Which electricity market design to encourage the development of demand response?

Vincent Rious¹, Fabien Roques², Yannick Perez³

1. Microeconomix & LDP-EUI,
2. CERA,
3. CentraleSupélec
Outline

- Motivation
- Problem
- Methodology
- Results
- Conclusion
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Rationale of demand response

- **Demand response**
  
  = reduction of load level for some consumers when high price (1-2-300 ... €/MWh)

- **Interest of DR** = clean substitute to the extreme peak generation
  
  – Participation in the system balancing for some hundreds of hours a year
  
  – Similar to extreme peak generation
  
  – But avoiding the very expensive and CO2-emitting use of fossil fuels
Debate about the business model for demand response toward small consumers

- Considering its potential Public Good attribute and uncertain cost structure, is DR competitive or regulated activity?

- In the North East of USA, mostly developed on a competitive basis

- In Europe, mostly developed on a regulated mandatory roll-out basis
Current mode for demand response development in Europe

Figure 1 Mapping the Status of EU Smart Meters Roll-out Policies

Source: (1) ERGEG: Status Review on Regulatory Aspects of Smart Metering, 19th October, 2009
(2) Jorge Vasconcelos: Survey of Regulatory and Technology Development Concerning Smart Metering In the European Union Electricity Market, 2008
Problem of remuneration for demand response operator on a market

- Similar to extreme peak generation
  - Revenue for short periods in a year (around 100s hours)
  - Annual variability of the revenue

- + special pbs when targeting small consumers
  - Very high investment cost to implement DR on tertiary and domestic consumers
    - Change the meters for smart ones in every households
    - IT for DR dispatching and aggregation of individual DR into tradable DR blocks
    - E.g. for France: costs are estimated between 4 to 8 billion euros for 30 million new meters...
Demand response on small consumers can only be active in Day Ahead and balancing markets (not reserves)

- Because
  - DR is only possible when demand is high
  - DR is an Intermediation good:
    - DR can be automated but then more expensive
    - The customers can always decide to bypass
  - Size of the customer database is dynamic
  - Level of Cold-load pick-up effect (CLPU) is uncertain
    - We will assume 3 levels: 0% / 50% / 100%
    - Empirics range on CLPU effects on the next hour
      - 0% Computer or TV;
      - 50% Fridge;
      - 100 to 250% air conditioning or heating systems
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Problem

- **Q1** Smart metering & demand response
  - Regulated or competitive activity?
  - Solved through Q2

- **Q2** Assume it is competitive
  - Which market design to see the development of demand response?
  - If answer to Q2, then answer to Q1
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Global methodology

1. **Comparison of cost and benefits from DA and balancing markets for DR in France**
   - Possible missing money issue

2. **Same problem of revenue as peak generator**
   - Capacity mechanisms to complement the energy markets
   - Adaptation of the solution for peak generator -capacity mechanisms- to DR?
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Results

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Assumptions for Cost benefit comparison for DR in France

- 2 scenarios: optimistic & pessimistic

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Costs (M€)</th>
<th>Lifetime for meters (years)</th>
<th>Discount rate</th>
<th>Annualised investment cost (M€)</th>
<th>Demand response capacity (GW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimistic</td>
<td>4 000</td>
<td>40</td>
<td>8%</td>
<td>335</td>
<td>13</td>
</tr>
<tr>
<td>Pessimistic</td>
<td>8 000</td>
<td>20</td>
<td>15-20%</td>
<td>1 267 – 1 636</td>
<td>6</td>
</tr>
</tbody>
</table>
Assumptions for Cost benefit comparison for DR in France

- 2 scenarios: optimistic & pessimistic

<table>
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<tr>
<th>Scenarios</th>
<th>Average annualised investment cost (k€/MW)</th>
<th>Minimal needed revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimistic</td>
<td>$\frac{335}{13} = 26$</td>
<td></td>
</tr>
<tr>
<td>Pessimistic</td>
<td>$\frac{1267-1636}{6} = 211-273$</td>
<td></td>
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</tbody>
</table>
Calculation of benefits of DR with 0-50-100% CLPU effect on the French Market

Assumption #1: marginal analysis extrapolated to DR potential fully used each year (6 or 13 GW)

Revenue from DA market + Revenue from balancing = year total revenue

Mains secondary assumptions to max revenues size.

Assumption #2a: no change on price from massive DR

Assumption #2b: perfect anticipation of DA and balancing prices
e.g. the most optimistic cost-benefit comparison for DR (combining DA + balancing markets) with 0 % CLPU: improbable very favorable case

Recall: max need revenue 211 – 273 k€/MW
e.g. the most optimistic cost-benefit comparison for DR (combining DA + balancing markets) with 50 % CLPU : still very optimistic

Recall: max need revenue
211 – 273 k€/MW
With energy market only... simulations show:

Table of different cases studied

<table>
<thead>
<tr>
<th></th>
<th>Optimistic scenario</th>
<th>Pesimistic scenario</th>
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<tr>
<td>CPLU</td>
<td>0%</td>
<td>50%</td>
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<tr>
<td>Cost coverage?</td>
<td>green</td>
<td>yellow</td>
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Cost coverage?
Results

1. Comparison of cost and benefits from DA and balancing markets for DR in France
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   - Adaptation of the solution for peak generator -capacity mechanisms- to DR?
## Matching between DR and capacity mechanisms

### Comparison with DR policy

<table>
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<tr>
<th>Countries</th>
<th>Long term contracts</th>
<th>Capacity payment</th>
<th>Capacity Market</th>
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<tbody>
<tr>
<td></td>
<td>Portugal, Sweden, Norway, France, GB</td>
<td>Spain, Italy, Argentina, Chile, Colombia, Peru</td>
<td>USA regional markets: PJM, NYISO, ISO-NE</td>
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<th>Matching Demand Response Capacity Mech.</th>
<th>+/−</th>
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<th>+</th>
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<tr>
<td>Current mode for DR development</td>
<td>Pilot project + Mandatory roll-out</td>
<td>Mandatory roll-out + ? In L.A.</td>
<td>Mainly merchant &amp; roll-out by some utilities</td>
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</table>
Strategy of USA DR operators

- Energy Connect, X
- Energy Curtailment Specialists, X
- North America Power Partners, X
- EnerNOC, Inc., X
- CPower, Inc., X
- Comverge, X
- Site-Controls, LLC, X
- Powerit Solutions, X
- RTP Controls, Inc., X
- Energy Optimizers USA, X

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<th>Companies</th>
<th>1. Industrial</th>
<th>2. Tertiary</th>
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Harvesting with decreasing return on investment
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Conclusion

- With adapted market design, i.e., with capacity market, DR develops in a competitive way.

- Otherwise, market design needs to be patched with regulatory action for DR through mandatory roll-out.
Possible follows-up

- **Precise revenue calculation**
  - Impact of DR on price?
  - Imperfect anticipation of price and revenue risk?
  - Which revenue from capacity market?
  - Better distinction between the different types of DR customers?
    - Industrial + big tertiary vs small tertiary + residential
    - Competitive vs universal service?
  + Interaction between the massive development of intermittent RES and DR

- **Implementation of capacity market without pool**
  - E.g. France or more broadly in Europe