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  - Consumer pays retail price only on electricity withdrawn from grid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(retail) = P(Energy) + P(Trans) + P(Dist) + AC(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"
    - See Wolak. F.A. (2018) "Evidence from California on the Economic Impact of Inefficient Distribution Network Pricing" (March 2018) for methodology
    - "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

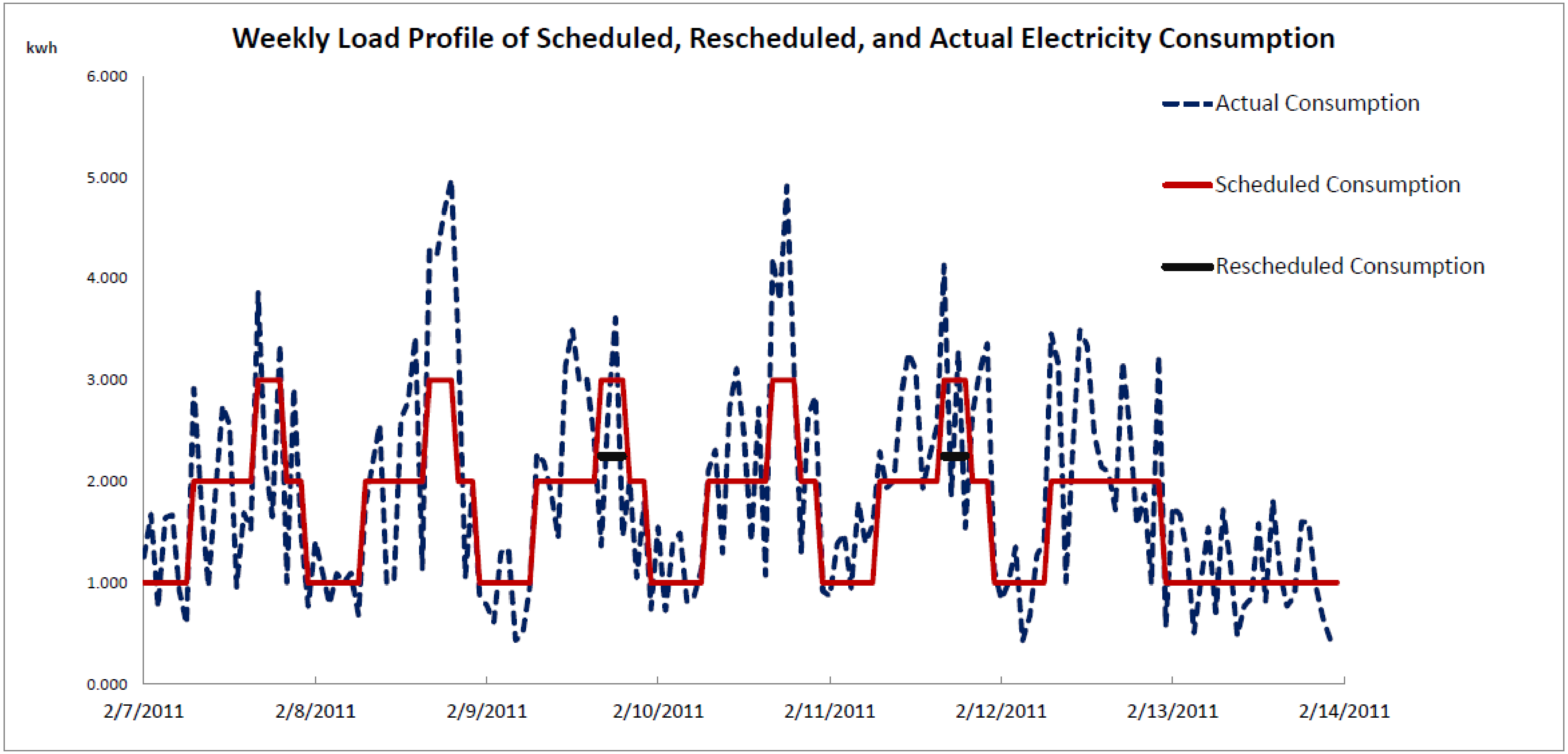
What is the Solution to #2?

