Time-of-Use Rates
Methods, Experience, Results

Utah Public Service Commission
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Richard Sedano, John Shenot, and Jim Lazar

The Regulatory Assistance Project (RAP)®
Agenda

• Why Consider TOU Rates
• Types of TOU Rates (with and without AMI)
• How to Select TOU Periods
• Expected Uptake and Results
• Incorporating TOU with Inclining Blocks
• Peak Time Rebates: An Alternative
• Communicating with Consumers
• Thinking Ahead: California and Hawaii
Why Consider TOU?

• Peak load (and cost) reduction
• Equity between customers
• Equitable treatment of solar
  • Reduction of load during high-cost hours
  • Augmentation of load during high-output
Peak Load Reduction

Pilot Impact versus Price Ratio (without Enabling Technology)

Peak Reduction

Peak to Off-Peak Price Ratio

Best-Fit Curve
Equity Between Customers

Hour of Day

0 1 2 3 4
kWh Usage

15 17 19 21 23

Peak Period

Apartment No AC
Single-Family Central AC
Equitable Treatment of Solar

Customer Load by Hour in 1 Day

- Retail Customer
- Energy Efficiency
- Solar Generation
- Power Export
Types of TOU Rates

- Simple Two-Period Rates
- Three-Period Rates
- Three-Period Seasonal Rates
- Critical Peak Pricing (CPP)
- Real-Time Pricing (RTP)
- Alternative: Peak-Time Rebates (PTR)
## Example Two-Period Rate
Jacksonville, FL

<table>
<thead>
<tr>
<th></th>
<th>Customer Charge</th>
<th>Energy Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$/month</td>
<td>$/kWh</td>
</tr>
<tr>
<td><strong>Standard</strong></td>
<td>$7.34</td>
<td>$0.1072</td>
</tr>
<tr>
<td><strong>Optional TOU</strong></td>
<td>$7.34</td>
<td>$0.2156</td>
</tr>
</tbody>
</table>

*Note: Energy solutions for a changing world*
Example Three-Period Rate
Arizona Public Service

June – August Billing Cycles
(Super Peak Summer)

<table>
<thead>
<tr>
<th>Time</th>
<th>Rate per kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Super Peak</td>
<td>$0.46517</td>
</tr>
<tr>
<td>On Peak</td>
<td>$0.24477</td>
</tr>
<tr>
<td>Off Peak</td>
<td>$0.05517</td>
</tr>
</tbody>
</table>

Super Peak: 3 – 6 PM
On-Peak: 12 – 3 PM and 6 – 7 PM
# Example Seasonal Three-Period Seasonal Rate

## Southern California Edison

<table>
<thead>
<tr>
<th></th>
<th>Summer</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Customer Charge</strong></td>
<td>$0.94</td>
<td>$0.94</td>
</tr>
<tr>
<td><strong>On-Peak</strong></td>
<td>$0.436</td>
<td>$0.336</td>
</tr>
<tr>
<td><strong>Shoulder</strong></td>
<td>$0.286</td>
<td>$0.282</td>
</tr>
<tr>
<td><strong>Off-Peak</strong></td>
<td>$0.131</td>
<td>$0.135</td>
</tr>
</tbody>
</table>
**Example Critical Peak Rate**

**Oklahoma Gas and Electric**

<table>
<thead>
<tr>
<th></th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Customer Charge</strong></td>
<td>$13.00</td>
</tr>
<tr>
<td><strong>Off-Peak</strong></td>
<td>$0.044</td>
</tr>
<tr>
<td><strong>On-Peak</strong></td>
<td>$0.160</td>
</tr>
<tr>
<td><strong>Critical Peak</strong></td>
<td>$0.400</td>
</tr>
</tbody>
</table>

**Critical:** Maximum 80 hours per year

**On-Peak:** 2 - 7 PM Monday - Friday
Example Critical Peak Rider
Arizona Public Service

RATES

A. Critical Peak Price

$ 0.250000 per kWh

Critical Peak Price applies to KWh usage during a CPP Event.

B. Energy Discount

All residential customers

$ (0.012143) per kWh
Real-Time Pricing Commonwealth Edison

• Customer Charge
• Distribution Charge
• “Personal Capacity Charge”
• Hourly Energy Charge
Choosing TOU Periods

- System Dispatch Characteristics
- Current Load Shape
- Projected Future Load Shape
- Integrated Resource Plan
- Market Price Data
Different Classes and Circuits
Peak at Different Times

- **Commercial Peak:** 2 PM Weekends
- **Residential Peak:** 5 PM Weekends
Class Demands May Drive Distribution Capacity Requirements

- Orange line: Hourly demand
- Blue line: Daily trend

Days:
- Sunday
- Monday
- Tuesday
- Wednesday
- Thursday
- Friday
- Saturday
System Peak Drives Power Supply Costs

System Peak:
2 – 5 PM Weekdays
Solar Can Change This

System “NET” Peak Moved to 6 PM
Possible Result:
Different TOU Periods for Different Classes

Residential: Monday – Sunday
3 PM – 8 PM

Commercial: Monday – Friday
1 PM – 6 PM
How Long Should the On-Peak Period Be?

