Characteristics of Successful Capacity Markets

PRESENTED TO

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THE Brattle GROUP

Market Designs for Resource Adequacy

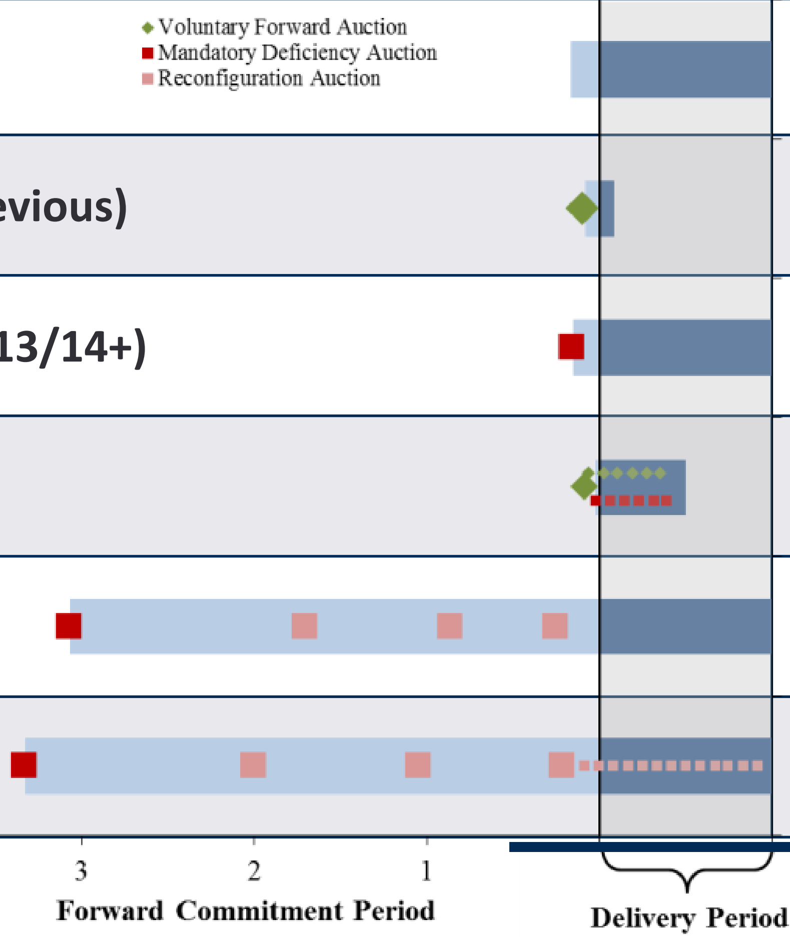
	Regulated Planning (Customers Bear Most Risk)			Market Mechanisms (Suppliers Bear Most Risk)		
	Regulated Utilities	**Administrative Contracting**	**Capacity Payments**	**LSE RA Requirement**	**Capacity Markets**	**Energy-Only Markets**
Examples	SPP, BC Hydro, most of WECC and SERC	Ontario	Spain, South America	California, MISO (both also have regulated IRP)	PJM, NYISO, ISO-NE, Brazil, Italy, Russia	ERCOT, Alberta, Australia's NEM, Scandinavia
Resource Adequacy Requirement?	Yes (Utility IRP)	Yes (Administrative IRP)	Yes (Rules for Payment Size and Eligibility)	Yes (Creates Bilateral Capacity Market)	Yes (Mandatory Capacity Auction)	No (RA not Assured)
How are Capital Costs Recovered?	Rate Recovery	Energy Market plus Administrative Contracts	Energy Market plus Capacity Payments	Bilateral Capacity Payments plus Energy Market	Capacity plus Energy Markets	Energy Market

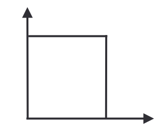
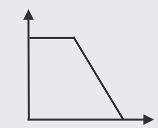
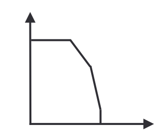
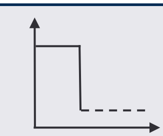
See Also:

Pfeifenberger & Spees (2009). *Review of Alternative Market Designs for Resource Adequacy*.

Spees, Newell, & Pfeifenberger (2013). "Capacity Markets: Lessons Learned from the First Decade," *Economics of Energy & Environmental Policy,* Vol. 2, No. 2, September 2013.

