Cost Allocation and Rate Design for a DER Future

Pennsylvania Bar Public Utility Law Conference

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Outline

• Basics of Utility Ratemaking and Cost Allocation
• Past and Future of the Electric System
• Rebuilding Ratemaking for the Future
Basics of Utility Ratemaking
Why and How 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
- 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
Why Does Cost Allocation Matter?

• Cost allocation matters to customers: the allocated costs are used to set rates for each class
• Two key analytical perspectives
  • Cost causation
  • Costs follow benefits
• Data and analysis from cost allocation process informs rate design
• Older techniques have trouble accounting for the features of the modern grid
Determining Customer Classes

Types:
- Residential
  - Single-Family
  - Multi-Family
  - Solar?
- Heating?
- Commercial
- Industrial
- Irrigation
- Street Lighting
Traditional Embedded Cost of Service Study (ECOSS) Process
Rate design should make the choices the customer makes to minimize their own bill consistent with the choices they would make to minimize system costs.
History and Future of the 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.


*Decarbonized and decentralized!*
Rebuilding Ratemaking for the Future
Challenges and Opportunities

• Storage and demand-side resources provide benefits across the spectrum
  • Generation, transmission, distribution and societal
• Traditional customer/demand/energy classifications are inflexible and don’t capture enough information
• The weaknesses of typical pricing structures are exposed
  • Primarily flat volumetric for residential
  • Major demand charges for larger C&I
What is “Customer-Related”?

- The marginal costs of adding a residential customer are relatively modest
  - Billing, simple metering for billing, service line in many cases, dedicated line transformer in a limited number of cases, and part of customer service
  - Long line extensions are paid for by the customer
- The cost of a “minimum system” does not vary with the number of customers, but rather area/miles spanned
Issues with Traditional Demand & Energy Classifications

- What is the proper split between demand and energy for capital assets?
- Demand at what hours?
  - System peak, equipment peak, or class peak?
  - Demand allocators typically only use a subset of the relevant hours
- Energy-classified costs are usually allocated using annual kWh usage
  - Fails to reflect time-varying costs
Key Principles in Focus

• 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
• If and when emissions are significantly lower, then externality rationales hold less force
Distribution System Economics 101

- Marginal customer costs
  - Billing and related customer service
  - Simple meters for billing (but not AMI!)
  - Service lines for single small customer premises
- Short-run marginal energy costs
  - Marginal line losses
- Marginal peak costs
  - Significant portions of distribution capacity are upsized for broad set of peak hours
Month and hour of Delmarva Power & Light substation peaks in 2014

Substation peak. Size of circle is proportional to peak load

Source: Delmarva Power & Light. (2016, August 15). Response to the Office of the People’s Counsel data request 5-11, Attachment D. Maryland Public Service Commission Case No. 9424
Build a Cost-Based TOU Rate for Shared Elements of System

- **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

- **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 |
  |---|---|---|---|---|---|---|---|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

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

**Transmission Backbone**

**All Hours Generation**

**Peaking Distribution**

**Peaking Generation**

**DR**

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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
Typical utility estimates of diversity in residential loads

The Hard Questions

- Administrative and general costs do not have a cost causation basis to follow
- Balancing accuracy on costs with implementation issues, understandability and risk of customer bill impacts
- Creation of new customer class distinctions
  - Multifamily residential versus single-family
  - “Simple” versus “advanced” residential
  - Technology-specific?
- How will general patterns of supply and demand change?
## Smart Rate Design for Today

<table>
<thead>
<tr>
<th></th>
<th>Residential</th>
<th>Medium C&amp;I</th>
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</thead>
<tbody>
<tr>
<td><strong>Customer charge ($/mo.)</strong></td>
<td>Multifamily: $7</td>
<td>$100</td>
</tr>
<tr>
<td></td>
<td>Small single-family: $10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Large single-family: $15</td>
<td></td>
</tr>
<tr>
<td><strong>Site infrastructure ($/kW)</strong></td>
<td>N/A</td>
<td>$2</td>
</tr>
</tbody>
</table>

| **Off-peak (cents/kWh)**          | 12 cents                             | 10 cents   |
| **Mid-peak (cents/kWh)**          | 18 cents                             | 16 cents   |
| **On-peak (cents/kWh)**           | 25 cents                             | 24 cents   |
| **Critical peak (cents/kWh)**     | 75 cents (peak-time rebate)          | 75 cents   |

**Volumetric components reflect both import charges and export credits, which should be netted by TOU period**
# Advanced Residential Rate Design for a High-DER Future

## Cost Recovery Only

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

## Symmetric Charges and Credits

<table>
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<tbody>
<tr>
<td>Off-peak (cents/kWh)</td>
<td>10 cents</td>
</tr>
<tr>
<td>Mid-peak (cents/kWh)</td>
<td>15 cents</td>
</tr>
<tr>
<td>On-peak (cents/kWh)</td>
<td>30 cents</td>
</tr>
<tr>
<td>Critical peak (cents/kWh)</td>
<td>75 cents</td>
</tr>
</tbody>
</table>
4 Conclusion and Resources
Key Takeaways

- As technology and regulatory frameworks change, old analytical techniques can’t keep up
- Smarter distinctions should be made among different types of costs with new data and analytical capabilities
- Flexible time-based cost allocation techniques are fair and can support smart time-based pricing
- 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
- Electricity Regulation in the U.S.: A Guide
About RAP

The Regulatory Assistance Project (RAP)® is an independent, non-partisan, non-governmental organization dedicated to accelerating the transition to a clean, reliable, and efficient energy future.

Learn more about our work at raponline.org
Key Terms for Rate Design

- **Customer charge**: Fixed monthly fee to access utility service
- **Energy charge**: Price per kWh of consumption
- **Demand charge**: A rate charged on a customer’s highest 15- or 30-minute individual peak usage
  - Typically defined as highest non-coincident individual peak over whole month, but sometimes during “peak window”
Key Terms for Rate Design

- **Time of use (TOU) rate**: Time-varying kWh prices with preset times and price schedules.
- **Critical peak pricing (CPP)**: Higher rate for highest 50-100 hours in year.
- **Peak time rebate (PTR)**: Bill discount for reductions below baseline at peak times.
- **Real time pricing (RTP)**: Granular price signals that fluctuate in response to system conditions or markets.
- **Demand response**: Program that compensates customer for reducing load in response to signal.
- **Vehicle-to-grid**: Range of advanced programs to provide grid services from EV batteries.