Rolling Out Residential Demand Charges

PRESENTED TO
EUCI Residential Demand Charges Summit

PRESENTED BY
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May 2015
So you’ve decided to roll out a demand charge…

Transition option 1
- The tariff change is made overnight
- “Customers will figure it out”

Transition option 2
- The transition is carefully planned
- It is grounded in quantitative research
- It is gradual
- It includes pre-emptive outreach
Throughout this presentation, I use a simple example to illustrate the rate transition

- The rates are revenue neutral
- Analysis is based on actual hourly utility load research data (~200 customers)
- Demand is measured as maximum (non-coincident) demand per month
- Demand is measured as average over a 60-minute interval

<table>
<thead>
<tr>
<th></th>
<th>Old Two-Part Rate</th>
<th>New Three-Part Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed charge</td>
<td>$10/month</td>
<td>$10/month</td>
</tr>
<tr>
<td>Volumetric charge</td>
<td>11 cents/kWh</td>
<td>6 cents/kWh</td>
</tr>
<tr>
<td>Demand charge</td>
<td>$0</td>
<td>$9/kW-month</td>
</tr>
</tbody>
</table>
The rate change will affect each customer’s bill differently

- Good news: A major cross-subsidy has been removed
- Bad news: Some customers will experience bill increases
- More good news: Transition plans help facilitate the change for these customers
Several issues should be considered when transitioning customers to the new rate

- Customer price response
- The role of enabling technology
- Opt-in versus opt-out deployment
- Rate transition strategies
Customer price response
Most assessments of bill impacts ignore likely customer response to the new rate

Under a three-part rate, customers can reduce peak demand to lower their bill

Price response has been observed in at least 40 different experimental studies of time-varying volumetric rates over the past decade

But will customers respond to a demand charge?
Three experimental pilots have detected significant response to demand charges

However...

- Two of the pilots are old and the third is from a unique climate
- The impact estimates vary widely
- Findings are based on small sample sizes
- New research is needed

Note: The North Carolina pilot was analyzed through two separate studies using different methodologies; both results are presented here.
Customers will respond to a demand charge if three conditions are met

1) **Customers must generally be sensitive to changes in price.** If customers are not generally sensitive to changes in the price of electricity, then they will not respond to rate changes. A customer’s degree of sensitivity to the price of electricity depends on a wide range of socio-economic variables and other factors that vary regionally.

2) **The rate design change must provide the customer with a meaningful bill savings opportunity.** Customers will only respond to a rate design change if it presents them with an opportunity to reduce their bill. Otherwise, there is no compelling reason to change behavior.

3) **The rate design must be actionable.** Even if customers are price responsive and the new rate provides a bill savings opportunity, customers will only respond if they know which actions will lead to those bill savings. If they do not know how or when to change their consumption pattern in order to reduce their bill, or do not understand the rate, they will not take action.
Is there a meaningful bill savings opportunity?

One Customer’s June Consumption Profile

YES: 30% of max demand is concentrated in the top 1% of hours
Is the new rate actionable?

It can be, with the right customer education

Responding to a demand charge does **not** require that the customers know exactly when the interval of maximum demand will occur

If customers generally know to avoid the simultaneous use of electricity-intensive appliances, they could easily reduce their maximum demand without ever knowing when it occurs

This simple message should be stressed in customer marketing and outreach initiatives associated with the demand rate

The following example is a hypothetical illustration of the composition of the typical customer’s maximum demand (8.5 kW), and the benefits of staggering the use of a few key appliances
Staggering the use of a few key appliances could lead to significant demand reductions

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Avg. Demand (kW)</th>
<th>Flexible Load (7.5 kW)</th>
<th>Inflexible Load (1 kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dryer</td>
<td>4.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oven</td>
<td>2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stove</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand iron</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Misc. plug loads</td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lighting</td>
<td>0.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refrigerator</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8.5</strong></td>
<td><strong>Flexible Load (7.5 kW)</strong></td>
<td><strong>Inflexible Load (1 kW)</strong></td>
</tr>
</tbody>
</table>

**Comments**

- Use of some of the appliances is inflexible (1 kW)
- Use of other appliances could be easily staggered to reduce demand
- Simply delaying use of the dryer until after the oven, stove, and hand iron had been turned off would reduce the customer’s maximum demand by 3.5 kW
- This would bring the customer’s maximum demand down to 5 kW, a roughly 40% reduction in demand
We have developed a model to simulate customer response to demand charges

The model is based on a widely accepted methodological framework that captures two key effects:

- **Load shifting** in response to a change in rate structure
- **Conservation (or the opposite)** in response to a change in average rate level

The model draws on an extensive library of customer price elasticity estimates found in pricing pilots over the past decade.
Customers could modify consumption patterns by a significant amount

**Average Change in Residential Load Profile Due to Price Response**

<table>
<thead>
<tr>
<th></th>
<th>Average change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer max demand</td>
<td>-5.3%</td>
</tr>
<tr>
<td>Class peak demand</td>
<td>-1.7%</td>
</tr>
<tr>
<td>System peak-coincident demand</td>
<td>-1.5%</td>
</tr>
<tr>
<td>Annual consumption</td>
<td>0.2%</td>
</tr>
</tbody>
</table>
The change in consumption leads to lower customer bills
The role of enabling technology
Technology will help customers manage demand

Smarter demand management will be enabled by new technologies

And third parties will compete to be the customer’s energy advisor
Examples of enabling technologies & services

**Demand limiters:** Demand limiters are a technology that has been around for a long time. They prevent the simultaneous use of multiple appliances, as specified by the owner.

