Lessons from Demand Response: Trials and Potential Savings for the EU

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Smart Meters, Smart Prices
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Contents

♦ Smart tariffs overview
♦ Results from demand response trials
♦ What is the value of demand response?
♦ Measures to boost the adoption of dynamic tariffs
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Smart prices come in a variety of shapes and colors

- Inclining block rate (IBR)
- Time-of-use (TOU) rate
  - Seasonal rate
  - Time-of-day (TOD)
- Critical-peak pricing (CPP) rate
  - Called Day-ahead (CPP-F)
  - Called Day-of (CPP-V)
- Peak Time Rebate
- Variable peak pricing (VPP) rate
- Real-time pricing (RTP) rate
  - Year-round capacity cost allocation
  - Critical-peak hours capacity cost allocation
By enabling customer choice, they enhance economic efficiency.
Comparison of Fixed and Dynamic Rates

Flat and dynamic rates for residential customers in New York City
Simulated impact of dynamic pricing

Impact of dynamic pricing on hourly loads (top 500 hours)
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49 tests with dynamic pricing have yielded 49 different estimates of demand response.
The picture sharpens if we group results by pilot

Notes: (1) OP refers to Olympic Peninsula Pilot. (2) GP refers to Gulf Power Pilot. (3) Others include Anaheim, ESPP, Australia, GPU, Idaho and PSE pilots.
It sharpens further if we group results by rate type.
And it sharpens even further when we introduce enabling technology as an explanatory variable.
Enabling technologies facilitate greater demand response

Role of Technology on Pilot Program Impacts

- No Technology
- Technology

% Reduction in Load

Pilot Program:
- PSE&G (TOU)
- PSE&G (CPP)
- CA SPP (CPP)
- AmerenUE-2004 (CPP)
- AmerenUE-2005 (CPP)
PRISMetrics

Dynamic Rate
Weather Data
Load Shape
CAC Saturation

PRISM
Customer-Level Demand Response
Customer Participation Forecast
System-wide Peak Reduction

Avoided Capacity
Avoided Energy
Market Price Mitigation
Additional Benefits
The PRISM software integrates all these results.

Customer-Level Peak Impacts from Dynamic Pricing

- Residential with CAC
- Large C&I
- Residential w/o CAC
- Small/Medium C&I

Price Ratio (Peak Rate to Existing Rate)

Peak Reduction
Some of the latest results come from Baltimore, Maryland.

<table>
<thead>
<tr>
<th>Rate Design</th>
<th>Enabling Technology</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPP</td>
<td>None</td>
<td>DPP</td>
</tr>
<tr>
<td>DPP</td>
<td>Energy Orb and A/C Switch</td>
<td>DPP_ET_ORB</td>
</tr>
<tr>
<td>PTRL</td>
<td>None</td>
<td>PTRL</td>
</tr>
<tr>
<td>PTRL</td>
<td>Energy Orb Only</td>
<td>PTRL_ORB</td>
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<td>PTRL_ET_ORB</td>
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<tr>
<td>PTRH</td>
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<td>PTRH</td>
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<td>PTRH_ET_ORB</td>
</tr>
</tbody>
</table>
The experiment yielded elasticities that vary with weather

<table>
<thead>
<tr>
<th>Program Type</th>
<th>Elasticity (Substitution or Daily)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Based on Minimum Weather</td>
<td>-0.15</td>
</tr>
<tr>
<td>Based on Average Weather</td>
<td>-0.10</td>
</tr>
<tr>
<td>Based on Maximum Weather</td>
<td>-0.05</td>
</tr>
</tbody>
</table>

- Price Only
- Price + ORB
- Price + ET_ORB
- Daily
Significant demand response impacts were observed
Smart rates can reduce bills in the near-term for most customers

Distribution of Bill Impacts

- Revenue Neutral
- Credit for Hedging Cost Premium
- Demand Response Plus Credit for Hedging Cost Premium

Customers with Flatter Consumption

Customers with Peakier Consumption

Percentile of Customer Base
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What is the value of demand response?

**Operational**
- Easier meter reading
- Faster outage detection
- Reduced theft/billing errors etc.

**Infrastructure/energy**
- Reduced need for peak capacity
- Less Transmission capacity
- Energy savings

Estimated at between 50-80% of meter costs

We estimate these benefits for the EU
Principal saving is the reduction in peak capacity.

