Competitive Markets and Pricing Structures: Reforming Retail Rates to Integrate DER

Paul Centolella
President, Paul Centolella & Associates, LLC
Senior Consultant, Tabors Caramanis Rudkevich

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Integrating Distributed and Renewable Resources

ISO New England 2016 Regional Electricity Outlook[1]

Opportunities:

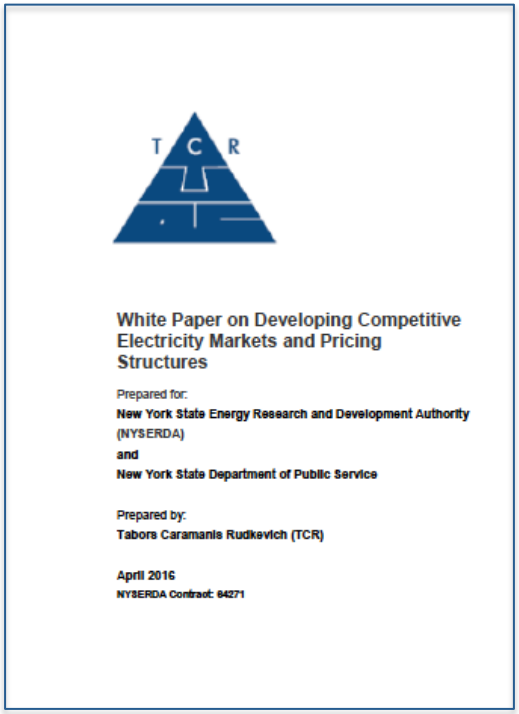
- DG may reduce local outages
- Gas and renewables have environmental and cost benefits, when adequate gas is available
- Smart grid technology and rate design changes will empower consumers and reduce costs

Challenges:

- In the next decade, up to 20% of power resources could connect to distribution or retail customers
  - PV forecast to grow from 900 MW to 2,400 MW by 2024
- Interconnection queue: 4,200 MW wind – 5X existing capacity
- Limited gas pipeline capacity + non-gas generation retirements
- Potential clean energy contracts to inhibit competitive investment

Markets & Pricing for DER in NY REV

- Tabors Caramanis Rudkevich team: *White Paper on Developing Competitive Electricity Markets and Pricing Structures*[2]
- Funded by NYSERDA and prepared for New York REV proceeding – PSC Case No. 14-M-0101
- Addressed the development of efficient pricing structures for DER at both Bulk Power and Distribution levels
- Applied principles of Platform Economics to describe Platform Market Structures



