Economics of Modern Rate Design: Optimizing Value for the Customer & System

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Fundamental Truths

• Trio of Power System Challenges:
  – Remaining Affordable despite slowly growing sales
  – Ensuring Reliable, Secure, and Resilient Service to Customers
  – Enabling Environmental Sustainability

• Digital Technology has Changed the Economy
  – Affordable and ubiquitous sensors, computing, communications, & data

• Emergence of Distributed, Autonomous Technologies
  – Internet of Things
  – Electric Vehicles
  – Solid State Power Electronics
  – Distributed Energy Resources

• Dynamic Competitive Markets Improve Efficiency
  – Prices tend to equal marginal cost, thereby communicating the value of next best alternative use of scarce resources
  – Markets coordinate diverse participants without centralizing information & control
Economic Principles of Modern Rate Design

• Rate Designs that Extend the Impacts of Dynamic Competitive Markets into the Distribution Grid Can Optimize Customer and System Value:
  – Better Reflecting the Time- and Location-specific Value of the Products (real power, reactive power, reserves) produced by DER, thereby incenting more efficient DER investment, siting, and operation
  – Avoiding the Socialization of DER Costs and Risk and Reducing the Regulatory Burden that is associated with Administratively Determining DER Value
  – Communicating value to Distributed, Autonomous Technologies, which will not be readily integrated into grid operations by either Demand Response Programs or Centralized Dispatch

• Bedrock principle of microeconomics: Economic efficiency is maximized when prices equal marginal cost

• Natural Monopoly Costs Generally Cannot be Recovered at Marginal Cost Prices

• Efficient Rate Design, all else being equal, will seek to combine:
  – Dynamic Rates that reflect short run marginal costs, with
  – Recovery of Residual Revenue Requirements in charges having minimal impacts on short-run demand and resource allocation
Marginal Costs in Rate Design

• Rates that reflect marginal costs tend to optimize supplier and customer choices and the allocation of scarce resources

• Marginal Cost is the cost of a very small additional unit of short-run output
  – Marginal Costs are the current and future costs of a short-run change in output (includes impact on equipment life of an additional small unit of output)
  – Marginal Cost is Granular: Time, Location, and Product Specific, It Recognizes that Electricity Used at Different Times imposes Different Costs and represents Different Products

• Common issues in identifying marginal costs:
  – Terminology: Planning terms initially from the era of vertical integration (PURPA and IRP): “avoided” or “long-run marginal” costs are often conflated with more tightly defined economic “marginal cost”
  – Perspective: Fixed transmission costs that RTO rates recover on a per kWh basis are not marginal costs

• Social Costs: Efficient markets would internalize environmental impacts
  – Second Best approach: Estimation of Externality Costs which can be complicated.
  – Externality Cost impacts: $40/Ton CO₂ Dividend might equate to as much as 3¢/kWh.
Time Varying vs. Market-Based Rate Options

• **Time Varying Rates (TVR): Time of Use (TOU), Critical Peak Rebates (CPR), and Critical Peak Prices (CPP) Can Reduce Peak Demand**
  - Statistically significant impact on Peak Demand based on over 300 evaluations at 60 utilities
  - 10% Difference in Peak to Off-peak Prices associated with 6.5% reduction in peak demand
  - Enabling technology (e.g. In-Home Display or Smart Thermostat) associated with an increased peak reduction, for 10% peak to off-peak rate difference, of an additional 4.6% (Total reduction 11.1%) \(^1\)

• **Market Based Rates (Real-Time Prices (RTP), RTP + Capacity Adder (RTP+), 2-Part RTP (Block & Index)) can Provide Much More Information and Potentially Greater Efficiency**
  - Idealized TOU Rates (set with perfect foresight) have been found to capture only 23% of the actual variation in PJM prices and 6% to 13% of the variation in CA ISO prices \(^2\)

• **Different Objectives:**
  - TVR targets Behavioral Responses for a Limited Number of Events
  - RTP enables Continuous Optimization leveraging the Automated Responses of Smart Technology
Default Service Thought Experiment

- **Hybrid Default Service Option, combining:**
  1. Consumer Education and Notices of High Price Periods to Elicit Behavioral Responses to Peak Prices
  2. Dynamic RTP Component and Smart Technology to Automate Customer Savings / Comfort Preferences
  3. RTP structured as a 2-Part (Block and Index) Rate that Stabilizes Customer Bills
     - Customers pay a Fixed Price to Pre-purchase Energy for a Standard Hourly Load Shape designed to be Representative for their Customer Class
     - Receive a Rebate equal to Real-Time Price any time they use less Energy than they Pre-purchased
     - Pay Real-Time Price for any Energy used in excess of their Pre-purchased Hourly Load Shape
   - Default Service Auctions would transition from requirements to block purchases following the deployment Interval or Advanced Meters

- **Auction Prices Decline:** Suppliers no longer fully responsible for correlated price & quantity risks

