Demand Response as a Power System Resource

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Major points today

1. **What?** What is Demand Response (DR)?
2. **Why?** Proven values of DR
3. **How?** Many ways that DR is delivered
4. **History and Status:** DR in the US and challenges for DR in Europe
WHAT?

WHAT is Demand Response?
Traditional DR – Peak Shaving
DR: “Changes in demand, compared to baseline conditions, in response to power system conditions” —not just responses to prices
New Challenge: Managing “Net Load” in High-RES Power Systems

Net load (Demand – available RES) is more volatile than overall demand, lacks a predictable, repeatable pattern.

A challenging week for West Connect, USA, assuming 35% wind penetration.
DR Can Cover 8% to 10% of Peak Demand in Major Regional Markets in the US

Source: FERC (2011)
# DR technical potential in Europe

Table 1. Share of theoretical potential for DR at system peak load

<table>
<thead>
<tr>
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<th>Total DR (GW)</th>
<th>Peak (GW)</th>
<th>Total DR / Peak</th>
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</thead>
<tbody>
<tr>
<td>France</td>
<td>11.6</td>
<td>102</td>
<td>11%</td>
</tr>
<tr>
<td>Poland</td>
<td>3.6</td>
<td>25</td>
<td>14%</td>
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<tr>
<td>UK</td>
<td>8.0</td>
<td>56</td>
<td>14%</td>
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WHY?

WHY should we care about Demand Response?
Benefits (1): DR lowers wholesale power costs to ALL consumers
Benefits (2): Capacity Savings from Peak Load Mgt
Benefits (3): DR + EE to Avoid T & D Upgrades

Con Edison Brooklyn-Queens Demand Management Project

- ConEd needs local distribution peak reductions (149 MW)
- Decided to use distributed resources as less expensive, and to avoid major disruptions in city (e.g. digging uptreets)
- Employs EE, DR, DG, thermal storage, fuel-switching
- Uses competitive bidding to deliver ideas and projects
- Extensive M&V
- Costs born by all customers thru regulated (e.g., distribution network operator) tariffs
- Utility reports $200 million cost will deliver savings of about $1 Billion
Benefits (4) DR providing Contingency Reserves

In ERCOT and PJM demand response provides ancillary services including reserve services, dynamic system regulation, and load-following capabilities to the grid during any hour of the year.

Demand Response Deployment of Emergency Reserves in Texas on August 4, 2011

Benefits (5) Matching Variable Renewables

Net demand (subtracting wind production) Denmark example

*Net demand*: gross demand minus demand effectively served by low-marginal-cost, uncontrollable supply.
HOW? HOW can we deliver Demand Response?
HOW? Many policies, many actors required to deliver “Efficiency First” in practice

- Wholesale market design
- Demand-side bidding in energy and capacity markets
- Retail rate design – will TOU and locational signals get through to customers, at least to their suppliers?
- PBR for distribution companies – RIIO-2 in the UK
- Smart grid and smart meters – not essential, but definitely useful
- Aggregators need an opportunity to act
US FERC promotes competition, including DR

FERC Directives (2007 -2011):

• System operators must give equal opportunity to bids from DR and traditional generators
• DR aggregators may bid the collective demand of many small customers
• If DR helps to balance supply and demand in the same way as generators, they must be paid equally
• System operators must pay for resources based on their operational capabilities (speed, precision) not type of resource (DR vs. turbine)
Where is DR commercially active in Europe?

Figure 3: Map of Explicit Demand Response development in Europe Today (SEDC, 2015)
Rate Design for DR: French Tempo Tariff

- Customers are told day-ahead what “color” tomorrow’s rates will be (note peak period is 6am to 10 pm; focus is winter heating period)
- Since 1996, now 400,000 customers
- Total reduction 450MW (45% reduction on “red” days, 10% “white” days
- On average enrolled customers save 10%
- Customer options for automatic controls on some appliances
Using Competition to Reveal DR Potential

- **Issue:** Power system needs reliable capacity on a forwards basis (to avoid future capacity crisis)
- **Generator proposal:** Pay for Generator capacity in advance, for 10-year forward period
- **Better solution:** Let supply and demand-reduction also bid to meet growth needs
- First auction (New England ISO) 2007: demand resources including EE won **2/3rds of the bids for new capacity** & lowered the clearing price
- PJM auction (for 2012/2013) DSM bids lowered the clearing price by 90% --Consumers saved $12 Billion in one auction period alone.
- Contrast: 1st UK auction (2014) limited DR access & got almost nothing from demand response
With open competition DR grows (PJM example)
Who Provides DR?
– Not Just Industrial Customers

Percent of Nominated Capacity (MWs) – PJM 2015/16
“Smart Grid” is Largely About Responsive Load

Reduced operating costs
 – Meter reading, outage management
 – Better bill collection

Enhanced reliability, quick response

Peak load management
 – Reduced energy, capacity, and transmission & distribution costs

Reduced energy consumption
 – Automation and behavioral changes that complement energy efficiency programs

Ability to control (“dispatch”) large new loads
 – Including electric vehicles, heat pumps

Interconnect, balance and deliver renewable resources
Not necessarily high-tech: Thermal storage options

- Thermal storage – low tech solution
  
  {“Ice Energy: A battery for your air conditioner”}

- Thermal resources are large-scale, inexpensive, widely distributed

- Example: 53 million connected water heaters in PJM

- Converted to storage, each has 60% more storage capability than “smart-charging” an electric vehicle.

- 30 GW of hot water heaters = >the 24GW of pumped storage on the PJM system today

- “So if we had a Smart Grid to do the controls and the water heaters, most of our problems on regulation go away.” – Terry Boston, CEO PJM Interconnection
Innovation will be essential – huge variation in customer response across many pilots

![Average Peak Reduction from Time-Varying Rate Pilots](chart-image)

- TOU
- TOU w/ Tech
- PTR
- PTR w/ Tech
- CPP
- CPP w/ Tech
- RTP
- RTP w/ Tech

**Peak Reduction**:
- 60%
- 50%
- 40%
- 30%
- 20%
- 10%
- 0%

**Pricing Pilot**:
- 1
- 109
Regulatory Assistance Project (RAP)

RAP is a global, non-profit team of experts providing technical and policy assistance to government officials on energy and environmental issues.

RAP has advised governments in more than 30 countries and 50+ provinces and states, and now has major programmes in the US, China, India and Europe.

European offices and staff are in Brussels, Berlin, Warsaw, and the UK.

Experience with Demand Response in all of our regions:

- In China – aggressive DR used to drive capacity factors >90%
- In India – where “DR” often consists of rotating power cuts
- In US – growth of systemwide DR in regional ISOs and markets
- In the EU – for cost savings, reliability, RES integration, and the “prosumer” idea

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