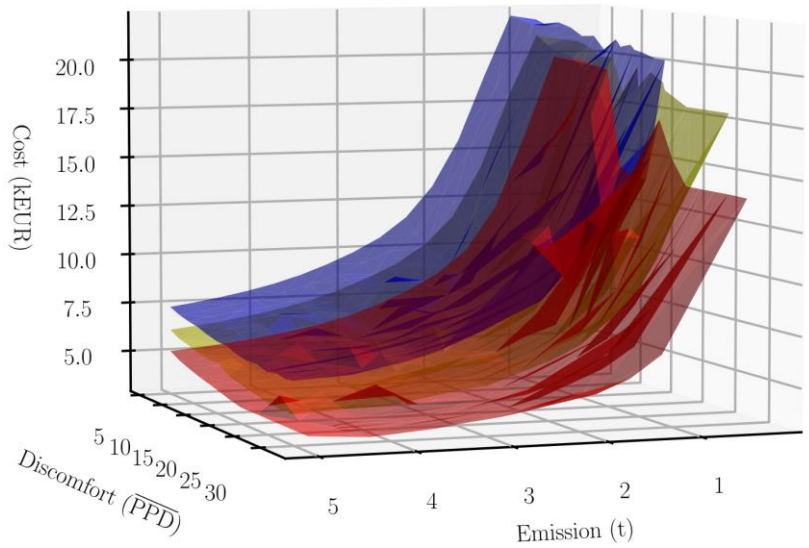


RUB

RUHR-UNIVERSITÄT BOCHUM

SUPPORTING THE RESIDENTIAL ENERGY TRANSITION WITH MULTI-OBJECTIVE OPTIMISATIONS

Chair of Energy Systems & Energy Economics

Jonas Finke __ 25.11.2022 __ Energie Campus 2022

Decision support for the energy transition

For many years...
The energy transition faces challenges: economic, environmental, technical and social

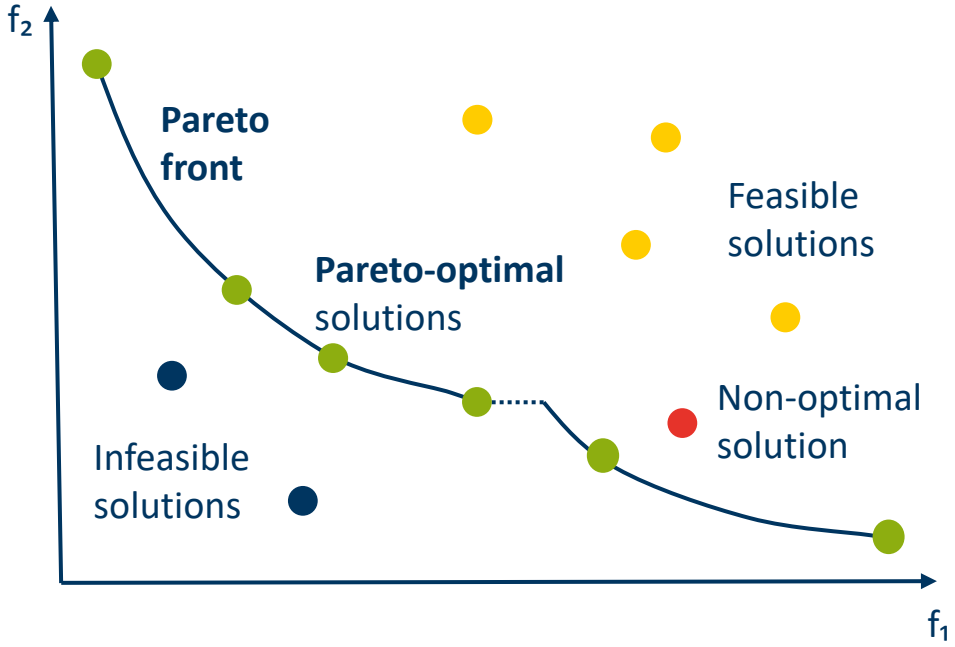
Every day...
Energy system models inform stakeholders and decision makers

However...
Optimised scenarios are not realised due to lack of individual acceptance or behaviour

