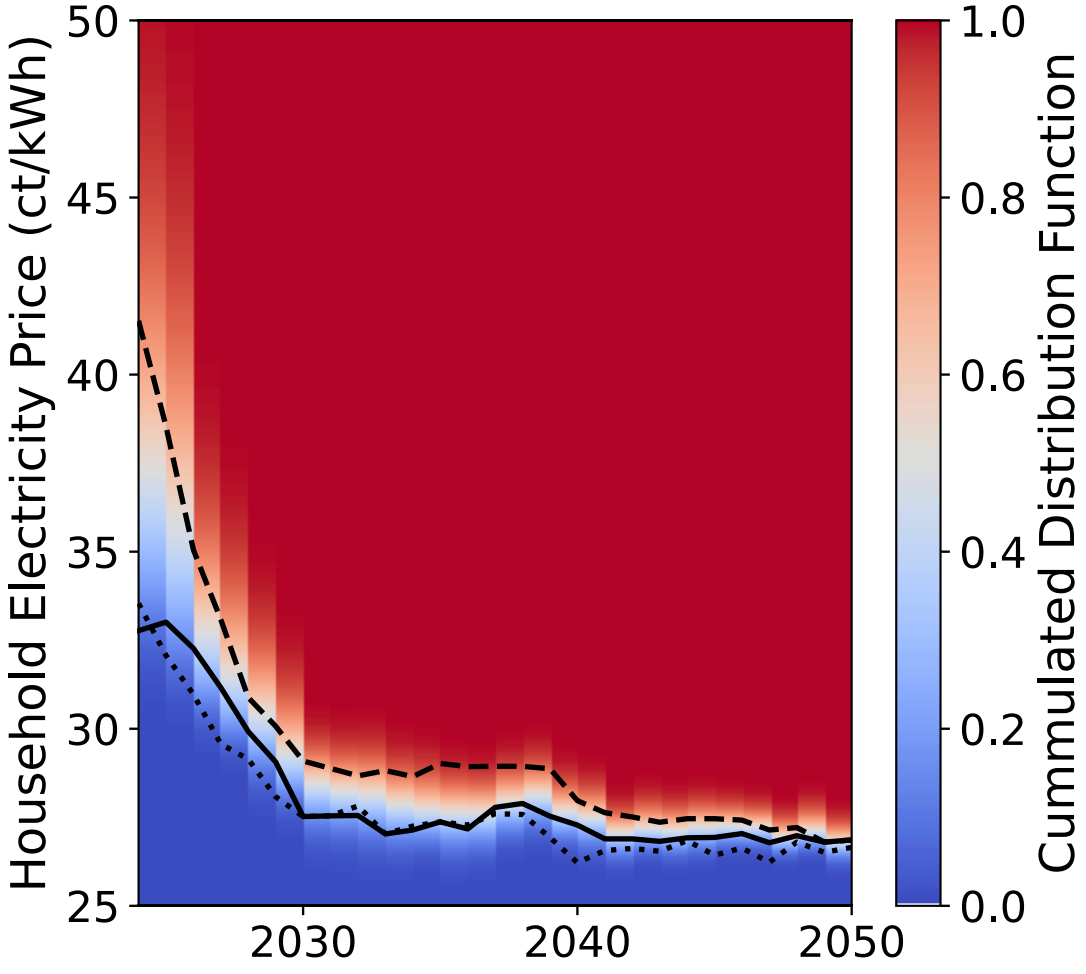




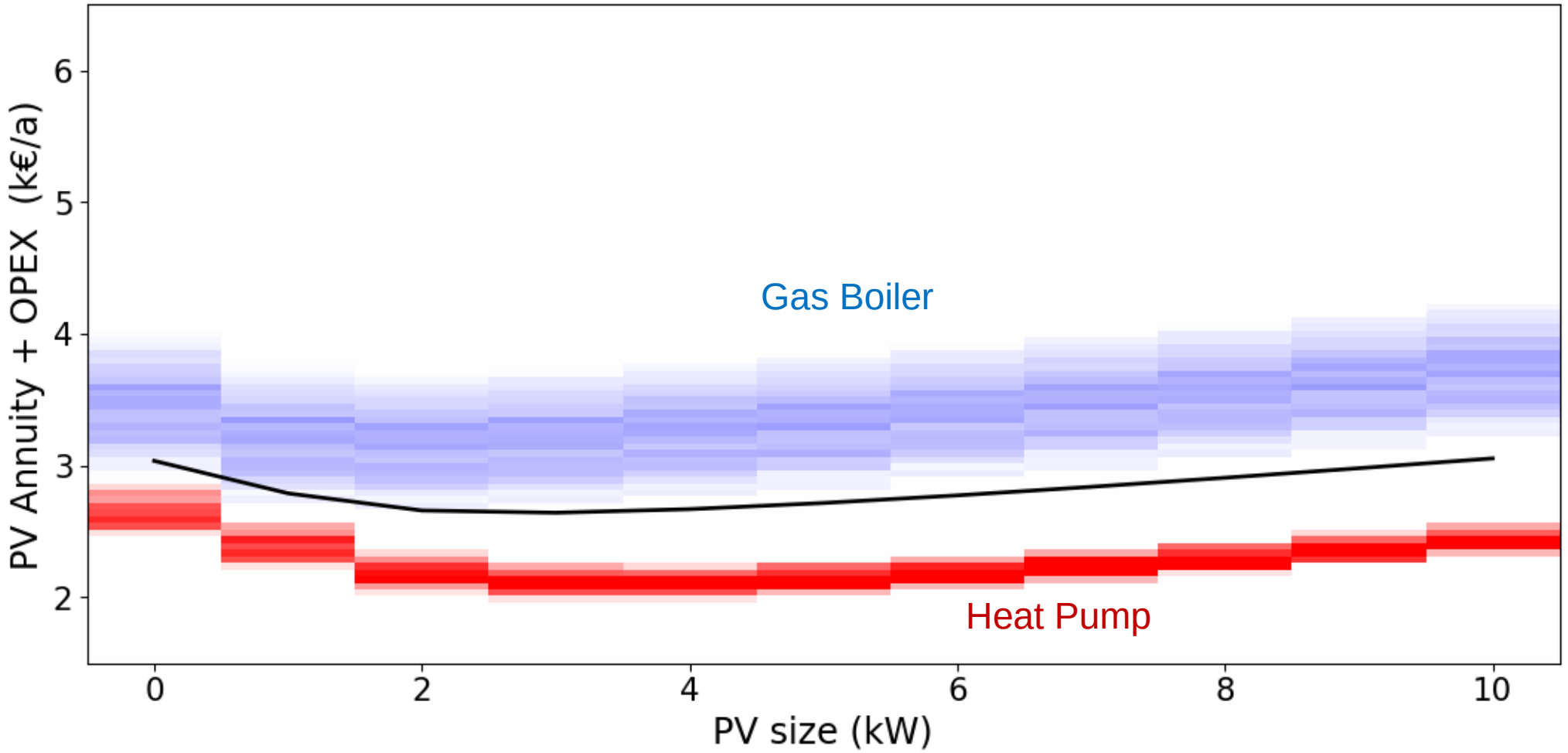
Energy Price Scenarios

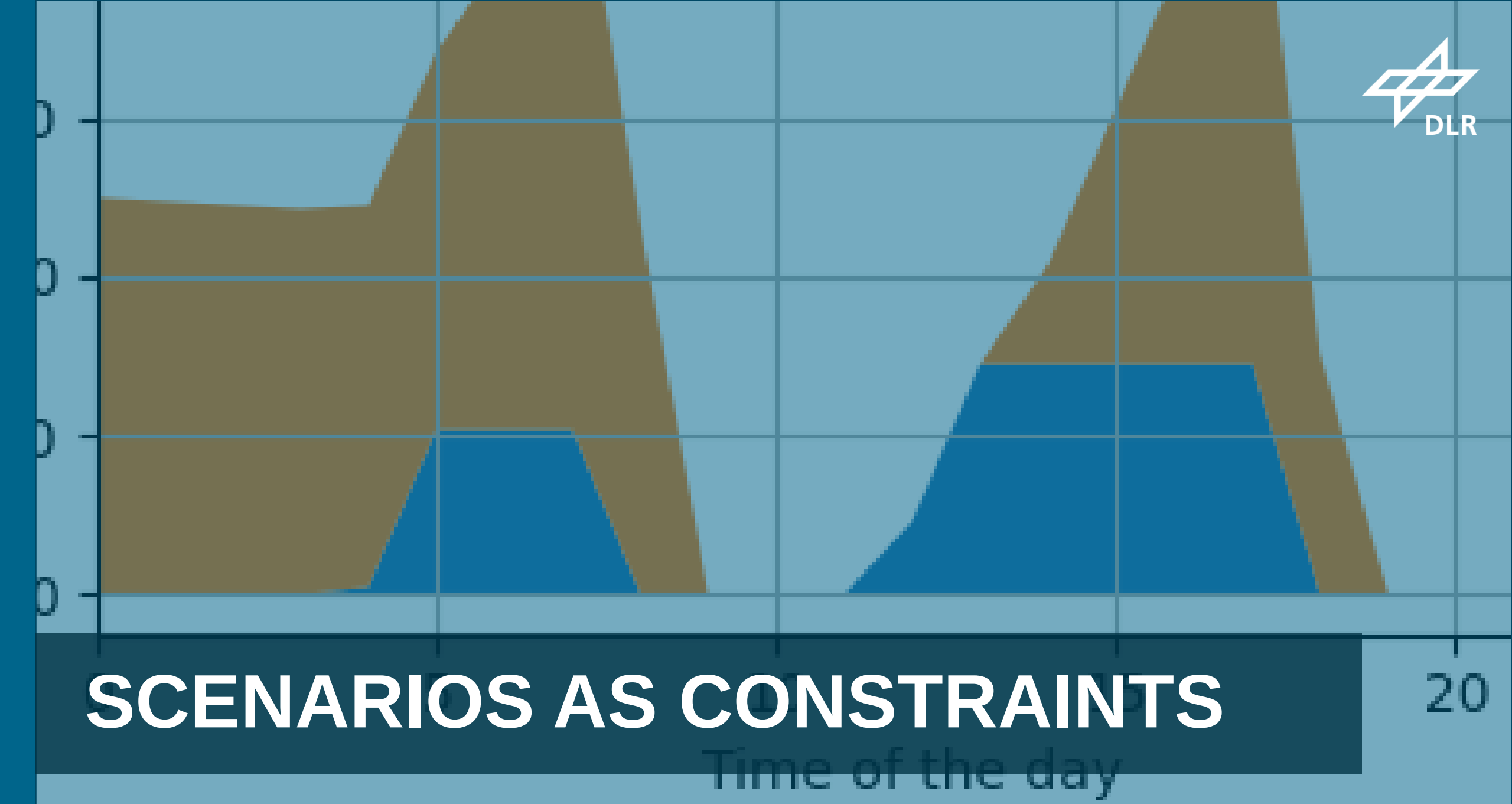
(Section 2 in Proceedings)





Average Costs in Long-Term Scenarios





SCENARIOS AS CONSTRAINTS

Participation in Flexibility Market

- Battery storage to store energy
- Optionally charged externally (flexibility market)

- Decision: Guaranteed storage or offer flexibility (probably no charging)

