



CAMPUT 2022 | Deep Dive into Disruption

# Retail Pricing to Support a Low Carbon Electricity Supply Industry

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# Transition to a Low Carbon Energy Sector

- Increase amount of intermittent renewables in electricity supply industry
  - Primarily through wind and solar resources
  - Batteries and other technologies to shift energy use in time
- Electrify transportation and space heating sectors
  - Reduce fossil fuel consumption in transportation
  - Reduce fossil fuel in space heating
- Efficient pricing of retail electricity is a key driver of this energy transition

# The Marketing Challenge of Efficient Retail Pricing



# The Challenge of Electrifying Transportation and Space Heating

- Customers more likely to switch to electric vehicles (EVs) if they are cheaper relative to internal combustion (ICE) vehicles
  - Similar logic applies electric versus natural gas or fuel oil space heating
- Average cost-based retail pricing of electricity dulls incentive for adoption of EVs and electric space heating
  - Wholesale energy cost and cost of transmission and distribution grids and other sunk costs recovered from cents/KWh price of electricity
- Current average residential price in California is ~23 cents/KWh
  - Highest marginal price in Pacific Gas & Electric territory is 42 cents/KWh
  - Annual average marginal cost of energy (wholesale electricity price plus marginal losses) in California in 2021 was ~5 cents per KWh
- **Conclusion: Marginal cost-based pricing of electricity supports energy transition**

# The Challenge of Electrifying Transportation and Space Heating

- Marginal cost-based pricing of electricity supports adoption of EVs and electric space heating
- Must recover fixed cost of transmission and distribution network and other sunk costs from monthly fixed charge
  - Outstanding question is how to allocate these fixed costs across customers
  - Same charge for all customers adversely impacts low-income customers
- Wolak (2018) “Evidence from California on the Economic Impact of Inefficient Distribution Network Pricing” proposes a methodology for setting customer-level fixed costs
- McRae and Wolak (2021) “Retail Pricing in Colombia to Support the Efficient Deployment of Distributed Generation and Electric Stoves,” implements methodology for Colombia

# The Challenge of Significant Intermittent Renewables

- Reliable grid operation requires supply to equal demand at every instant in time and all locations in transmission network
  - Dispatchable generation units increase and decrease output to balance supply and demand
  - A larger share of renewable resources reduces the amount of dispatchable generation units in electricity supply industry
- **Conclusion**--Demand must become more responsive to real-time system conditions in order for reliable grid operation with a larger share of intermittent renewables
- Dynamic retail prices provide economic incentive for demand to be flexible
  - Higher prices in certain hours provides incentive for customers to shift consumption away from these hours and into lower-priced hours
  - Provides revenue stream to finance investments in load shifting technologies
    - Storage devices
    - Automated load-shifting technologies

