Demand Response of Industrial Energy Customers – Two Case Studies

Daniel Schwabeneder, Andreas Fleischhacker, Georg Lettner

IEWT 2019
11. Internationale Energiewirtschaftstagung
"Freiheit, Gleichheit, Demokratie: Segen oder Chaos für Energiemärkte?„
13. – 15. Februar 2019, Wien, Österreich

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°691689.

Overview

- Motivation – Introduction to the BestRES project
- Methods
- Example 1 – Activation of end users‘ flexibility in Portugal
- Example 2 – Using Flexibilities of customers as third party
- Conclusions

Motivation

Intoduction to the BestRES project

Motivation

The BestRES project investigates and aims to improve business models for aggregators of RES and flexible demand.

Motivation

Improved business models that have been developed within the consortium:

Automation and control	Providing decentralized units access to balancing markets	Demand Side flexibilization of small customers
“Peer-to-peer” (local) energy matching	Market renewables on multiple market places	Invest and market distributed generation of customers in apartment houses
Dispatch flexible generation under changing market design on multiple markets	Trading PV and Wind power	Activation and marketing of end user’s flexibility.
Suppling „mid-scale“ customers with time variable tariffs including grid charges optimization	Using flexibility of customers as third party	Pooling flexibility for local balancing market and energy service provision.

Demand side flexibilisation of households and small customers

Demand side flexibilisation of medium and large-scale customers

BestRES

Methods

Methods

For the evaluation of improved business models we use Femto:

- A modeling framework to construct linear and mixed-integer optimization models to simulate the operation of aggregators on different markets
- Flexibly adaptable for different aggregator portfolios (production, storage, flexible loads) and markets (day-ahead, reserve and intraday)
- Written in the Julia language
- Developed at Energy Economics Group (TU Wien)

Example 1

Activation and marketing of end user’s flexibility.

Case study description

EDP Portugal wants to use the flexibility of medium and large-scale customers to reduce cost for energy procurement.

We analyzed the following options to valorize flexibility:

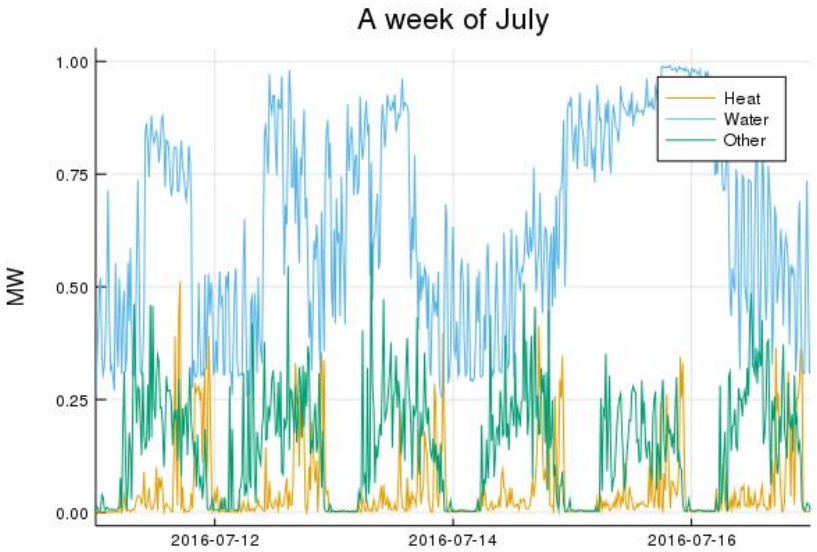
- *Spot*: Day-ahead spot market
  Increase load during hours of low prices and reduce it during high market prices.

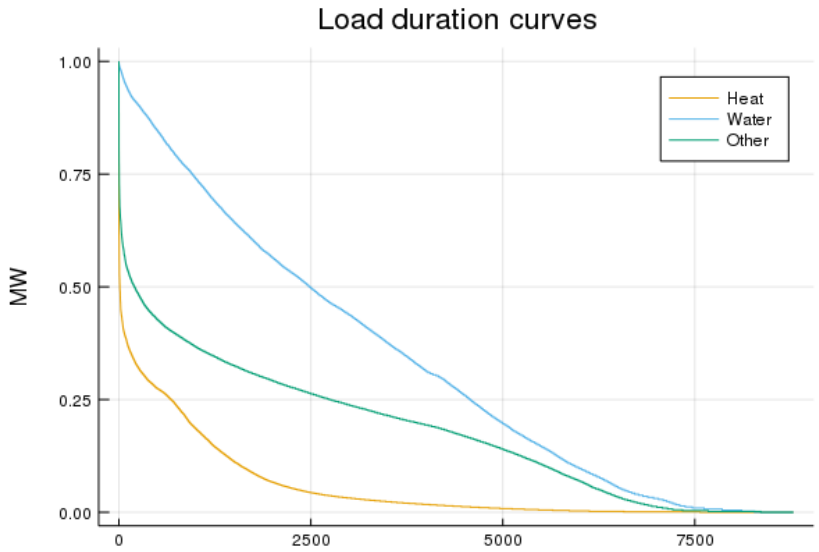
- *Imbalance*: Imbalance reduction
  Increase load when EDP has positive imbalance and reduce it during hours of negative imbalance.

- Optimal:
  Theoretical scenario (assuming perfect foresight of imbalance prices) and choosing the best option between *Spot* and *Imbalance*.

Model scaling

Load and market data from the year 2016.