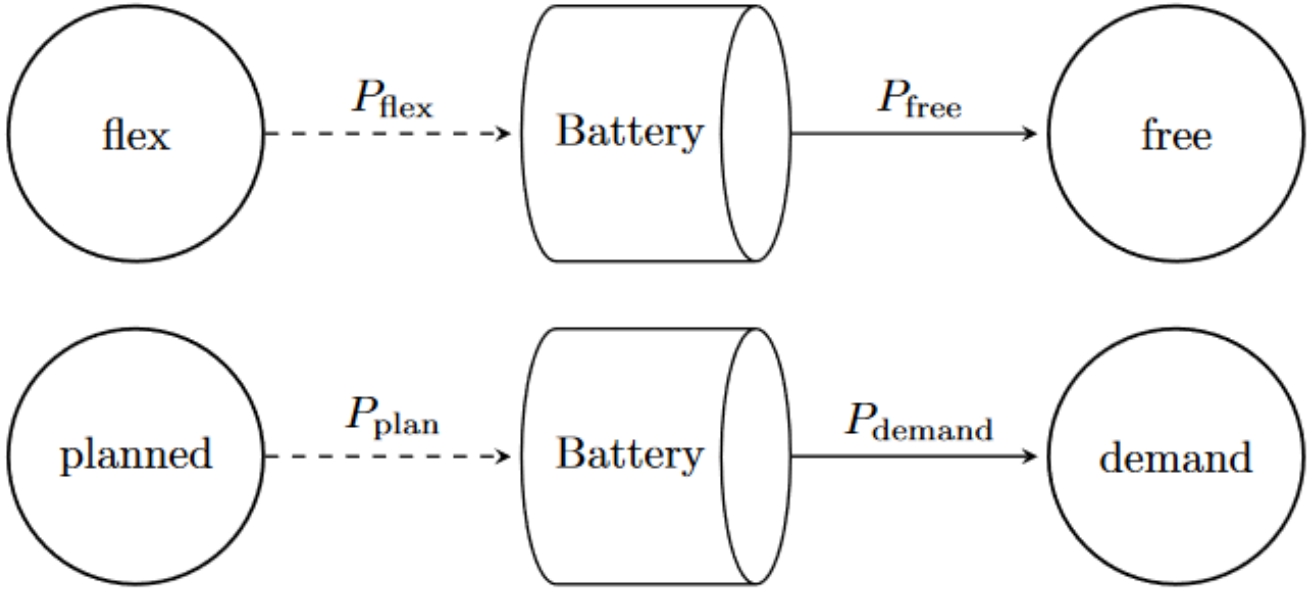
- Problem: Optimiser must not know in advance

- Would potentially not charge because flexibility is used

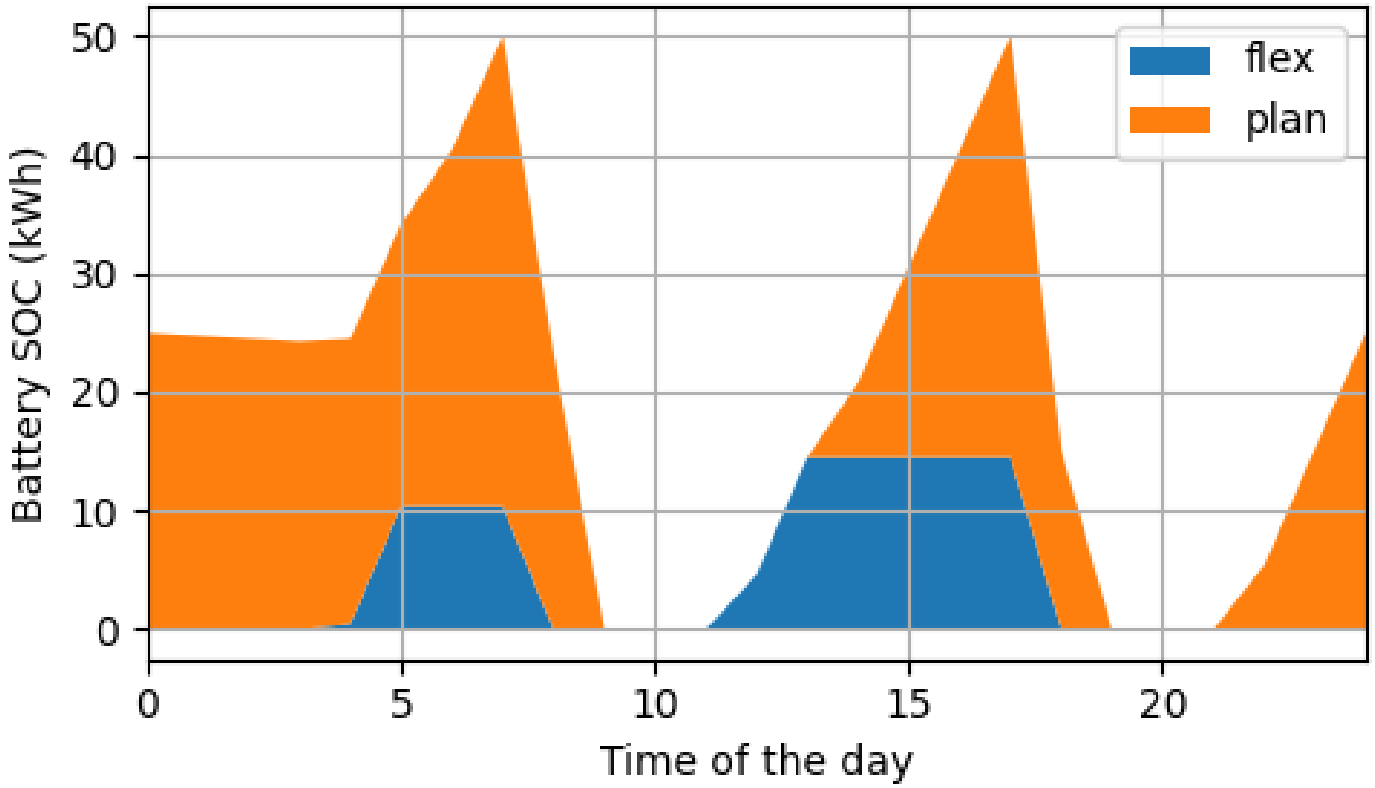
(Section 3 in Proceedings)

