RATE DESIGN FOR THE DISTRIBUTION EDGE

ELECTRICITY PRICING FOR A DISTRIBUTED RESOURCE FUTURE

RMI. Creating a clean, prosperous, and secure energy future.™
August 2014 eLab publication “Rate Design for the Distribution Edge: Electricity Pricing for a Distributed Resource Future”

Summary

• Adding sophistication to rates can unleash innovation in DER products and services
• Default rate options can be more sophisticated with the ability for customers to opt-into more and less complicated rates
• DER solution providers can maintain a simple customer experience

<table>
<thead>
<tr>
<th>NEAR-TERM DEFAULT OR OPT-IN POSSIBILITIES</th>
<th>LONGER-TERM, MORE SOPHISTICATED POSSIBILITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time-of-Use Pricing</td>
<td>Real-Time Pricing</td>
</tr>
<tr>
<td>Energy + Capacity Pricing (i.e., demand charges)</td>
<td>Attribute-Based Pricing</td>
</tr>
<tr>
<td>Distribution “Hot Spot” Credits</td>
<td>Distribution Locational Marginal Pricing</td>
</tr>
</tbody>
</table>
UNBUNDLING ALONG THREE SPECTRUMS CAN UNLEASH INNOVATIVE PRODUCTS AND SERVICES

<table>
<thead>
<tr>
<th>Pricing Method</th>
<th>Attribute Unbundling</th>
<th>Temporal Granularity</th>
<th>Locational Granularity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TODAY’S BUNDLED, VOLUMETRIC, BLOCK PRICING</strong></td>
<td>Fully bundled</td>
<td>No time- or location-based differentiation</td>
<td></td>
</tr>
<tr>
<td><strong>ENERGY + CAPACITY PRICING</strong></td>
<td>Fully unbundled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breaking apart energy and capacity values begins to unbundle prices, but leaves many still bundled. Time- and location-based differentiation is still minimal.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ATTRIBUTE-BASED PRICING</strong></td>
<td>Fully unbundled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attributed-based pricing more fully unbundles electricity prices, while doing so could also add time- and location-based sophistication.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TIME-OF-USE PRICING</strong></td>
<td>Fully unbundled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relatively basic time-of-use pricing (e.g., off-peak, peak, critical peak) begins to add time-based differentiation, but could still allow attributes to remain fully bundled with no location-based differentiation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>REAL-TIME PRICING</strong></td>
<td>Fully unbundled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real-time pricing, with prices dynamically varying by one-hour or sub-hour increments, adds much time-based sophistication, but could still allow attributes to remain fully bundled with no location-based differentiation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DISTRIBUTION SYSTEM HOT SPOT PRICING</strong></td>
<td>Fully unbundled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identifying distribution system “hot spots” begins to add location-based differentiation, but could still allow fully bundled attributes and little or no time-based differentiation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DISTRIBUTION LOCATIONAL MARGINAL PRICING</strong></td>
<td>Fully unbundled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distribution LMP adds location-based sophistication, and in turn a high degree of temporal sophistication</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Some of these solutions are achievable in the near term in many locations!
AN APPROACH TO EVOLVE TOWARD MORE SOPHISTICATED RATES: DEFAULTS AND ALTERNATIVES

![Diagram showing levels of rate sophistication and time]

- **Default Rate**: Basic rate option.
- **Opt In / Out Alternatives**: Rate options available to customers with varying degrees of sophistication.

**High Sophistication Rate**
- Alternative rate options available to customers that are more sophisticated than the moderate sophistication default rate.

**Moderate Sophistication Rate**
- Alternative rate options available to customers that are more sophisticated than the traditional default rate, and alternatively less sophisticated than the high sophistication default rate.

