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# Introduction to Cost of Service Studies and Rate Design

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October 18, 2011

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# Topics For Discussion

- What is a Cost of Service Study
  - Types of Studies
  - Key controversial elements
  - Policy Decisions for the Board
- Rate Design
  - Major Issues
  - Principal Goals
  - Policy Decisions for the Board

# Many Ways To Calculate “Cost of Service”

## Categories of Studies

- Marginal Cost
- Embedded Cost

## Approaches Within Each Category

- Production / Transmission
  - Peak Responsibility
  - Base – Intermediate – Peak
  - Peak Credit
- Distribution Costs
  - Minimum System
  - Basic Customer

## All Of These Rates Are Based On The “Cost of Service”

<b>Pedernales</b>			
Customer Charge			\$ 22.50
Energy Charge		All kWh	\$ 0.102

<b>Austin</b>			
Customer Charge			\$ 6.00
Winter		First 500 kWh	\$ 0.067
		Over 500 kWh	\$ 0.091
Summer		First 500 kWh	\$ 0.067
		Over 500 kWh	\$ 0.109

<b>Pacific Gas and Electric</b>			
Customer Charge		Minimum \$5/month	
Energy Charge		First 350 kWh	\$ 0.122
		Next 150 kWh	\$ 0.139
		Next 500 kWh	\$ 0.294
		Over 1,000 kWh	\$ 0.404

# Types of Cost of Service Studies

## Embedded Cost

- Divide up actual current costs of the utility system
- Backward-looking
- Require extreme detail of historical costs
- Most common type for coops; most state regulators use for IOUs
- Dozens of different methods

## Marginal Cost

- Measure the cost of building and operating a new utility system.
- Forward-looking
- Base cost allocation on the replacement cost of the system
- Require less data
- Used by many of the states, including California, Oregon, Montana

**Vintaging:** Assigning certain older, usually cheaper resources to specific customers. Seldom used, but sometimes applicable.

# Some of the Basic Theories and Principles for Cost Analysis

- There are as many ways to calculate “cost of service” as there are analysts doing studies.
- No method is “correct”
- Many regulators require multiple studies, and consider the results of multiple methods.
- Some are based on engineering principles, some on economic principles.

# Determining the Customer Classes

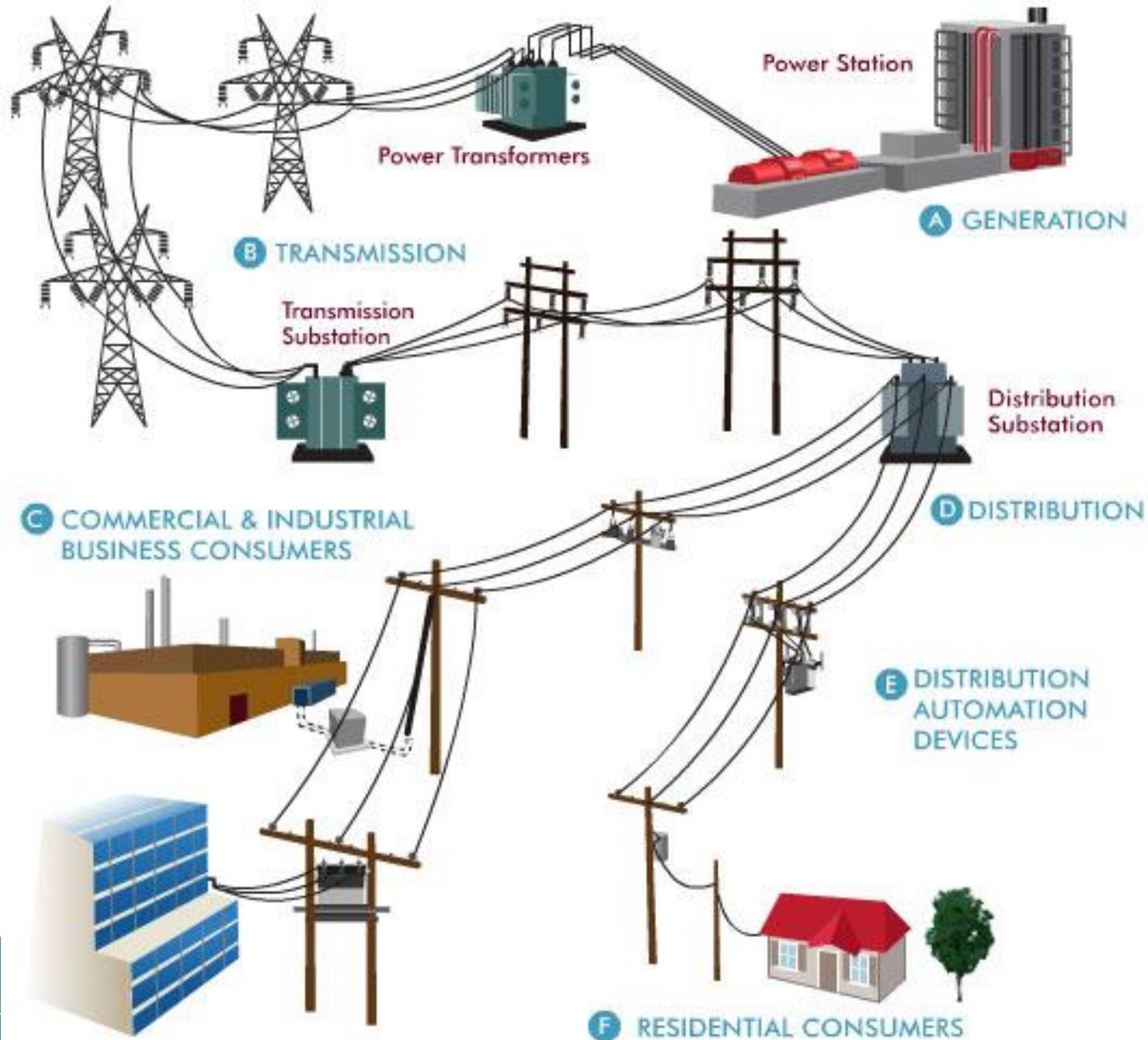
- Residential
- Commercial
- Industrial
- Agricultural

