The Impact of Missing Price Signals

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Why Pay Attention to Missing Prices?

- Economic Principles support efficient, increasingly Granular Pricing
- Current Issues: Wholesale Load Settlements & DER Valuation
- Efficiency Benefits of Price Granularity: Reflecting Actual Variance
- Implementation of Increasingly Granular Pricing: Market Platforms
- Key Value Propositions:
  - Market Access & Valuation for DER
  - Improved Asset Utilization

Economic Pricing Principles

- **Efficiency:** *"We must look at the price system as … a mechanism for communicating information if we want to understand its real function—a function which, of course, it fulfills less perfectly as prices grow more rigid."* - Friedrich Hayek, *The Use of Knowledge in Society* (1945)
  - By communicating marginal cost and value, a dynamic and efficient price system promotes economic efficiency, enables cost savings, and incents innovation
- **Non-Discrimination:** Price discrimination occurs when a firm charges different prices to different customers for reasons other than differences in costs
  - Charging the same rate to customers for whom the marginal cost of service differs creates a cross-subsidy. It is not price discrimination.
- **Equitable Allocation:** For costs in excess of marginal costs consider:
  - **Horizontal Equity:** Treat equally situated customers equally and unequally situated customers differently
  - **Competitive Equity:** Avoid subsidies for uneconomic entry
  - **Behavioral Impacts:** Minimize uneconomic distortions of participant behavior

Wholesale Market Load Settlements

- For most consumers in organized markets:
  - Load is settled at an **Average Zonal Price**: Fails to recognize nodal price differences
    - For example, there are 11 Zonal prices in New York State, the 64 ConEd distribution areas see the same Zonal price, and only 20% have peaks coincident with system peak demand
  - Load is settled at an **Average Hourly Price**: Fails to recognize opportunities to shift demand between intervals to minimize costs
  - Load is often settled on **Historical Average Customer Class Load Profiles**: Unrelated to actual demand by the customers of load serving entities
- FERC jurisdictional load settlements have been largely overlooked in wholesale market pricing
- Retail electric suppliers have limited or no incentive to compete based on helping customers manage demand

Comments of Paul Centolella on the Application of Interval Settlements to Load Serving Entities, FERC Docket No. RM15-24-000 (Nov. 30, 2015.