Example from the French load duration curve:

Capacity only used for 1% of hours.

The Brattle Group
What could demand response be worth in the EU?

\[
\text{Saving, } \varepsilon \hspace{2cm} = \hspace{2cm} \begin{array}{c}
\text{Cost of} \\
\text{capacity,} \\
\text{€/MW}
\end{array} \times 
\begin{array}{c}
\text{Peak} \\
\text{demand,} \\
\text{MW}
\end{array} \times 
\begin{array}{c}
\text{Reduction} \\
\text{in peak} \\
\text{from DR,} \\
\text{%}
\end{array} \times 
\begin{array}{c}
\text{Adoption} \\
\text{rate of} \\
\text{dynamic} \\
\text{tariffs,} \\
\text{%}
\end{array}
\]

Known parameters

These are the two factors that are difficult to estimate
Demand response rate in the EU

As the previous slides illustrate, to date most trials have been carried out in North America.

The main difference between the EU and North America is the lower intensity of energy use in the EU.

♦ For example, there is much lower penetration of Air Conditioning in the EU.

How transferable are DR rates from N. America to the EU?

*Current trials should help answer these questions*
EU smart meter trials

Currently many demand response trials being conducted in the EU

♦ Ireland - Customer Behaviour Trials, start in January 2010
♦ GB - smart meters in around 18,000 houses and real-time display devices in about 8,000 homes. Final reporting will be complete in Autumn 2010.
♦ France and Germany are also undertaking large-scale trials, with Austria, the Czech Republic and Spain piloting smaller smart-meter schemes.

Data from the US trials indicate peak demand reductions of between 10-15% should be possible.
Adoption rates (1)

In markets with retail competition like the EU, dynamic pricing is a two-stage process
- The customer must first choose a dynamic tariff
- Then he or she responds to it.

Trials ‘assume’ this first step.
In many parts of the US step 1 is a non-issue because there is a standard tariff set by the regulator, or no retail competition at all.
Adoption rates (2)

Where consumers have a choice, adoption rates are relatively low.

- Data from the US indicates that where tariffs are ‘opt out’ the adoption rate is 80%.
- Where tariffs are ‘opt in’ and consumers must choose smart tariffs, adoption is only 20%.

These numbers find support from experience in GB. About 15% of households have adopted the simple TOU ‘Economy 7’ tariff.

Texas, which has full retail competition, has one of the lowest rates of smart meter adoption in the US.
Adoption rates and estimated savings from DR

We have estimated the cost of installing smart meters in the EU. The likely savings assuming adoption rates are:

♦ 20% – low adoption rate
♦ 80% – high adoption rate

We take the case that in the low adoption case peak demand is reduced by 2%, where as the reduction is 10% in the high case.

♦ Details of other assumptions and our calculations are in our discussion paper available at [www.brattle.com](http://www.brattle.com)
Estimated ‘non-operational’ benefits of dynamic tariffs for the EU – savings per year

- **High case**
  - T&D: 536
  - Energy: 589
  - Capacity: 4,774

- **Low case**
  - T&D: 118
  - Energy: 955
  - Capacity: 107

€ mln per year
Other benefits we do not quantify

Environmental benefits – ‘dirtier’ plants tend to operate in peak hours.

Increased competitiveness – more ‘elastic’ demand side reduces the incentive to exercise market power.
  ♦ Simple models indicate a doubling of demand elasticity is equivalent to a 50% reduction in market concentration.

Reduced volatility of prices – DR should make wholesale prices less volatile.
  ♦ PJM estimated that load reductions in August of 2006 reduced real-time prices by more than $300/MWh equivalent to more than $650 million in energy payments.

Better able to manage extreme events
  ♦ Multiple generator outages, extreme weather conditions etc.
Present value costs and benefits of smart meters

The PV difference between the high and the low case benefits is €53 billion.
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What are the barriers to adoption?

A recent Brattle-authored study FERC study identified 24 potential barriers to demand response, which were grouped into four categories:

♦ Regulatory – regulatory regime, market design, market rule, or the demand response program itself;
♦ Technical – include the need for new types of metering equipment, metering standards, or communications technology.
♦ Economic – the financial incentive for suppliers to offer demand response programs, and for customers to pursue these programs, is limited.
♦ Other – These are generally related to customer perceptions of demand response programs and a willingness to enroll.
Customers often find it difficult to judge the benefits of alternative tariff arrangements

An October 2009 consumer panel sponsored by Ofgem is instructive. The report noted that:

…it is observed that there is continued confusion surrounding energy tariff structures, despite the fact that Panel members have discussed tariffs in depth at previous panel events.”