Or

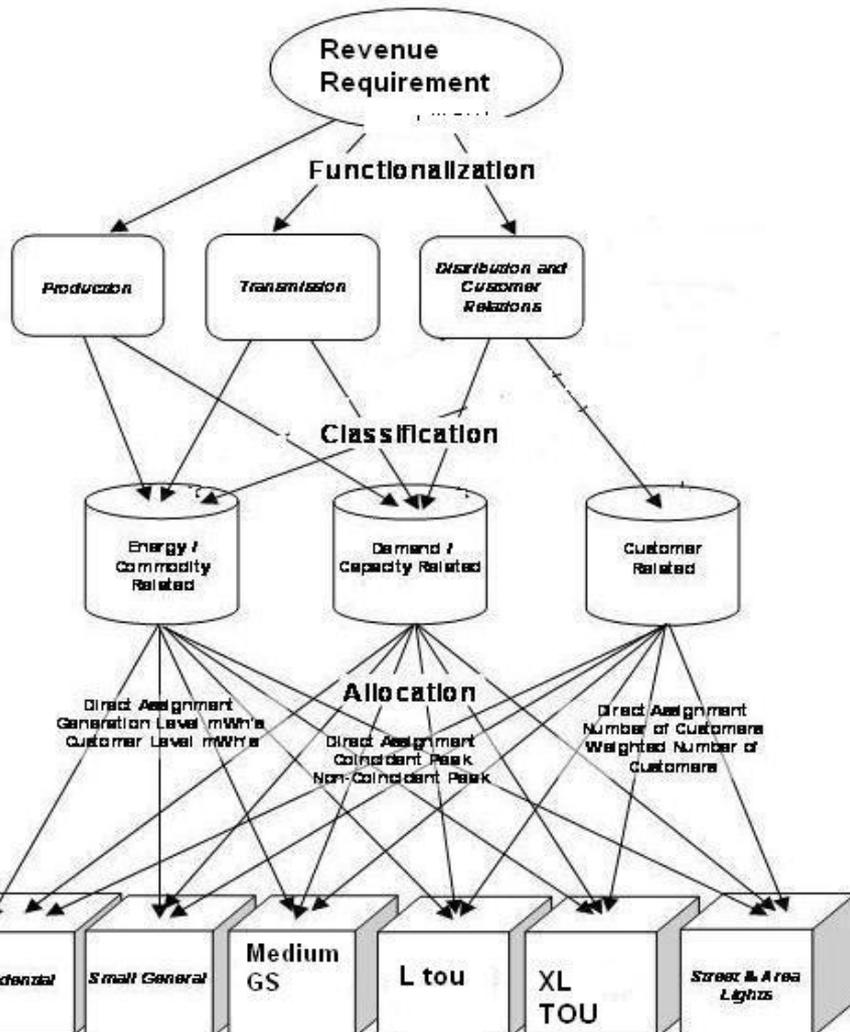
- Secondary Voltage
- Primary Voltage
- Transmission Voltage

- Biggest issue for PEC is probably whether to separate rural customers into a separate sub-class
  - Line extension payment credits
  - Lower system density
  - Different usage characteristics