A Decade of U.S. Capacity Markets Designs



	Forward Period	Procurement	Demand Curve
California		Bilateral	n/a
MISO (Previous)		Bilateral + Voluntary Auction	n/a
MISO (2013/14+)		Bilateral + Mandatory Auction	
NYISO		Bilateral + Voluntary & Mandatory Auctions	
PJM		Bilateral + Mandatory Auctions	
ISO-NE		Bilateral + Mandatory Auctions	

Experience with Options Currently Considered

Significant experience exists with various approaches to resource adequacy currently considered in many markets (see Appendix)

Approach	Our Experience and Clients
Energy-Only Markets	ERCOT (Texas), Alberta, most European markets
Strategic Reserves	Extensively considered and simulated as one of five options to assure resource adequacy in ERCOT
"Focused" (discriminatory) Capacity Market	Evaluated various degrees of "focus" in CAISO, PJM, ISO-NE, MISO, U.K., Russia, Spain, Italy and UK. Some workable solutions but significant inefficiencies of discrimination between existing/new plants
Comprehensive Capacity Market	PJM, ISO-NE, NYISO, MISO, Italy, Russia, one of ERCOT's options; Analyzed both short-term and multi-year forward designs
Bilateral Resource Adequacy Markets	Previous MISO and PJM markets, aspects of CAISO, specific European proposals (e.g., France)
Capacity payments	Inefficiencies documented in review of Spain and Ontario for PJM
Integrate demand side; differentiate reliability	Analyzed role, market design, and experience with integrating demand-side into resource adequacy (PJM, MISO, ERCOT, AESO)
Interties	Analyzed role and impact of interties on resource adequacy and cross border capacity sales (AESO, MISO, PJM, ISO-NE, FERC)

Characteristics of Successful Capacity Markets

Experience with resource adequacy designs from the last decade strongly suggests that successful capacity markets require:

1. Well-defined resource adequacy needs and drivers of that need
2. Clear understanding why the current market design will not achieve resource adequacy targets without a capacity construct
3. Clearly-defined capacity products, consistent with needs
4. Well-defined obligations, auctions, verifications, and monitoring
5. Efficient spot markets for energy and ancillary service
6. Addressing locational reliability challenges
7. Participation from all resource types
8. Carefully-designed forward obligations
9. Staying power to reduce regulatory risk while improving designs and addressing deficiencies
10. Capitalizing and building on experience from other markets

Characteristics of Successful Capacity Markets

1. **Well-defined resource adequacy needs**
   - Meet seasonal/annual peak loads or ramping/flexibility constraints?
   - Drivers of the identified needs?
   - System-wide or location-specific due to transmission constraints?
   - Near-term vs. multi-year forward deficiencies? Uncertainty of projected multi-year forward needs?
   - Ability of all demand- and supply-side resources , including interties, to meet the identified need?

Characteristics of Successful Capacity Markets

2. **Clear understanding why the current market design will not achieve resource adequacy targets without a capacity construct**

- Energy market designs that lead to price suppression?
  - Low price caps and inadequate scarcity pricing?
  - Poor integration of demand-response resources?
  - Substantial locational differences not reflected in market prices?
  - Operational actions that depress clearing prices?
- Challenging investment risks (e.g., in hydro-dominated markets)?
- Distortions created by out-of-market payments for some resources that lead to over-supply?
- Incomplete or poorly-designed ancillary service markets?
  - Missing ramping products?
  - Not co-optimized with energy market?
  - Operational actions that depress clearing prices?
- **Most Likely**: Resource adequacy preferences higher than what even fully-efficient energy and ancillary service markets would provide

Characteristics of Successful Capacity Markets

3. **Clearly-defined capacity products, consistent with needs**
   - Annual and seasonal capability
   - Near-term or multi-year forward obligations
   - Peak load carrying vs. ramping capability
   - Effective load carrying capability and outage rates of different resource types (including renewables, demand-response, and interties)
   - Integration with energy and ancillary service markets

4. **Well-defined obligations, auctions, verifications, monitoring, and penalties**
   - Ensure quality of resources and compliance without creating inadvertent bias against certain resources (e.g., demand-response, intermittent resources, imports)

Characteristics of Successful Capacity Markets

5. **Efficient spot markets for energy and ancillary service**
   - Capacity markets can "patch-up" deficiencies in energy and ancillary service markets from a resource adequacy perspective
   - Less efficient investment signals (e.g., resource types, supply- vs. demand-side resources, locations) if deficiencies in energy and ancillary service are not addressed

6. **Addressing locational reliability challenges**
   - Resource adequacy won't be addressed efficiently if reliability concerns are locational but capacity markets aren't
   - Requires locational resource adequacy targets and market design
   - Requires understanding of how transmission (including interties between power markets) affect resource adequacy

Characteristics of Successful Capacity Markets

7. **Participation from all resource types**
   - Existing and new generating plants
   - Conventional, renewable/intermittent, and distributed generation
   - Load (demand response)
   - Interties (actively committed imports vs. resource adequacy value of uncommitted interties)

8. **Carefully-designed forward obligations**
   - Efficiency of near-term obligations (avoid forecasting uncertainty, adjust to changes in market conditions, reduced commitment risk)
   - Benefits of multi-year forward obligations (competition between new and existing resources; forward visibility; financial certainty)
   - Questionable need for forward commitments greater than 3-4 years
   - Avoid capacity markets as substitute for long-term contracts