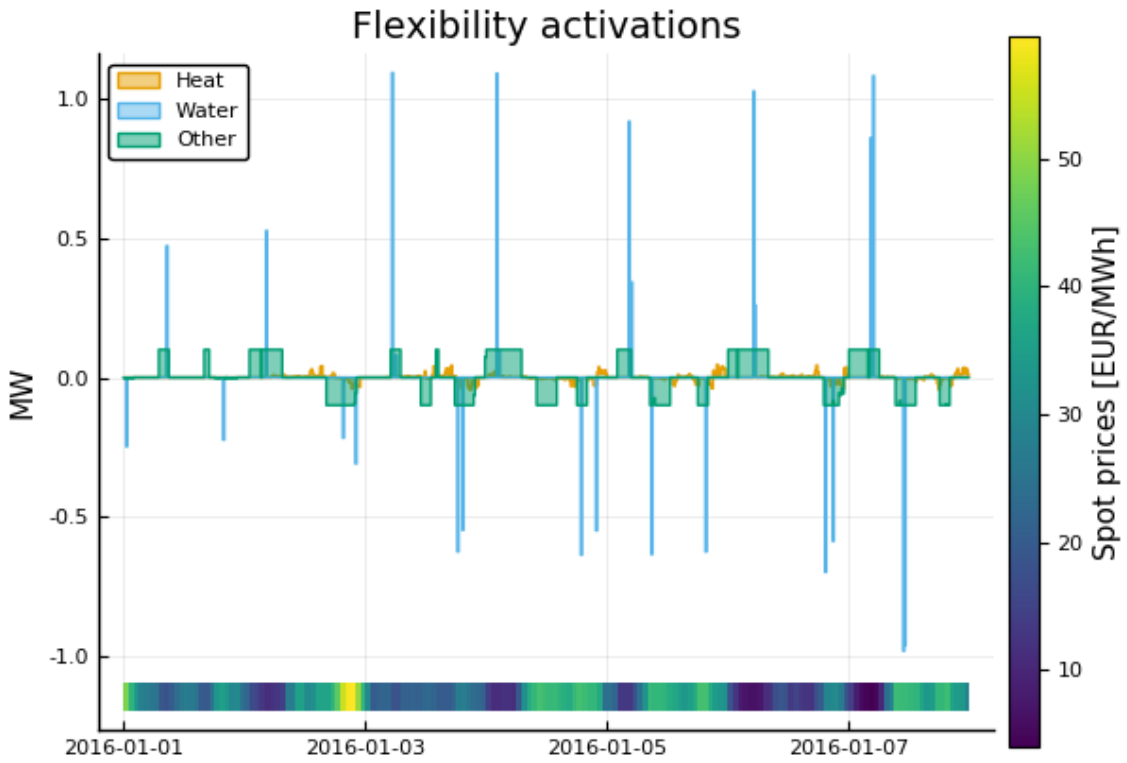


Flexibility assumptions	Heat	Water	Other
Max. load change	±10%		±0.1 MW
Max. number of activations		2 per day	3 per day
Max. duration of activations		15 min	2 h
Equilibrium period	Day	Day	Week