# The Power Grid



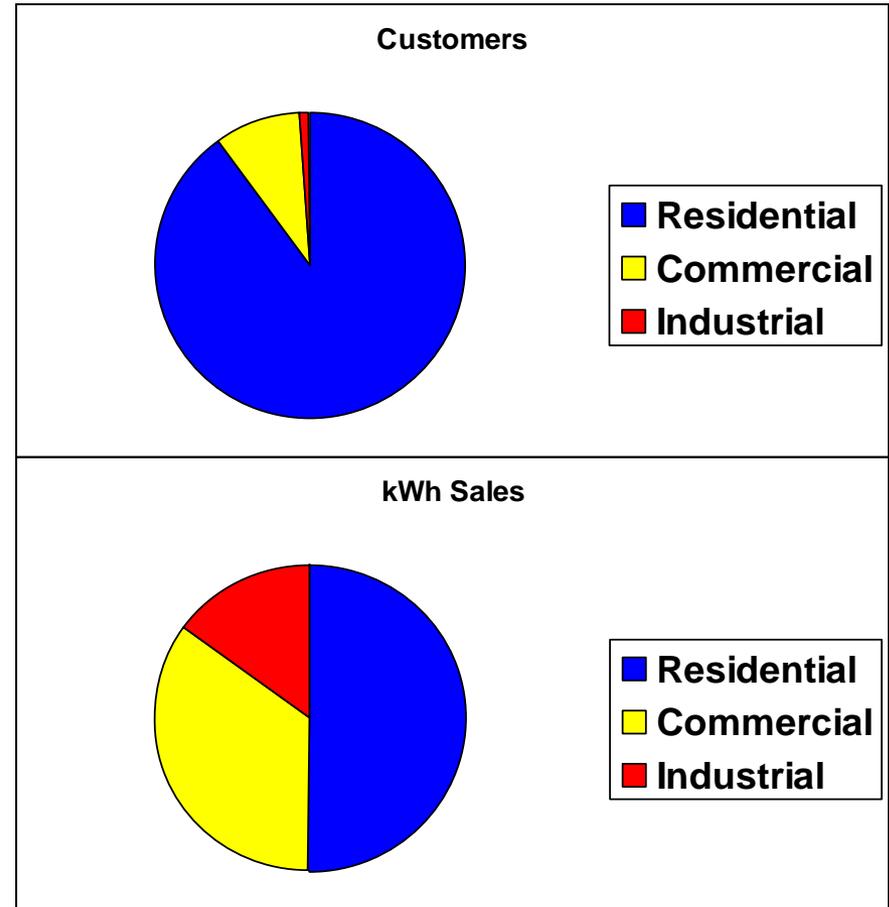
# Dividing Up the Revenue Requirement



- Costs are **FUNCTIONALIZED** between Electric and Water, and between Production, Transmission, Distribution, and Common
- Costs are **CLASSIFIED** between Energy, Demand, and Customer related.
- Costs are **ALLOCATED** between customer classes.
- In general, we try to track costs through to rates on the same basis that they are classified and allocated.

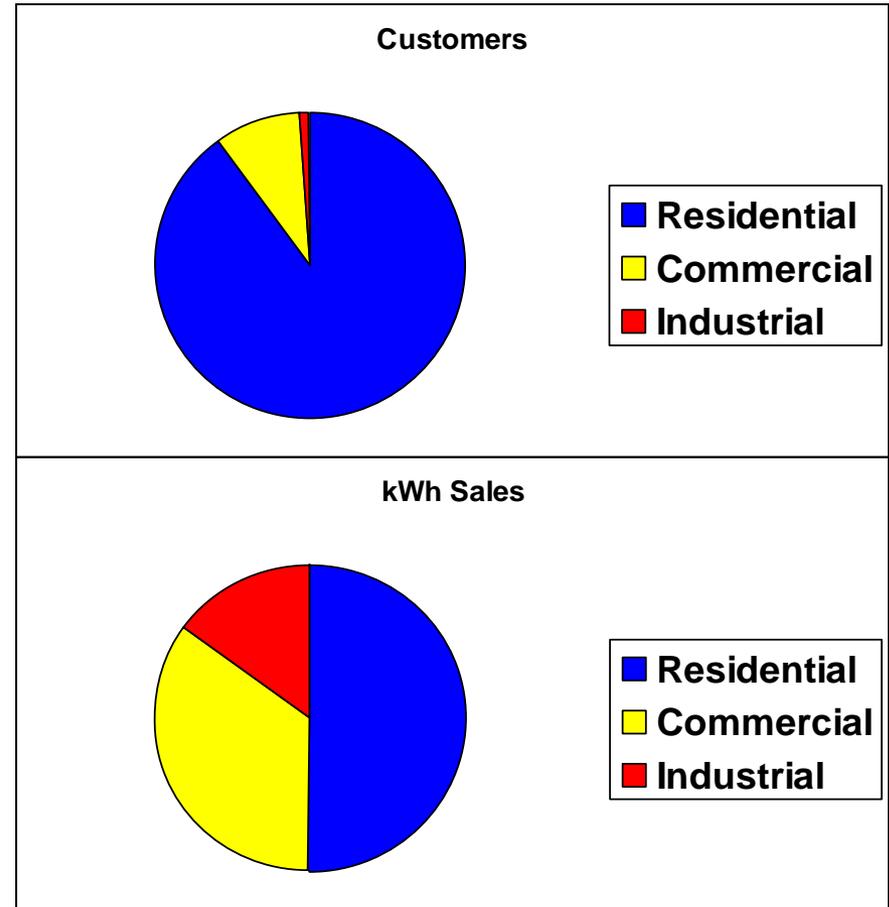
# Why Does It Matter?

- On a **typical** utility system, residential class is 90% of customers, 60% of peak demand, 50% of kWh sales.
  - Costs classified as “customer-related” fall heavily on this class.
  - Industrial customers advocate for higher classification to customer and demand.