DER Valuation

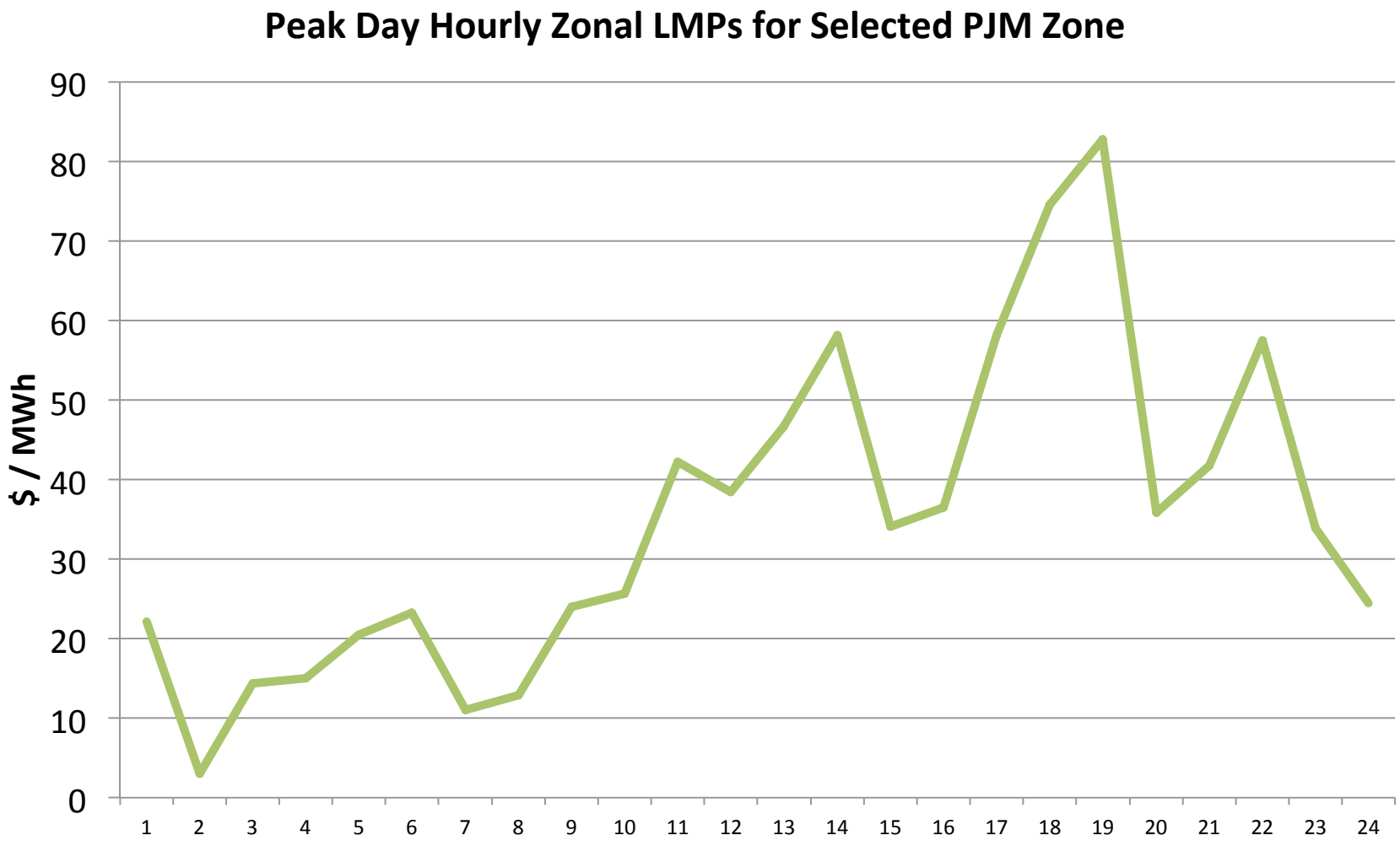
- Fundamental Approaches to Valuation:
  - Administrative valuation approaches (e.g. LMP +D, feed-in tariff, net metering retail rate credits)
  - Market based valuation via Distribution Locational Marginal Prices (DLMP)
- What is the difference?
  - LMP+D and similar approaches are **average, administrative forecasts** of the "avoided cost." For example LMP (i.e. nodal, or wholesale value, of real energy) plus D (an administrative forecast of average avoided distribution system costs).
  - LMP+D requires more transparent distribution planning & more detailed regulatory review of distribution plans
  - DLMP is a **granular, market measure** of short run marginal cost (SRMC) at the specific **time** and **location** for the provision or use of core electric products

Core Electric Products from DER (ONLY 3!)

- The 3 Rs
  - Real Energy
  - Reactive Power
  - Reserves
- The 3 Rs require tradeoffs
  - Tradeoff between producing real versus reactive power
  - Tradeoff between committing now to produce real or reactive power (now and forward) and being available to provide reserves