- **Consumers Value Control:** Dynamic RTP component + Smart Technology and Education will give Consumers greater Control over their Monthly Bills

- **Retail Market Animated:** Retail suppliers have an incentive to offer new services, including: Superior Demand Management and Custom Hedges to better matches individual preferences
Steps toward Marginal Cost Rates

• Work with PJM: Reduce Socialization of Supply and RTO Costs
  – Base RTO Settlements on Actual Customer Demand (Not on Load Profiles)
  – Consider Nodal and Interval RTO Demand Settlements (Not Zonal, Hourly)
  – Following the example of Energy Efficiency, Gather Data and Enable PJM to consider Dynamic Retail Pricing in its RPM Peak Load Forecasts

• Unpack the Marginal Cost Components in Distribution Rates
  – Non-Wires Alternatives: Procure Option Call Contracts to Dispatch DER when needed, enabling DER to respond to Market Prices in other hours
  – Consider adding a Variable Marginal Loss Component in Distribution Rates
  – Consider Time- & Location-Specific Hot Spot Surcharges to avoid distribution constraints and negative impacts equipment (Surcharges could be Revenue Neutral, Offsetting Residual Revenue recovery)

• Evaluate and Plan for the Development of Transactional Market with Appropriately Granular Distribution Locational Marginal Pricing
Recovery of Residual T&D Costs

• Objective is to minimize changes in the efficient resource allocation that were created by pricing at marginal costs.
  – Recover utility costs in excess of marginal costs in rate elements that have comparatively little or no impact on short-run demand.

• More Efficient Options:
  – Customer Charge: Used in Residential Rates. Fixed charge avoids uneconomic incentives: Not Cost-effective for most Customers to leave the grid.
  – Demand Charges for C&I Customers with Limited Flexibility: Functions like a fixed charge for customers with flat loads, many near-peak hours.
  – Subscription Pricing: Advance Demand Subscription for Base or Greater Network Access, with Overage Charges for exceeding subscribed demand.
    • Used in Europe, in Network Industries (e.g. internet, mobile phone), and for Products with High Fixed and Low Marginal Costs (e.g. software).
    • Base subscription price stabilizes revenue, while different subscription levels recognize different usage patterns for the allocation of residual costs.
    • Advance subscriptions may help align consumer and utility investment.
Recovery of Residual T&D Costs

• Less Efficient Options:
  – Volumetric Rates in Excess of Social Marginal Costs:
    • Discourages economically efficient electrification, e.g. Electric Vehicle adoption.
    • Provides an uneconomic incentive for distributed generation.
    • Increases net metering subsidies.
  – Demand Charges for Residential Customers and C&I Customers with Demand Flexibility:
    • Less efficient than marginal cost based rates covering the customer’s entire demand profile.
    • Customer, distribution circuit, and system peak demand often occur at different times.
  – Minimum Bills:
    • If binding, minimum bills combine a fixed charge, a quantity of free electricity, followed by a sharp price increase for subsequent usage.
    • Creates perverse incentive of a zero price during the first usage block.
Four Equity Perspectives

- **Efficiency Perspective**
  - Oxford University economist H. Peyton Young argues a competitive markets is equitable because, “It is the only efficient and consistent way of reallocating the property that leaves everyone at least as well off as he was initially.” In this view, equity is how, “societies resolve distributive problems when efficiency by itself yields indeterminate results.”

- **Bonbright’s Perspective**
  - Equity in three dimensions: (1) horizontal (i.e., equals treated equally); (2) vertically (i.e., unequals treated unequally); and (3) anonymous (i.e., no ratepayer’s demands can be diverted away uneconomically from an incumbent by a potential entrant).

- **Gradualism Perspective**
  - Recognizes and seeks to ameliorate undue impacts on customers who have made significant investments in reliance on continuation of prior rate designs.

- **Social Justice Perspective**
  - American political philosopher John Rawls argued for a “difference principle” - An unequal distribution of cooperatively produced goods must benefit everyone, especially must improve the conditions of those who are worst-off.
Impacts on Low Income Consumers

• Impact of Time-Varying or Dynamic Rates on Low Income Consumers
  – AEP-Ohio Low Income Customers tended to have less peak oriented load patterns and to respond to price signals.⁶
  – Study of a large urban utility found that 92% of low income customers would benefit from dynamic pricing, with the average bill for those who would not benefit increasing by no more than $5 per month.⁷
  – US DOE consumer behavior studies have analyzed the effects of CPP on low income and other vulnerable consumers and found:
    • Their level of participation and continuing enrollment was comparable to that of non-vulnerable consumers
    • They benefited financially at roughly similar proportional level as non-vulnerable participants
    • While overall satisfaction levels were extremely high with 91% to 100% of all customers wanting to remain on CPP rates, low income consumers enrolled in the default (opt-out) CPP rate had a statistically significant higher level of satisfaction than their higher income counterparts.⁸
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References