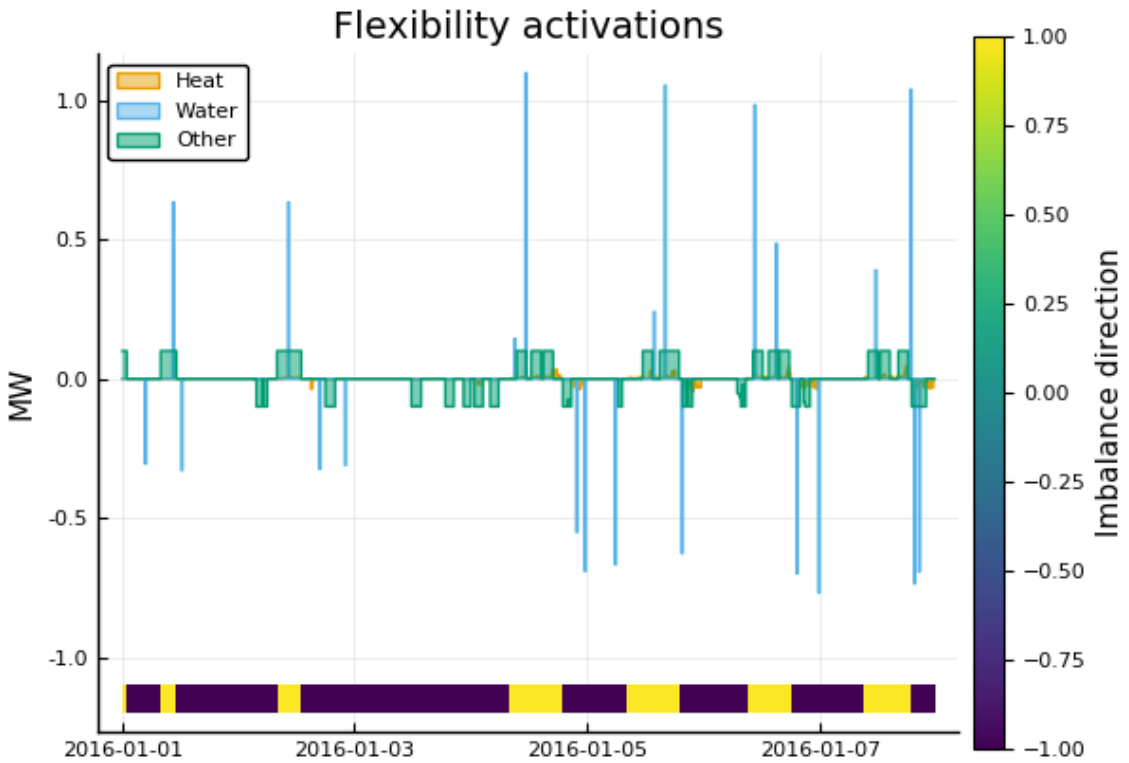
BestRES

Flexibility Activations

Spot

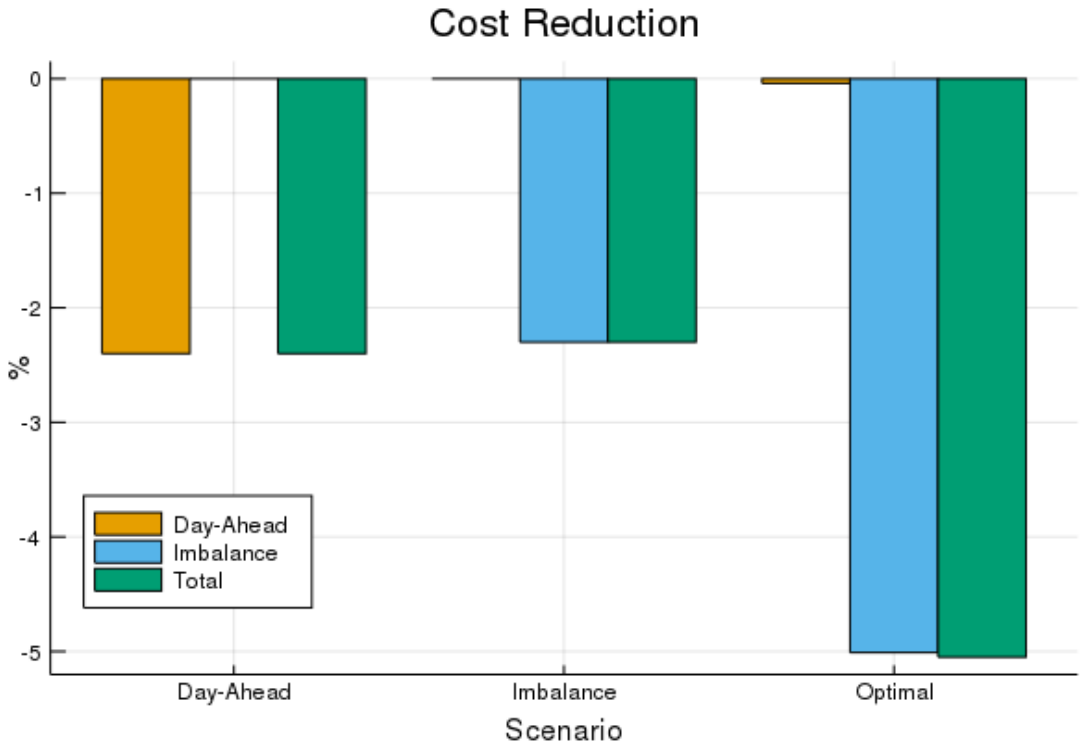


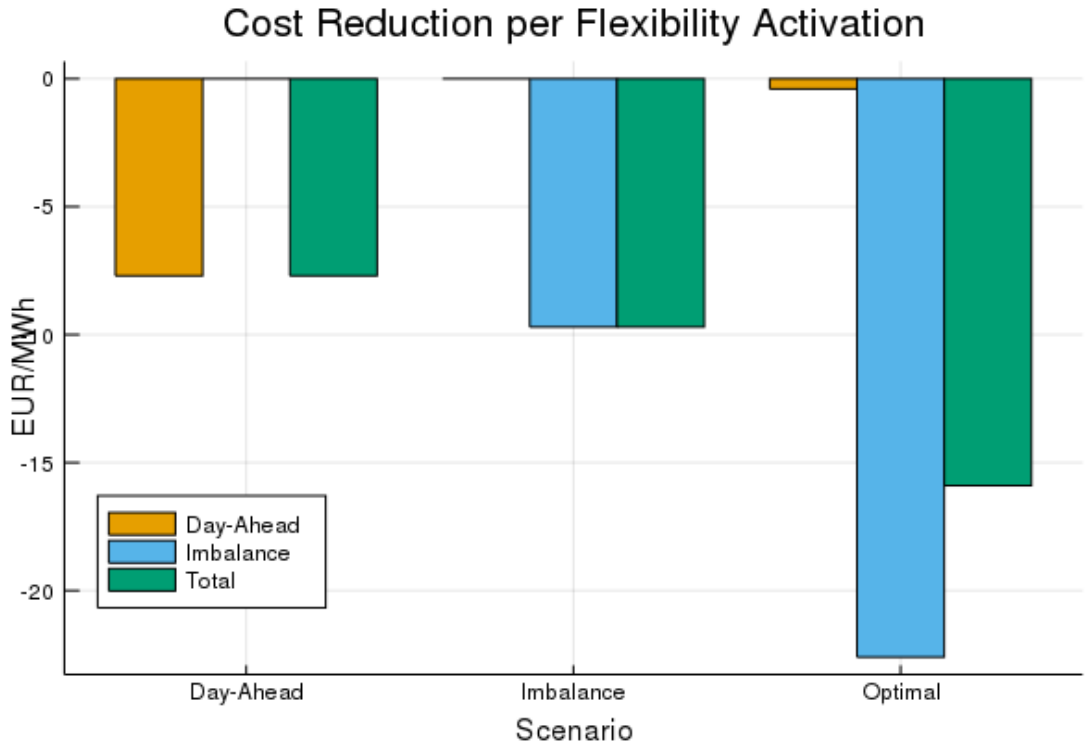
Imbalance



BestRES

Results: Cost reduction

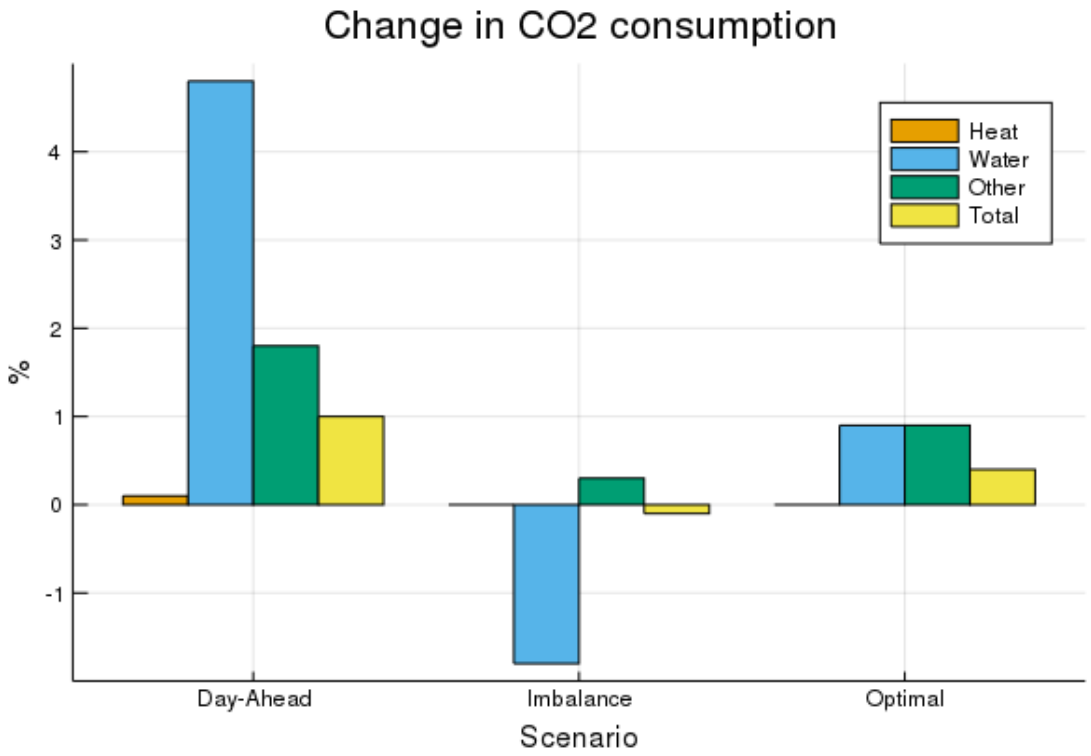


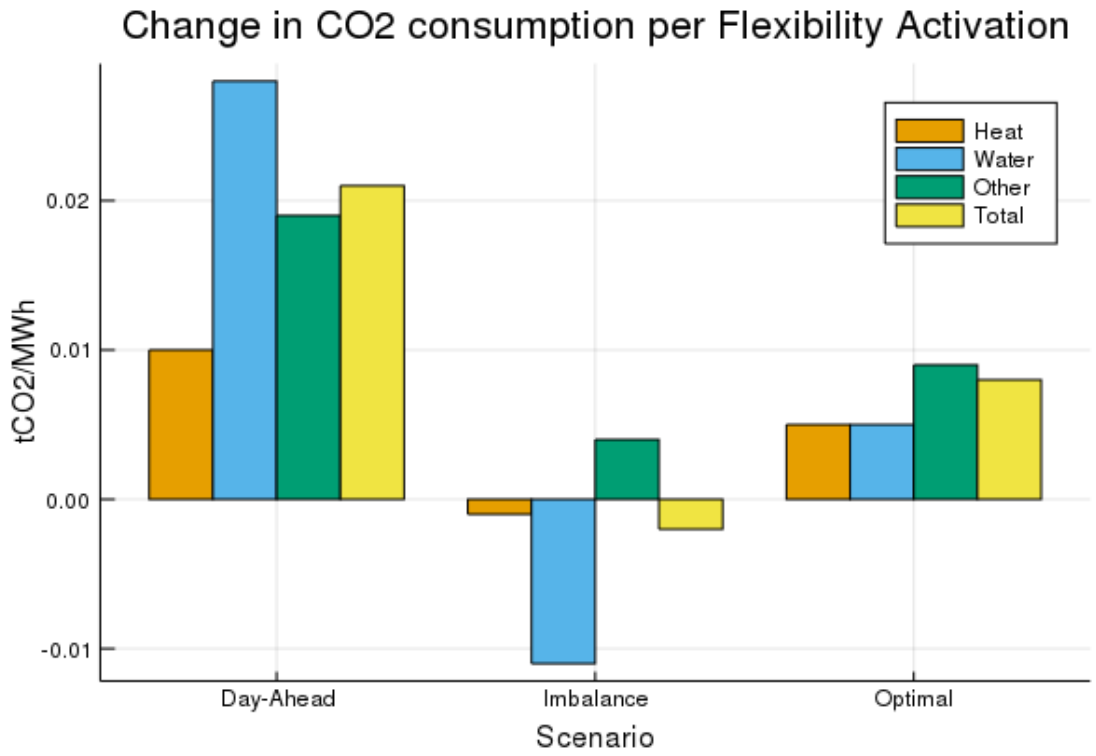


- The *Spot* and the *Imbalance* scenario achieve quite similar results
