Dynamic Pricing in a Smart Grid World

MADRI Dynamic Pricing Workshop

May 12, 2011

Theresa Flaim, Ph.D., Energy Resource Economics, LLC
Presentation to
Mid-Atlantic Distributed Resources Initiative
Baltimore, MD

*Work sponsored by the Lawrence Berkeley Laboratory, Electricity Markets and Policy Group under Contract No. 6898299.
So Many Rates . . . So little time . . .
How Products Align with Market Time Frames

- **Energy Efficiency**
- **Time of Use Rates**
- **Day-ahead RTP**
- **CPP PTR**

### Time Frame and System Functions

#### Capacity Markets
- **Years**
  - System Planning
- **Months**
  - Operational Planning

#### Energy Markets
- **Day-ahead**
  - Scheduling
- **In-day**
  - Dispatch

#### Ancillary Services
- Emergency Programs
- Ancillary Services

- **Real-time**
- < 15 minutes
Tradeoffs: Basic Service or Product Overlay?

Basic Service
- Pros: Offers greatest potential for economic efficiency gains
- Cons: Will be more difficult due to conflicting regulatory goals (bill impacts)

Product Overlays
- Pros: Can design the overlay without having to re-design the underlying rate for basic service
- Cons: Will have more limited potential for improving overall economic efficiency
Defining Dynamic Pricing: Six Basic Structures for Firm or Default Service*

- Flat energy rates
- Flat demand/energy rates
- Tiered rates (inclining or declining blocks)
- Time of use (TOU) rates
- Variable peak pricing (VPP) rates
- Real time pricing (RTP) rates

*Most rate structures also include a customer or access charge.
Time-Varying Rate Structures (typical designs)

- **Time of Use**
  - Prices for peak, shoulder and off-peak periods established a year in advance

- **Variable Peak Pricing (VPP)**
  - A hybrid of TOU and RTP
  - The on-peak *period* (hours and seasons) is defined in advance
  - Peak period *prices* for the next day are established based on the day-ahead forecast of wholesale market prices

- **Real-time Pricing (RTP)**
  - Hourly prices change based on system or market conditions on a day-ahead, hour-ahead or real-time basis

*There is also a product overlay known as variable peak pricing which is a variant of critical peak pricing.*
Comparison of TOU and Variable Peak Pricing

### Proposed 3-Part TOU

|       | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|-------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Wkdy  |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Wknd  |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

Under traditional TOU, the peak, shoulder and off-peak price would typically be established a year in advance.

### Proposed VPP

|       | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|-------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Wkdy  |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    | Avg. DA LMP |
| Wknd  |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

Under VPP, the on peak price is set equal to the average day-ahead wholesale market price for the on-peak hours.
Defining Dynamic Pricing: Product Overlays

- A product overlay can simply be layered on top of the existing firm rate under specified conditions, with no (or minimal) adjustments to the underlying basic firm rate.

- Examples:
  - Reliability-differentiated
    - Interruptible/curtailable (I/C) rates
    - Direct load control (DLC)
  - Economic Overlays
    - Critical peak pricing (CPP)
    - Peak time rebate (PTR)
    - 2-part real time pricing (2-Part RTP)
## Economic Potential, Bill Impacts and Smart Grid Benefits of Different Rates (compared to flat rates)

<table>
<thead>
<tr>
<th>Rate Structure</th>
<th>Economic Efficiency Potential</th>
<th>Initial Bill Impacts (assumes no response)</th>
<th>Potential to Maximize Smart Grid Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flat Rates + PTR or CPP Overlay</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flat + PTR</td>
<td>Low/moderate</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Flat + CPP</td>
<td>Low/moderate</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td><strong>TOU + PTR or CPP Overlay</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOU + PTR</td>
<td>Moderate/high</td>
<td>Moderate/high</td>
<td>Moderate</td>
</tr>
<tr>
<td>TOU + CPP</td>
<td>Moderate/high</td>
<td>Moderate/high</td>
<td>Moderate</td>
</tr>
<tr>
<td><strong>Dynamic Base Rates</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two-Part RTP</td>
<td>High/higher w/ technology</td>
<td>Low</td>
<td>High/very high</td>
</tr>
<tr>
<td>TOU-VPP</td>
<td>High/very high</td>
<td>High</td>
<td>Moderate/high</td>
</tr>
<tr>
<td>Real Time Pricing</td>
<td>High/higher w/ technology</td>
<td>Very high</td>
<td>Very high</td>
</tr>
</tbody>
</table>
Contact Information

Theresa Flaim
Energy Resource Economics, LLC
E-mail: Flaim_t@msn.com
865 909-0535
Appendix
# Pricing Product Overlays: CPP & PTR (Typical Designs)

<table>
<thead>
<tr>
<th>Design Feature</th>
<th>Critical Peak Pricing</th>
<th>Peak Time Rebate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource goal</td>
<td>Peak load reductions</td>
<td>Same</td>
</tr>
<tr>
<td>Critical Peak Period Definitions</td>
<td>Typically defined in advance</td>
<td>Same</td>
</tr>
<tr>
<td>Event Price</td>
<td>Typically defined in advance</td>
<td>Same</td>
</tr>
<tr>
<td>Revenue Neutrality (relative to base case)</td>
<td>Firm rate + CPP rate designed to be revenue neutral</td>
<td>PTR not designed to be revenue neutral (requires initial rate increase to cover rebates)</td>
</tr>
<tr>
<td></td>
<td>▪ Can create windfall gains &amp; losses</td>
<td>▪ Can create windfall gains due to how the CBL is defined</td>
</tr>
<tr>
<td></td>
<td>▪ May need revenue adjustments if all events are not called in order to recover required revenue</td>
<td>▪ Can be called only as needed</td>
</tr>
<tr>
<td>Customer-specific baseline load (CBL)</td>
<td>Not required</td>
<td>Required – a major implementation issue</td>
</tr>
</tbody>
</table>
Pricing Product Overlays: Two-Part RTP Overlay

- **Part 1 – Customer baseline load (CBL):**
  - Retains the price hedge embedded in the customer’s basic service rate
  - Requires setting a CBL, typically defined by the historical hourly load profile

- **Part 2 – Hourly marginal cost:**
  - Changes in usage from the CBL would be priced at utility’s marginal cost (or market price)
Pricing Product Overlays: Two-Part RTP Overlay

- Customer “sells” usage at marginal cost
- Customer “buys” additional usage at marginal cost

MWh

1

Hours in Typical Week Day of Billing Period

24

CBL

Actual Load