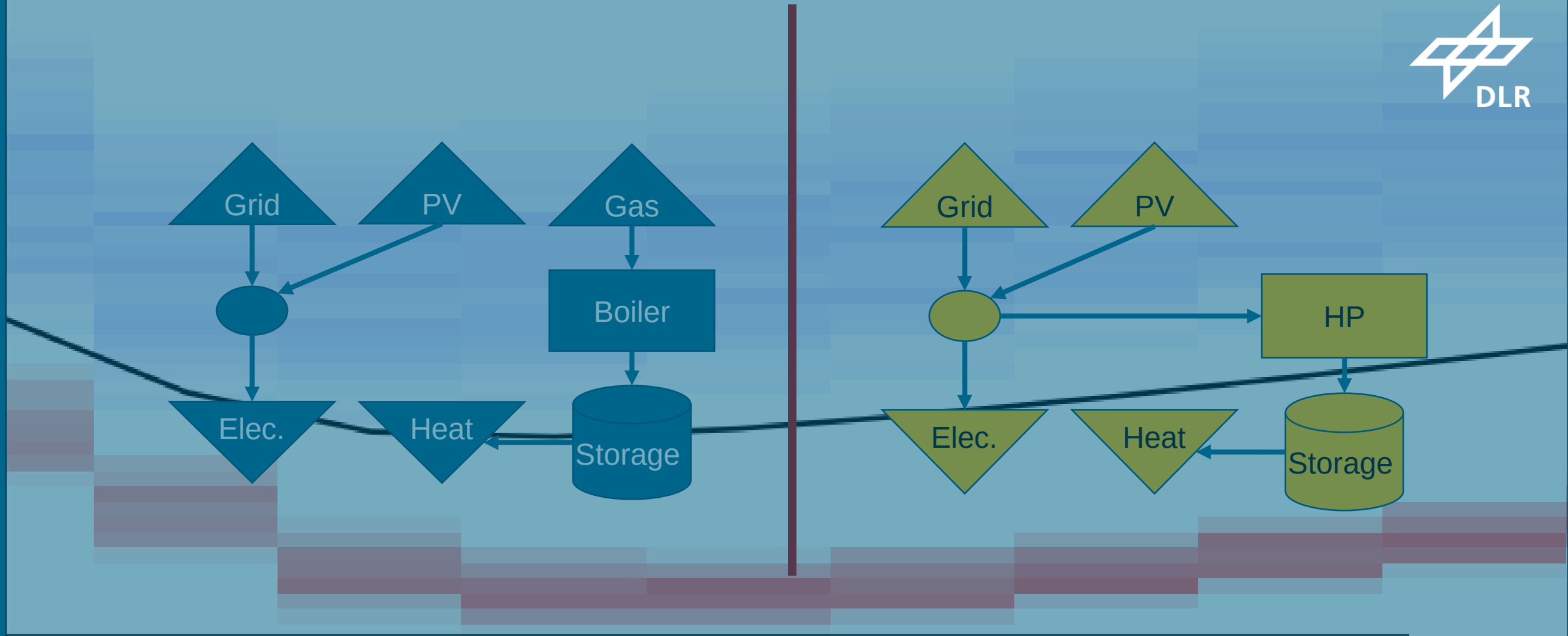
Flexibility Optimisation Model

- Two copies of the Battery
- Shared capacity
- Unload “flex battery” only when there is demand