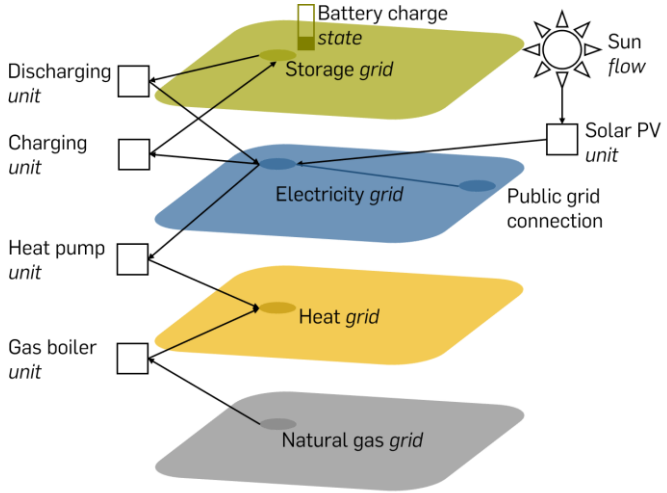
Therefore...
Considering people's multiple interests in models balances conflicting interests and includes the human dimension to ultimately generate more feasible outcomes

Implement and use
multi-objective energy system optimisation models to
support the residential **energy transition**

What is a multi-objective optimisation?



Multi-objective energy system optimisation model



Backbone

Algorithm 1: Parellelised calculation of a subset of the Pareto front

Input: Energy system data, number and distribution of emission caps represented by $d(\cdot,\cdot)$

Output: Subset of Pareto front, energy system designs

do in parallel

- $p_{CO_2}^{\text{lowestEmission}} = \min_{x \in V} v_{CO_2}^{\text{obj}}(x)$
- $p^{\text{lowestCost}} = \min_{x \in V} v_{BB}^{\text{obj}}(x)$

do in parallel

- $p^{\text{highestCost}} = \min_{x \in V} v_{BB}^{\text{obj}}(x)$ s.t. $\text{emission}(x) = p_{CO_2}^{\text{lowestEmission}}$
- $p_{CO_2}^{\text{highestEmission}} = \min_{x \in V} v_{CO_2}^{\text{obj}}(x)$ s.t. $\text{cost}(x) = p^{\text{lowestCost}}$

for $p_{CO_2}^{\text{emissionCap}}$ in $d(p_{CO_2}^{\text{lowestEmission}}, p_{CO_2}^{\text{highestEmission}})$ **do in parallel**

- $\min_{x \in V} v_{\text{AUGMECON}}^{\text{obj}}(x)$ s.t. $\text{emission}(x) = p_{CO_2}^{\text{emissionCap}} + s$