- 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
  - For more details see Chapter 7 of Wolak. F.A. and Hardman, I. (2021) *The Future of Electricity Retailing and How We Get There*, Springer Publishing.
- 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

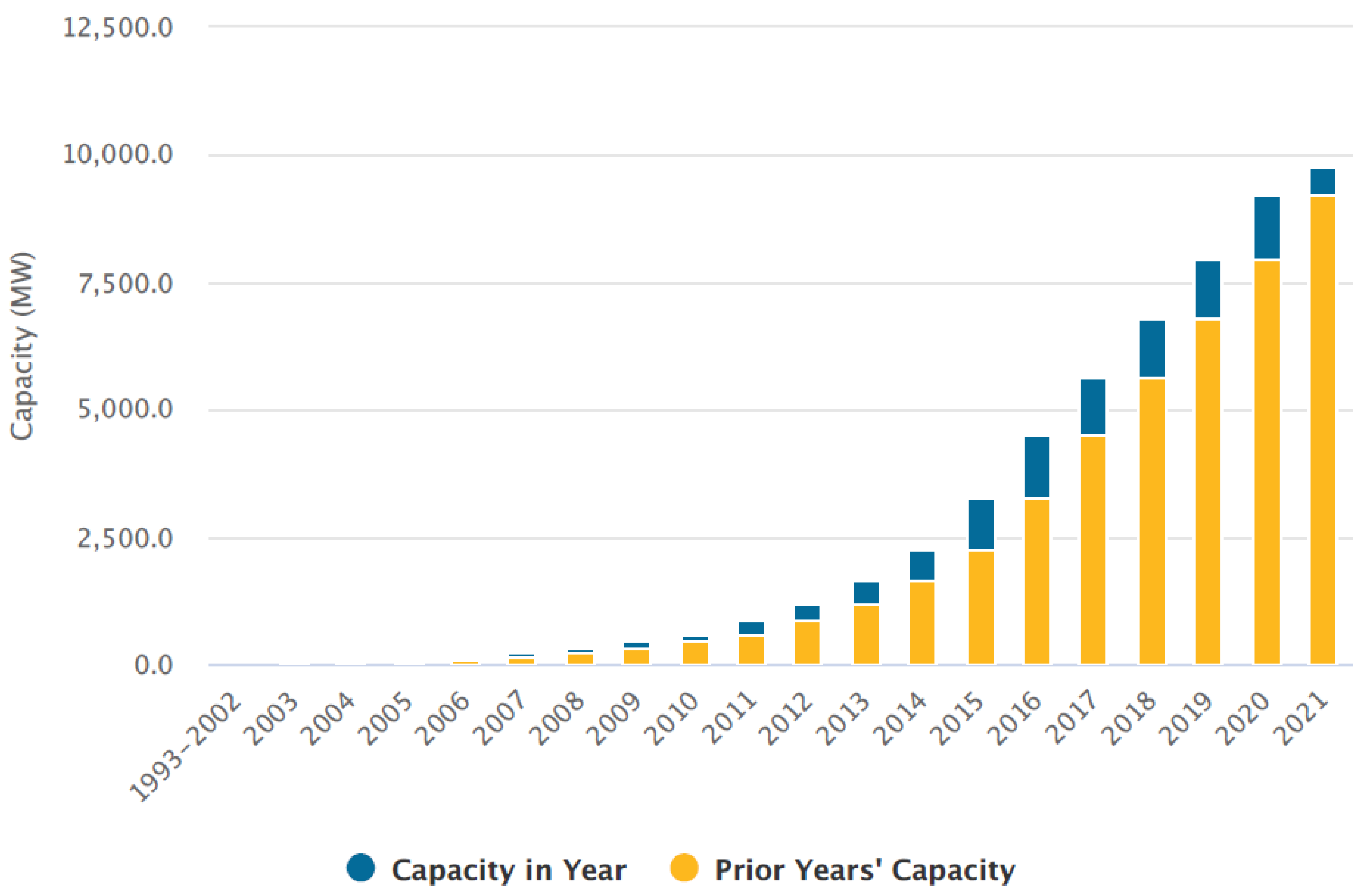
- Marginal cost based price of energy with customer-specific monthly fixed charge
  - Fixed-charge based on customer's "willingness to pay to purchase electricity at marginal cost"
  - Low income consumers pay low, no, or negative monthly fixed charge to purchase at marginal cost
  - For an empirical example implementing this mechanism see
    - McRae, Shaun D., and Frank A. Wolak. "Retail pricing in Colombia to support the efficient deployment of distributed generation and electric stoves." *Journal of Environmental Economics and Management* 110 (2021): 102541.
- 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

