Quantifying the Costs of Demand Response for Industrial Businesses

IECON 2013
2013-11-12, Vienna

Anna Gruber, Lukas Kreuder, Serafin von Roon
1. Application Area of Demand Response
2. Methodology
3. Cost Structure
4. Results & Conclusion
Energy Consumption and Energy Intensity by Sector

- **Electricity Consumption**
  - Chemicals
  - Metal working
  - Paper and cardboard
  - Car production
  - Food and feed
  - Rubber and plastics
  - Production of metals
  - Glass, ceramics, stone/earth
  - Mechanical engineering
  - Coking plants and oil

- **Electricity Intensity (MWh / millions of EUR gross value added)**
  - Chemicals
  - Metal working
  - Paper and cardboard
  - Car production
  - Food and feed
  - Rubber and plastics
  - Production of metals
  - Glass, ceramics, stone/earth
  - Mechanical engineering
  - Coking plants and oil
Cross-Sectional Technologies

- Electrical Engines
- Ventilation
- Compressed Air
- Lighting
- Cooling Production and Distribution
- Heat Production and Distribution
- IT
- Pumps
- Power Production
Duration of Activation

Electricity consumption that can be switched off for cross-section technologies in southern Germany (normal operation) relative to duration – technical potential for suitable businesses without consideration of the cost of implementation (staff and ICT)

Figure 3
Agenda

1. Application Area of Demand Response
2. Methodology
3. Cost Structure
4. Results & Conclusion
Methodology

Research Approach
- Definition of three Types of Costs
  - Investments
  - Fixed Costs
  - Variable Costs

Questionnaire
- Online Questionnaire
- Face to Face Interviews
- Telephone Interviews

ROI Analysis
- Participation in Energy Markets
  - Intraday (EPEX)
  - Balancing Power (Secondary & Tertiary Frequency Control)
Findings (Technical Part of the Questionnaire)

- Ventilation systems: 13 positive responses
- Refrigerating machines: 9 positive responses
- Electric lighting: 8 positive responses
- Heating circulation pumps: 5 positive responses
- Electric hot water preparation: 2 positive responses
- Band-conveyors: 1 positive response

(N = 16)
Agenda

1. Application Area of Demand Response
2. Methodology
3. Cost Structure
4. Results & Conclusion
## Types of Costs for Implementing and Operating Demand Response

<table>
<thead>
<tr>
<th>Initial Costs (Investments)</th>
<th>Fixed Costs</th>
<th>Variable Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Development of Demand Response Strategy</td>
<td>- Information</td>
<td>- Personnel in Case of Activation</td>
</tr>
<tr>
<td>- Communications Technology</td>
<td>- Personnel for Audit</td>
<td>- Value of Lost Load</td>
</tr>
<tr>
<td>- ICA</td>
<td></td>
<td>- Storage</td>
</tr>
<tr>
<td>- Software</td>
<td></td>
<td>- Maintenance</td>
</tr>
<tr>
<td>- Storages</td>
<td></td>
<td>- Comfort Losses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Efficiency Losses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Fuel</td>
</tr>
</tbody>
</table>
Agenda

1. Application Area of Demand Response
2. Methodology
3. Cost Structure
4. Results & Conclusion
### Summary of Initial Costs (Investments)

#### I.a Unit-Independent Investments

<table>
<thead>
<tr>
<th>Type</th>
<th>Investments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel Costs for Potential-Analysis,</td>
<td>6,000 EUR</td>
</tr>
<tr>
<td>Operating-Strategy &amp; Employee-Training</td>
<td></td>
</tr>
<tr>
<td>Communication Box for Data Exchange with</td>
<td>3,000 EUR</td>
</tr>
<tr>
<td>Demand Response Aggregator</td>
<td></td>
</tr>
</tbody>
</table>