DER Valuation

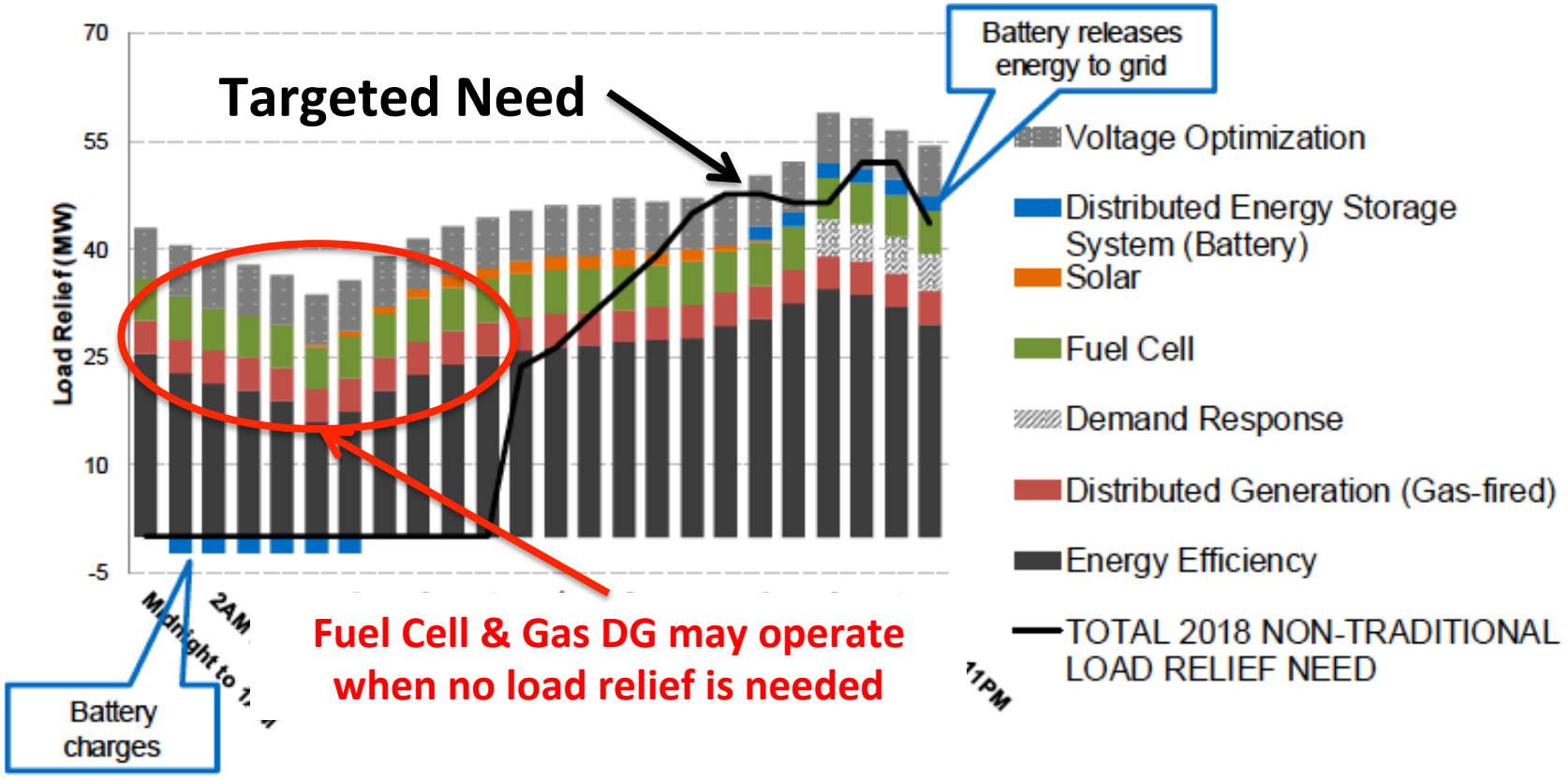
- Fundamental Approaches to Valuation:
  - Administrative valuation approaches (e.g. LMP +D, feed-in tariff, net metering retail rate credits)
  - Market based valuation via Distribution Locational Marginal Prices (DLMP)
- What is the difference?
  - LMP+D and similar approaches are **average, administrative 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
  - Transition: Bulk Power extension of interval, nodal LMP to load settlements creating value of managing net demand
  - 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

Planning and Regulatory Valuation

- Role of Planning: Targeting DER can defer more expensive distribution investments
- Limitations of Planning:
  - While planning can forecast expected values, more difficult to reflect time variance, dynamic change, & emerging resource options
  - Difficult to give customers and suppliers generally the incentives to develop and operate just where and when DER are cost-effective
  - Planning requires multi-layer forecasts on a circuit-by-circuit basis
  - Regulatory review of circuit-by-circuit valuation may be difficult to scale up in a timely manner
  - Procurements may reduce costs in some hours and provide unneeded or more costly power in others

Anticipated 2018 BQDM Resource Portfolio[3]

- Expect to rely on: Energy Efficiency, Voltage Optimization, Gas-fired Generators, Fuel Cells, and Evening Demand Response
- Supplemented with modest contributions from PV and Battery Storage