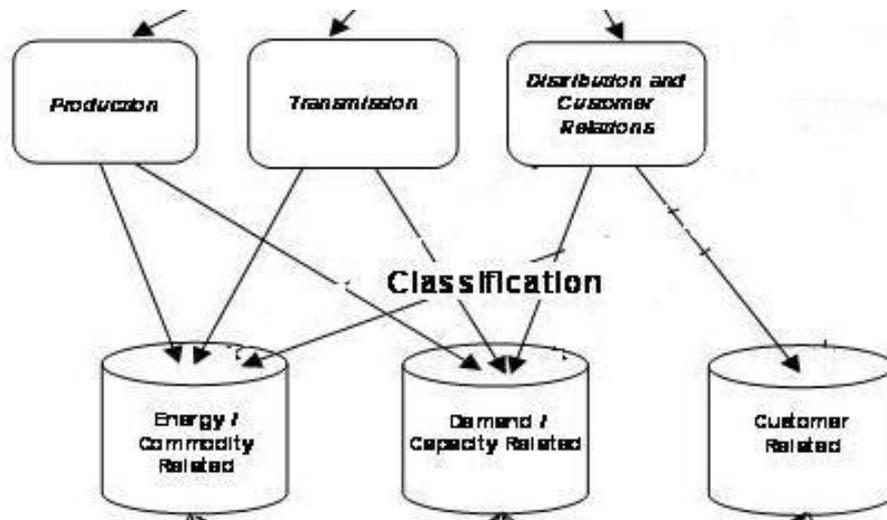
# Why Does It Matter?

- Costs classified as “customer-related” often (not always) flow through to the fixed monthly charge.
- This lowers the kWh charge against which consumption decisions are made.
- The marginal cost of adding a customer is low; the marginal cost of adding energy supply is not.



# Classification of Costs Between Different Usage Elements

- Classification of costs means deciding whether they are related to “demand”, “energy”, or “customer” functions so they can be assigned to the classes based on usage characteristics.
- Many costs have dual purposes, and must be split.

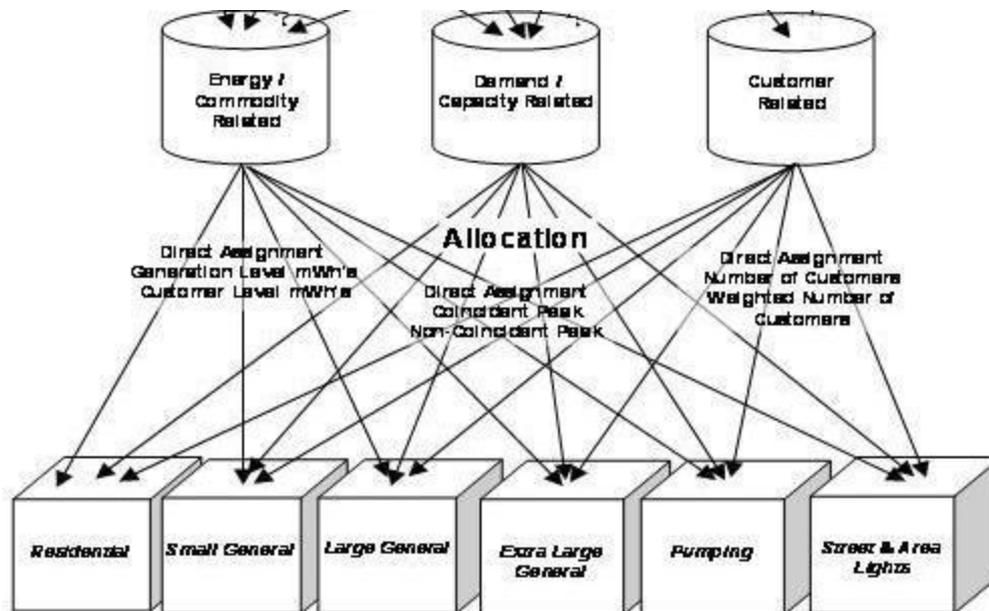


# Classification: Not so easy.

- Some are easy:
  - Substation capacity is ‘demand’ related
  - Fuel is ‘energy’ related
  - Billing is ‘customer’ related.
- Some are less clear
  - Baseload power plants are not built to meet “peak demand” but to serve energy needs all year.
  - Long-distance transmission lines are sized based on capacity, but built to avoid fuel costs.
  - 14 kv distribution upgrades reduce energy losses
- Important to always ask: **“Why is this cost being incurred?”**

# Allocation: Assigning Costs To Customer Classes

- The **allocation** step assigns all of the utility's costs to the different customer classes, based on their number of customers, peak demand, and energy usage.



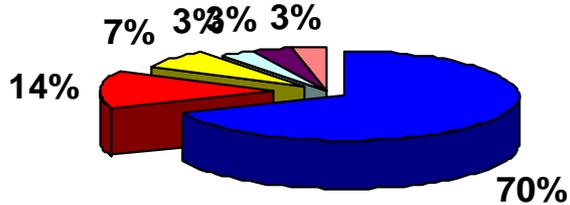
# Basic Principles of Cost Allocation

## What? Why? How? What's Next?

- **Cost Causation:** What costs are caused by the usage of a customer group?
- **Why Was It Built?** Just because it's "engineered" based on a certain demand does not mean it was built because of that particular demand.
- **Shared Usage:** Different customers use the system at different times of day or seasons of year. All should share in the system costs.
  - Even a 100% off-peak customer should help pay for the utility infrastructure.
- **What Will It Cost To Replace:** Looking ahead, will the replacement cost be vastly different than the cost incurred in the past?

