Designing Politically-Correct Dynamic Pricing Plans to Realize the Benefits of Active Customer Participation in Wholesale Electricity Markets

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The Marketing Challenge of Real-Time Pricing

What we say to customers about real-time pricing

What Happens to Supporters of Default Real-Time Pricing of Electricity?

Real-Time Price is Default Price Paid for Virtually All Goods
(except electricity)

Real-Time Price is Default Price Paid for Virtually All Goods

- In all markets but electricity, the *real-time price* is the default price all consumers must pay and producers must receive
  - Price of oil changes on a daily basis
  - Price of gasoline can change on a daily basis
  - Price of coffee beans can change daily
  - Price of coffee can change daily
- Neither consumers or producers are required to pay or receive real-time price
  - Market participant can sign a hedging arrangement
- Widespread hedging activities to manage real-time price
  - Cell phone service (calling plan choice)

Real-Time Price is Default Price Paid for Virtually All Goods

- Example from airline industry
  - Customers always have option to show up at airport and purchase ticket for flight they would like to travel on at real-time price
    - Default real-time price purchase strategy has significant price risk because flight can sell out (effectively an infinite price)
  - To hedge price risk, consumer purchases ticket in advance (fixed-price forward contract)
- Hedging arrangements benefit airlines and customers
  - Airlines can increase load factors (seats filled/seats flown)
  - Customers benefit with lower average fares

Why Is Electricity Different?

- Because of legacy of vertically integrated-monopoly market structure customers have “free” hedge against real-time price for unlimited quantity of electricity
  - In vertically-integrated monopoly regime, utility provided spot electricity price insurance to customer
  - Customer paid firm’s average cost for each KWh consumed and utility ensured supply was always available

Is Electricity Really Different?

- In wholesale market regime it is very risky to set a fixed retail price for unlimited quantity of energy that is guaranteed to always cover wholesale energy costs
  - Significant risk of bankruptcy of retailer
  - No secondary market activity in this kind of contract
- Wholesale electricity typically traded under standardized fixed price and fixed quantity contracts
  - Retail pricing must be adopted to this reality for consumers to benefit from wholesale markets

Important Point 1

- Fixed-retail price does not imply customers avoid paying real-time hourly wholesale prices in retail price
  - Retailers will go bankrupt if retail price does not satisfy equation given below on an annual basis
    - P(retail) ≥ P(wholesale) + P(transmission) + P(distribution)

9

Important Point 1

- Conclusion—Cannot "protect customers from volatile wholesale prices"
  - Can only prevent them from taking actions to limit wholesale price volatility and reduce their monthly bill
  - *Investments in energy storage and demand flexibility can only be profitable with real-time price as default price*
    - *If pay 10 cents/KWh for all KWH, how you do make storage and load-shifting investments pay?*

10

Default real-time pricing is nothing new: Load-profile billing with customer's actual hourly consumption

11

Important Point 2

- Real-time pricing is nothing more than load-profile billing with customer's actual hourly consumption instead of "load profile" of monthly consumption in each hour
- Under load-profile billing, each customer is assigned weights, w(t), giving share of monthly consumption customers with their load shape consumes in hour t
  - "Implied hourly consumption" is w(t)Q(m), where Q(m) is customer's monthly consumption
  - If p(t) is wholesale price in hour t, customer's monthly wholesale energy costs are $[\sum_{t=1}^{T} p(t)w(t)]Q(m)$
- Default real-time pricing just substitutes customer's actual consumption q(t) in hour t, into above formula to yield $[\sum_{t=1}^{T} p(t)q(t)]$

12

Why Default Real-Time Pricing is the Endpoint

- Because it's what we do with every other product sold through a market mechanism
- Many states have ambitious renewable energy goals
- Renewables are often unavailable during peak periods
- Major factor driving need for dynamic pricing—High wholesale prices do not cause more wind or solar energy to be produced
  - As share of renewable energy grows final consumers must supply more "dispatchable negawatts" to maintain system balance

Hourly Metering is Required

- Lack of hourly metering of final demand makes it impossible to set hourly retail prices that pass-through hourly wholesale price
  - Customer reduces monthly bill by same amount by reducing consumption by 1 KWh during hour when wholesale price is $5000/MWh as he does when price is $0/MWh
- Economics of hourly meters is rapidly changing because of technological change
  - Major cost of monthly reading for conventional meters is labor cost
  - Modern hourly meters are read remotely by wireless or wireline technology

Day-Ahead versus Real-Time Dynamic Pricing

- All US wholesale markets are ideally suited for active participation of final consumers--Multiple settlement periods
  - Day-ahead forward market
    - Buy and sell energy for delivery and withdrawal during each hour of following day at fixed hourly price
  - Real-time imbalance market
    - Buy or sell imbalances relative to day-ahead schedules during each hour of day at hourly price
- Day-ahead prices are substantially less volatile than real-time prices

