Electric Cost Allocation for a New Era: Principles and Concepts

Hawaii PUC
March 11, 2020

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The Regulatory Assistance Project (RAP)®
Major Topics

• Purpose of cost allocation studies
• Historical Hawaii Cost Allocation
• What’s New?
• A Modern Cost Allocation Study
• Related rate Design Issues
• Best Practices in Implementation
1 Purpose of Cost Allocation Studies
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. Allocate costs among customer classes
   - Residential
   - Commercial
   - Industrial
   - Street lighting

3. Design retail rates
   - Dollars per month
   - Cents per kWh peak
   - Cents per kWh off-peak
The 1992 Grid

Illustrative traditional electric system

Generation
Transmission
Distribution

Transmission lines 765, 500, 230 and 138 kV

Generating station
Generator step-up transformer
Transmission customer 138 kV or 230 kV

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

Line transformer
Substation step-down transformer

Traditional Embedded Cost of Service Study (ECOSS) Process
2 Traditional Cost Allocation Methods Used in Hawaii
Major Issue in Hawaii: Fuel and Purchased Power

• Historically, fuel and purchased power have been recovered on a per-kWh basis.

• New PPAs cover both investment-related costs and operating costs.

• For wind and solar “steel for fuel”
What’s New?
Wind and Solar

- Capital intensive
- No fuel
- Peak Value of Solar May Be Exhausted
Peak Load Benefits May Be Exhausted

2006 Peak: 1,200 MW at 1 PM

2014 Peak: 1,050 MW at 7 PM

Figure 1-7. O'ahu System Load Profiles, 2006–2014
Storage

- Capital intensive
- Multiple purposes:
  - Shift energy to high-value periods
  - Location: 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 and load shifting 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
Planning Criteria

- **Historical:** Capacity to meet peak

- **Future:** Complex algorithm to serve most load with low-cost renewables, but have some contingency for multiple cloudy days in a row.
Illustrative modern electric system

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

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

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

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

**Disturbance in the grid**

**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.

How Do Things Compare?

• Simple studies were adequate in the past.

• Tomorrow’s system is different.
  • Some capacity meets peak
  • Some capacity works only when it’s sunny
  • Storage has limited kWh
4 A Modern Cost Allocation Study
Determining Customer Classes

Types:

- Residential
  - Single-Family
  - Multi-Family
  - Urban / Rural
  - Solar?
- Commercial
- Institutional
- Pumping
Low Income Customers As A Class

- Less AC
- More water heat
  - Controllable
- Small to large usage
  - Single occupancy
  - Large multi-generational households
Residential Subclasses

• What actually causes a different COST to provide service?
  • Power Supply Costs
    • Amount and Time of Usage
  • Distribution Costs
    • Location and Density
  • Customer-specific costs
    • Maximum Usage (or backfeed)
    • Billing and Collection Frequency
Discussion on Customer Class Issues

• What should be key principles?
• What changes are needed in Hawaii?
• What considerations should be applied:
  • Cost apportionment equity
  • Customer impact
  • Environmental impact
  • Reliability issues
Break
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
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

Allocation

Residential
Commercial
Industrial
Street lighting

Site infrastructure, billing and collection
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
- Only customer-specific costs are customer-related
- Demand-related costs allocated on usage in broad peak periods
Treatment of Smart Grid Costs

- “Meters” do more than measure kWh
- Circuit data enables phase balancing
- Circuit data enables optimization of storage
- Customer data enables transformer right-sizing
- Communications system has multiple uses
- **Bottom line:** these are NOT “customer-related” costs; they also have demand and energy benefits
A Smart Grid Success Story: Burbank, California

- ARRA Grant supported
- Began in 2009
- Operational in 2012
- No rate increase required
  - Transformer right-sizing
  - Phase balancing
  - Billing cost savings
- And one more thing…
And Free City-Wide WiFi
Questions on Cost Allocation Issues

Rate Design

Next
5 Rate Design Following Cost Allocation Principles
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
Smart Rate Design

For a Smart Future

Authors
Jim Lazar and Wilson Gonzalez

July 2015
Principle #1

- A customer should be allowed to connect to the grid for no more than the cost of connecting to the grid.
Principle #2
Customers should pay for power supply and grid services in proportion to how much they use, and when they use it.
Principle #2

Customers should pay for power supply and grid services in proportion to how much they use, and when they use it.
Principle #3

Customers delivering power to the grid should receive full and fair value—no more and no less.
How Do Other Industries Recover Fixed Costs?
We Pay For Other “Grids”
In Volumetric Prices
And They Are Happy To Have Our Business
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