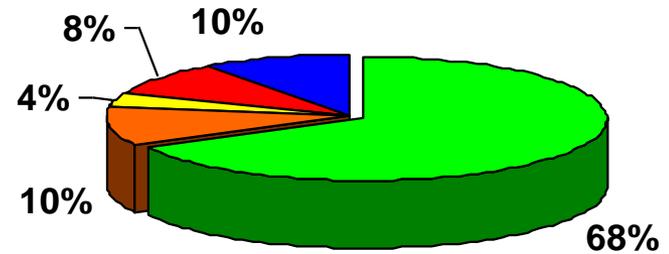
# The Result: Cost of Service By Class

Costs By Category



■ Purchased Power    ■ Labor    ■ Depreciation  
■ Interest exp    ■ Materials    ■ Margin

Revenue Requirement By Class



■ Residential    ■ Small Power  
■ Other Classes    ■ Large Power  
■ Industrial

# Sustainability Issues

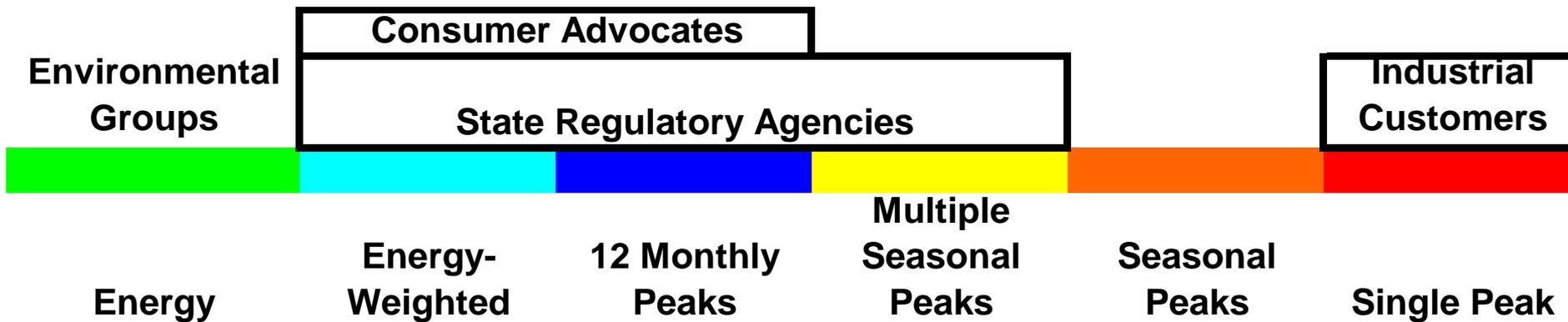
- The more costs classified to **energy**, the higher the cost-based energy charges are, and the greater the incentive to conserve energy.
- The more costs classified to **demand**, the higher the demand charges are, and the greater the incentive to control peak demand.
- The more costs classified to **customer**, the higher the monthly service charges, and the lower the costs for energy and demand, reducing price incentives for efficiency.

# How State Regulators Make These Decisions

- Several days of expert testimony before the Commission.
  - Utilities
  - Industrial intervenors
  - Consumer intervenors
  - Environmental intervenors
  - Commission staff analysis
- Written Decision On Specifics

# Spectrum of Methods

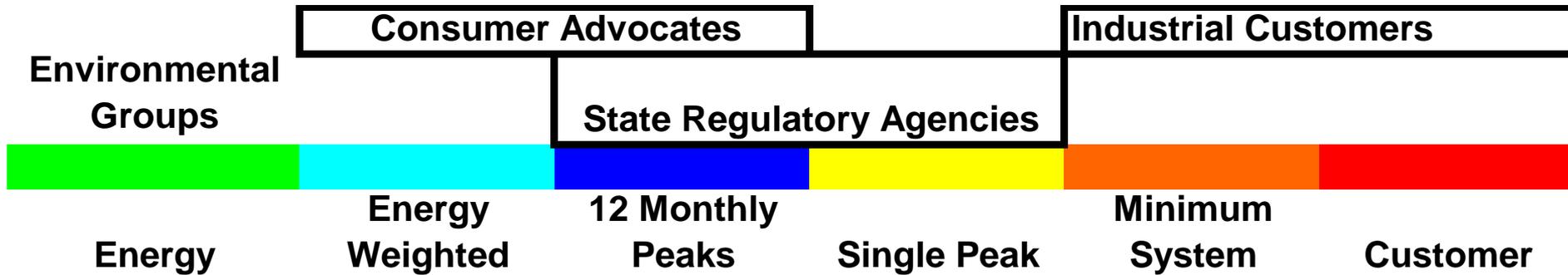
## Production Costs



**Issue: Should the LCRA wholesale rate design be flowed through to the PEC retail rate design?**

# Spectrum of Methods

## Distribution Costs



**Issue: How should PEC classify and allocate the distribution infrastructure costs?**

# Production Costs

- **Fixed Costs: Investment in power plants, maintenance, depreciation, interest.**
  - **Peak Responsibility Method:** Classify these as “demand” related, allocate based on peak demand
  - **Energy-Weighted Method:** Classify only the cost of peaking units as demand related; baseload units mostly classified as energy-related.
- **Variable Costs: Fuel, and Operations**
  - Nearly all studies classify these as energy-related
- **PEC: Embedded in LCRA Rate Design**