Day-Ahead versus Real-Time Dynamic Pricing

- If default price that supplier receives and load pays is real-time price
  - Only if supplier sells in day-ahead forward market can it be paid the day-ahead price, but only for quantity sold in day-ahead market and not for actual production
  - Only if load buys in day-ahead forward can it be charged the day-ahead price, but only for quantity purchased in day-ahead market and not for actual consumption
- Automated demand-side participation in wholesale market can help overcome regulatory barriers to symmetric treatment of load and generation

Day-Ahead versus Real-Time Dynamic Pricing

- In all US markets, there are a number of periods with very high real-time prices
  - With default real-time pricing, shifting demand away from certain periods can yield significant cost savings for consumer
  - Buy energy at $50/MWh in day-ahead market and sell it back at $2,000/MWh in real-time market
- Most volatile prices are near major load centers
  - California retailers are currently able to buy at Load Aggregation Point (LAP) prices averaged over large geographic areas covered by three investor-owned utilities
  - LAP pricing is likely to end in the near future
    - Wolak, Frank (2010) "Quantifying the Benefits of Spatial versus Temporal Granularity in Retail Electricity Pricing," on web-site
    - Wolak, Frank (2011) "Measuring the Benefits of Greater Spatial Granularity in Short-Term Pricing in Wholesale Electricity Markets"
      - Supply-side benefits of greater spatial granularity in pricing in California

What is Are Optimal Dynamic Rates for New York?

18

Retail Competition

- If default price consumer must pay is real-time price, then competition among retailers can find optimal price for each customer
  - Customers switch to plan that suits them
- NY PSC may initially need to set default plan that all utilities must offer that "protects" consumers
  - Customers are welcome switch away from this plan to find what is optimal for them

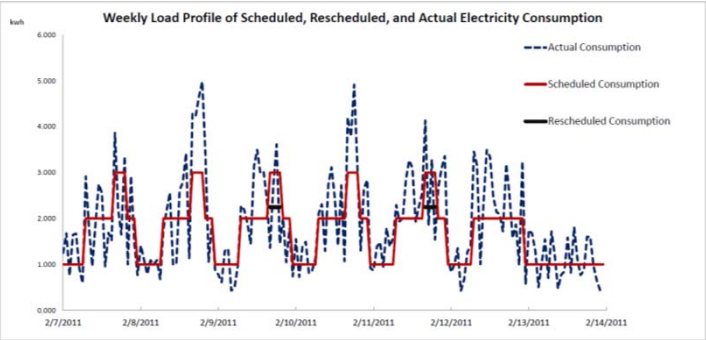
19

Managing Price Risk

- Retail customer with interval meter purchases analogue to cellular telephone "calling plan" for electricity consumption
  - Fixed-price contract for fixed quantity of energy
  - Examples
    - 7x24 for 1.5 KWh at 10 cent/KWh
    - 6x16 for 0.5 KWh at 12 cents/KWh
    - 5x4 for 0.5 KWh at 15 cents/KWh
  - This yields a load shape that approximates customers actual consumption at average price of 10.5 cents/KWh
    - Customer only exposed to real-time price for deviations from this load shape, upward and downward

20

Load Profile: Purchased and Consumed



Weekly Consumption Monday to Sunday

Managing Low Income Concerns

- Can give low-income customers the right to purchase load shape at reduced price
  - Examples
    - 7x24 for 1.0 KWh at 4 cent/KWh
    - 6x16 for 0.5 KWh at 6 cents/KWh
    - 5x4 for 0.25 KWh at 8 cents/KWh
  - This yields a load shape that approximates customer's actual consumption at reduced average price of 4.5 cents/KWh to account for being low income
    - Customer only exposed to real-time price for deviations from this load shape, upward and downward

Conclusions 1

- Default real-time pricing for all consumers maximizes benefits of smart technologies
  - Makes day-ahead dynamic pricing, storage and automated load shifting technologies financially viable
  - No customer needs to pay real-time price for any consumption, only face it as a default price, just like in all other markets
- Consumers, or retailer on their behalf, purchases fixed load shape at a fixed prices
  - Consumers, or retailers on their behalf, buy and sell deviations from fixed load shapes in day-ahead and real-time markets to minimize bill risk
  - Similar to cell phone model
    - Purchase total monthly minutes at fixed price in advance
    - Real-time price per minute for consumption above total monthly minutes
    - Rollover of unused minutes similar to selling unconsumed contract quantity in day-ahead or real-time market
- Important note—Customer does not even need to know day-ahead or real-time price only have technology installed and follow instructions of retailer

Conclusions 2

- Whether default real-time pricing is implemented in most US states is still uncertain
  - Significant regulatory barriers in all but one state
  - Information provision is key to success
    - Kahn and Wolak (2013) "Using Information to Improve the Effectiveness of Nonlinear Pricing: Evidence from a Field Experiment" on web-site
    - Ongoing experiments at PESD on information provision
- Texas is test case for potential benefits of default real-time pricing
  - Large renewable energy share
    - Wind in west Texas
  - Interval meters are currently installed
  - Full retail competition allowed
  - Default price charged to retailer for consumption of each customer it serves is hourly real-time price

Questions/Comments

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25