Reinventing Demand Response

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PRESENED BY
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Prepared with Ahmad Faruqui and Ryan Hledik

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THE Brattle GROUP
Demand Response (DR)

What is the objective? — Essentially to identify and engage customers’ demand flexibility

Unlocking the “Real” Demand Curve

- Hidden: system planning and operations mostly rely on best estimates of static/fixed demand
- With some proxies, e.g., VOLL
- Estimates anywhere from minute-to-minute to year-by-year
- A surprisingly large “resource” if it can be tapped (60 GW today): customers respond to price, instruction, and/or externalities (e.g., greenness)
- Provides cost savings and efficiency, at customer level and system level
Many ways to engage DR; this presentation focuses on price-based signaling residential customers via retail rates... but signaling for greenness is emerging

Price-based programs:
- Real-time pricing
- Critical peak pricing
- Time-of-use pricing
- Other time-varying rates

Incentive-based programs:
- Reliability programs (retail or wholesale)
- Other wholesale programs
Why Does DR Need Reinvention?

Traditional DR programs, that assume none of the following exists, cannot fully engage customers to meet system and customer needs:

- **Customer appetites for green energy** are fundamentally changing the supply mix and how the system operates; flexibility in all aspects of the system is becoming increasingly important.

- **Advanced meters, customer surveying techniques, and data analytics** are making it easier to observe the “true” demand curve and nuances in customer preferences.

- **Smart home tech, smart appliances, EVs and storage** are creating new demand flexibility with residential customers.

- **Communication technology, webware, and apps** are making it possible to engage customers on short notice and with complex shopping decisions.
Flexible Demand... Not a New Concept!

DR Peak Impacts: 2005–2017

Traditional DR capability doubled in 10 years, but more recently hit a saturation point

Total U.S. Peak Reduction Capability from DR

Contributing Factors

- Wholesale market refinements
- Low capacity and energy market prices
- Slowdown in load growth

A new Brattle study shows that a portfolio of load flexibility programs could triple existing DR capability, approaching 200 GW (20% of system peak) by 2030.

U.S. Cost-Effective Load Flexibility Potential

Source: Hledik, Ryan, Ahmad Faruqui, Tony Lee, John Higham, “The National Potential for Load Flexibility: Value and Market Potential through 2030,” June, 2019. Note existing DR capability does not account for impacts of retail pricing programs, as fewer than 1% of customers are currently enrolled in dynamic pricing rates and the impacts of long-standing TOU rates are already embedded in utility load forecasts.
DR Retail Pricing Methods

If achieved via dynamic pricing, depends on regulator **and** customer appetites for bill stability vs. cost saving opportunities

Source: Ahmad Faruqui et al., The Brattle Group.
Responsiveness to Dynamic Pricing

Studies around the world have shown that some customers are responsive to dynamic pricing, and even more so with enabling tech.

Retail Rate (Tariff) Modernization

- Nationally, about half of all meters are smart meters, but only 5% of customers are on advanced rates (FERC, 2018)

- Important to get the signal to customers “right”
  - Affects investment decisions and day-to-day behavior
  - Rate components/structure to better reflect cost of service (customer segmentation, fixed/demand/variable, time profile/dynamic pricing)
  - But balanced with other rate design objectives (see Bonbright, 1988)
  - Subsidies and incentive payments help to launch new technologies and programs, but will increasingly distort signals as DR resources grow
  - Customers increasingly interested in greenness signal, not just price
## Example of Retail Pricing Options: Arizona Public Service

