Electric Cost Allocation for a New Era: Principles and Concepts

Presentation to NARUC Staff Subcommittee on Rate Design

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The Regulatory Assistance Project (RAP)®
Major Topics

- Principles and Background
- Technology and Regulatory Change
- Overarching Issues for All Frameworks
- Embedded and Marginal Cost Frameworks
- Using Cost Studies
- Key Takeaways
## About the Authors

<table>
<thead>
<tr>
<th>Author</th>
<th>First Rate Case</th>
<th>Dockets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jim Lazar</td>
<td>1974</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Paul Chernick</td>
<td>1977</td>
<td>&gt;350</td>
</tr>
<tr>
<td>Bill Marcus</td>
<td>1978</td>
<td>&gt;300</td>
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</tbody>
</table>

Collective experience:

43 states, 8 provinces
1 Principles and Background
Simplified rate-making process

1. 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

2. Calculate total in $ 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 kW monthly
- Dollars per light per month
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 often informs rate design
- Older techniques have trouble accounting for the features of the modern grid
The 1992 Grid

Illustrative traditional electric system

- **Generation**
- **Transmission**
- **Distribution**

Transmission lines 765, 500, 230 and 138 kV

- Subtransmission customer 26 kV or 69 kV
- Primary customer 13 kV or 4 kV
- Secondary customers 120 V or 240 V

Traditional Embedded Cost of Service Study (ECOSS) Process
Typical cost classifications used in cost allocation studies are summarized below.

<table>
<thead>
<tr>
<th>Typical Cost Function</th>
<th>Typical Cost Classification</th>
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<tbody>
<tr>
<td>Production</td>
<td>Demand Related</td>
</tr>
<tr>
<td></td>
<td>Energy Related</td>
</tr>
<tr>
<td>Transmission</td>
<td>Demand Related</td>
</tr>
<tr>
<td></td>
<td>Energy Related</td>
</tr>
<tr>
<td>Distribution</td>
<td>Demand Related</td>
</tr>
<tr>
<td></td>
<td>Energy Related</td>
</tr>
<tr>
<td></td>
<td>Customer Related</td>
</tr>
</tbody>
</table>
Traditional MCOSS Process

- Created in the 1970s
  - Adopted in a handful of states
- The basics
  - Functionalize, like ECOSS
  - Estimate marginal unit costs for each function
  - Compute sum of marginal costs by class
  - Reconcile to total revenue requirement
- Theory that efficient pricing should be better linked to marginal costs at all points in the process
- Will be addressed in more detail in future technical webinar
2 Technology and Regulatory Change
The Evolving Electric System

- Most current methods pre-date 1990s; many pre-date 1950s
- Numerous changes since then need to be accounted for:
  - Technology changes
  - Regulatory changes
Wind and Solar

- Capital intensive
- No fuel
- Peak reliability benefit may be limited in some regions
Storage

• Capital intensive

• Multiple purposes:
  • Shift energy to high-value periods
  • Support T&D
  • Very reliable capacity
  • Ancillary services
  • Resilience
Customer-Sited Resources

• Shift net peak hours for both generation and delivery

• Distribution system provides upstream benefits
Energy Efficiency

- Implemented at customer level
- Saves generation, transmission & distribution
- Often booked as customer service
Demand Response

- Peaking resource with little utility investment
- Substitution of data and controls for both capital and fuel
- Cheap compared to any supply option
Smart Grid and Big Data

• Reduce system costs and lower losses
• Granular customer and distribution system data
• Storage locations can be optimized
Electric Vehicles

- Potential very large additional load
- High incremental costs if done wrong
- But can be almost all off-peak, or even flatten net load
Illustrative modern electric system

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

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

**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.

Regulatory Changes Since 1990

- Restructuring and new wholesale and retail markets
- Performance-based regulation
- Public policy costs for efficiency, environment, equity, etc.
- New stranded cost risks
3 Overarching Issues
Cost Causation for Electric System

