Retail Electricity Rate Reform

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What is Problem #1?

• Average cost-based pricing of retail electricity
  – Wholesale energy cost and cost of transmission and distribution grids from cents/KWh price of electricity
  – Historically this pricing mechanism did not lead to inefficient outcomes because consumers had no choice but to purchase electricity from grid

• Distributed solar provides consumer with ability to avoid purchases from grid
  – Consumer pays retail price only on electricity withdrawn from grid
  – Retail price is avoided cost of energy from solar panels
    • \[ P(\text{retail}) = P(\text{Energy}) + P(\text{Trans}) + P(\text{Dist}) + AC(\text{Other}) \]
    • Other = retailing margin, energy efficiency programs, above market cost of Renewables Portfolio Standard (RPS) energy, low-income energy programs, distributed generation and storage support mechanisms
Inefficient Network Pricing in CA

- Current average residential price in California is ~23 cents/KWh (https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_6_a)
  - All three investor-owned utilities have increasing block prices for retail electricity
    - Highest marginal price in PG&E E-1 plan is 44 cents/KWh
  - At $3.50/Watt installed, rooftop solar photovoltaic (PV) panels have a levelized cost equal to ~15 cents/KWh (at 3 percent real discount rate)
    - Going solar requires no subsidies to make it privately profitable for "average" California consumer

- Average wholesale cost of energy in California in 2020 was ~4 cents per KWh (California ISO Annual Report on Market Issues and Performance)
  - Socially unprofitable to invest in rooftop solar, because it is much cheaper for customer to get electricity from wholesale market

- Divergence between privately optimal decision and socially optimal decision due to inefficient distribution network pricing
  - Economically inefficient bypass of grid-supplied electricity
Inefficient Network Pricing in CA

- **Inefficient bypass of grid supplied electricity**
  - Privately profitable action by consumer to install distributed solar increases cost to serve all California consumers
- **Customer installs solar to avoid 23 cents/KWh grid-supplied electricity and buys 15 cents/KWh solar PV**
  - Utility no longer receives 19 cents/KWh = 23 cents/KWh – 4 cents/KWh in fixed cost recovery from customer
  - Remaining customers must still cover these costs through higher retail prices
- **Suppose customer consumes 1,000 KWh before and after solar panels are installed**
  - Customers saves 0.08 $/KWh x 1000 KWh = $80 by installing solar PV system
  - Utility no longer receives 0.19 $/KWh x 1000 KWh = $190 from customer for fixed cost recovery
  - Societal cost increases by $190 - $80 = $110 because of customer installing solar PV system
What is Problem #2?

• Fixed retail price schedule provides no incentive for customers to reduce demand during stressed system conditions
  – Little incentive for consumers to invest in storage and other load flexibility technologies

• Exposing customers to retail prices that vary with real-time system conditions (dynamic prices) can expose customers to significant bill volatility
  – Griddy customers in Texas during February of 2021

• How to capture benefits of dynamic retail prices without exposing customers to significant risk of a high bill
What is the Solution to #1?

• Marginal cost pricing of retail electricity
  – Average marginal cost of grid supplied electricity in 2020 is ~5 cents/KWh
    • ~4 cents/KWh (average wholesale price) + ~1 cent/KWh (average marginal losses)
  – Recover remaining costs through a customer-specific monthly fixed charge based on “willingness of customer to pay for electricity at marginal cost”
    • “Willingness to pay for grid supplied electricity at marginal cost” based on customer’s distribution of hourly grid withdrawals throughout year

• Address equity concerns through reduced, zero, or negative monthly fixed charge
  – All customers pay marginal cost of grid-supplied electricity

• Distributed solar owners receive marginal cost of grid supplied electricity for injections to grid
  – Willingness to pay measure rewards storage that reduces volatility of grid withdrawals with a lower monthly fixed charge
What is the Solution to #2?

• Allow customers to purchase a fixed load shape for fixed cost
  – Hourly consumption above fixed load shape pays hourly marginal cost of grid supplied electricity for difference
  – Hourly consumption below fixed load shape sells energy at hourly marginal cost of grid supplied electricity for difference

• Limits bill volatility but provides strong incentive for investments in storage and load flexibility technologies

• Can virtually eliminate upward bill volatility by purchase fixed load shape higher than expected load shape
  – Sell back energy at real-time price in virtually all hours
Managing Short-term Price Risk

• Retail customer purchases analogue of cellular telephone “calling plan” for electricity consumption
  – Fixed-price contract for fixed quantity of energy delivered according to a fixed load shape, analogous to fixed price for fixed amount of minutes from cellular provider
  – For example
    • 7x24 for 1.5 KWh at 4 cent/KWh
    • 6x16 for 0.5 KWh at 7 cents/KWh
    • 5x4 for 0.5 KWh at 10 cents/KWh

• This yields a fixed load shape that approximates customers actual consumption for 4.66 cents/KWh
  – Customer only exposed to real-time price for deviations from this load shape, upward and downward, analogous to rollover minutes and penalty minutes for cellular provider
Load Profile: Purchased and Consumed

Weekly Consumption Monday to Sunday
Concluding Comments

- Marginal cost based price of energy with customer-specific monthly fixed charge
  - Fixed-charge based on customer’s “willingness to pay to purchase electricity at marginal cost”
  - Low income consumers pay low, no, or negative monthly fixed charge to purchase at marginal cost
  - For an empirical example implementing this mechanism see

- Consumers purchase fixed load shape of energy at fixed price
  - Pay hourly price for consumption above load shape
  - Receive hourly price consumption below load shape
  - Maximizes benefits of investments in storage and load-shifting technologies
Questions/Comments
For more information
http://www.stanford.edu/~wolak
CA Solar PV Installations

Capacity (MW):
- 0.0
- 2,500.0
- 5,000.0
- 7,500.0
- 10,000.0
- 12,500.0

Years:
- 1993-2002
- 2003
- 2004
- 2005
- 2006
- 2007
- 2008
- 2009
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020
- 2021

- Blue: Capacity in Year
- Yellow: Prior Years' Capacity
Grid-Scale versus Rooftop Solar
Global Capacity-Weighted Average Levelized Cost of Energy (LCOE) for Wind and Solar--2010 to 2020