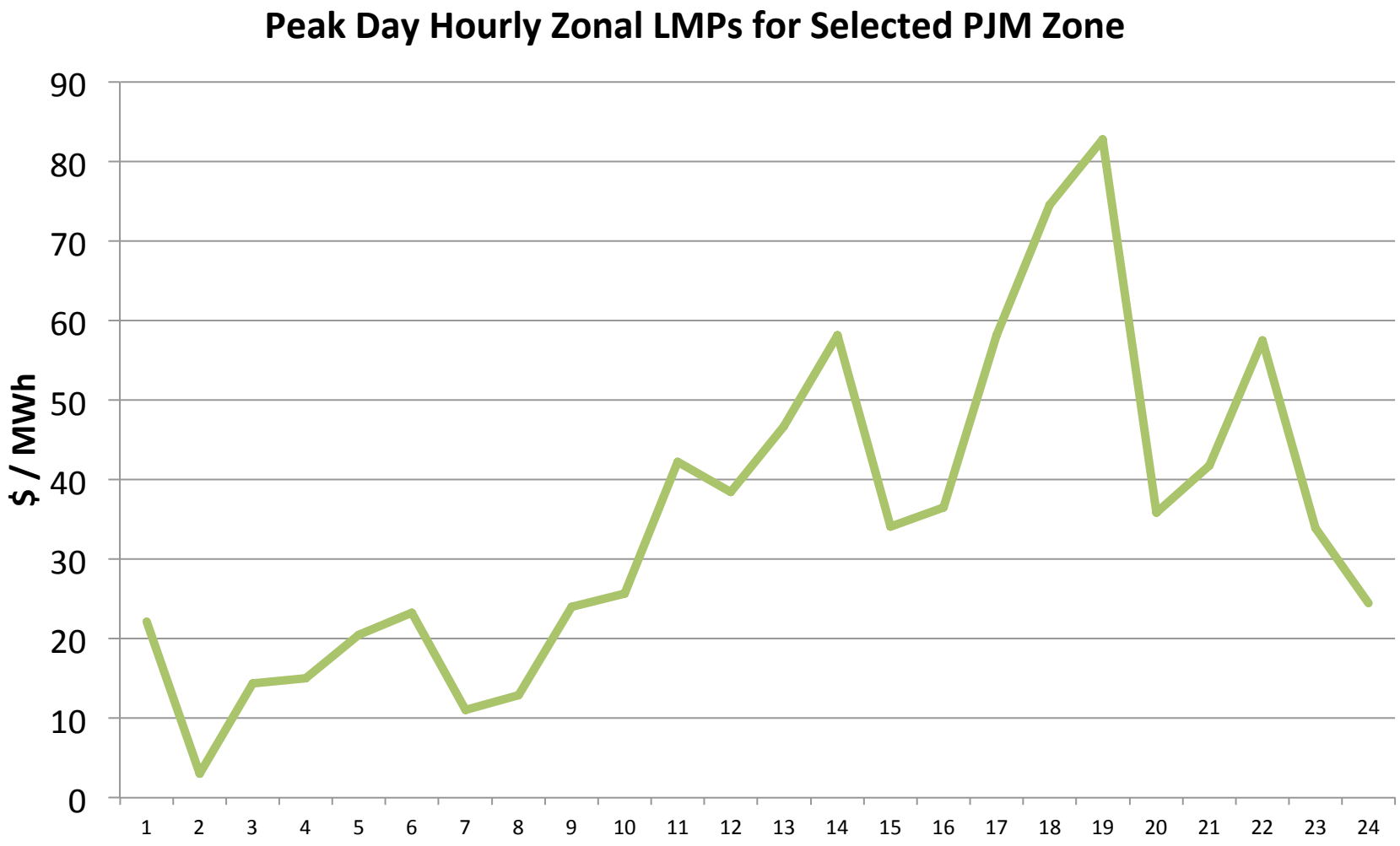
Economic Pricing Principles

- **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
- **Equity:** For costs in excess of marginal cost prices consider:
  - **Horizontal Equity:** Treat equally situated customers equally and unequally situated customers differently
  - **Behavioral Impacts:** Minimize uneconomic distortions of participant behavior

