Carrots, Sticks and Other “Smart” Tricks

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Other people whose tricks make me look smart: P. Hines, J. Clothiaux, S. Gautam, R. Mina

Support from DOE and Green Mountain Power (nee Central Vermont Public Service)
Carrots and Sticks

Source: Sanem Sergici, Brattle Group
eEnergy Vermont Experiment

Fall 2011
- Fall 2011: Smart meter installation begins.
- February – April 2012: Customer recruitment.
- April 2012: Smart meter installations completed. Meter data collection begins.
- August 2012: CPP and CPR customers placed on new rate; IHDs mailed to customers.
- September 14, 21, 25; Oct. 5, 2012: Year 1 events called.
- December 2012: Interim survey completed.

Dec. 2013
- July 5, 15, 16, 17, 18, 19, 2013: Year 2 events called.
- August 13, 21, 22, 28, 2013: Year 2 events called.
- Sept. 30, 2013: Meter data collection ends.
- December 2013: Post-treatment survey completed.
eEnergy Vermont Experiment

• RCT involving 3,735 GMP residential customers in Rutland;

• Opt-in to enroll; opt-out at any time;

• Event-based study with 24-hour notification of “peak days,” rate treatments: peak pricing, peak rebates and a transition group who started on a rebate and were moved to peak pricing;

• Tech and no-tech groups;

• Notification mode choices (phone, e-mail, text message);

• Detailed pre/mid/post study surveys.
## eEnergy Vermont Experiment

<table>
<thead>
<tr>
<th>Group No</th>
<th>Group Name</th>
<th>Survey</th>
<th>Year 1</th>
<th>Year 2</th>
<th>IHD</th>
<th>Notification</th>
<th>Required sample size</th>
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### eEnergy Vermont Experiment

<table>
<thead>
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<th>Rate/Information Treatment</th>
<th>Technology Treatment</th>
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<td>Critical Peak Price (CPP)</td>
<td>IHD</td>
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<tr>
<td>Critical Peak Rebate (CPR)</td>
<td>IHD</td>
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<tr>
<td>CPR in Year 1, CPP in Year 2</td>
<td>IHD</td>
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<tr>
<td>Flat Rate w/Notification</td>
<td>No IHD</td>
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~ 4,000 customers involved in the pilot.  
A “Hawthorne” group was created but no Hawthorne effect detected.
The Carrot: Critical Peak Rebates (CPR)

Consumers are given a credit for measured reductions in electricity use during declared peak periods.
The Stick: Critical Peak Pricing (CPP)

Electric rate increases during declared peak periods, but is slightly lower (relative to flat-rate) during all other periods.
In Home Device (Circa the Stone Age)

Overview

- Displays current household energy use in both kilowatts and dollars-per-hour
- Displays current day accumulated energy usage and compares cost with previous day’s cost
CPR, CPP and GMP

- Some utilities have run pilot programs that use peak-time rebates. Others have used critical-peak pricing.

- GMP was convinced to do both. This made their state regulator confused, and a little irritated. Aren’t peak prices and peak rebates basically the same thing? Why punish the poor people of Vermont?

Image source: NPR
Framing Gains and Losses

“The aggravation that one experiences in losing a sum of money appears to be greater than the pleasure associated with gaining the same amount.” - Kahneman and Tversky, 1979

- Avoiding a loss is somehow preferred to achieving a gain that is identical in magnitude.
- Suggests that we should expect larger savings from CPP than CPR.
- Can ratepayers be trained to like the stick?

Graphic: Annika Todd, LBNL
Data and Estimation

\[ y_{it} = \beta + \sum_j \beta_j T_{ij} + \sum_k \beta^{DB}_{ik} D_B + \sum_k \beta^{DE}_{ik} D_E + \sum_k \beta^{DA}_{ik} D_A + \sum_j \sum_k \beta^{DE(k)}_{jk} T_{ij} D_B + \sum_j \sum_k \beta^{DB(k)}_{jk} T_{ij} D_E + \sum_j \sum_k \beta^{DB(k)}_{jk} T_{ij} D_A + \beta_t^{CD} C + \beta_t^{HI} H + \epsilon_{it} \]

• 15-minute interval meter data for several thousand GMP residential customers in Rutland

• Plus some socio-economic data (house size, appliance stock, income, education, household size, etc)
Weekday Load Shapes