- System serves joint needs of all customers across all hours of the year
- Each function has distinct cost drivers
  - Energy supply costs are time-differentiated
  - Transmission lines serve multiple purposes
  - Distribution is built only where there is load to support it
  - Basic meters are for billing, but the costs of AMI are incurred for a broad array of purposes
Determining Customer Classes

Types:
- Residential
  - Single-Family
  - Multi-Family
  - Solar?
  - Heating?
- Commercial
- Industrial
- Irrigation
- Street Lighting
4 Embedded Cost Frameworks
Best Practices for All Frameworks

• Apportion shared assets on measures of usage
• Ensure broad sharing of administrative and general costs
• Eliminate the artificial distinction between fixed and variable costs
• Only customer-specific costs are customer-related.
Fixed Costs Generally

- All enterprises incur costs that are fixed in the short run
- Most fixed costs are spread over the units that are sold
- As businesses grow, they incur additional fixed costs.

Source: www.alexslemonade.org
Fixed Costs in the Electric System

- Equipment type and cost depend on expected use
  - Generation mix
  - Transmission lines added to connect remote resources
  - Line and transformer sizing
- Wear and tear drives continuing costs
  - Generator usage
  - T&D equipment ages from repeated high loads
Fixed versus Variable Example

• Multiple ways to serve an increase in peak demand
  • Peaker – mix of fixed and variable
  • Battery storage – almost entirely fixed costs
  • Demand response – variable costs
Reforms to Traditional ECOSS

• Energy drives significant portions of transmission, shared distribution, and generation capacity costs
  • These costs are not entirely caused by peak demand
• Some energy-related costs vary by time
  • E.g., fuel and purchased power
• Use broad peak measures for demand-related costs
  • Eliminate 1CP/4CP/12CP for transmission and generation capacity
• Use basic customer method for customer connection costs
  • Minimum system and zero intercept methods are unreasonable
• Functionalize and classify AMI and distributed energy resources across all elements of electric system that they benefit
Issues with Traditional Demand & Energy Allocators

- 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
- Time-based allocation addresses these issues
Creating a Modern ECOSS

- Smarter customer classes;
- New and more granular functions;
- Classification and allocation should reflect time-varying loads;
- Clear division between shared distribution plant and the equipment that connects individual customers.
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

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Old Ways vs. New Methods

Generation

The Old Way

- Fixed costs classified to demand
- Allocated on narrow measures of peak demand (1CP, 12CP)

Modern Methods

- Fixed and variable costs assigned to relevant hours.
- Costs allocated on class hourly usage
Old Ways vs. New Methods

Transmission

The Old Way
• All costs classified as demand-related
• Allocated on narrow measures of peak

Modern Methods
• Each component is allocated based on its use and need.
Old Ways vs. New Methods

Distribution

The Old Way

• Many shared costs classified as customer-related
• Demand costs allocated on non-coincident load

New Methods

• No shared costs are customer-related
• Demand costs allocated on usage in broad peak periods
5 Presenting and Using Results
# Presentation of Results