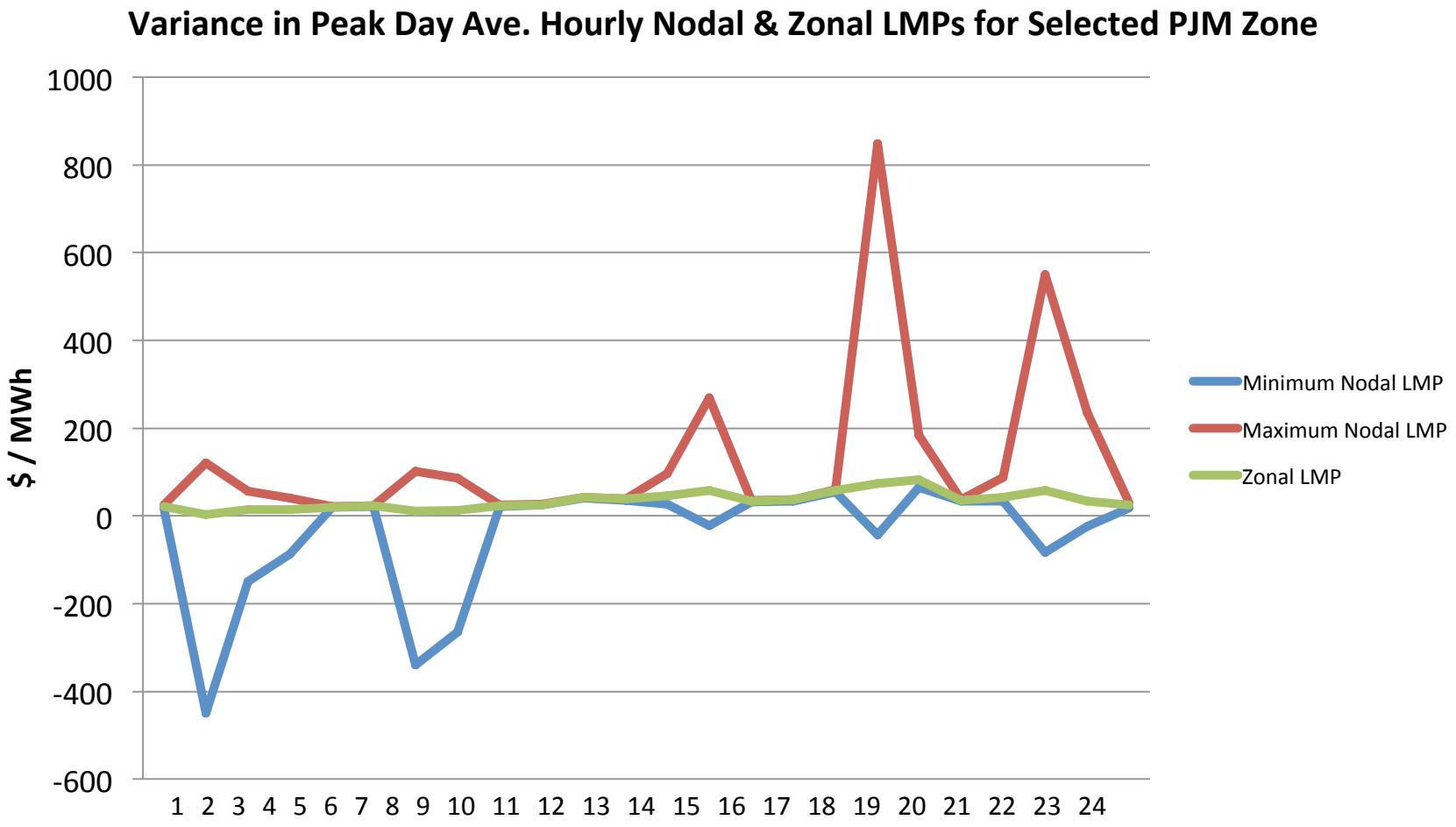
Market Valuation: Bulk Power Load Settlements

- 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
- Retail electric suppliers have limited or no incentive to compete based on helping customers manage demand
- Existing practices reflect the 20th Century formation of markets before growth of the digital economy

Market Valuation: Time Variance in RTO LMP[4]



Market Valuation: Locational Variance in RTO LMP[4]



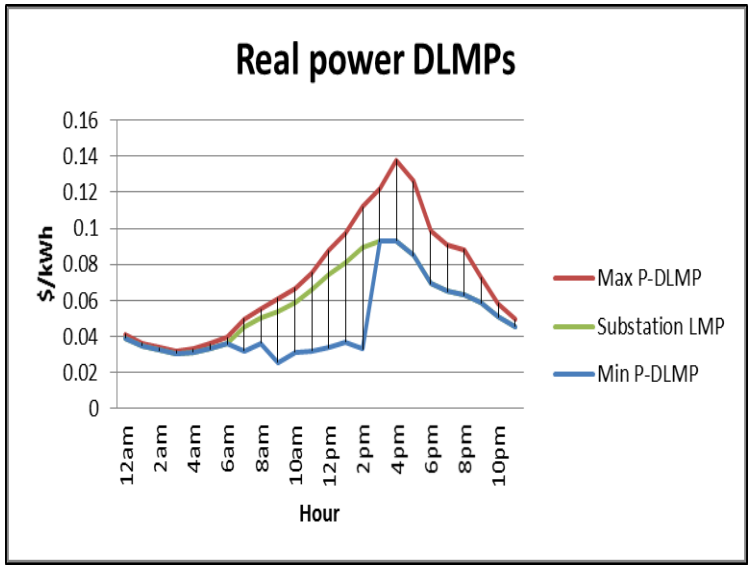
12 Hours with LMP Variance in Zone >$50/MWh