**Energy “orb”:** The energy orb has also been around for at least a decade. It glows different colors depending on trends in stock price, weather, or any other index that the owner ties it to. In the case of demand charges, it could provide an indication that the customer is approaching certain demand thresholds.

**In-home information displays:** These devices display real-time information about the owner’s usage. They would help not only in alerting the customer when his demand is high, but would help the customer understand the electricity consumption of various appliances.

**Smart appliances:** The “connected home” is emerging as a fast growing consumer product industry segment. Companies like Nest are seeking to provide home smart automation services through networked appliances, such as the central air-conditioner. Other products are also available today that apply window air-conditioners. This network could be leveraged to manage energy consumption in many ways.

**Curtailment service providers:** In the C&I sector, curtailment service providers who provide demand response programs to their clients are also working with these clients to manage their demand and reduce their demand charge. Similar services could be offered by residential DR providers.
Technology will enable larger, more targeted demand reductions

We assume that technology will allow customers to target the top 1% of demand intervals each month

Response is similar to that observed in residential critical peak pricing rates

<table>
<thead>
<tr>
<th></th>
<th>Without Tech</th>
<th>With Tech</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer max demand</td>
<td>-5.3%</td>
<td>-22.0%</td>
</tr>
<tr>
<td>Class peak demand</td>
<td>-1.7%</td>
<td>-3.1%</td>
</tr>
<tr>
<td>System peak-coincident demand</td>
<td>-1.5%</td>
<td>-3.0%</td>
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<tr>
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<td>0.2%</td>
</tr>
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Bill savings could increase significantly with technology

Avg bill savings with tech = $140/year
Opt-in versus opt-out deployment
The new rate could be offered on an opt-in basis

With an opt-in offering, customers remain on the existing rate unless they proactively sign up for the new rate

This reduces the risk that customers will be surprised by a bill change

But...

Will customers enroll?

Will this enrollment lead to revenue loss for the utility?
Customer enrollment in TOU rates is shown to be lower with opt-in deployment than with opt-out.

With good marketing and outreach, opt-in rates of 20% to 30% are feasible.

APS has over half of its customers on opt-in TOU rates.

10% of APS’s residential customers have a demand charge.

Residential TOU Enrollment Rates

- Hashed pattern indicates heavily marketed full-scale deployment, solid bar indicates primary market research.

<table>
<thead>
<tr>
<th>Utility</th>
<th>Opt-in TOU</th>
<th>Opt-out TOU</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO New England</td>
<td>14%</td>
<td>79%</td>
</tr>
<tr>
<td>Utility A*</td>
<td>19%</td>
<td>84%</td>
</tr>
<tr>
<td>Xcel Energy (Colorado)</td>
<td>21%</td>
<td>86%</td>
</tr>
<tr>
<td>California IOUs</td>
<td>23%</td>
<td>90%</td>
</tr>
<tr>
<td>Utility B*</td>
<td>24%</td>
<td></td>
</tr>
<tr>
<td>Salt River Project</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>Arizona Public Service</td>
<td>43%</td>
<td></td>
</tr>
<tr>
<td>Utility C</td>
<td>53%</td>
<td></td>
</tr>
<tr>
<td>California IOUs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xcel Energy (Colorado)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utility B*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ontario, Canada</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Utility identity is concealed because study results have not yet been made public.
Opt-in enrollment will depend in part on the bill savings opportunity for customers

One extreme approach is to assume that customers are “human supercomputers” who always choose the rate that minimizes their bill

With this assumption, a customer will enroll in the new rate even if it saves him one penny

Bill savings are the only thing that matter in this scenario; there is no consideration for factors like awareness and risk aversion

We call this the “perfect choice” scenario
The “perfect choice” scenario is the worst case scenario from a utility revenue perspective.

Distribution of Bill Changes

Decrease in residential revenue = 5%
A summary of the “perfect choice” scenario

Impact Due to “Perfect Choice” Rate Switching

<table>
<thead>
<tr>
<th>Change</th>
</tr>
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<tbody>
<tr>
<td>Customers opting in to new rate</td>
</tr>
<tr>
<td>Utility revenue loss (%)</td>
</tr>
<tr>
<td>Avg switcher's bill savings (%)</td>
</tr>
<tr>
<td>Avg switcher's bill savings ($/mo)</td>
</tr>
</tbody>
</table>
In reality, customers are not “human supercomputers”

Customers are more likely to opt-in to the new rate if it provides large bill savings, but they will not choose the bill-minimizing rate with complete certainty.