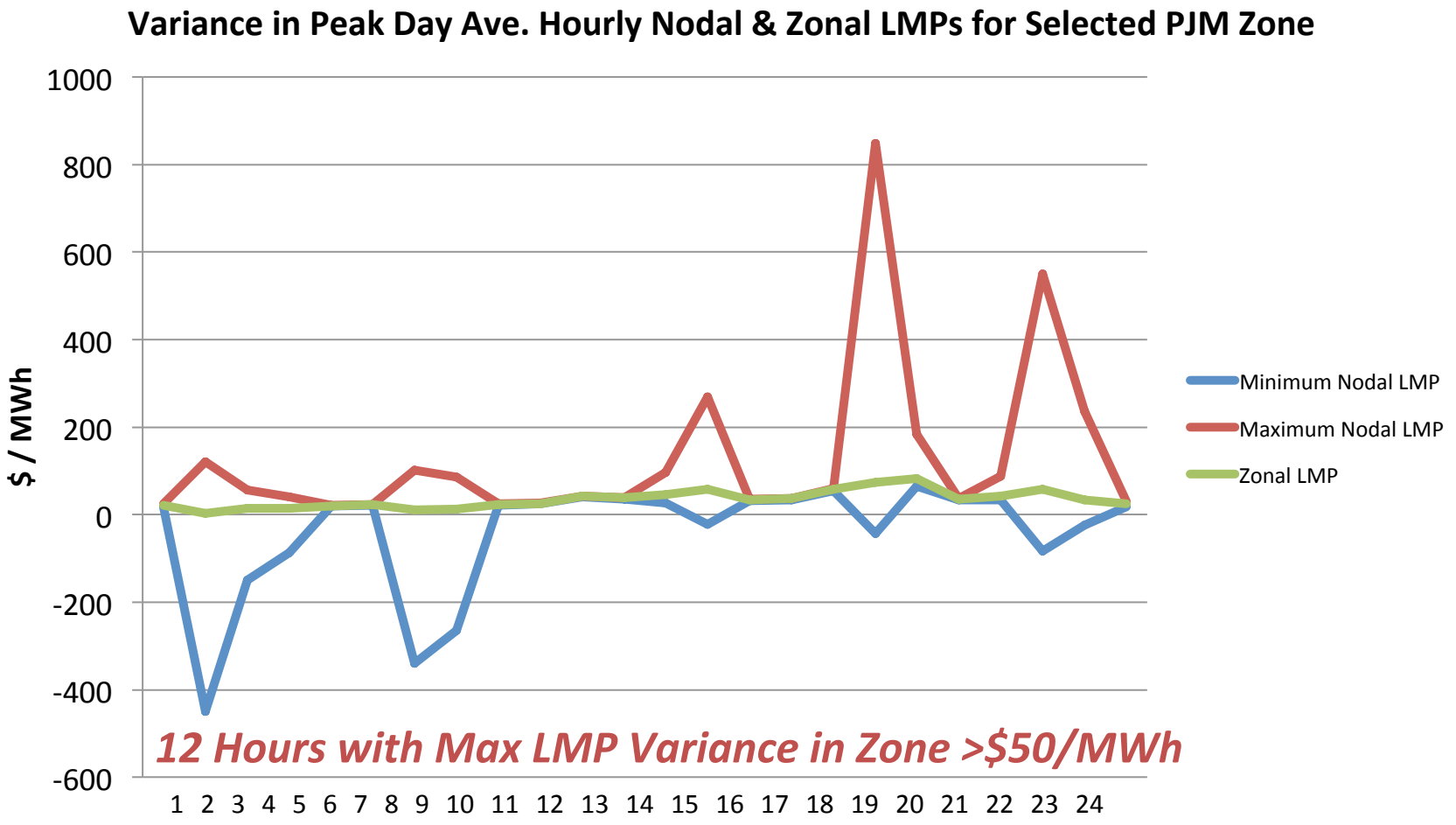
Tabors Caramanis Rudkevich "White Paper – Developing Competitive Electricity Markets and Pricing Structures" NYSERDA released April 2016.
HTTP://www.tcr-us.com/projects.html

Benefits of Granular Pricing: Time Variance (RTO)



PJM Data Miner: Locational Marginal Prices Total LMP

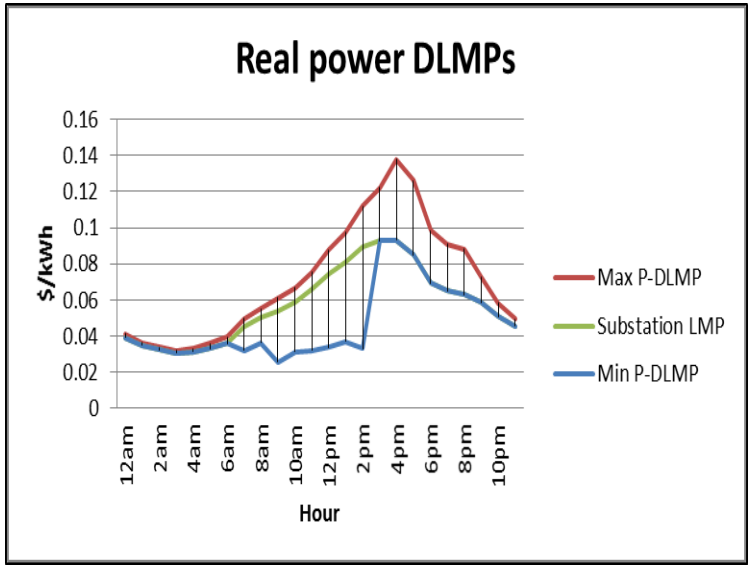
Benefits of Granular Pricing: Locational Variance (RTO)

