Analysis of Incentive-based Demand Response Mechanism

ENERDAY – 8th April 2016

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In 2007 the energy consumed by data centres (DC) in Western Europe was 56 TWh and is projected to increase to over 100 TWh per year by 2020.

ICT resources of DCs are over-provisioned to cope with workload fluctuations and to guarantee QoS.

- Almost 70% of servers in DCs are in idle state.

Servers contribute 40% to overall DC energy consumption.

- The other 60% is due to storage, networking devices and cooling equipment.
Demand Response (DR) is used in electricity grids to manage customers’ energy consumption during power shortage.

Demand Response Research Center in LBNL analyzed DR for the case of DCs and showed that:

- DCs are very good candidates to participate in DR due to:
  - Significant energy demand
  - Highly automated IT infrastructure providing flexibilities

- Major drawback of today’s market condition is the inflexibility of electricity tariffs
  - Making DR in practical for DCs
Roadmap

- Problem Description
- Our Approach
  - Current Situation
  - Energy Management
  - Green Agreements
- Cost-benefit Analysis
  - Methodology
  - Obtained Results
- Conclusion
Problem Description

- Distribution System Operators (DSO) have:
  - Local power generation sources
  - Renewables
  - Fossil-based generators

- Contract with Energy Suppliers (ES)

In the studied use case, the contract states:
- Maximum power demand is 61 MW
- Additional 1 KW of demand (even for 1 sec) is assumed to cost 54 € (2011)
Our Approach

Current Situation

DSO

DC

ITC

Tariffs

SLAs
Our Approach
Energy Management

DSO

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Our Approach
Green Agreements

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Our Approach
Green Agreements

- Dynamic demand reshaping in case of Surplus / shortage of energy
- Energy management in the eco-system
- Minimization of energy consumption

DSO

ITC

Energy management in the DC

Management of hardware
Management of services

DC

Management of cooling

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Cost-benefit Analysis

Methodology

- Analysis was performed on 3 steps
  - No energy management
  - With GreenSDA
  - Both with GreenSDA and GreenSLA

- DSO
  - Costs of 27918 € to cover a power shortage of 517 kW (exceeding 61 MW in 2011)

- DC
  - We studied the dependent and independent flexibilities of Innowerk-IT
  - 55 kW of power reduction

- Assumption
  - Maximum static reward of 2500 €
## Cost-benefit Analysis

### Obtained Results

<table>
<thead>
<tr>
<th>Type of Benefit</th>
<th>Euro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static reward for one DC of type Innowerk-IT</td>
<td>250,00 €</td>
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<tr>
<td>Dynamic reward</td>
<td>2216,52 €</td>
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<tr>
<td>Saved Energy Per Flexibility Internal</td>
<td>0 €</td>
</tr>
<tr>
<td>Saved Energy Per Flexibility External</td>
<td>0,48 €</td>
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<tr>
<td>Total</td>
<td>2467,00 €</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of Cost</th>
<th>Euro</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC Penalty</td>
<td>0 €</td>
</tr>
<tr>
<td>Flexibility Recovery Cost</td>
<td>4,03 €</td>
</tr>
<tr>
<td>Static ITC Reward</td>
<td>125,00 €</td>
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<tr>
<td>Dynamic ITC Reward</td>
<td>42,54 €</td>
</tr>
<tr>
<td>Total</td>
<td>171,57 €</td>
</tr>
</tbody>
</table>

- Innowerk IT’s profit would be $2467 - 171,57 = 2295,43$
- All the detailed results can be found at
  - [http://www.all4green-project.eu/sites/default/files/documents/](http://www.all4green-project.eu/sites/default/files/documents/)
  - D4.3 Section III1.4
Conclusion

- DR schemes for the case of DCs are attractive through incentive-based mechanisms
  - GreenSDAs and Green SLAs
  - Reward and penalty schemes
- Reward and penalty schemes contribute to incentivize parties in DR participation
  - The collaboration scheme
  - Is beneficial for three parties (DSO, DC, ITC)
  - Induces a WIN/WIN/WIN situation