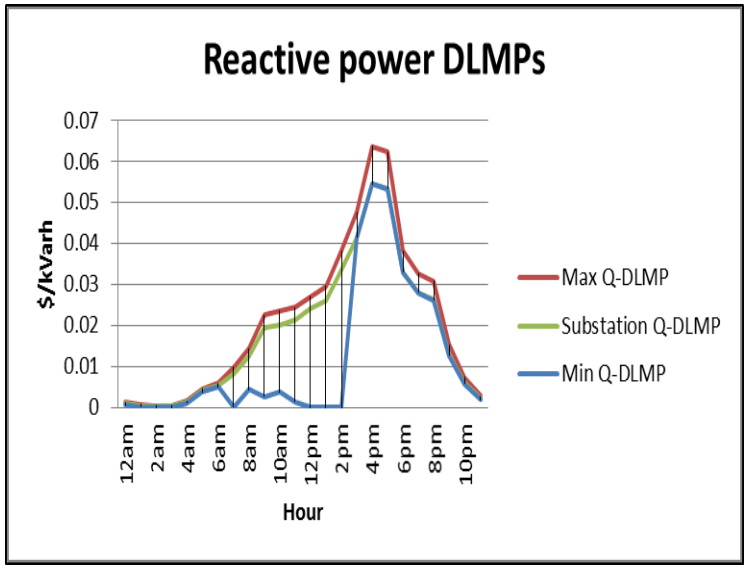
Core Electric Products from DER

- The 3 Rs: **ONLY 3!** Products in Distribution
  - 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

Market Valuation: Real & Reactive Power DLMPs[5]

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





- Cost of EV charging 42% lower
- Cost of Commercial Space Conditioning reduces 12% with 20% flexible demand
- PV revenue increases 6% with reactive power sales

DER value is time- and location-specific, changes with load and network state, and can erode with additional DER on a feeder

Distribution System Platform

- **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.[5]
  - Fundamental differences from ordinary product delivery business model
- **What is a Distribution System Platform?** In addition to distribution planning & operations, a distribution 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: DLMP Markets

- **Real Time / Balancing Market (*ex post*)**
  - **DER:** Clears imbalances between scheduled / actual deliveries and usage
  - **Variable Delivery Charges:** Can settle differences between LMP at the substation and prices at a distribution locations
  - With data on actual consumption, production, load flows, and distribution topology, the Platform runs a straight forward mathematical calculation, using substation LMP as the reference price, to determine a real-time price for real and reactive power at each distribution pricing location
- **Forward market (*ex ante*)**
  - Continuous, bilateral financial transactions: location- and time-based bids and offers are matched to set prices
  - **Hedge:** Parties can lock in prices as operating schedules are set or updated
  - **Distribution System Management:** Utility can use forward options contracts to avoid distribution system investments by obtaining advance commitments from DER to provide location-specific resources when needed by the utility

Market Evolution and Technology Deployment

Market Walk:
- Bulk power interval & nodal settlement for interval metered segment of each RES's demand
- Installing AMI / Interval Meters & Flow Sensors

< 2 Years

Market Jog:
- Bulk power interval & nodal settlement for all RES demand
- DLMP on radially operated circuits
- Universal AMI / Interval Meters & Flow Sensors

2 to 5 Years

Market Run:
- Bulk power interval & nodal settlement for all RES demand
- DLMP extended to mesh networks & microgrids
- Universal AMI / Interval Meters & Flow Sensors