Flexibility Optimisation Results




Grid
PV
Gas
Boiler
Elec.
Heat
Storage
Grid
PV
HP
Elec.
Heat
Storage

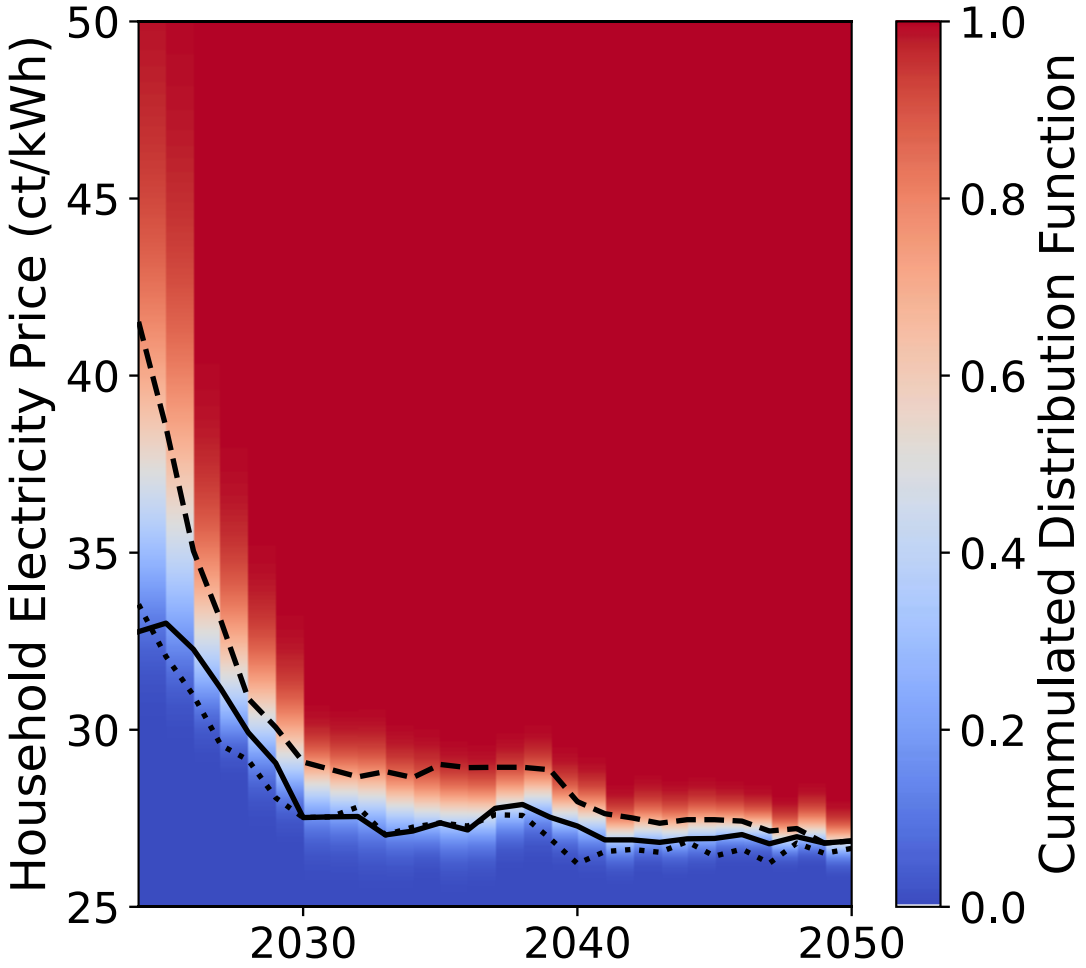
SUMMARY

Summary

- Scenarios can be used to consider uncertainty

1. Stochastic optimisation
2. Monte-Carlo (Markov chain)
3. Robust optimisation

- Best methodology depends on number and type of scenarios



Imprint

Topic:	**Considering Uncertainty in Energy System Optimisation** Talk at the „Regenerative Energietechnik Konferenz in Nordhausen“
Date:	2025-02-14
Autors:	Patrik Schönfeldt, Carlos Munoz, Elif Turhan
Institut:	Institute of Networked Energy Systems
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