“Most Panel members do not understand their current pricing plans and report that they are not aware of the tariff they are currently on; they even voice surprise when told they have a choice of tariff.”

Panel member: “When I have looked at tariffs, I just couldn’t understand them.”

“Most Panel members do not know if they are a high or low user, so assume they are the latter, and conduct their tariffs analysis with this assumption in mind.”

“Many suggest they would need to make substantial behaviour changes, such as having appliances on a timer, or changing the time of day when they do their cooking or washing, to make cost savings on this [TOU] tariff. Most Panel members agree that these changes are too substantial and too much effort for most, making this tariff quite undesirable to the majority.”

Quotes from ‘Ofgem Consumer First Panel - Research Findings from the Third Events' October 2009
Barriers to adopting smart tariffs

♦ There may be insufficient financial incentives to participate.

♦ Customers may be risk-averse, worrying that their bills increase if they switch to a dynamic tariff, rather than focusing on the potential savings.

♦ Customers may feel that they do not know how to shift demand to make the most of dynamic pricing.

♦ There may also be inertia which contributes to low participation rates in voluntary programs.
Stress the environmental benefits – many consumers who are attracted by ‘green’ tariffs could find dynamic tariffs attractive.

♦ Estimate environmental benefits of shifting load off-peak.
♦ We could imagine a ‘green-o-meter’ which gives the real-time carbon intensity of power production.

Ensuring transparent and adequate financial rewards can also help overcome customer inertia.

♦ Critical Peak Pricing (CPP), where customers agree to load curtailment at times of peak demand in return for a lower flat-rate tariff.
♦ Innovative use of IT could also help – once AMI is in place, customers could simply enter their meter number into a website to generate an estimate of savings, assuming various levels of DR.
What can be done to promote smart tariffs? (2)

Some Member States could set a dynamic regulated tariff
♦ In states where there is a regulated tariff, many consumers remain on it

Dynamic Transmission and Distribution (T&D) tariffs
♦ While regulators cannot set retail tariffs, they do have control over T&D charges
♦ T&D charges make up between 20-30% of retail consumers’ bills
♦ A dynamic tariff – where T&D charges very with customer use at times of peak demand – could encourage further demand management
♦ T&D tariffs could also increase when there is congestion on the grid
Demand response and technology

There may be more scope to investigate the costs and benefits of enabling technologies.

For example, the GB trial includes visual display units, but these do not give feedback on current prices.

Technologies include:
- Visual prompts – the ‘energy orb’
- Text alerts
- Remote switching of devices
- Programmable thermostats

A recent FERC study found that enabling technology was cost effective for 84% of States.
Conclusions

♦ DR pilot studies are underway in many Member States:
  • More work is needed on the costs and benefits of enabling technology in Europe.
  • Need to be careful about extrapolating the results of the pilot studies.

♦ The adoption of smart tariffs will be crucial to the success of the EU’s investment in smart meters. The PV difference in benefits between high and low adoption rates is €53 billion

♦ More research is required to understand what would increase the adoption rates of dynamic tariffs
  • What dynamic-tariff designs would different groups of consumers find attractive?
References

♦ You can find more information and cites to most of the public references and source material used in the discussion paper: “Unlocking the €53 Billion Savings from EU Smart Meters” available at www.brattle.com
Ahmad Faruqui is a principal with *The Brattle Group*. His state-by-state assessment of the potential for demand response in the US for the Federal Energy Regulatory Commission was filed with Congress in June. Last year, he assessed the national potential for energy efficiency for the Electric Power Research Institute and wrote a report on quantifying the benefits of dynamic pricing for the Edison Electric Institute.

He has worked on fostering economic demand response for several transmission planning organizations in the US and researched the development of load management standards for the California Energy Commission. In addition, he has assisted some two dozen utilities and commissions in North America assess the economics of dynamic pricing, demand response and advanced metering. He has also written a primer on these issues for the World Bank.

His early work on time-of-use pricing is cited in Bonbright’s canon. The author of several books and more than a hundred papers, he holds a doctoral degree from the University of California at Davis.