Other factors will influence their enrollment decision, such as:

- Lack of awareness of the new rate
- Uncertainty about the impact of the new rate on their bill
- Limited time and resources at to conduct the research necessary to make the optimal decision
- Perception that features of the bill-minimizing rate are negative attributes (e.g. increased bill volatility)

Realistic switching rates can be estimated using a “discrete choice model”
Illustration of the rate choice model

- If rate choice perfectly minimizes bill
- If rate choice is completely random

Market share of new rate

Bill savings of new rate relative to existing rate (positive = savings)
Illustration of the rate choice model

If rate choice perfectly minimizes bill

If rate choice reflects realistic behavior

If rate choice is completely random
**Realistic rate switching behavior can still lead to significant revenue impacts**

### Impact Due to Rate Switching

<table>
<thead>
<tr>
<th></th>
<th>Perfect Choice</th>
<th>Realistic Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers opting in to new rate</td>
<td>52%</td>
<td>22%</td>
</tr>
<tr>
<td>Utility revenue loss (%)</td>
<td>-5%</td>
<td>-3%</td>
</tr>
<tr>
<td>Avg switcher's bill savings (%)</td>
<td>-8%</td>
<td>-9%</td>
</tr>
<tr>
<td>Avg switcher’s bill savings ($/mo)</td>
<td>-$13</td>
<td>-$17</td>
</tr>
</tbody>
</table>

- One approach to mitigating the revenue impact has been to build the anticipated revenue loss into the new rate design
- Another approach is to recover the lost revenue from the customers who are on the old flat rate
Rate transition strategies
With an opt-out rate offering, a gradual transition will minimize annual bill changes.

Distribution of Bill Changes by Year

- Year 3 ($9/kW)
- Year 2 ($6/kW)
- Year 1 ($3/kW)
Other available tools for making the transition include the following

- Temporary bill protection
- Tiered demand charges or ceiling on applicable demand
- Shadow bills
- Enhanced customer outreach and education
- Rebates for enabling technologies
- Separate rate for vulnerable / low income customers
The transition to demand charges will take time

**Rate Design**
- Rate benchmarking
- Cost structure review
- Formation of ratemaking objectives
- Rate development

**Pilots**
- Pilot design
- Sample selection
- Process evaluation
- Customer satisfaction surveys
- Load impact analysis

**Impact Analysis**
- Load impacts
- Bill impacts
- Revenue impacts
- Conservation impacts
- Societal costs & benefits

**Transition Plans**
- Multi-year rate rollout strategies
- Protections for vulnerable customers
- Customer education

**Regulatory Activity**
- Rate case testimony
- Stakeholder outreach and education
- Conferences, whitepapers, webinars, etc.
This is just the beginning!

- How should the new three-part rate be designed?
- How does the new rate design compare to that of other utilities?
- How will customer bills be impacted?
- Who will be the “winners” and “losers”?
- Can “vulnerable” customers be protected?
- How will owners of distributed generation be impacted?
- Will the “death spiral” be avoided or just delayed?
- Should the rate be opt-in, opt-out, or mandatory?
- Should customers be offered a menu of rate options?
- If there is rate choice, how will utility revenue be impacted?
- Should the rate be piloted before full-scale deployment?
- How should the pilot be designed?
- Will the new rate change consumption patterns?
- What are the financial implications of these changes in consumption?
- How should the consumption changes be measured?
- How should the rate be marketed to customers?
- How should the transition to the new rate be made?
- What tools can be offered to customers to facilitate the transition?
- What is the best way to present all of this to regulators?
- And the list goes on...
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Ryan Hledik is a Principal in The Brattle Group’s San Francisco office. Mr. Hledik specializes in the economics of policies and technologies that are focused on the energy consumer. He assists clients confronting complex issues related to the recent slowdown in electricity sales growth and the evolution of utility customers from passive consumers to active managers of their energy needs.

Mr. Hledik has supported utilities, policymakers, law firms, technology firms, research organizations, and wholesale market operators in matters related to retail rate design, energy efficiency, demand response, distributed generation, and smart grid investments. He has worked with more than 50 clients across 30 states and seven countries.

A frequent presenter on the benefits of smarter energy management, Mr. Hledik has spoken at events throughout the United States, as well as in Brazil, Canada, Korea, Saudi Arabia, and Vietnam. He regularly publishes articles on complex retail electricity issues.

Mr. Hledik received his M.S. in Management Science and Engineering from Stanford University, with a concentration in Energy Economics and Policy. He received his B.S. in Applied Science from the University of Pennsylvania, with minors in Economics and Mathematics. Prior to joining The Brattle Group, Mr. Hledik was a research assistant with Stanford University’s Energy Modeling Forum and a research analyst at Charles River Associates.
About The Brattle Group

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- Energy Contract Litigation
- Environmental Compliance
- Fuel and Power Procurement
- Incentive Regulation
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- Risk Management
- Market-Based Rates
- Market Design and Competitive Analysis
- Mergers and Acquisitions
- Transmission
- Transmission
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Further reading


Further reading (concluded)