Computing class rate of return in a embedded cost study

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Residential</th>
<th>Small (up to 20 kWs)</th>
<th>Medium (20 to 250 kWs)</th>
<th>Large (more than 250 kWs)</th>
<th>Large primary</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues</td>
<td>$117,760,688</td>
<td>$28,116,419</td>
<td>$8,342,138</td>
<td>$26,156,458</td>
<td>$38,730,796</td>
<td>$15,134,759</td>
<td>$1,280,117</td>
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<tr>
<td>Allocated expenses</td>
<td>$112,438,805</td>
<td>$28,297,246</td>
<td>$8,997,362</td>
<td>$23,807,377</td>
<td>$35,927,265</td>
<td>$14,280,041</td>
<td>$1,129,515</td>
</tr>
<tr>
<td>Operating income</td>
<td>$5,321,883</td>
<td>-$180,827</td>
<td>-$655,223</td>
<td>$2,349,081</td>
<td>$2,803,532</td>
<td>$854,718</td>
<td>$150,603</td>
</tr>
<tr>
<td>Allocated rate base</td>
<td>$87,878,094</td>
<td>$24,935,855</td>
<td>$8,339,503</td>
<td>$18,481,728</td>
<td>$26,069,711</td>
<td>$9,399,629</td>
<td>$651,667</td>
</tr>
<tr>
<td>Allocated return</td>
<td>$5,321,883</td>
<td>$1,510,111</td>
<td>$505,039</td>
<td>$1,119,251</td>
<td>$1,578,778</td>
<td>$569,240</td>
<td>$39,465</td>
</tr>
<tr>
<td>Rate of return</td>
<td>6.06%</td>
<td>-0.73%</td>
<td>-7.86%</td>
<td>12.71%</td>
<td>10.75%</td>
<td>9.09%</td>
<td>23.11%</td>
</tr>
<tr>
<td>Profit margin</td>
<td>4.52%</td>
<td>-0.65%</td>
<td>-7.82%</td>
<td>8.94%</td>
<td>7.21%</td>
<td>5.62%</td>
<td>13.33%</td>
</tr>
<tr>
<td>Revenue-cost ratio</td>
<td>100.00%</td>
<td>94.33%</td>
<td>87.79%</td>
<td>104.93%</td>
<td>103.27%</td>
<td>101.92%</td>
<td>109.51%</td>
</tr>
<tr>
<td>Revenue shortfall (or surplus)</td>
<td>$1,690,938</td>
<td>$1,160,262</td>
<td>($1,229,831)</td>
<td>($1,224,754)</td>
<td>($285,478)</td>
<td>($111,138)</td>
<td></td>
</tr>
<tr>
<td>Percentage increase for equal rate of return</td>
<td>6.01%</td>
<td>13.91%</td>
<td>-4.70%</td>
<td>-3.16%</td>
<td>-1.89%</td>
<td>-8.68%</td>
<td></td>
</tr>
</tbody>
</table>

Note: Independent rounding may affect results of calculations.
Sankey diagram for modern embedded cost of service study

Revenue requirement: 1,500

Generation: 600
Transmission: 200
Distribution: 400
Customer service, billing and A&G: 300

Peak hours: 250
Intermediate hours: 375
All hours: 635

Site infrastructure, billing and collection: 240

Residential: 500
Commercial: 460
Industrial: 400
Street lighting: 140
Using The Results of Studies

- Examine multiple reasonable approaches
- Define a range of reasonableness
- Apply judgment
- Change allocation of costs (and rates) gradually
Relationship Between Cost Allocation and Rate Design

- Cost allocation and rate design have different purposes:
  - Cost allocation = group equity
  - Rate design = customer understanding and efficient incentives
- Bad allocation techniques encourage bad rate design
- Good cost allocation techniques can inform modern rate design
Start With Costs By Function

- Billing and Collection
- Site Infrastructure
- A&G Costs
- Distribution Peaking
- Distribution Mid-Peak
- Distribution Backbone
- Network Transmission
- Transmission Backbone
- Demand Response
- Peaking Generation
- Mid-Merit Generation
- All Hours Generation
Build a Cost-Based TOU Rate for Shared Elements of System

Critical Peak Rate
75 cents per kWh

On-Peak Rate
22 cents per kWh

Mid-Peak Rate
14 cents per kWh

Off-Peak Rate
8 cents per kWh

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour of Day
Important Takeaways
Key Concepts

• Consider both cost causation and benefits of all types of costs
• Technology and regulation have changed
• Use newly available load and system data
• Smart-grid costs provide benefits for multiple functions
Key Reforms

• Smarter customer classes based on real cost distinctions
• Time-based methods for classification/allocation
• Shared assets are NOT customer costs
• Thoughtful apportionment of A&G costs
“Allocation of costs is not a matter for the slide rule. It involves judgment of a myriad of facts. It has no claim to an exact science.”

Justice William O. Douglas, U.S. Supreme Court

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

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