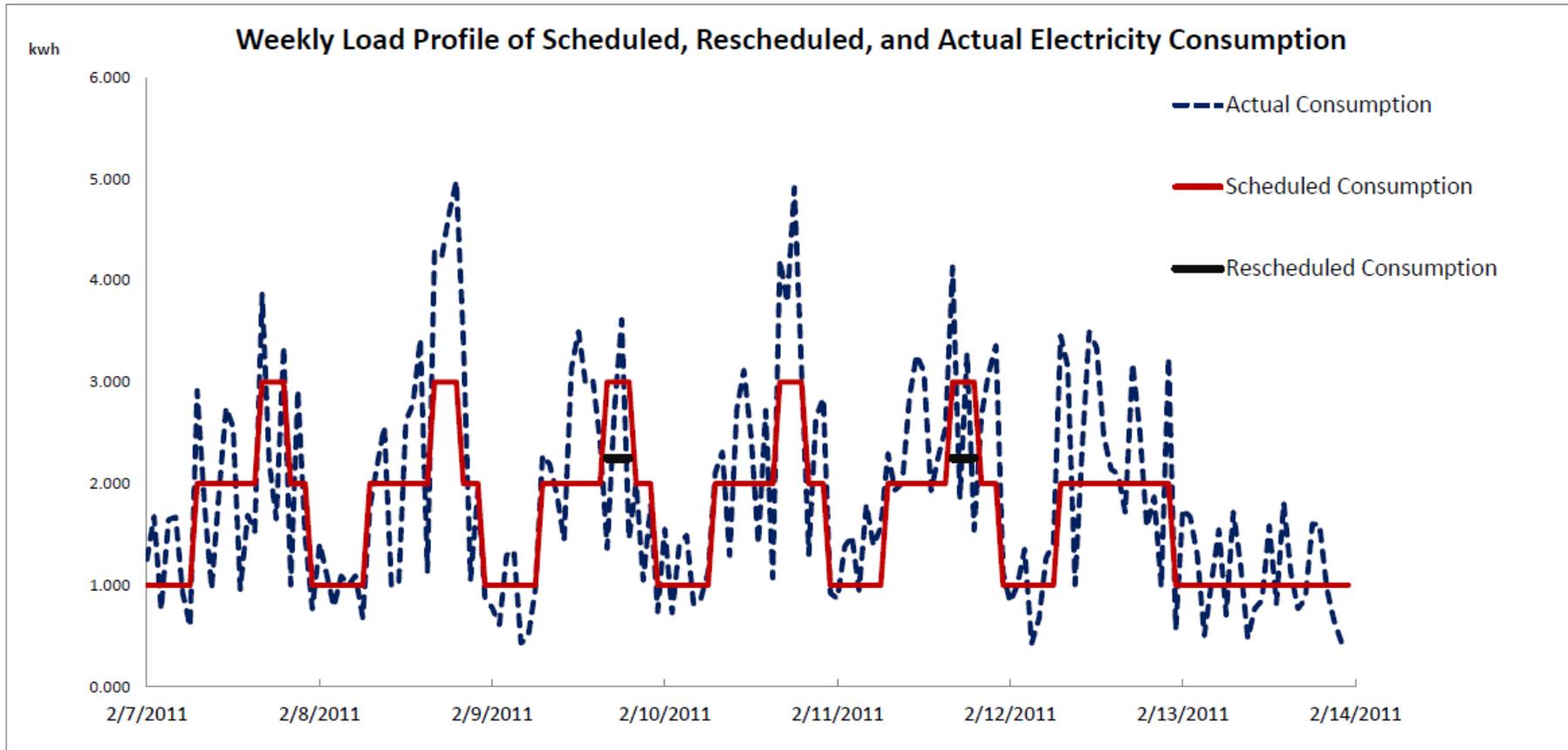
# Dynamic Pricing and Bill Volatility

- 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 bill volatility
- Allow customers to purchase fixed load shape for fixed cost
  - Consumption above fixed load shape pays hourly marginal cost of grid supplied electricity for difference
  - 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.

# Dynamic Pricing and Bill Volatility

- Retail customer with interval meter purchases analogue to cellular telephone “calling plan” for electricity consumption
  - Fixed-price contract for fixed quantity of energy delivered according to a fixed load shape
  - 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 customer’s actual consumption for 4.66 cents/KWh
  - Customer only exposed to real-time price for deviations from this load shape, upward and downward
- Exposes customer to real-time price for “marginal” consumption, but protects customer from bill volatility

# Load Profile: Purchased and Consumed



Weekly Consumption Monday to Sunday

# Dynamic Distribution Network Pricing

- Charging of EVs and electric space heating can overload local distribution network if all customers attempt to charge their EVs at once
  - Even if wholesale electricity price is extremely low
- Dynamic distribution network pricing can be used to manage constraints in local distribution network
  - Price capacity and other operating constraints on distribution network
- Dynamic distribution network prices can be used to coordinate vehicle charging across customers in distribution network to ensure all EVs charged by pre-specified hour of following morning
  - Triolo and Wolak (2022) “Dynamic distribution network pricing to facilitate EV and electric space heating adoption,”

# Conclusions

- Marginal cost of energy pricing with customer-specific monthly fixed charge
  - Fixed-charge based on customer's willingness to purchase electricity at marginal cost
  - Low income consumers pay low or no monthly fixed charge to purchase at marginal cost
- Consumers purchase fixed load shape of energy at fixed price
  - Pay hourly price for consumption above load shape
  - Receive hourly price for consumption below load shape
  - Maximizes benefits of investments in storage and load-shifting technologies
- Dynamic distribution network pricing to facilitate least cost EV and electricity space heating adoption

Questions/Comments  
For more information  
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