Freiheit, Gleichheit, Demokratie: Segen oder Chaos für Energiemärkte?

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Demand Response of Industrial Energy Customers - Two Case Studies

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“Freiheit, Gleichheit, Demokratie: Segen oder Chaos für Energiemärkte?”,

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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

Introduction 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:

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

Demand side flexibilisation of households and small customers

Demand side flexibilisation of medium and large-scale customers
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.
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:

- **Max. load change**: ±10% for Heat, ±0.1 MW for Other
- **Max. number of activations**: 2 per day for Water, 3 per day for Other
- **Max. duration of activations**: 15 min for Heat, 2 h for Other
- **Equilibrium period**: Day for Heat and Water, Week for Other
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)

Change in CO2 consumption

Change in CO2 consumption per Flexibility Activation
Results: CO2

Why the increase in CO2?
Example 2

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.
Load and market data from the year 2017

**Flexibility assumptions**

<table>
<thead>
<tr>
<th></th>
<th>Lighting</th>
<th>Cooling</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. load change</td>
<td>±50%</td>
<td>±0.1 MW</td>
<td>±0.2 MW</td>
</tr>
<tr>
<td>Max. number of activations</td>
<td>4 per day</td>
<td>10 per week</td>
<td></td>
</tr>
<tr>
<td>Max. duration of activations</td>
<td>1 h</td>
<td>4 h</td>
<td></td>
</tr>
<tr>
<td>Availability</td>
<td>8 PM - 6 AM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equilibrium period</td>
<td>Day</td>
<td>Day</td>
<td>Week</td>
</tr>
</tbody>
</table>
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**
  – Flexibilities 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 Spot

Customer Cost and Revenues

Supplier Cost and Revenues
Results Reserve

Customer Cost and Revenues

- Lighting
- Cooling
- Industry
- Diesel generator
- Total
- Cost
- Revenue
- Org. Cost

Supplier Cost and Revenues

- Lighting
- Cooling
- Industry
- Diesel generator
- Total
- Cost
- Revenue

BestRES
• 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!

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