Average Hourly KW load during weekdays of 2013

Hour of the day

- CPR
- CPR-IHD
- CPP
- CPP-IHD
- Control
Event-Day Behavior, 2012 and 2013

IHD Customers, 2012

Non-IHD Customers, 2012

IHD Customers, 2013

Non-IHD Customers, 2013
Average Peak Time Load Reductions

Average Hourly KW Difference During Event Hours (Treatment: No Notification Control)

- CPR: 5.3%
- CPR+IHD: 7.4%
- CPP: 7.3%
- CPP+IHD: 14.1%
- Flat Rate w/ notification: 6.5%
Table E-1: Summary of load impacts (percentage reductions relative to the no-notification control group), 2012 and 2013

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2012</th>
<th></th>
<th></th>
<th>2013</th>
<th></th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Before</td>
<td>During</td>
<td>After</td>
<td>Before</td>
<td>During</td>
<td>After</td>
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<tr>
<td>Flat Rate w/ Notification</td>
<td>-6.45%</td>
<td>-3.38%</td>
<td>0.15%</td>
<td>-3.81%</td>
<td>-8.18%</td>
<td>-5.81%</td>
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<tr>
<td>CPR-CPR</td>
<td>-4.72%</td>
<td>-5.29%</td>
<td>-0.57%</td>
<td>1.06%</td>
<td>-2.17%</td>
<td>-1.52%</td>
</tr>
<tr>
<td>CPR-CPR w/ IHD</td>
<td>-2.65%</td>
<td>-7.64%</td>
<td>3.41%</td>
<td>2.41%</td>
<td>-9.55%</td>
<td>-5.77%</td>
</tr>
<tr>
<td>CPP-CPP</td>
<td>-1.51%</td>
<td>-7.42%</td>
<td>1.77%</td>
<td>-0.56%</td>
<td>-7.46%</td>
<td>-3.79%</td>
</tr>
<tr>
<td>CPP-CPP w/ IHD</td>
<td>-8.67%</td>
<td>-11.80%</td>
<td>2.68%</td>
<td>3.56%</td>
<td>-14.48%</td>
<td>-0.67%</td>
</tr>
<tr>
<td>CPR-CPP</td>
<td>-4.29%</td>
<td>-8.57%</td>
<td>-1.27%</td>
<td>16.86%</td>
<td>1.40%</td>
<td>1.90%</td>
</tr>
<tr>
<td>CPR-CPP w/ IHD</td>
<td>-5.29%</td>
<td>-6.24%</td>
<td>-4.40%</td>
<td>1.82%</td>
<td>-16.40%</td>
<td>-3.43%</td>
</tr>
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</table>
Monetary Savings

Average Monetary Savings ($\text{Per Customer Per Event, 2012 and 2013}$)

- CPR
- CPR+IHD
- CPP
- CPP+IHD
- Flat Rate + Notification

$-$ $0.05$ $0.10$ $0.15$ $0.20$ $0.25$ $0.30$ $0.35$ $0.40$
So, What Did We Learn?

Source: Sanem Sergici, Brattle Group
Capacity Value of Retail DR

2012 Events

2013 Events

9/12 78°
9/21 69°
9/25 65°
10/5 70°
7/5 86°
7/15 88°
7/16 87°
7/17 89°
7/18 87°
7/19 90°
8/13 68°
8/21 82°
8/22 82°
8/28 83°
How Not to be Popular!

Who dropped out???
- Receive Peak-Time Notification by Phone
- Younger Customers
- Large Households
How Not to be Popular!

Period of interim surveys

- CPR
- CPR+IHD
- CPP
- CPP+IHD
- CPR–CPP
- CPR–CPP+IHD
- Control
Actions Reported

Proportion of Customers Who Reported Taking Each Action

- CPR
- CPR+IHD
- CPP
- CPP+IHD
- Flat Rate w/ Notification

Legend:
- Thermostat Settings
- Turn off Lights
- Appliance Timers
- Delay Laundry
- Delay Cooking
- Adjust Air Conditioning
How Do Consumers Value Smart Grids?

“They knew where we were when we had power outages”

--GMP customer (without IHD)
Words Are Worth a Thousand Pictures

CPR Customers

CPP Customers
Utility Lessons

Sticks work better than carrots…

…but sticks are unpopular, especially after dangling carrots before customers/regulators.

Customers DO respond to incentives…

…but not persistently enough to have much (retail) capacity value.

Information CAN be useful…

…but the supporting systems need to become as EASY as making coffee.
A Final Musing

• Why do *households* care about the carrot or the stick?
• GMP customers each saved *tens of cents* during every peak event!
• What motivates customers? Does the penny make the conservation choice more or less complicated?
Thank You!

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