return Energy system model outputs of all optimisations

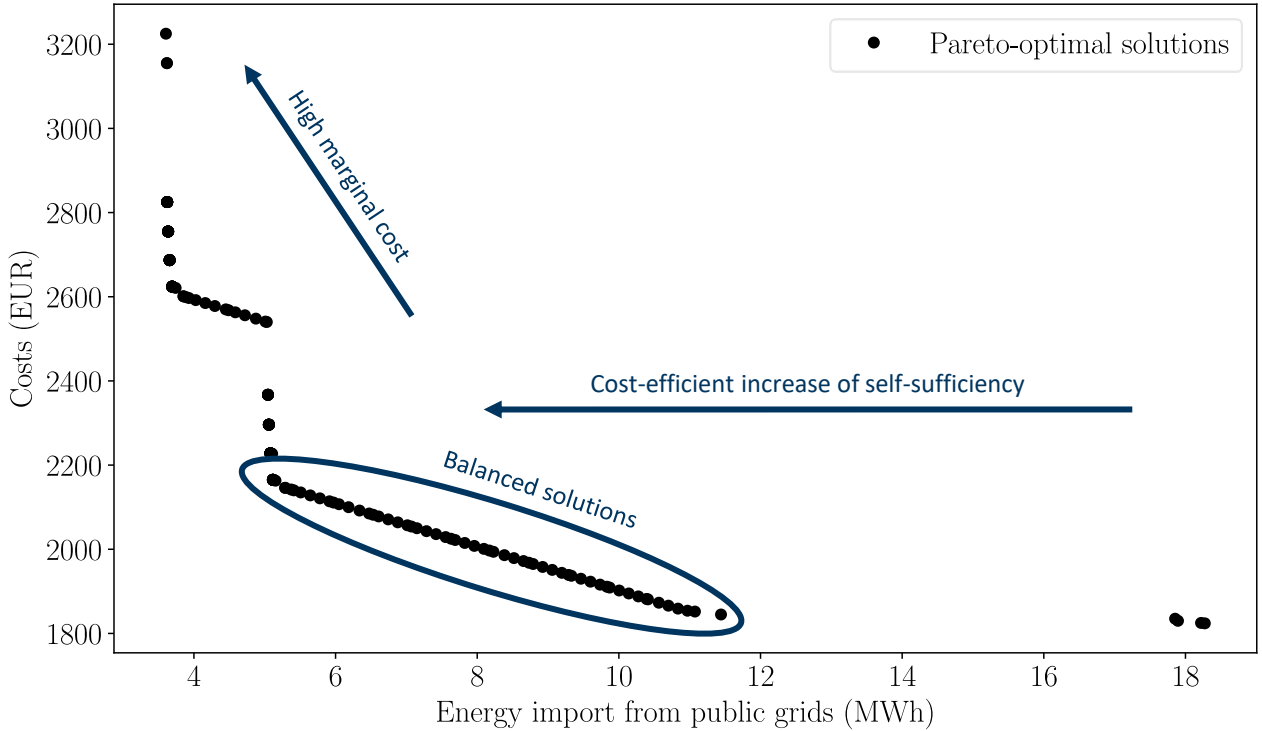
AUGMECON

Helistö et al., *Backbone—An Adaptable Energy Systems Modelling Framework*, Energies 2019.

Mavrotas, *Effective implementation of the epsilon-constraint method in Multi-Objective Mathematical Programming problems*, Applied Mathematics and Computation 2009.

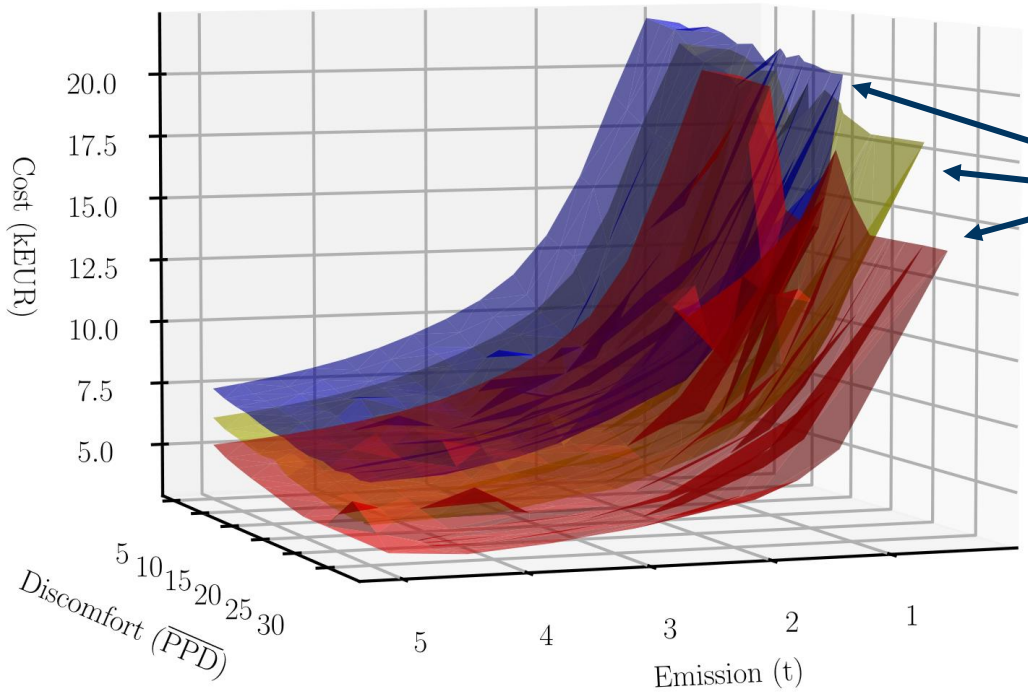
Openly available

1. Balancing conflicting objectives efficiently



Finke and Bertsch, *Implementing a highly adaptable method for the multi-objective optimisation of energy systems*, Revise and Resubmit in Applied Energy.

2. Including human dimension: Thermal comfort



Clothing behaviour impacts "translation" of temperature in comfort

People's interest in comfort drives heating demand

Huckebrink, Finke and Bertsch, Optimisation of costs, carbon emissions and thermal comfort in a building-level energy system model, Work in progress.

Thank you for your attention!

Considering **multiple objectives** in energy planning helps **balancing conflicting interests** and including the **human dimension.**