### Residential Plan Comparison*

<table>
<thead>
<tr>
<th>PLANS</th>
<th>BASIC SERVICE CHARGE (PER DAY)</th>
<th>ENERGY CHARGE (PER KWH)</th>
<th>OFF-PEAK PRICING</th>
<th>SUPER OFF-PEAK WINTER PRICING</th>
<th>ON-PEAK SUMMER PRICING</th>
<th>ON-PEAK WINTER PRICING</th>
<th>ON-PEAK SUMMER PEAK USAGE (DEMAND) CHARGE PER KW</th>
<th>ON-PEAK WINTER PEAK USAGE (DEMAND) CHARGE PER KW</th>
<th>OFF-PEAK HOURS</th>
<th>SUPER OFF-PEAK WINTER HOURS</th>
<th>ON-PEAK HOURS</th>
<th>ENERGY USE RESTRICTIONS (12 MONTH AVERAGE)</th>
<th>RENEWABLE ENERGY COMPATIBLE</th>
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</thead>
<tbody>
<tr>
<td>Saver Choice</td>
<td>42.7€</td>
<td>-</td>
<td>10.873€</td>
<td>3.200€</td>
<td>24.314€</td>
<td>23.068€</td>
<td>8 p.m. – 3 p.m. weekdays, all weekend +10 holidays</td>
<td>10 a.m. – 3 p.m. weekdays</td>
<td>3 p.m. – 8 p.m. weekdays</td>
<td>8 p.m. – 3 p.m. weekdays, all weekend +10 holidays</td>
<td>-</td>
<td>Yes (with grid access charge)</td>
<td></td>
</tr>
<tr>
<td>Saver Choice Plus</td>
<td>42.7€</td>
<td>-</td>
<td>7.798€</td>
<td>-</td>
<td>13.160€</td>
<td>11.017€</td>
<td>8 p.m. – 3 p.m. weekdays, all weekend +10 holidays</td>
<td>-</td>
<td>3 p.m. – 8 p.m. weekdays</td>
<td>-</td>
<td>-</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Saver Choice Max</td>
<td>42.7€</td>
<td>-</td>
<td>5.230€</td>
<td>-</td>
<td>8.583€</td>
<td>6.375€</td>
<td>8 p.m. – 3 p.m. weekdays, all weekend +10 holidays</td>
<td>-</td>
<td>3 p.m. – 8 p.m. weekdays</td>
<td>-</td>
<td>-</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Lite Choice</td>
<td>32.9€</td>
<td>11.672€</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Under 600 kWh per month</td>
<td>-</td>
<td>No</td>
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<tr>
<td>Premier Choice</td>
<td>49.3€</td>
<td>12.393€</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>601-999 kWh per month</td>
<td>-</td>
<td>No</td>
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</tbody>
</table>

*The following plan is available to eligible customers after a trial of 90 days on one of the Saver Choice plans.

Future DR growth will also depend on expanded definitions of the type and method of services provided.

<table>
<thead>
<tr>
<th>Service</th>
<th>Generation capacity avoidance</th>
<th>Reduced peak energy costs</th>
<th>System peak related T&amp;D deferral</th>
<th>Targeted T&amp;D capacity deferral</th>
<th>Load shifting/building</th>
<th>Ancillary services</th>
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</thead>
<tbody>
<tr>
<td>Direct load control</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>Interruptible tariff</td>
<td>X</td>
<td>X</td>
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<td>Demand bidding</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>Time-of-use (TOU) rates</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>Dynamic pricing</td>
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<td>Behavioral DR</td>
<td>X</td>
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<td>EV managed charging</td>
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<td>X</td>
<td>X</td>
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<tr>
<td>Smart water heating</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
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<td>X</td>
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<tr>
<td>Timed water heating</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td>Smart thermostat</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Ice-based thermal storage</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
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<tr>
<td>C&amp;I Auto-DR</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Example: DR Impacts on a Peak Demand Day

New demand response could provide flexibility throughout the day

Illustration of Demand Flexibility Across Hours in a Peak Day

Ms. Mariko Geronimo Aydin, a Senior Associate in The Brattle Group’s San Francisco office, has almost fifteen years of experience in analyzing the policies and economics of electricity system planning, regulation and de-regulation of electricity supply, and wholesale electricity markets across the U.S. Her more recent work has focused on finding sustainable and creative ways to adapt traditional planning processes and analytical tools to an industry rapidly shifting towards cleaner and more scalable supply technologies. Today’s electricity industry still has untapped potential to meet goals of clean energy, cost-effectiveness, and operational and planning flexibility through greater electricity customer engagement, cutting-edge data analysis, and new technologies. To reach this potential with a robust and modern grid, Mariko works with clients to explore options for evolving utility business models, customer choice, and wholesale market refinements that can make the best use of distributed and customer-driven power supply resources, in synergy with more traditional resources.

Mariko holds a B.S. in Economics and an M.A. in Applied Economics from Northeastern University in Boston, Massachusetts.

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