# Transmission Costs

- **Fixed Costs:** Investment in transmission lines, maintenance, depreciation.
  - **Peak Responsibility Method:** Classify these as “demand” related, allocate based on peak demand
  - **Energy-Weighted Method:** Classify only the cost of transmission associated with peaking units as demand related; transmission for baseload units mostly classified as energy-related.
- **PEC: Very small portion of expense**

# Distribution Backbone Costs

**Minimum System Method:** The cost of a hypothetical “minimum distribution infrastructure” is driven by the number of customers, and should be recovered in the customer charge. (Minimum system method)

- **Used by most (not all) consultants to coops.**
- **Last PEC Consultant used a variation of this.**
- **Rejected by most state regulatory commissions.**

**Basic Customer Method:** Only meters, meter reading, and billing are considered “customer-related.” All other distribution costs are Demand or Energy

- **Used by most state regulatory commissions, including TX**

# **Customer-Related Costs**

## **Meters, Meter Reading, Billing**

**Nearly all studies consider the meters, meter reading, and billing costs to be customer-related.**

**Usually “weighted” according to the complexity of the rate design – industrial customers are assigned a weighting of 5 – 10.**

# Time of Use Issues

- Should the study differentiate customer usage by time of day?
  - Residential usage spreads into evenings
  - Office building usage peaks during day
  - Lighting is mostly off-peak
- Direct power costs are lower off-peak
- Environmental impacts may differ by time of day.

# Marginal Cost Studies

- **Marginal cost studies measure the CHANGE in costs as the number of customers, the peak demand, or the kWh sales changes.**
  - **Look at cost of new power resources, not older, depreciated low-cost units.**
  - **Generally ignore system backbone costs, because these do not change.**

# Marginal Cost Studies

- **Measure cost of a peaking resource (demand response) as the cost of peaking capacity**
- **Measure marginal cost of a baseload power plant as the marginal cost of energy;**
- **Measure marginal cost of an additional meter, meter read, and bill as the marginal cost of an additional consumer.**
- **Multiply each by the relevant usage quantities for each class.**
- **Must reconcile to the revenue requirement.**

# Controversy Over Long-Run Marginal Cost Methods

- **Production:**
  - Full replacement costs, or only variable running costs until a capacity deficiency occurs?
- **Distribution:**
  - Use the full cost of rebuilding the distribution system, or only the cost of connecting additional customers to an existing system

# Benefit of Marginal Cost Study

- **Looks at the changes in cost going forward. Can guide rates that are forward looking.**
- **Full recognition of new power supply costs, including environmental costs.**
- **Communicates to the utility and to customers the long-run costs imposed (or saved) by additional (decremental) usage.**
- **Most studies find that power supply costs have risen more than distribution costs, so weight power supply more heavily.**

# Cost of Service

## Policy Issues for the Board

- **Type of study:** Embedded, marginal, or both.
- **Customer sub-classes:** Differentiate large residential from small, urban from rural, etc.
- Include **time-of-use** analysis?
- **Single** methodology or **multiple** methodologies.
  - Treatment of baseload resource costs (demand vs. energy; as-billed or cause-causation?)
  - Distribution infrastructure: per consumer, per kW, or per kWh?
  - **Option:** Ask Texas Office of Public Utility Counsel for a set of assumptions appropriate for Texas.

# Rate Design

# Rate Design

- Principles of Rate Design
- Methods need not be identical to COS
- Determining the monthly service availability charge
- Determining rate blocks and demand charge levels
- Advanced Rate Design
- Revenue Stability

# Principles of Rate Design

- Simplicity, understandability, public acceptability, and feasibility of application
- Freedom from controversy as to interpretation
- Effectiveness at recovering the revenue requirement
- Revenue stability from year to year
- Gradual change over time
- Fairness in apportionment of costs
- Avoid “undue discrimination”
- Encourage efficient use of service
- Discourage inefficient use of service

# Elements of Electric Rates

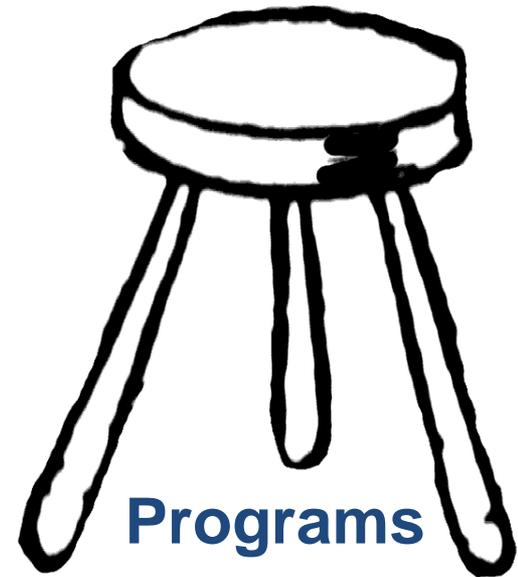
- **Service Availability Charge** (or “Basic” charge of “Customer” Charge)
  - Fee for being connected to the system, without any usage included.
- **Energy Charge**
  - Price per kilowatt-hour
    - May be differentiated by block, by time of day, or by season
- **Demand Charge** (Schedule D and larger)
  - Price per kW or kVA of peak demand
    - May be differentiated by time of day or season