Off-Peak Rate
8 cents per kWh

Transmission Backbone

All Hours Generation

Hour of Day

Transmission Backbone

Distribution Backbone
## Future Rates for SF and MF Customers

<table>
<thead>
<tr>
<th>Multi-Family</th>
<th>Single-Family</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Customer Charge:</strong></td>
<td>$5.00</td>
</tr>
<tr>
<td><strong>Site Infrastructure:</strong></td>
<td>$5.00</td>
</tr>
<tr>
<td>$2.50/kW x 2</td>
<td>$2.50/kW x 6</td>
</tr>
<tr>
<td><strong>Energy Charge:</strong></td>
<td>$0.30/kWh Off-Peak</td>
</tr>
<tr>
<td></td>
<td>$0.30/kWh Mid-Peak</td>
</tr>
<tr>
<td></td>
<td>$0.45/kWh On-Peak</td>
</tr>
<tr>
<td></td>
<td>Critical Peak</td>
</tr>
<tr>
<td><strong>Controlled water heater</strong></td>
<td><strong>monthly bill credit:</strong></td>
</tr>
</tbody>
</table>
Effect of this rate on Solar

PV Customers vs. Non-PV Customers Average Daily Load Profile Comparison
May 2014 to June 2015

Data from homes in Diamond Head, Kahala, Pearl City, and Moanalua

531 PV Homes
2,727 Non-PV Homes

PV Energy from Home 20.6 kWh

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<tr>
<th>Direction of Energy</th>
<th>PV</th>
<th>Non-PV</th>
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</thead>
<tbody>
<tr>
<td>Monthly Energy into home</td>
<td>626</td>
<td>534</td>
</tr>
<tr>
<td>Monthly Energy from home</td>
<td>-498</td>
<td>0</td>
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PV Customers vs. Non-PV Customers Average Daily Load Profile Comparison
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Mid-Peak
531 PV Homes

Off-Peak
2,727 Non-PV Homes

On-Peak

PV Energy from Home
20.6 kWh

Direction of Energy
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## Impact: Solar customer with 0 kWh

### NEM

<table>
<thead>
<tr>
<th>Rate Element</th>
<th>Amount</th>
<th>Unit</th>
<th>Period</th>
<th>Usage kWh</th>
<th>PV kWh</th>
<th>Net kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer</td>
<td>$11.50</td>
<td>Month</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Off-Peak</td>
<td>$0.153</td>
<td>kWh</td>
<td>9 AM - 5 PM</td>
<td>195.3</td>
<td>477</td>
<td>(281.70)</td>
</tr>
<tr>
<td>Mid-Peak</td>
<td>$0.345</td>
<td>kWh</td>
<td>All Other</td>
<td>198.6</td>
<td>42</td>
<td>156.60</td>
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<tr>
<td>On-Peak</td>
<td>$0.436</td>
<td>kWh</td>
<td>5-10 PM</td>
<td>140.1</td>
<td>15</td>
<td>125.10</td>
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Total: 534 534 0.00
Impact: Solar customer with 0 kWh NEM

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<th>Billed Amount</th>
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<tr>
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<td>$ 11.50</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>534</td>
<td>534</td>
<td>0.00</td>
<td>76.97</td>
</tr>
</tbody>
</table>
Non-Residential Rates
## Current HECO Schedule J Rate

<table>
<thead>
<tr>
<th>Charge</th>
<th>Amount</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer</td>
<td>$66.00</td>
<td>Month</td>
</tr>
<tr>
<td>Demand</td>
<td>$13.00</td>
<td>kW (NCP)</td>
</tr>
<tr>
<td>Energy</td>
<td>$.2381</td>
<td>kWh</td>
</tr>
</tbody>
</table>
Problems with HECO Schedule J

- **Demand Charge**: Applies to NCP demand; irrelevant for system planning or system costs, except for site infrastructure at customer premises.

- **Energy Charge**: Not differentiated by time of use.

- **Invites battery installation** to shave demand charge – even at non-peak system hours.
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.
Solution: Smart Rates

- Demand Charge:
  - Limit to site infrastructure only

- Energy Charge
  - Use same TOU principles as for residential rate
# Concept Rate for HECO Schedule J

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<tr>
<td>Site Infrastructure</td>
<td>$2.00</td>
<td>kW (NCP)</td>
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<tr>
<td>Off-Peak</td>
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<td>kWh</td>
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<tr>
<td>Critical</td>
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Electric Vehicles

- High demand (6 - 11 kW)
- Average 1-2 hours/day
- Controllable hours
Illustrative Rates Work Well for EVs

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“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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