

# **Economics of Modern Rate Design: Efficient Pricing & Equitable Rates**

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# Modern Rate Design: Enhanced Objectives

- Engage Demand & DER to Efficiently Address Simultaneous Challenges
  - Remain Affordable – Improve Asset Utilization
  - Ensure Reliability & Resilience – Minimize Constraints when Grid is Stressed & Maintain Service when Disruptions Occur
  - Enable Environmental Sustainability – Manage Renewable Variability, Avoid EV Demand Spikes, Enable EV Adoption & Beneficial Electrification
- Develop an Efficient Participation Model for Distributed, Intelligent Devices
  - Affordable and Ubiquitous Sensors, Distributed Computing, and Solid State Power Electronics are enabling Intelligent, Rapidly Responding, Semi-Autonomous Demand and DER Technologies:
    - Internet of Things
    - Electric Vehicles
    - Distributed Energy Resources

# Limitations of Current Demand & DER Participation Models

- A Distribution Utility's system may soon include:
  - Millions of Smart End Use Devices,
  - Hundreds of Thousands of EVs, and
  - Thousands of MW of Distributed Resources
- ***Dispatch of Millions of Distributed Devices becomes Computationally Intractable***
- Intelligent End Use Devices and Electric Vehicles will respond Dynamically to the Real-time Price, Expectations of Future Prices, and Continuously Changing Customer Choices
- ***Smart Devices will Anticipate DR Events & Increase Baseline Use to Earn Incentives, making Demand Response Programs Increasingly Ineffective***
- Smart Technology Offers Significant Time-, Location-, & Product-Specific Value
- ***Zonal / Hourly RTO Demand Settlements & Flat Rates Conceal Distributed Value***

# Modern Rate Design: Requirements

- Efficient Integration of Demand & DER requires Dynamic or Market-based Rates that Communicate Time-, Location-, & Product-specific Marginal Costs & Value
  - Marginal Cost Pricing reflects the value of next best alternative use of scarce resources
- Effective Participation Model requires Engaging Consumers & Smart Technology
  - Provide Access to Distributed Intelligent Technology that can Continuously Optimize Demand & DER
  - Elicit Behavioral Responses with Timely, Actionable Information based on Consumer Preferences
- Acceptance requires the Ability to Reduce Uncertainty & Hedge the Risk
- Given Natural Monopoly Costs Cannot be Recovered at Marginal Cost Rates, Retaining the Efficiency Created by Marginal Cost Pricing requires Recovering Residual T&D Costs in Rates that have a Minimal Impact on Usage Patterns
  - Recovery of Residual Costs needs to be Consistent with Equity Principles

# Basic Economics: Marginal Costs in Rate Design

- Marginal Cost is the cost of a very small additional unit of short-run output
  - Marginal Cost is Granular: Time, Location, and Product Specific, Recognizing that Electricity Used at Different Times & Grid Locations imposes Different Costs
- Common issues in identifying marginal costs:
  - Terminology: Planning & embedded cost allocation terms initially from the era of vertical integration: “avoided” or “long-run marginal” costs are often conflated with 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
  - Alternative: Estimation of Externality Costs can be complicated.
  - FEJA sets externality value for ZECs, based on Social Cost of Carbon, at \$16.50/MWh or 1.65¢/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%) <sup>1</sup>
- Market Based Rates, e.g. Real-Time Prices (RTP), RTP + Capacity Adder (RTP+), Block & Index (Hedged RTP), can Provide More Accurate and Efficient Price Signals
  - Idealized TOU Rates (set with perfect foresight) have been found to capture 21% to 29% of the actual variation in PJM prices and 6% to 13% of the variation in CA ISO prices <sup>2</sup>
- Complementary Objectives:
  - TVR enable Behavioral Responses for a Limited Number of Events
  - RTP enables Continuous Optimization leveraging the Automated Responses of Smart Technology