# Rate Classes and Complexity

- Smaller customers are less sophisticated, and need simpler rate design.
- The largest customers have full-time purchasing managers who understand extreme details.
  - But 8-year olds understand the Baskin-Robbins rate design.
    - 1 scoop \$1.50
    - 2 scoops \$2.50
    - 3 scoops \$3.00
  - And almost every cellphone user understands “free nights and weekends.”

# Achieving Clean Energy Goals

- Achieving ambitious clean energy goals requires dramatic changes in the production and utilization of electricity.
  - Renewable Resources
  - Energy Efficiency
  - Smart Technologies
  - Coal retirement
- Three principal tools
  - **Policies:** IRP, RPS, EEPS
  - **Programs:** EE Funding, Smart Grid
  - **Pricing:** This topic



**Policies**

**Pricing**

# Many Rate Philosophies

- **CPUC:** Reflect marginal costs for usage; much lower rates for basic level of service.
- **Electric Cooperatives:** Recover a large part of fixed costs in fixed charges. Set energy rates based on power supply cost only
- **Washington State:** Baseline approach: hydro at hydro rates, thermal at thermal rates
- **Municipal Utilities:** Low basic charges, with incentives for conservation
- ALL of these are based on “**cost of service.**”

# A Few Important Rate Design Terms

- **Load Factor**

- The ratio of average usage to peak usage.
  - A 100 kW demand customer, using 36,000 kWh/month has a 50% load factor.
    - $100 \text{ kW} \times 720 \text{ hours /month} = 72,000$
    - $36,000 / 72,000 = 50\%$
- Customers and loads with low load factors cost more to serve per kWh.

- **Load Shape**

- The relative amount of usage during on-peak hours versus off-peak hours.
  - Street lights have a 50% load factor, but it's all off-peak.
  - Office buildings have a 50% load factor, but it's almost all during the business day Monday – Friday
  - Residential customers have a 50% load factor, but about 35% of their usage is on weekends.
- Customers and loads with on-peak load shapes cost more to serve per kWh

- **Power Factor**

- Power factor is the cosine of the angle between the active power (kW) and apparent power (kVA) in a circuit. *Yeah, right.*
  - Power Factor is a measure of the stability between usage and generation
  - It's like the foam on the head of the beer – fills the glass, but doesn't do any good.
- **Customers and loads with low power factors cost more to serve per kWh.**

# Methods Need Not Be Identical to the Cost of Service Method

- Cost of service studies apportion costs between classes. They are focused on ONE ELEMENT of a fair rate design.
- Rate design sets rates within classes, and influence consumption decisions.
- Allocation can be retrospective (embedded cost study) with rate design forward-looking (marginal).

# Determining the Rate Classes

- Currently, all residential customers in a single class: large, small, urban, rural
  - Usage patterns (Load shape) may be different
  - Distribution costs per customer are different
- Not clear why water wells are a separate class.
- Small Power is all customers under 75 kW; many utilities cut this off at 20 kW.

# Determining the Monthly Service Availability Charge

- Current charge recovers about 35% of the distribution system costs.
- “Basic Customer” method sets this based on metering and billing costs alone – more like 10% of total distribution costs.
- Gradualism principle may guide a policy to hold the current level, and apply future increases to the usage charges.

# Determining the Rate Blocks

- PEC currently has a “flat” rate: same price for all kWh.
- In residential and small power, this recovers some distribution costs that are classified as “demand” related in the COS studies.
- May be useful to study load shape by usage level, to see if (as on most utilities), load shape and load factor are worse for larger (i.e., water heat and space conditioning) customers.
- **Example:** Introduce a higher cost block for usage in excess of 1,000 kWh (about where space heating and cooling begin).

# Example: Gradually Implement a Rate Like Arizona Public Service's

Winter (November - April billing cycles)	Cents per kWh
All kWh	\$0.09397
Summer ( May - October billing cycles)	Cents per kWh
1 - 400 kWh	\$0.09671
401 - 800 kWh	\$0.13739
801 - 3000 kWh	\$0.16281
3001 and up	\$0.17358

# Inverted Block Rate for PEC

## 4-Year Phase-In

**Based On Assumption of a 3% Overall Annual Increase**

		Current	Year 2	Year 3	Year 4
<b>Service Charge</b>		\$ 22.50	\$ 22.50	\$ 22.50	\$ 22.50
<b>First 1,000 kWh</b>		\$ 0.1042	\$ 0.1042	\$ 0.1042	\$ 0.1042
<b>Over 1,000 kWh</b>		\$ 0.1042	\$ 0.1125	\$ 0.1215	\$ 0.1313