- Evidence is that 3 hours is the longest that people can defer without significant impact.
- Example: SRP EZ-3 Rate
  - Peak Period is 3 PM – 8 PM
  - Each customer chooses 3 hour slot
  - All customers are in the 5-6 PM slot
Assigning Costs to Periods Based on System Utilization in Periods

<table>
<thead>
<tr>
<th>Period</th>
<th>Related Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-Peak</td>
<td>Baseload Generation, Transmission, Distribution</td>
</tr>
<tr>
<td>Mid-Peak</td>
<td>Intermediate Generation, Transmission, Distribution</td>
</tr>
<tr>
<td>On-Peak</td>
<td>Peaking Generation, Distribution</td>
</tr>
<tr>
<td>Critical Peak</td>
<td>Demand Response</td>
</tr>
</tbody>
</table>
Functionalized System Costs
$6/month
Expected Results

• Lower loads during peak hours
• Higher loads during off-peak hours
• Value proposition for:
  – Load management technology
  – Consumer engagement
  – Customer-based storage
Demand Charges

• Historically used for Commercial and Industrial customers
• NOT used for small commercial or residential due to high diversity.
• Non-Coincident Peak (NCP): – $/kW measured at any hour
• Coincident Peak (CP): – $/kW measured 3 PM – 7 PM ONLY
What Rate Form Is Most Effective at Tracking Capacity-Related Costs

Exhibit 3. Garfield and Lovejoy Criteria and Alternative Rate Forms

<table>
<thead>
<tr>
<th>Garfield and Lovejoy Criteria</th>
<th>CP Demand Charge</th>
<th>NCP Demand Charge</th>
<th>TOU Energy Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>All customers should contribute to the recovery of capacity costs.</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>The longer the period of time that customers pre-empt the use of capacity, the more they should pay for the use of that capacity.</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Any service making exclusive use of capacity should be assigned 100% of the relevant cost.</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>The allocation of capacity costs should change gradually with changes in the pattern of usage.</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Allocation of costs to one class should not be affected by how remaining costs are allocated to other classes.</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>More demand costs should be allocated to usage on-peak than off-peak.</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Interruptible service should be allocated less capacity costs, but still contribute something.</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
</tbody>
</table>
# Impact of Different Rate Forms On kWh Usage and Peak Demand

<table>
<thead>
<tr>
<th>Rate Form</th>
<th>Peak Demand</th>
<th>Total kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat Rate $5/mo + $.12/kWh</td>
<td>Baseline</td>
<td>Baseline</td>
</tr>
<tr>
<td>Inclining Block</td>
<td>▼5% -10%</td>
<td>▼5% -10%</td>
</tr>
<tr>
<td>High Fixed Charge</td>
<td>▲5% - 10%</td>
<td>▲5% - 10%</td>
</tr>
<tr>
<td>NCP Demand Charge</td>
<td>▼1% -2%</td>
<td>▲5% - 10%</td>
</tr>
<tr>
<td>CP Demand Charge</td>
<td>▼5% -10%</td>
<td>▲5% - 10%</td>
</tr>
<tr>
<td>TOU Rate</td>
<td>▼10% -20%</td>
<td>Little Change</td>
</tr>
<tr>
<td>Critical Peak Rate</td>
<td>▼20% - 30%</td>
<td>Little Change</td>
</tr>
<tr>
<td>TOU + Inclining Block</td>
<td>▼15% - 30%</td>
<td>▼5% -10%</td>
</tr>
<tr>
<td>Critical + Inclining Block</td>
<td>▼25% - 35%</td>
<td>▼5% -10%</td>
</tr>
</tbody>
</table>
SMUD: Customers Actually Do Things

- Did Laundry Off Peak: Default CPP 82.6%, Default TOU-CPP 76.3%, Default TOU 86.1%, Opt-in CPP 88.7%
- Turned Off Lights: Default CPP 73.5%, Default TOU-CPP 71.6%, Default TOU 73.2%, Opt-in CPP 80.5%, Opt-in TOU 81.4%
- Did Dishes Off Peak: Default CPP 62.1%, Default TOU-CPP 63.6%, Default TOU 58.9%, Opt-in CPP 70.5%, Opt-in TOU 72.7%
- Turned Off Air Conditioner: Default CPP 45.8%, Default TOU-CPP 52.6%, Default TOU 45.4%, Opt-in CPP 70.0%, Opt-in TOU 61.8%
- Increased Temperature on Thermostat: Default CPP 43.4%, Default TOU-CPP 35.8%, Default TOU 37.5%, Opt-in CPP 40.9%, Opt-in TOU 47.4%

Energy solutions for a changing world
TOU and Critical Peak Pricing Works

Average Peak Reduction from Time-Varying Rate Pilots

Approximate Savings from Demand Charge Rate
Current Rocky Mountain Power Rate (Summer)

Energy Charge:

Billing Months - May through September inclusive
8.8498¢ per kWh first 400 kWh
11.5429¢ per kWh next 600 kWh
14.4508¢ per kWh all additional kWh
Incorporating TOU with Inclining Blocks Is Not Difficult

Energy Charge:

Billing Months - May through September inclusive
8.8498¢ per kWh first 400 kWh
11.5429¢ per kWh next 600 kWh
14.4508¢ per kWh all additional kWh

TOU Overlay:

On-Peak Surcharge:  $.05/kWh
Off-Peak Discount:  $.05/kWh
Peak-Time Rebates

- Targeted at key critical peak hours
- Events announced
- Customer usage during event compared to a baseline usage for that customer.
- Credit applied for reduced usage

**NO surcharge applied for increased usage**
# Baltimore Gas and Electric PTR

<table>
<thead>
<tr>
<th>Charge Type</th>
<th>Unit</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Charge</td>
<td>$/month</td>
<td>$7.90</td>
</tr>
<tr>
<td>Distribution Charge</td>
<td>$/kWh</td>
<td>$0.035</td>
</tr>
<tr>
<td>Default Supply</td>
<td>$/kWh</td>
<td>$0.092</td>
</tr>
<tr>
<td>PTR Credit</td>
<td>$/kWh</td>
<td>$1.25</td>
</tr>
</tbody>
</table>
Customer Empowerment

• Keep it simple!
• Print the rate on the bill, including all riders.
• Provide technology to curtail use “hands-free” for major loads
• Shadow billing / Bill Guarantee for first year.
Technology Can Help
Looking Ahead: Hawaii and California

Once installed solar passes about 25% of peak demand, the system “net” load shape changes.
### Hawaii: Solar @ 16% of Customers

#### Table 3. HECO Companies' Net Energy Metering Program Capacity and Enrollment

<table>
<thead>
<tr>
<th></th>
<th>HECO</th>
<th>HELCO</th>
<th>MECO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed or Approved</td>
<td>327.9</td>
<td>73.3</td>
<td>88.8</td>
</tr>
<tr>
<td>In the Queue</td>
<td>17.3</td>
<td>5.1</td>
<td>11.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>345.2</strong></td>
<td><strong>78.4</strong></td>
<td><strong>100.7</strong></td>
</tr>
<tr>
<td>Total NEM Customers</td>
<td>51,680</td>
<td>11,549</td>
<td>12,893</td>
</tr>
<tr>
<td>System Peak Load (MW)</td>
<td>1,165</td>
<td>188</td>
<td>191</td>
</tr>
<tr>
<td>NEM % of All Customers</td>
<td>17%</td>
<td>14%</td>
<td>18%</td>
</tr>
<tr>
<td><strong>NEM of System Peak</strong></td>
<td><strong>30%</strong></td>
<td><strong>42%</strong></td>
<td><strong>53%</strong></td>
</tr>
</tbody>
</table>
Peak Load Impacts May Reach A Limit

2006 Peak: 1,200 MW at 1 PM
2014 Peak: 1,050 MW at 7 PM

2006: 500 MW ramp 6 AM to 1 PM
2014: 250 MW ramp 6 AM to 1 PM

Source: Hawaiian Electric Co
# Grid-Supply Rate (Hawaii)

<table>
<thead>
<tr>
<th>Charges for all power received from grid</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Charge</td>
<td>$10.30</td>
</tr>
<tr>
<td>First 350 kWh</td>
<td>$.234</td>
</tr>
<tr>
<td>Next 850 kWh</td>
<td>$.246</td>
</tr>
<tr>
<td>Over 1,200 kWh</td>
<td>$.265</td>
</tr>
<tr>
<td>Minimum bill:</td>
<td>$25.00</td>
</tr>
<tr>
<td>Credit for all power delivered to grid</td>
<td>($.151)</td>
</tr>
</tbody>
</table>

Any customer surplus credit at end of month is forfeited.
Summary

• Customers can, will, and do respond.
• TOU rate design is utility-specific
• Costs can be assigned based on multiple functions
• TOU is more effective at reducing peak demand than demand charges.
• TOU combined with inclining block rates = BOTH load-shifting AND kWh savings.
• Peak-Time Rebates are an option.
## Smart Rate Design

<table>
<thead>
<tr>
<th>Customer-Specific Charges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Charge</td>
</tr>
<tr>
<td>Transformer:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bi-Directional Energy Charges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-Peak</td>
</tr>
<tr>
<td>Mid-Peak</td>
</tr>
<tr>
<td>On-Peak</td>
</tr>
<tr>
<td>Critical Peak</td>
</tr>
</tbody>
</table>
The Regulatory Assistance Project (RAP) is a global, non-profit team of experts that focuses on the long-term economic and environmental sustainability of the power sector. RAP has deep expertise in regulatory and market policies that:

- Promote economic efficiency
- Protect the environment
- Ensure system reliability
- Allocate system benefits fairly among all consumers

Learn more about RAP at www.raponline.org

Jim Lazar, jlazar@raponline.org
John Shenot, jshenot@raponline.org