5 to 10 Years

21st Century technology enables an escape from 20th Century rate designs

Value Proposition: Market for DER

- Expands DER access to markets beyond participation in DR programs:
  - Creates **opportunities for DER:** to sell real power, reactive power, or reserves to distribution utility to support operations or avoid investment, utility as the default energy supplier, competitive retail energy suppliers, and potentially directly to retail customers in peer-to-peer transactions
  - Creates **efficient competitive market:** well-defined products, price transparency, multiple buyers and sellers, minimal transaction costs or barriers to market entry
- Provides an incentive to invest in and operate DER where and when will be cost-effective
  - Creates a **transition path** out of or avoids locking in subsidies for uneconomic DER
- Animates emergence of new products and services
  - **Services Platform** enables combinations of products and services from DER and third parties: e.g. responsive demand and building commissioning
  - **Reactive Power** pricing could improve distribution efficiency through the integration of DER into utility Volt / VAR control

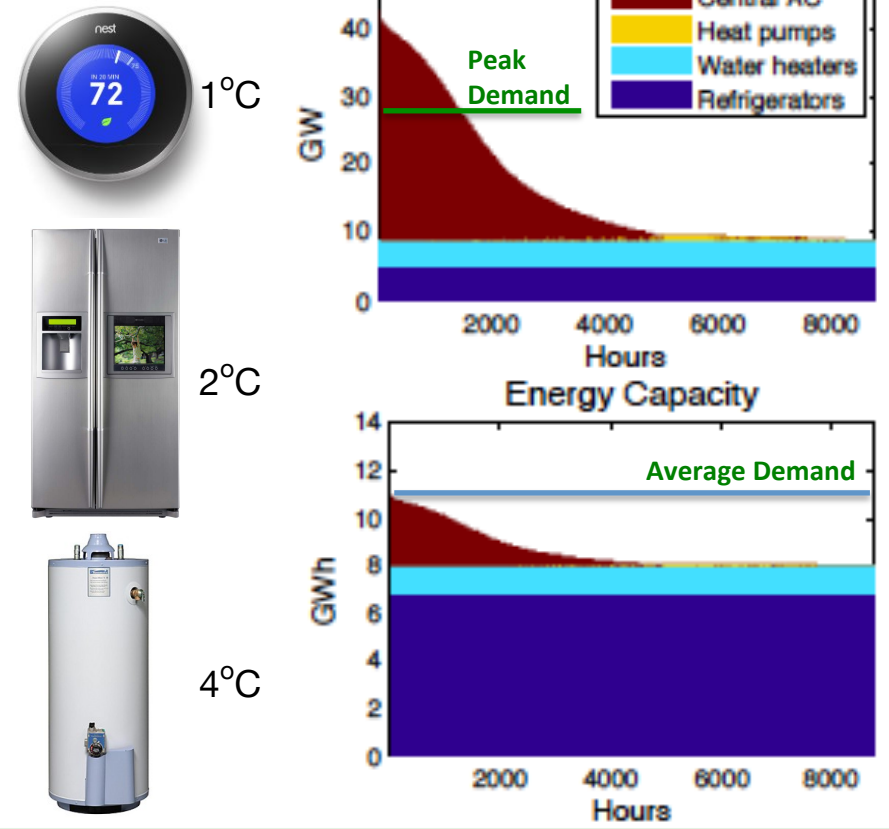
Value Proposition: Enable Responsive Demand

Significant potential for residential and commercial demand to be shifted in time reducing costs without impacting consumers:

- Pre-cooling to take advantage of building thermal inertia
- Smart refrigeration, water heating, and appliances
- Electric vehicle charging
- Pumping and flexible demand

Many Commercial Buildings Can Use Thermal Inertia to Cut Peak 20-50%[6]

Flexible Residential Demand: CA Potential Study[7]



Value Proposition: Enable Responsive Demand

- Enabling demand to match supply will:
  - Improve utility asset utilization: currently below 50% and far below that in other capital intensive industries
  - Enable more efficient integration of renewables and DER
  - Enhance reliability
- Tens of millions already installed smart thermostats and smart commercial building management systems are rapidly becoming the backbone of an energy internet of things
- Market valuation would incent retail suppliers to compete to help customers manage demand (e.g. offering lower fixed prices in return for temperature flexibility)

Paul Centolella
President, Paul Centolella & Associates, L.L.C.
Senior Consultant, Tabors Caramanis Rudkevich
(614) 530-3017
centolella@gmail.com

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