# Steps in Developing More Efficient Dynamic Rates

- Give Consumers Notice of High Price Periods & Access to Smart Tech to Automate RTP Response
  - Marketplace Websites can help Consumers Access Smart Technology and Services to Manage Demand
- Block & Index Rate offers Predictable Bills for Typical Use & Efficient Prices for Incremental Use
  - Customers Pre-purchase Blocks of Energy covering a Representative Hourly Load Shape
  - 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
- Work with RTOs to Reduce Socialization of Supply Costs <sup>3</sup>
  - Consider Nodal and Interval RTO Demand Settlements (Not Zonal, Hourly)
  - Gather Data to Enable RTOs to reflect Dynamic Pricing in Peak Load Forecasts
- Unpack Marginal Cost of Delivering Energy using Variable Distribution Rates
  - Consider adding Marginal Losses as a Component in Variable Distribution Rates
  - Consider Time- & Location-Specific Scarcity Pricing Adders to avoid Distribution Constraints
  - Additional Variable Components would be Revenue Neutral, Offsetting Recovery of Residual T&D Costs
- Evaluate Developing Distribution Level Markets with Distribution Locational Marginal Pricing <sup>4</sup>

# Recovery of Residual T&D Costs

- Basic Economic Objective: Minimize changes in Efficient Resource Allocation created by Marginal Cost Pricing: Have Little or No Impact on Relative Demand
- Standard Options may Conflict with the Economic Objective or Lead to Impasse
  - Volumetric (kWh) Rates above Marginal Cost: Produces a Net Economic Loss, Distorts Investment Decisions, & Creates Disincentives to Beneficial Electrification and EV adoption
  - Demand Charges: Allocate Costs in Excess of Marginal Cost to a Limited Number of Hours
  - Customer Charge: High Customer Charges tend to Raise Low Income & Equity Concerns
- Subscription Rates for Residual T&D: Flexible Approach to Equitable Rate Design
  - Purchasing Network Access at Fixed Rates that Vary by Category: Different Subscription Categories Within a Customer Class can recognize Differences in Usage Patterns & Equity
  - Used by European Electric Utilities, in Network Industries (e.g. cable, mobile phone), and for Products with High Fixed and Low Marginal Costs (e.g. software)
  - Absent a Risk of Grid Defection, Allocating Residual Costs to Different Subscription Rate Categories is primarily an Equity Issue



# Equity Principles

- **Bonbright's Perspective**
  - Equity in three dimensions: (1) horizontal (equals treated equally); (2) vertical (unequals treated unequally); and (3) anonymous (no ratepayer demands can be uneconomically diverted away from an incumbent by a potential entrant)<sup>5</sup>
- **Gradualism / Transitional Perspective**
  - Seeks to ameliorate 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 <sup>6</sup>

# Impacts on Low Income Consumers

- Time-Varying Rates Often Benefit Low Income Consumers
  - Low Income Customers tended to have less peak oriented load patterns and to respond to price signals <sup>7</sup>
  - 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 <sup>8</sup>
  - 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 <sup>9</sup>
- Impact of Fixed Charges on Low Income, Low Use Customers
  - Can Discount a Subscription Rate for this Customer Segment

# Modern Rate Design: An Efficient and Equitable Approach

- **Supply Rates combine:**
  1. Block and Index Rate: Stabilizes Bills + Uses Efficient RTP to Rebate Reduced or Price or Increased Use
    - Advance Supply Purchase of a Representative Load Shape Minimizes Variation in Customer Bills
    - Liberal Default Hedge can Minimize Risk of Unanticipated High Bill
  2. Access to Smart Technology: Automates based on Customer Preferences for Savings & Comfort
  3. Notice of High Price Periods: Enables Behavioral Responses to Peak Prices
- **Distribution Rates combine:**
  1. Option: Time- & Location-Specific Variable Rates for Cost of Distribution Constraints & Marginal Losses
    - Revenue Neutral: Any Variable Cost Adders would Reduce Subscription Rates
  2. Subscription Rates: Flexible Way to Recover Utility Revenue Requirements in Excess of Marginal Cost
    - Subscription Categories primarily Equity based, reflecting Significant Differences in Usage Patterns
- **Engage Demand and DER:** Introducing Variable Time-, Location-, & Product-Specific Marginal Cost based Rate Components
- **Consumer Control:** Block & Index & Subscription Rates give Consumers Simple Predictable Bills; Access to Smart Technology and Notice of High Prices enables Consumers to impact System Costs with their impacts on Marginal Costs reflected in Incremental Bill Adders or Rebates

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