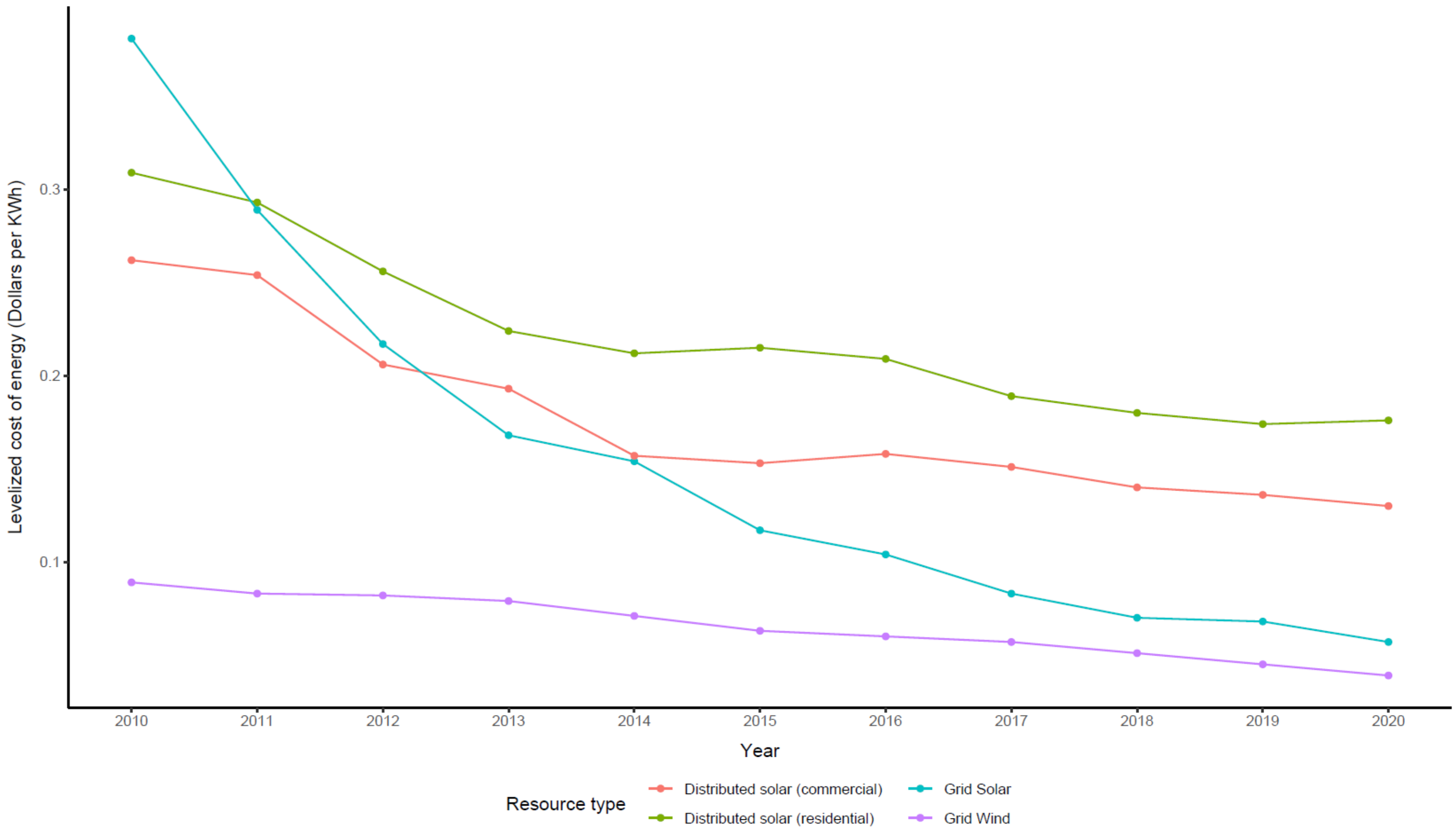
http://www.stanford.edu/~wolak

CA Solar PV Installations



Grid-Scale versus Rooftop Solar

Global Capacity-Weighted Average Levelized Cost of Energy (LCOE) for Wind and Solar--2010 to 2020



Source: International Renewable Energy Agency (IRENA) “Renewable Power Generation Costs in 2020”