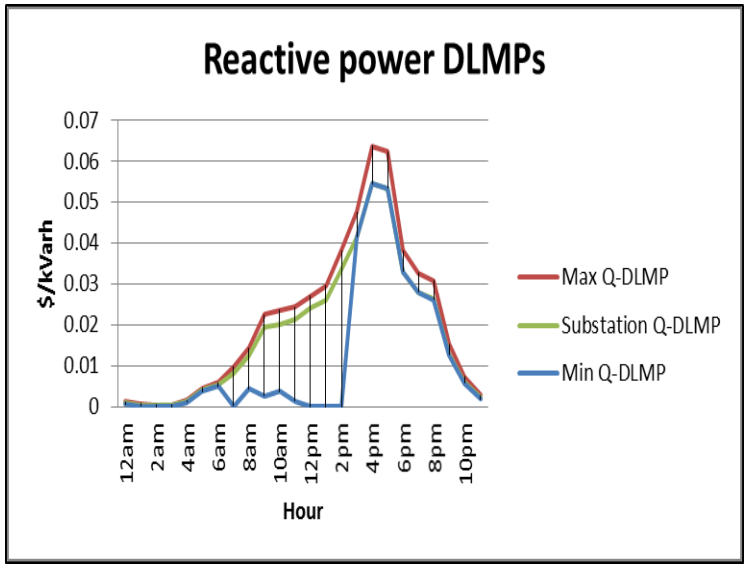


PJM Data Miner: Locational Marginal Prices Total LMP

Benefits Granular Pricing: Real & Reactive Power DLMPs

Modeling Results: Summer Day, High DER Scenario for an Illustrative 800 Bus Commercial / Residential Distribution Feeder