- The *Optimal* scenario shows the potential improvement if information on imbalance prices were available

Results: CO2

Change in average CO2 emissions of electricity consumed by the loads.
Source:
Actual generation per power plant type for Portugal (ENTSO-E)
Emission factors per power plant type (IPCC)

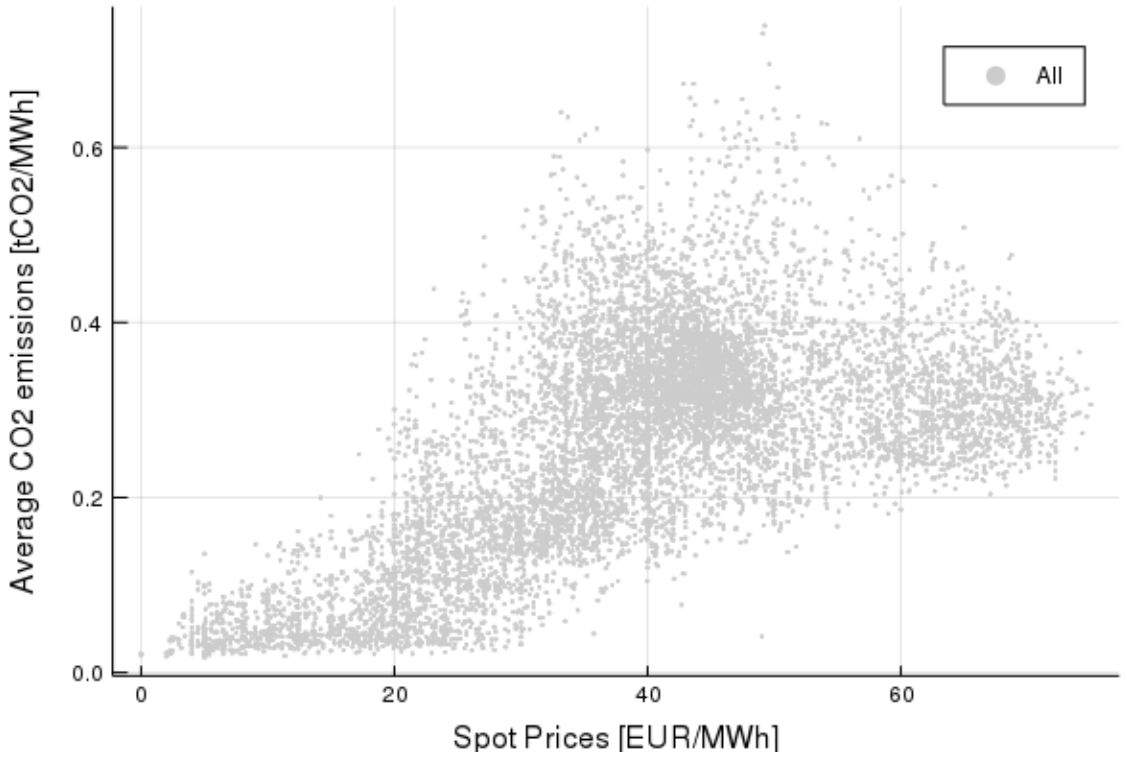




BestRES

Results: CO2

Why the increase in CO2?



