Smart Rate Design for a Smart, Clean and Distributed Future

Mark LeBel
Associate, Regulatory Assistance Project
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Outline

• Basics of Utility Ratemaking
• Past and Future of the Electric System
• Rebuilding Ratemaking for the Future
BASICS OF UTILITY RATEMAKING
How and Why Do We Regulate Utilities?

• Public policy goals
  – Efficient competition and control of monopoly pricing
  – Reliable provision of service
  – Societal equity (e.g., universal access and affordability)
  – Environmental and public health requirements
  – And many more...

• Principles for setting utility prices
  – Effective recovery of revenue requirement
  – Customer understanding, acceptance, and bill stability
  – Equitable allocation of costs
  – Efficient forward-looking price signals
Simplified rate-making process

**Determine revenue requirement**

- Net rate base
  - (Plant in service – depreciation reserve)
- Rate of return
- Depreciation expense
  - (Plant in service x depreciation rate)
- Operating expense
  - (Fuel + purchased power + labor + labor overheads + supplies + services + income taxes)
- Other taxes
  - $ millions

**Allocate costs among customer classes**

- Residential
- Commercial
- Industrial
- Street lighting

**Design retail rates**

- Dollars per month
- Cents per kWh peak
- Cents per kWh off-peak
- Dollars per month
- Cents per kWh peak
- Cents per kWh off-peak
- Dollars per month
- Cents per kWh peak
- Cents per kWh off-peak
- Dollars per kWh monthly
- Dollars per light per month
Determining Customer Classes

Types:
- Residential
  - Single-Family
  - Multi-Family
  - Solar?
  - Heating?
- Commercial
- Industrial
- Irrigation
- Street Lighting
Traditional Embedded Cost of Service Study Process
Efficient forward-looking pricing should make the choices customers make to minimize their own bills consistent with the choices they should make to minimize system costs.
Algorithm for Socially Efficient Price Signals

1. Start with short-run marginal costs where possible
2. Layer in long-run marginal costs
3. Add any unpriced externalities
4. End by allocating and pricing “residual” costs that must be recovered through rates
HISTORY AND FUTURE OF ELECTRIC SYSTEM
Brief History of U.S. Electric System

• Pre-1960
  – Combustion steam units, with significant hydro in some parts of the US

• 1960-1980
  – Emergence of nuclear power and combustion turbines
  – Oil crises and beginning of federal environmental regulation

• 1980-2000
  – PURPA implementation and then restructuring in many areas
  – Introduction of energy efficiency programs and demand-side resources
  – Emergence of combined cycle generation

• 2000-2020
  – Major increase in fossil gas extraction from hydraulic fracturing
  – Emergence of utility-scale wind and solar, distributed generation, advanced meters and smart grid
To Infinity and Beyond...

- Massive increases in computing power and data storage capabilities
- High penetrations of variable renewable resources change operation and economics of electric system
- Energy management technology becomes cheap and widespread
- Electrification of transportation and heating may increase load
- Continued cost declines for clean distributed generation and energy storage
Illustrative modern electric system

**Smart appliances**
- Can shut off in response to frequency fluctuations.

**Processors**
- Execute special protection schemes in microseconds.

**Demand management**
- Use can be shifted to off-peak times to save money.

**Sensors**
- Detect fluctuations and disturbances, and can signal for areas to be isolated.

**Storage**
- Energy generated at off-peak times could be stored in batteries for later use.

**Generators**
- Energy from small generators and solar panels can reduce overall demand on the grid.

**Disturbance**
- in the grid

**Isolated microgrid**

**Central power plant**

**Industrial plant**

REBUILDING RATEMAKING FOR THE FUTURE
Challenges and Opportunities

• Weaknesses of cost-of-service revenue requirement are widely discussed but hard to solve
• Storage and demand-side resources provide benefits across the spectrum
• Traditional customer/demand/energy classifications are archaic
• Current typical pricing structures are inefficient
  – Primarily flat volumetric for residential
  – Major demand charges for C&I
Finding the Path Forward

• Cost allocation and pricing tied more closely to marginal costs should reduce misallocation of revenue burdens
  – Even in an embedded cost framework
• Costs follow benefits is fair principle for equitable cost allocation
  – Particularly if marginal-cost-based prices recover insufficient revenue
• Externality rationales are important, but decrease in significance along with emissions
Modern embedded cost of service study flowchart

Revenue requirement

Functionalization

Generation
Transmission
Distribution
Billing, customer service, and A&G costs

Time assignment

Peak hours
Intermediate hours
All hours, including off-peak

Site infrastructure, billing and collection

Allocation

Residential
Commercial
Industrial
Street lighting
Critical Peak Rate
75 cents per kWh