**Traditional Rates**
- Alternative rate options available to customers that are less sophisticated than the moderate sophistication default rate.
SOLUTION PROVIDERS CAN MAINTAIN A SIMPLE CUSTOMER EXPERIENCE AS RATES BECOME MORE SOPHISTICATED

DESIRED STATE FOR MOST MASS-MARKET CUSTOMERS:
Sophisticated Rates With Technologies & Solution Providers Simplifying The Customer Experience

CURRENT & FUTURE STATE FOR SELECT CUSTOMERS:
Customers Respond To Price Signals Directly (e.g., Respond To TOU Rates Through Behavior Change)

TRADITIONAL EXPERIENCE FOR MOST MASS-MARKET CUSTOMERS TODAY:
Simplified Rates With No Role For Complexity Management

COMPLEXITY OF CUSTOMER EXPERIENCE
WHERE AND HOW COULD SOPHISTICATED RATES BE IMPLEMENTED AT SCALE?

• Possibilities for discussion:
  – Time-of-Use (SMUD)
  – Variable Pricing Plan (OG&E)
  – Energy + Demand (Black Hills Power)
  – Vehicle Grid Integration (SDG&E)
  – Real-time Pricing (E3 study)
A well-designed TOU rate offers customers the ability to be compensated for shifting load:

- Multiple time periods
- Meaningful variation in prices
  - Across times of day
  - In comparison to the standard retail rate offering

- TOU savings must be worth the investment of customer time and resources to achieve
SMUD offers three distinct time periods (with an additional critical peak period that can be called as needed).

**Comparison of pricing plans**

- **Off-Peak Base**
- **Off-Peak Base Plus**
- **On-Peak**
- **Critical Peak**

**Critical peak from 4 to 7 PM on up to 12 event days between June & September (~1% of all summer hours)**

**On-peak from 4 to 7 PM on all non-holiday weekdays from June through September (~10% of all summer hours)**

Source: SMUD SmartPricing Options Final Evaluation Sept. 2014
OG&E Smart Hours offers multiple time periods with significant price differential presents a compelling value proposition to customers to shift load.

- **Peak period is 2pm-7pm in summer.** Customers receive day ahead signal that sets the price point for the following day.
  - Critical price events can be called with two hour advance notice and can last for up to eight hours and are applicable all year.

### Standard Rate Plan*

<table>
<thead>
<tr>
<th>Summer (June-Sept.)</th>
<th>Winter (Nov.-Apr.)</th>
<th>Shoulder (May, Oct.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>First 1,400 kWh = $0.05</td>
<td>First 600 kWh = $0.05</td>
<td>All kWh = $0.05</td>
</tr>
<tr>
<td>Additional = $0.06</td>
<td>Additional = $0.01</td>
<td>* $/kWh rounded to two decimals</td>
</tr>
</tbody>
</table>

Source: OG&E Smart Study Together Impact Results Final Report Summer 2011
Black Hills Power proposed to require all residential DG customers to take service under the available Optional Residential Demand Service.

The proposal was withdrawn Sept. 2014.

Source: Rate case testimony of Black Hills Power March 2014

<table>
<thead>
<tr>
<th>Standard Service*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Charge</td>
</tr>
<tr>
<td>$10.00/month</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Optional Residential Demand Service*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Charge</td>
</tr>
<tr>
<td>$14.00/month</td>
</tr>
</tbody>
</table>

* $/kWh rounded to two decimals
Customers can set price ceiling for charging, minimum charging requirements and participate in demand response based on market prices.

Prices delivered to customers via mobile app and web.

VGI = vehicle grid integration
C-CPP = commodity critical peak pricing
D-CPP = distribution critical peak pricing
CAISO = California Independent System Operator
PPP = public purpose programs
ND = nuclear decommissioning
CTC = competition transmission charges
RS = reliability services
DWR-BC = Dept. of Water Resources bond charge

All rates are $/kWh.
E3 California study shows:

- TOU rates may reflect the average cost of service but it misses the peaks and valleys of actual utility avoided costs
- The more volatile the real-time cost of electricity the more value comes from distributed control strategies

Note: ToU does poor job of capturing price spikes ... and also forces appliances to curtail for longer than needed

Source: E3 “It is time for residential real-time pricing: Aligning Customer Incentives