BestRES

Example 2

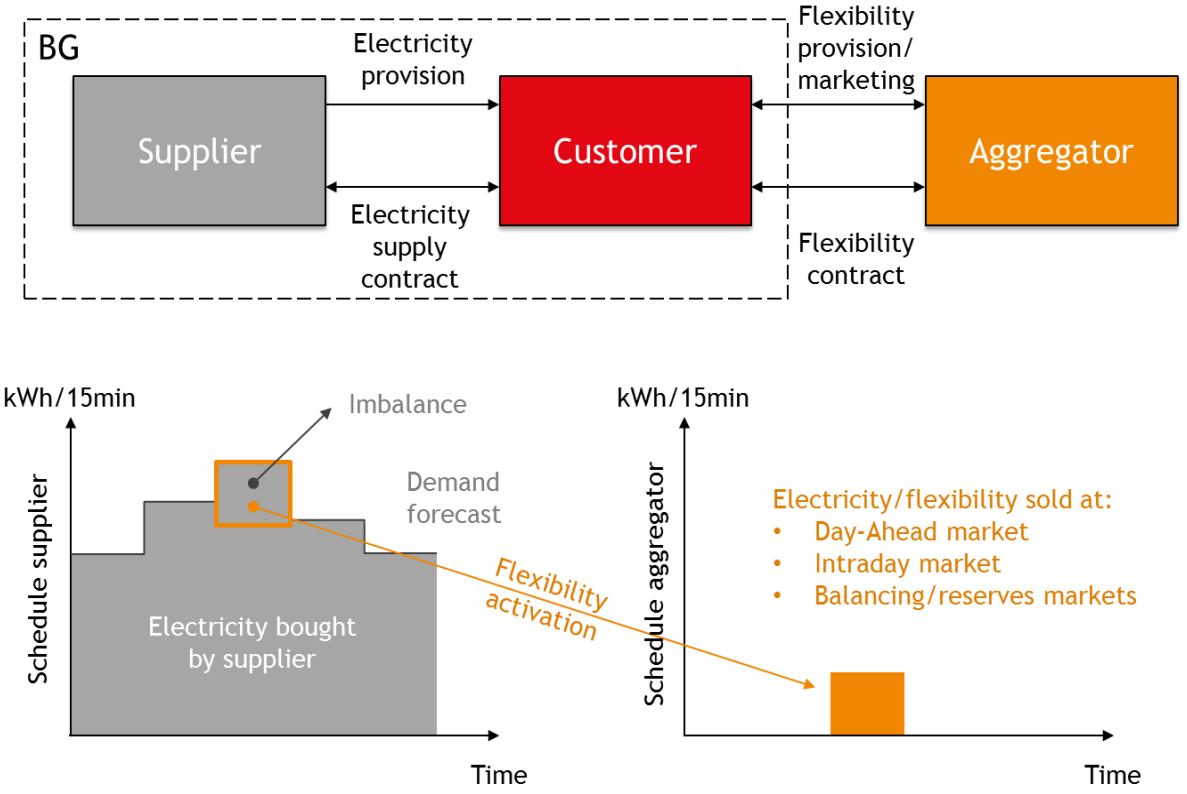
Using flexibility of customers as third party

Using flexibility of customers as third party

In this case study Next Kraftwerke Belgium (NKW-B) wants to use the flexibility electricity customers as third party.

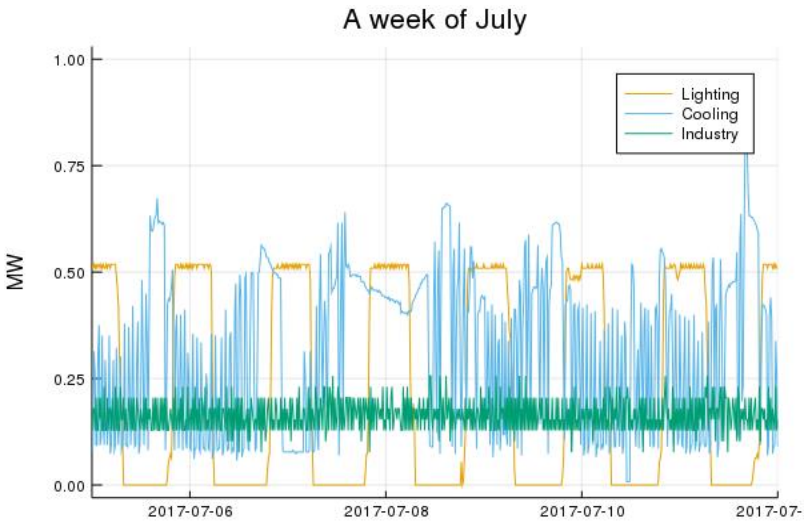
This means that customers and their supplier belong to a different Balance Responsible Party (BRP) than the aggregator NKW-B.

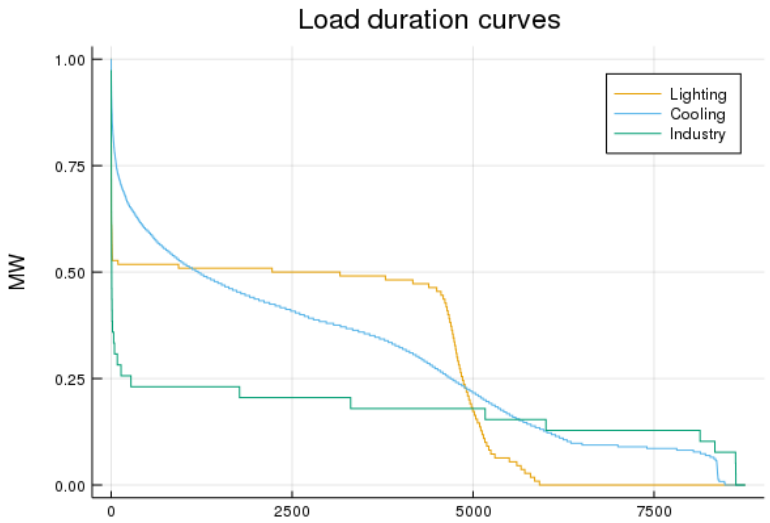
Hence, flexibility activations by NKW-B might cause imbalances in the supplier‘s BRP and change the revenue from energy supply.



Model scaling

Load and market data from the year 2017





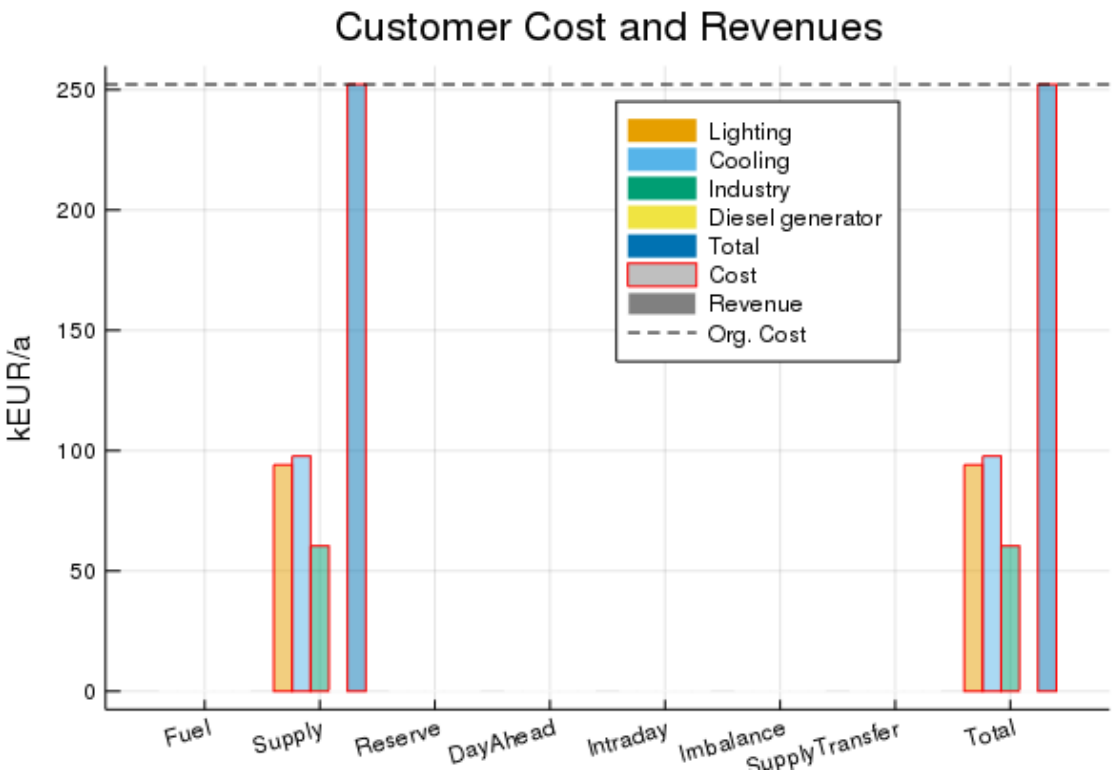
Flexibility assumptions	Lighting	Cooling	Industry
Max. load change	±50%	±0.1 MW	±0.2 MW
Max. number of activations		4 per day	10 per week
Max. duration of activations		1 h	4 h
Availability	8 PM – 6 AM		
Equilibrium period	Day	Day	Week