On-Peak Rate
13 cents per kWh

Mid-Peak Rate
8 cents per kWh

Off-Peak Rate
5 cents per kWh

DR

Peaking Distribution
Peaking Generation

Distribution Augmentation for Mid-Peak
Network Transmission
Mid-Merit Generation

Distribution Backbone
Transmission Backbone
All Hours Generation

Hour of Day
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Connecting Customers to Shared System

• Shared service drops and shared line transformers are sized for the combined peak of smaller groups of customers
  – Nearly impossible to allocate (or price) locationally, but class-specific tracking and using weighted averages can help
  – Significantly less load diversity than broadly shared elements of system

• For larger customers, dedicated service lines and dedicated line transformers are sized to the individual customer
  – May have diversity of usage behind the individual meter, but could plausibly be managed by the overarching entity
The Hard Questions

• Administrative and general costs do not have a cost-causation basis to follow
• Balancing accuracy on costs with implementation issues, understandability, risk of customer bill impacts, and revenue stability
• Creation of new customer class distinctions
  – Multifamily residential versus single-family residential
  – “Simple” versus “advanced” residential
  – Technology-specific?
• How will general patterns of supply and demand change?
Customer Understanding and Transitions

• Customers must be able to understand their rates and manage their bills
  – Basic explanations and educational materials
  – Data provision and online tools can help
  – Affordable energy management technology and on-site storage are game changers

• Gradual transitions can diffuse knowledge and help acceptance
  – Start with opt-in and move to opt-out or mandatory
  – Shadow billing and hold harmless protection

• Companion programs are important
  – Cost-effective energy management technology programs to enable customer response and minimize risk of negative bill impacts
## Smart Rate Design for Today

<table>
<thead>
<tr>
<th></th>
<th>Residential</th>
<th>Medium C&amp;I</th>
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<tbody>
<tr>
<td>Customer charge ($/mo.)</td>
<td>Multifamily: $7</td>
<td>$40</td>
</tr>
<tr>
<td></td>
<td>Small single-family: $10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Large single-family: $15</td>
<td></td>
</tr>
<tr>
<td>Site infrastructure ($/kW)</td>
<td>N/A</td>
<td>$2</td>
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<table>
<thead>
<tr>
<th></th>
<th>Off-peak (cents/kWh)</th>
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<tbody>
<tr>
<td></td>
<td>12 cents</td>
<td>10 cents</td>
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<table>
<thead>
<tr>
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<th>Mid-peak (cents/kWh)</th>
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<tbody>
<tr>
<td></td>
<td>18 cents</td>
<td>16 cents</td>
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<thead>
<tr>
<th></th>
<th>On-peak (cents/kWh)</th>
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<tbody>
<tr>
<td></td>
<td>25 cents</td>
<td>24 cents</td>
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<tr>
<th></th>
<th>Critical peak (cents/kWh)</th>
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<tbody>
<tr>
<td></td>
<td>75 cents (peak-time rebate)</td>
<td>75 cents</td>
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</table>

Volumetric components reflect both import charges and export credits, which should be netted by TOU period.
## Advanced Residential Rate Design

### Cost Recovery Only

<table>
<thead>
<tr>
<th>Charge Description</th>
<th>Amount</th>
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<tbody>
<tr>
<td>Customer charge ($/mo.)</td>
<td>$10</td>
</tr>
<tr>
<td>Site infrastructure ($/individual NCP kW)</td>
<td>$1</td>
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<tr>
<td>Distribution flow charge (cents/kWh on imports and exports)</td>
<td>2 cents</td>
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</table>

### Symmetric Charges and Credits

<table>
<thead>
<tr>
<th>Charge Description</th>
<th>Amount</th>
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<tbody>
<tr>
<td>Off-peak (cents/kWh)</td>
<td>10 cents</td>
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<tr>
<td>Mid-peak (cents/kWh)</td>
<td>15 cents</td>
</tr>
<tr>
<td>On-peak (cents/kWh)</td>
<td>30 cents</td>
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<tr>
<td>Critical peak (cents/kWh)</td>
<td>75 cents</td>
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</table>
NY Value of Distributed Energy Resources

Export Credit Pricing

• Hourly energy pricing from wholesale market
• Generation capacity credit
• Delivery credits
  – DRV – Utility system-wide value
  – LSRV – Locational adder
• Environmental value credit for eligible technologies
CONCLUSION AND RESOURCES
Key Takeaways

• As technology and regulatory frameworks change, old analytical techniques can’t keep up

• Increasing availability of energy management technology and storage will allow customers to deal with more complex rates

• Short-run marginal cost price signals will be increasingly important

• The future distribution system with high penetrations of DER will be built for flows, and cost allocation and pricing should follow
Resources from RAP

- Smart Rate Design for a Smart Future
- Demand Charges: What are They Good For?
- Smart Non-Residential Rate Design
Thank You!

Mark LeBel
Associate, Regulatory Assistance Project
mlebel@raponline.org