**Bill Impact** % Increase

Usage						
500	\$	74.60	\$	74.60	\$	74.60
1,000	\$	126.70	\$	130.87	\$	140.23
1,500	\$	178.80	\$	187.14	\$	205.86
2,000	\$	230.90	\$	243.40	\$	271.49
2,500	\$	283.00	\$	299.67	\$	337.12
3,000	\$	335.10	\$	355.94	\$	402.75
						0%
						11%
						15%
						18%
						19%
						20%

# Advanced Rate Design Topics

- Time of Use Rates
  - Fixed period TOU
  - Critical Peak Pricing
  - Peak-Time Rebates
  - Real-Time Pricing
- kVA Demand Charges
- Feed-In Tariffs
- Net Metering

# Time-Of-Use Pricing (TOU)

- Increasingly common as advanced metering becomes less expensive.
- Typically two or three-period.
- Would require new MDMS for PEC

<b>Off-Peak</b>		<b>\$0.08</b>
<b>Mid-Peak</b>		<b>\$0.10</b>
<b>On-Peak</b>		<b>\$0.12</b>

# Time-Of-Use Pricing (TOU) Combined With Inverted Block

- Increasingly common as advanced metering becomes less expensive.
- Typically two or three-period.
- Would require new MDMS for PEC

<b>Off-Peak</b>		<b>\$0.08</b>
<b>Mid-Peak</b>		<b>\$0.10</b>
<b>On-Peak</b>		<b>\$0.12</b>
<b>First 500 kWh</b>		<b>(\$0.03)</b>

# Critical Peak Pricing (CPP)

- Starts with a “normal” TOU rate, slightly lower than it would otherwise be.
- Adds an element of uncertainty: on extreme peak days, for defined hours, the price jumps sharply.
- Customers get notice of critical peak events, maximum 100 hours per year.
- Would require new MDMS for PEC

Off-Peak		\$0.07
Mid-Peak		\$0.10
On-Peak		\$0.13
<b>Critical Hours</b>		<b>\$0.50</b>

# Peak Time Rebates (PTR)

- A credit for reduced load at times of system extreme peaks.
  - \$/kW, or \$/kWh, for either utility control of load, or calculated load reductions.

Plan option	Conditions	Credits for customers on rate schedule GS-1 or TOU GS-1	Credits for customers on rate schedule GS-2, TOU GS-3 or TOU-8
<input type="checkbox"/> <b>Maximum Savings</b> Enhanced	A/C compressor off continuously for up to 6 hours per day <b>(unlimited interruptions during the summer season)</b>	\$0.400 per calculated ton per day	\$12.00 per calculated ton per month
<input type="checkbox"/> <b>Maximum Savings</b> Base	A/C compressor off continuously for up to 6 hours per interruption <b>(up to 15 interruptions during the summer season)</b>	\$0.200 per calculated ton per day	\$6.00 per calculated ton per month
<input type="checkbox"/> <b>Good Value</b> Enhanced	A/C compressor off 15 out of every 30 minutes for up to 6 hours per day <b>(unlimited interruptions during the summer season)</b>	\$0.140 per calculated ton per day	\$4.20 per calculated ton per month

# Real-Time Pricing

- Customer rate is tied to real-time market clearing price for power.
- Only for sophisticated consumers
- Georgia Power program has a cost-stabilization feature that makes it more acceptable to industrial customers.

# Feed-In Tariffs and Net Metering

- Rates designed to compensate customers with on-site generation for their power production.
- Feed-In Tariffs pay a price (usually a premium price) for power delivered to the grid.
- Net Metering charges customers only for the “net” power flow through their meters, effectively paying them the retail rate for the power they deliver to the grid.
- PEC currently has an energy-cost only net-metering program.
- A TOU net-metering program will recognize the on-peak nature of solar power.

# kVA Demand Charges

- PEC Demand charges are \$/kW; there are no charges or credits for low or high power factor.
- Distribution system capacity is rated in kVA, which accounts for the power factor ( $\text{kW} / \text{Power Factor} = \text{kVA}$ )
- kVA demand charges more appropriately collect for the costs imposed on the system.

# Revenue Stability Measures

- Decoupling is the most commonly discussed way to stabilize the utility net income.
- High service availability charges do this as well, but mute consumer price signals.
- High levels of financial reserves, together with the ability to adjust rates if needed, gives PEC a “simple” option.

# Rate Design

## Policy Issues for the Board

- **Rate Classes**
  - Single residential class, or multiple subclasses
  - Water wells as separate class
  - Intermediate demand-metered general service >20kW
- **Residential Rate Design**
  - Phase in inverted block
- **kW or kVA demand charges**
- **Advanced Pricing: TOU or CPP**
- **Feed-In Tariff or Net Metering**
- **Revenue stabilization options**

## About RAP

The Regulatory Assistance Project (RAP) is a global, non-profit team of experts that focuses on the long-term economic and environmental sustainability of the power and natural gas sectors. RAP has deep expertise in regulatory and market policies that:

- Promote economic efficiency
- Protect the environment
- Ensure system reliability
- Allocate system benefits fairly among all consumers

Learn more about RAP at [www.raonline.org](http://www.raonline.org)

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