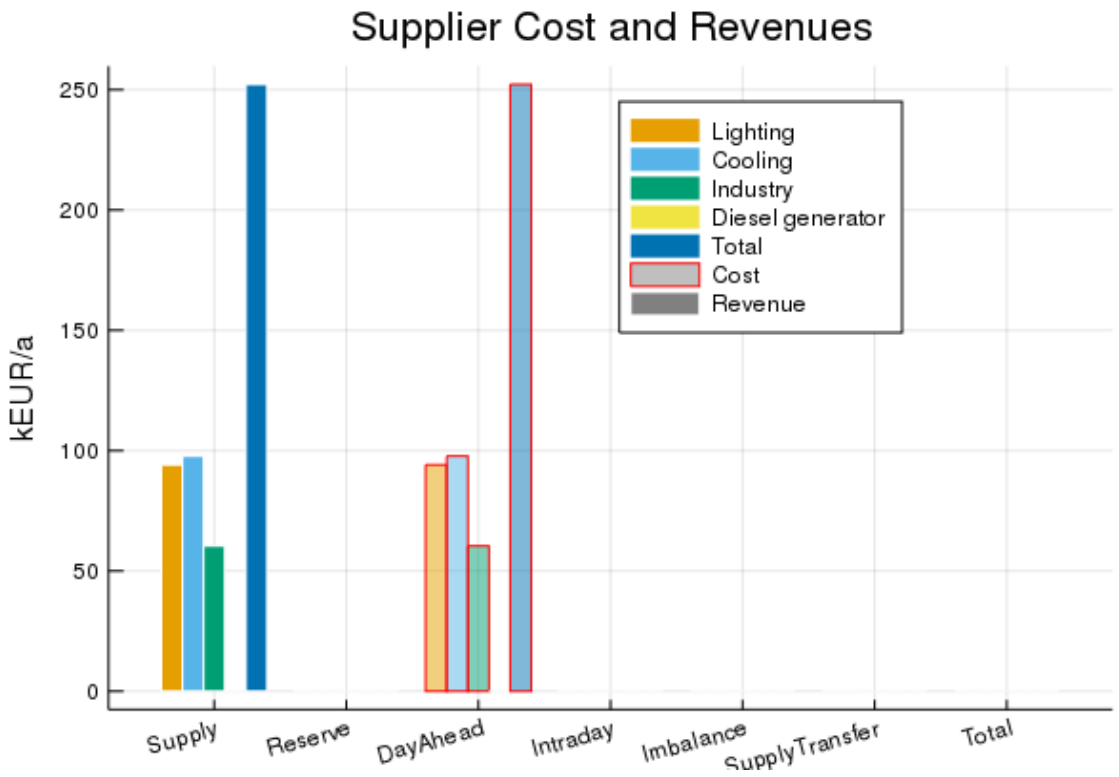
BestRES

Scenarios

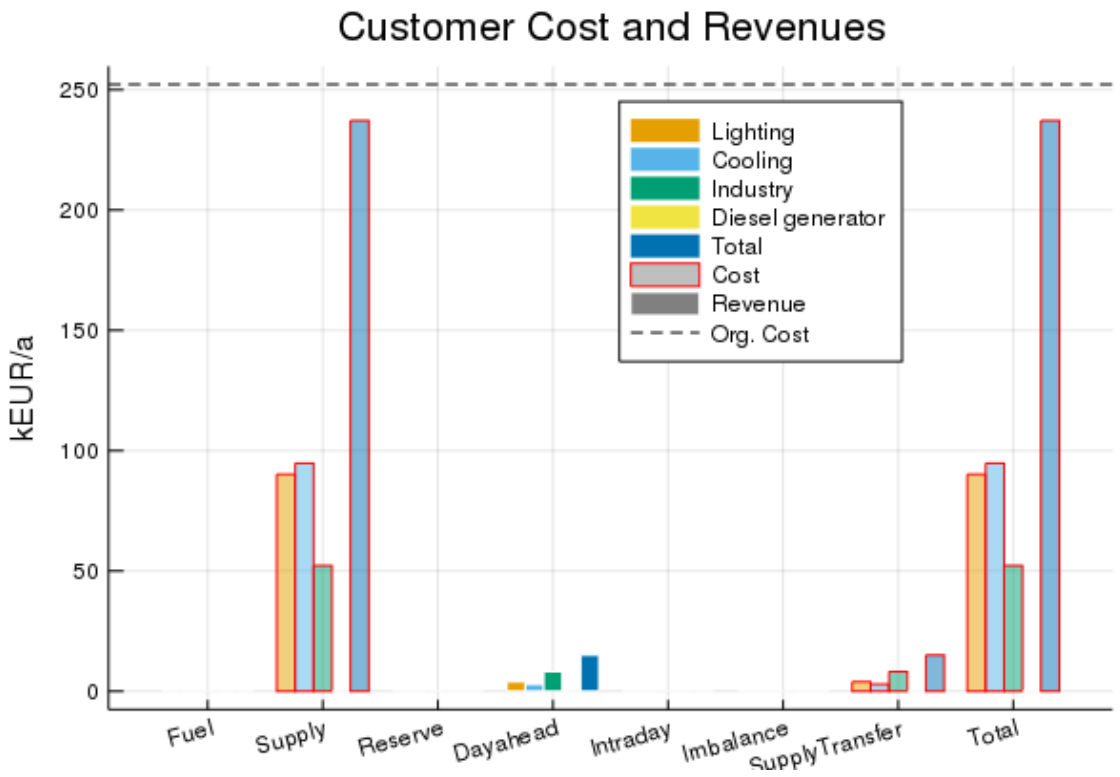
- *Baseline*
  - No flexibility activations at all
- *Spot*
  - Flexibility is used for day-ahead spot market optimization
  - We assume a bilateral contract between the supplier and the 3rd party aggregator:
    - The aggregator has to announce activations day-ahead → no imbalances for the supplier.
    - Changes in customer metering are compensated via a supply transfer payment.
- *Reserve*
  - Flexibilites are used for the R3+ reserve market.
  - Elia already cancels out supplier imbalances caused by the aggregator.
  - Load flexibilities are prioritized. A 1 MW diesel generator is used as backup
  - We assume shift-able loads. Hence reserve activations have to be balanced. This is done on the intraday market.