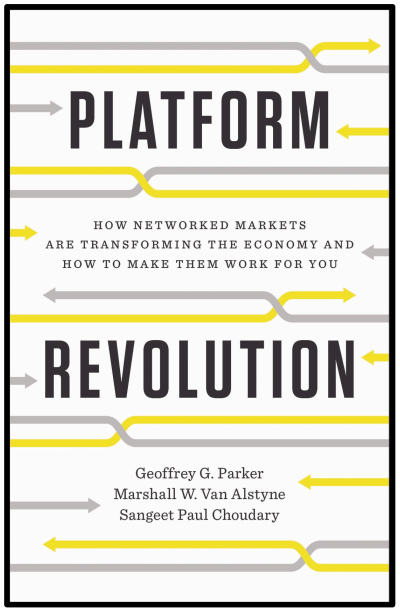




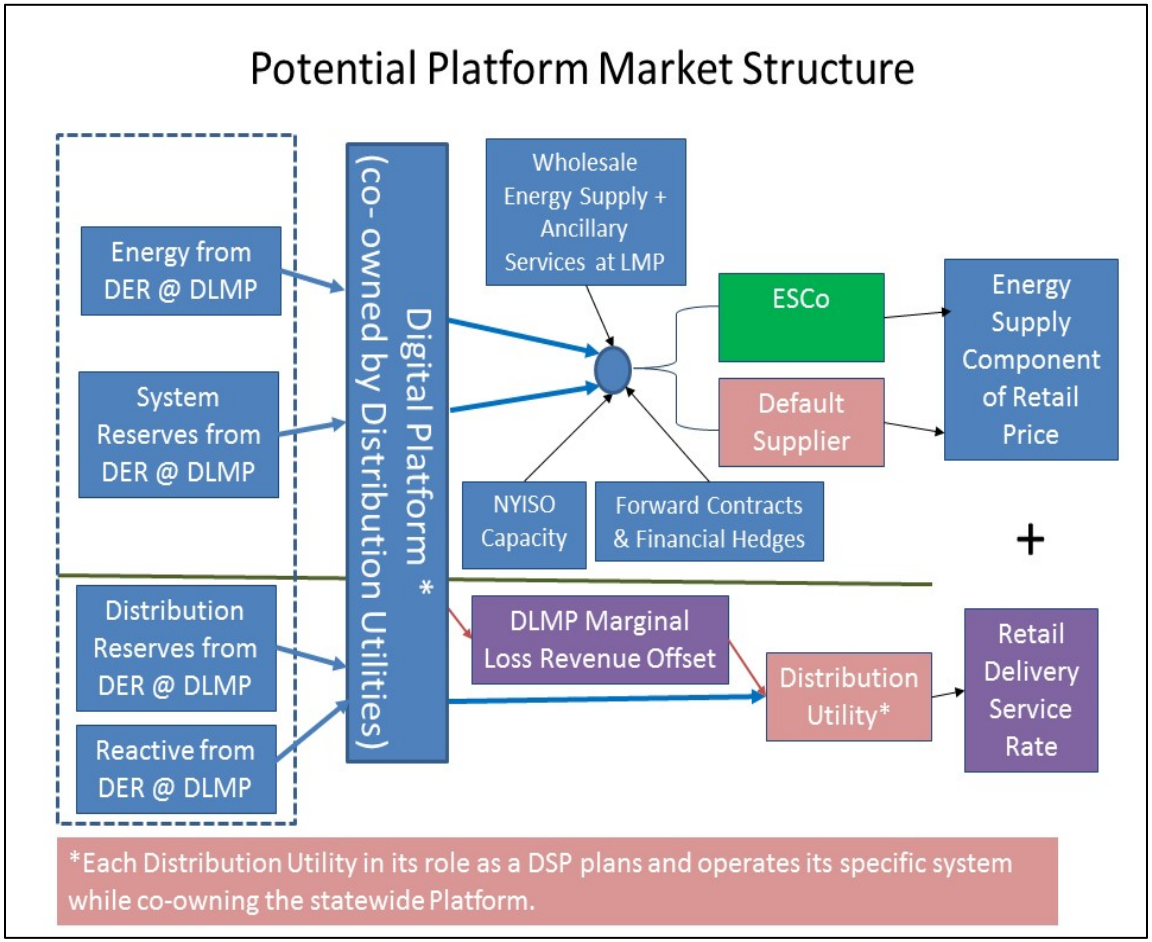
Tabors Caramanis Rudkevich "White Paper – Developing Competitive Electricity Markets and Pricing Structures" NYSERDA released April 2016. HTTP://www.tcr-us.com/projects.html; See also: M. Caramanis, E. Ntakou, W. Hogan, A. Chakrabortty, and J. Schoene, "Co-Optimization of Power and Reserves in Dynamic T&D Power Markets with Nondispatchable Renewable Generation and Distributed Energy Resources," *Proceedings of the IEEE,* Vol. 104, No. 4 (April 2016)

Granular Pricing: Market Platforms

- **What is a Platform?** The infrastructure of a business ecosystem that matches producers and consumers, who transact using the platform and resources provided by the ecosystem. The platform provides components and rules designed to facilitate interactions and creates value by facilitating matches and providing easy access to useful goods and services.
  - Parker, Van Alstyne, & Choudary, *Platform Revolution: How Networked Markets Are Transforming the Economy--And How to Make Them Work for You* (2016)
- **What is a Distribution System Platform?** In addition to distribution planning & operations, a platform includes markets and may provide:
  - **Transactional Platform:** Trading in Core Electric Products
  - **Services Platform:** Transactions enabling efficient demand management and other services



Transactional Platform Market Structure



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Transactional Market for Core Electric Products

- **Forward market (*ex ante*)**
  - Continuous, bilateral transactions: location- and time-based bids and offers are matched and price formation occurs
  - Closes immediately prior to the time of simultaneous production and consumption of electricity
  - Forward options contracts enable Distribution Utilities to avoid distribution system investments by obtaining advance commitments from DER to provide location-specific resources (e.g. distribution operating reserves) when needed by the utility
- **Clearing or Balancing Market (*ex post*)**
  - Needed to clear imbalances between scheduled energy deliveries and actual energy consumed
  - May be used to settle energy prices at a distribution level
  - DSOs provide the Platform with relevant data on actual "real time" consumption, production, load flows and distribution system topology
  - Platform runs a mathematical load flow calculation, with the substation LMP as the reference price, to determine a clearing price for energy and reactive power at each traded distribution node.
- **Market Evolution:** Pricing could become more granular in phases, starting at existing, sub-zonal transmission pricing nodes ("enhanced LMP" or eLMP) and moving to Distributed LMP (DLMP), as utilities implement interval measurement of real and reactive power at sufficient points to estimate distribution power flows.