#### I.b Unit-Dependent Investments

<table>
<thead>
<tr>
<th>Type</th>
<th>Investments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Upgrade Measurement</strong> (Capacity Measurement)</td>
<td>1,000 EUR per Unit</td>
</tr>
<tr>
<td><strong>Central Building Control System</strong></td>
<td>1,000 EUR 1. Unit</td>
</tr>
<tr>
<td><strong>Central Building Control System</strong></td>
<td>250 EUR 2. Unit</td>
</tr>
<tr>
<td><strong>Control Technologies:</strong> Relays</td>
<td>6 to 9 EUR per kW</td>
</tr>
<tr>
<td><strong>Control Technologies:</strong> Frequency Converters</td>
<td>10 kW: 2,000 EUR</td>
</tr>
<tr>
<td><strong>Control Technologies:</strong> Frequency Converters</td>
<td>100 kW: 7,000 EUR</td>
</tr>
<tr>
<td><strong>Control Technologies:</strong> Frequency Converters</td>
<td>500 kW: 30,000 EUR</td>
</tr>
<tr>
<td><strong>Control Technologies:</strong> Dimmable Ballasts</td>
<td>100 EUR per Tube</td>
</tr>
</tbody>
</table>

- No additional Storages → no Storage Costs
### II.a Fixed Personnel Costs

<table>
<thead>
<tr>
<th>Type</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Fixed Personnel Costs (1st Year)</td>
<td>5.000 EUR per Year</td>
</tr>
<tr>
<td>Annual Fixed Personnel Costs (2nd Year and following)</td>
<td>2.000 EUR per Year</td>
</tr>
</tbody>
</table>

### II.b Data Exchange

<table>
<thead>
<tr>
<th>Type</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Fixed Costs caused by Data Exchange between Companies and Demand Response Aggregator</td>
<td>0 EUR per Year</td>
</tr>
</tbody>
</table>
## Summary of Variable Costs

- Quantifying all other Types of Variable Costs was not possible for the respondents

<table>
<thead>
<tr>
<th>Type</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable Personnel Costs per Demand Response Activation</td>
<td>8 EUR per Activation</td>
</tr>
</tbody>
</table>
**Core Assumptions for Profitability Calculation**

- **Project Calculation Period**: 10 years
- **Interest Rate**: 8%

- **Flexible Load**: 250 kW in total (three Units)
- **Production Days**: 250 Days, 2x 8 h Shifts
- **Duration of Activation**: 30 Minutes
- **Max. Amount of Activation**: at most 1x per Shift
- **Real Amount of Activation**: 100 Activations per Year
- **Marketable Electricity**: 12.5 MWh/a

**Earnings on Energy Markets**

- **Average Market Prices* for**
  - Secondary and Tertiary Frequency Control
  - EPEX Intraday Spotmarket of 2012

*prices from 6 a.m. to 10 p.m. were considered
### Costs & Earnings

<table>
<thead>
<tr>
<th>Market</th>
<th>Capital Value [EUR]</th>
<th>IRR*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Secondary Frequency Control</td>
<td>-25.221</td>
<td>&lt; 0 %</td>
</tr>
<tr>
<td>Negative Secondary Frequency Control</td>
<td>-32.196</td>
<td>&lt; 0 %</td>
</tr>
<tr>
<td>Positive Tertiary Frequency Control</td>
<td>-18.626</td>
<td>&lt; 0 %</td>
</tr>
<tr>
<td>Negative Tertiary Frequency Control</td>
<td>-27.701</td>
<td>&lt; 0 %</td>
</tr>
<tr>
<td>Intraday Spotmarket</td>
<td>-32.576</td>
<td>&lt; 0 %</td>
</tr>
</tbody>
</table>

*IRR - internal rate of return

→ Basis Scenario is not profitable within the discussed Markets (Capital Values < 0)

→ Influence on the Profitability: Sensitivity Analysis
Sensitivity Analysis – Investments

Investments do not influence the Profitability
If offered flexible load increases to 550 kW, participation at the market for positive tertiary frequency control would be economical feasible.
If the available time increases to 2,600 h, participation at the market for negative secondary frequency control would be economical feasible.
Conclusion

Important Costs for Demand Response with Cross Sectional-Technologies

- Investments
- Annual fixed costs
  ➔ Low variable costs

Demand response with cross sectional-technologies is economical feasible, if…

- …the flexible load is at the minimum of 550 kW or
- …the available time of these loads is more than 2,600 h per year or
- …the market prices increase (e.g. act for interruptable load)
Thank you for your attention and the support of

Anna Gruber: agruber@ffe.de / +49-89-158-121-61
Forschungsgesellschaft für Energiewirtschaft mbH
Am Blütenanger 71
80995 München
www.ffegmbh.de