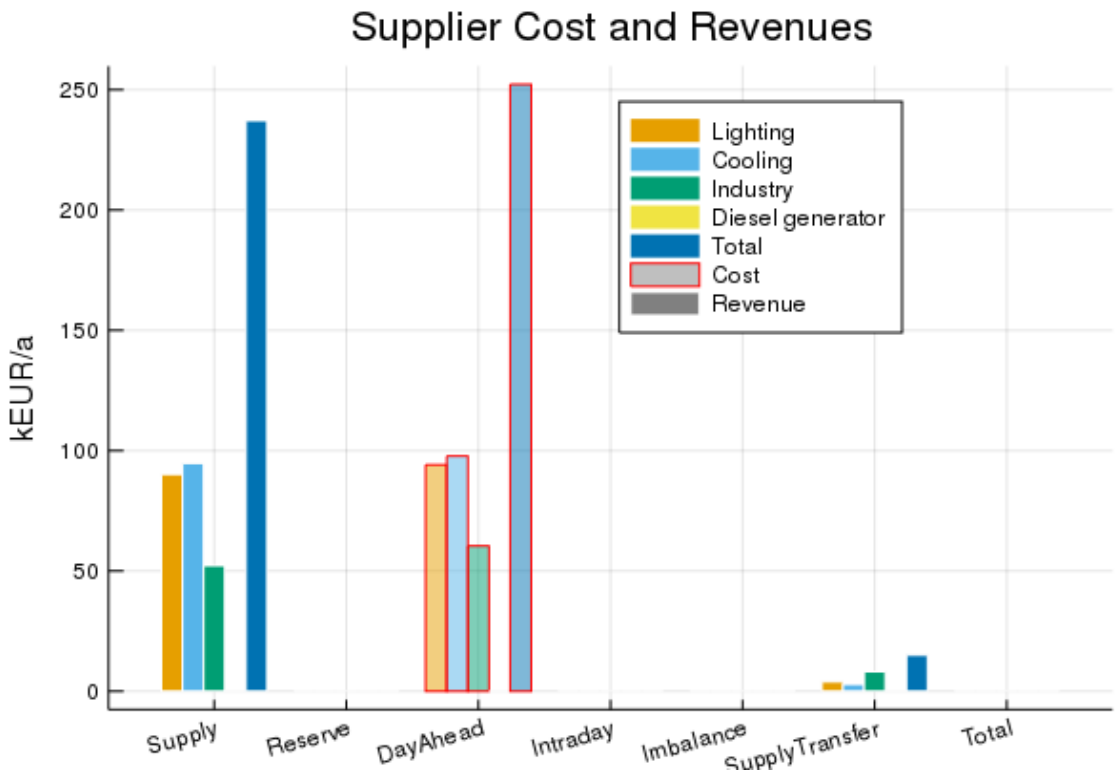
Results Baseline





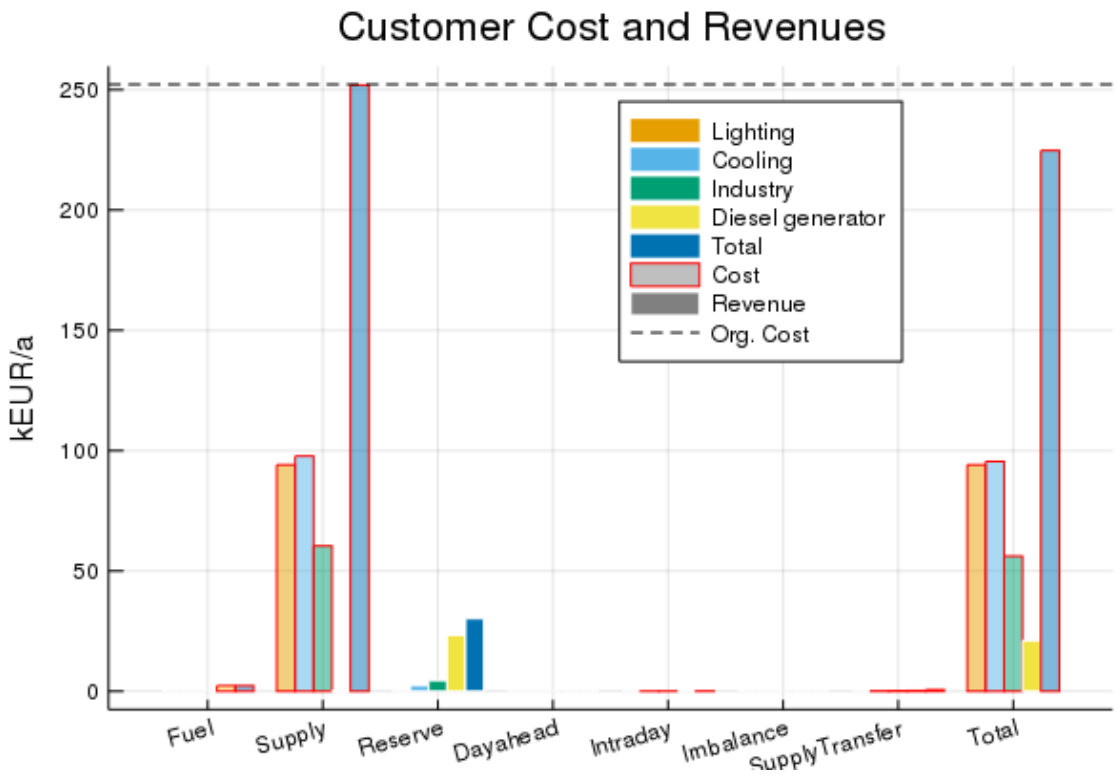
Results Spot

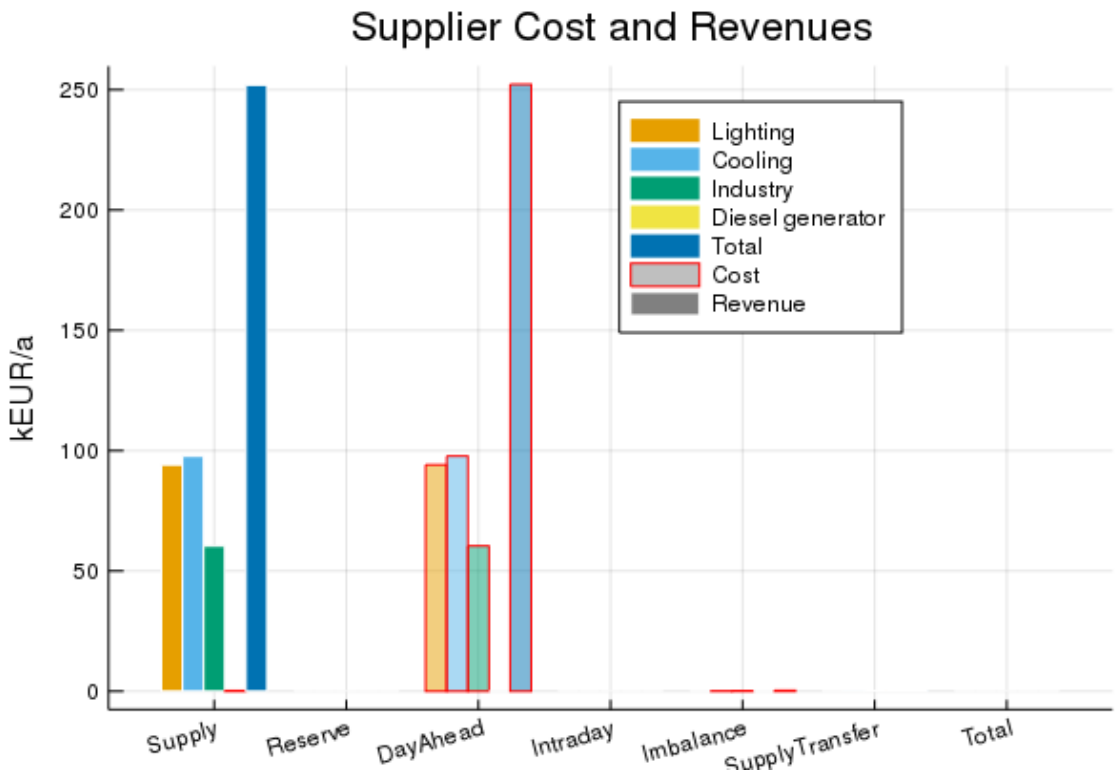




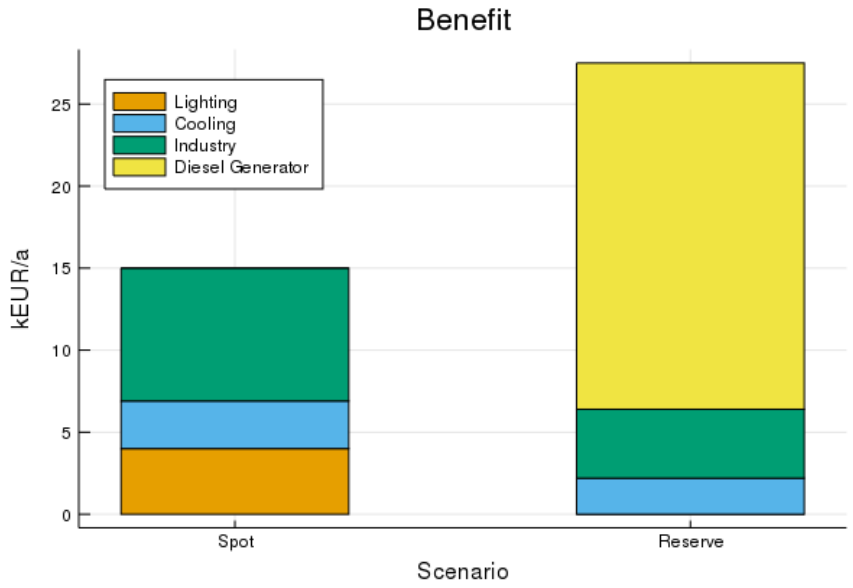
BestRES

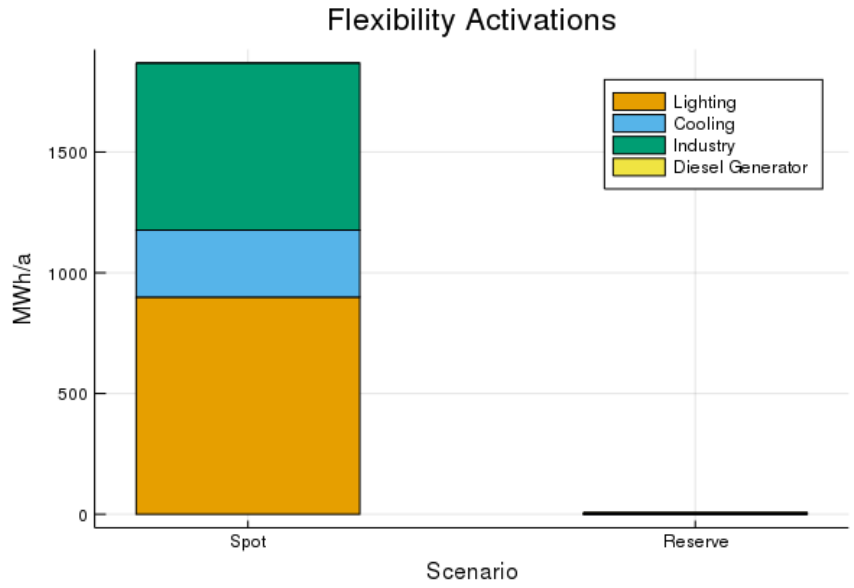
Results Reserve





Spot and Reserve benefits





- The Reserve scenario provides more benefits than the Spot scenario.
- However, most of the reserve benefits are provided by the diesel generator and flexible loads perform better in the Spot scenario.
- Both scenarios result in benefits for aggregator and customers and neither increases the cost of the supplier.
- The benefits of the business models can be divided among customer and aggregator.

Conclusions

Summary and Conclusions

- Flexible energy demand can be used in various ways to generate profit or reduce cost on different energy markets.
- Load shifting with respect to market prices does not necessarily result in CO2 reduction.
- Third party access to flexibility requires bilateral contracts or a legal framework for transfer payments.
- Demand side flexibilization can result in win-win situations among multiple actors

Thank you!

Daniel Schwabeneder
TU Wien
Institute of Energy Systems and Electrical Drives
Energy Economics Group (EEG)
Schwabeneder@eeg.tuwien.ac.at