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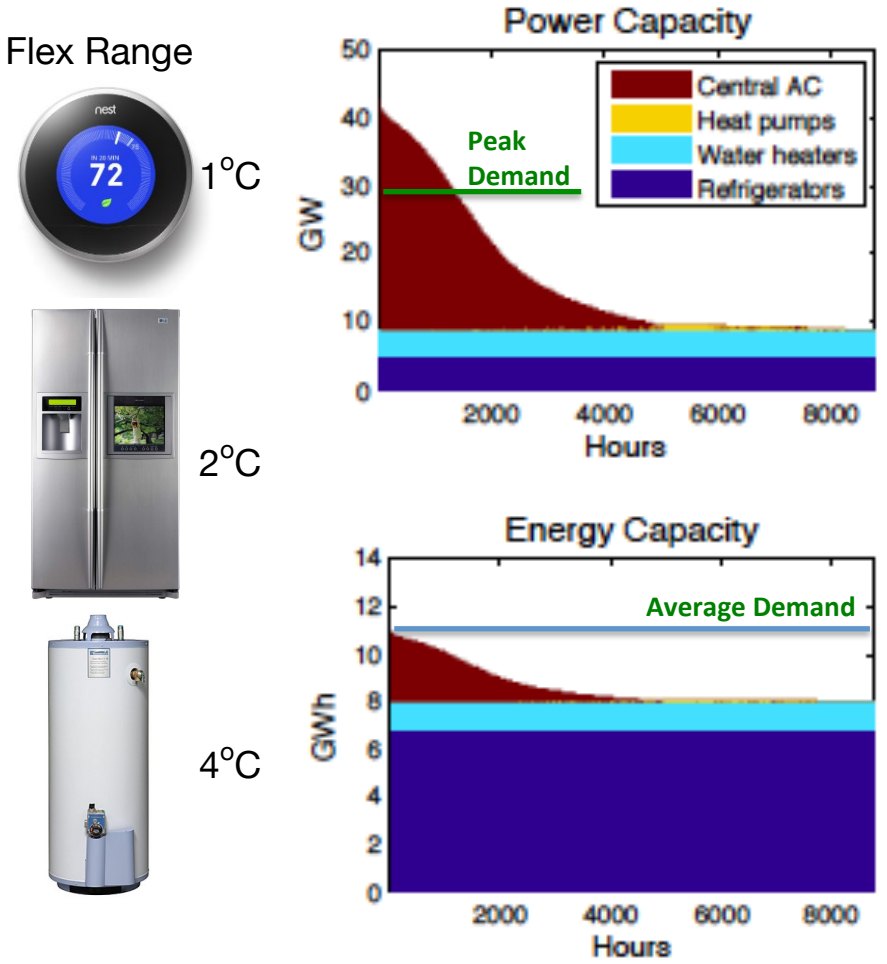
Platform Value Proposition: Market for DER

- Supports development and operation of a new, competitive market for core electric products, i.e., well-defined products, transparency, multiple buyers and sellers can enter and exit the market freely.
- Enables granular, economically efficient prices that reflect the time- and location-specific value of real energy, reactive power and reserves
- Minimizes transaction costs or friction associated with sale and purchase of core electric products and price discovery
- Expands DER access to markets for their core electric products
  - Real Energy (kWh)
  - Reactive Power (KVARh) in order to maintain voltage within an acceptable band
  - Reserves (a commitment to deliver real or reactive power in the future)
- Animates emergence of new products and services
  - Combinations of products and services from DER and third parties
  - Value-added services: price forecasts, analytics, smart technology
  - Enhanced distribution efficiency: Integration of DER in local Volt / VAR control

Value Proposition: Enhanced Asset Utilization

- Power system average asset utilization is below 50% - Far below other capital intensive industries
- Most commercial & residential demand can be shifted in time
- If wholesale loads settled on actual demand, suppliers could compete to efficiently manage demand
- With smart devices, dynamic retail prices are one, increasingly attractive, pricing option
- Customers can choose:
  - Lower flat price in exchange for supplier demand management
  - Dynamic retail price, OR
  - Dynamic retail price + optional price guarantee

Flexible Demand Potential: CA Residential Loads



Source: J. Mathieu, *Modeling, Analysis, and Control of Demand Response Resources,* LBNL-5544E (May 2012)

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