Characteristics of Successful Capacity Markets

9. **Staying power to reduce regulatory risk while improving designs**
   - Staying power of market design reduces regulatory risk and improves investment climate
   - Requires careful balancing of staying power and the need to improve design elements and address deficiencies
   - Challenge due to strong financial interests of different stakeholders

10. **Capitalizing and building on experience from other markets**
    - Regional difference are important but often overstated
    - Avoid the “not invented here” syndrome
    - Avoid “urban myths” (e.g., no new generation built in regions with capacity markets; insufficient to support merchant investments unless 5-10 year payments can be locked in)

Some Takeaways

Don't prematurely add capacity markets…

- …without a clear understanding of the resource adequacy needs and the drivers of these needs
- …that explicitly or inadvertently:
  - discriminate between existing and new resources
  - exclude participation by demand-side and renewable resources
  - ignore locational constraints and transmission interties
- …just to add revenues for certain resources or to address a perceived lack of long-term contracting
- …while also providing out-of-market payments to some resources (including long-term contracts) that oversupply the market and distort both short- and long-term investment signals
- …without understanding and addressing deficiencies in energy and ancillary service markets

Additional Reading

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Johannes (Hannes) Pfeifenberger is a principal of The Brattle Group and an economist with a background in power engineering and over 20 years of experience in the areas of public utility economics and finance. He has testified before FERC and numerous other commissions.

On behalf of his clients, which include ISOs, transmission owners, utilities, generators, and regulators, he has addressed RTO market designs, the economics of resource adequacy, the performance of capacity market design, the benefits and cost allocation of transmission projects, the reasons behind rate increases, implications of restructuring policies, competitive conduct in electric power markets, and the effects of proposed mergers. He has authored and co-authored numerous publications on these subject areas and frequently testifies as an expert witness before regulatory agencies, courts, and arbitration cases.

Hannes received an M.A. in economics and finance from Brandeis University and an M.S. ("Diplom Ingenieur") in electrical engineering, with a specialization in power engineering and energy economics, from the University of Technology in Vienna, Austria.

Dr. Kathleen Spees is a senior associate at The Brattle Group with expertise wholesale electric energy, capacity, and ancillary service market design and price forecasting. Dr. Spees has worked with system operators in the U.S. and internationally to improve their market designs with respect to capacity markets, scarcity and surplus event pricing, ancillary services, wind integration, and energy and capacity market seams.

For other clients, Dr. Spees has engaged in assignments to estimate demand response penetration potential, analyze client questions about virtual trading, FTR, or ancillary service markets, impacts of environmental regulations on coal retirements, tariff mechanisms for accommodating merchant transmission upgrades, renewables integration approaches, and market treatment of storage assets.

Kathleen earned a B.S. in Mechanical Engineering and Physics from Iowa State University. She earned an M.S. in Electrical and Computer Engineering and a Ph.D. in Engineering and Public Policy from Carnegie Mellon University.

About The Brattle Group

The Brattle Group provides consulting and expert testimony in economics, finance, and regulation to corporations, law firms, and governmental agencies worldwide.

We combine in-depth industry experience and rigorous analyses to help clients answer complex economic and financial questions in litigation and regulation, develop strategies for changing markets, and make critical business decisions.

Our services to the electric power industry include:

- Climate Change Policy and Planning
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- Demand Forecasting Methodology
- Demand Response and Energy Efficiency
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- Energy Asset Valuation
- Energy Contract Litigation
- Environmental Compliance
- Fuel and Power Procurement
- Incentive Regulation
- Rate Design and Cost Allocation
- Regulatory Strategy and Litigation Support
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- Resource Planning
- Retail Access and Restructuring
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Appendix:
Selected Experience from Other Markets

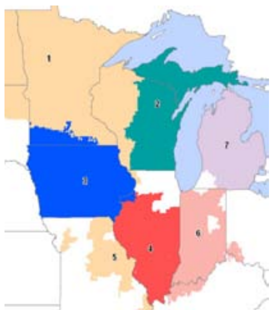
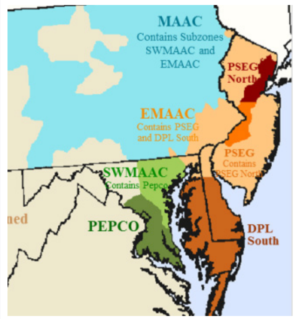
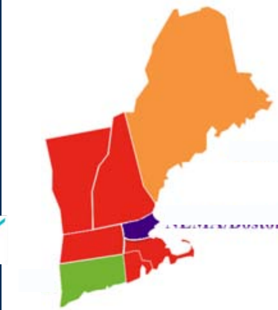
Experience from Other Markets

A Decade of U.S. Capacity Market Experience

	MISO	PJM	NYISO	ISO-NE	CAISO
Achieving Reliability Target	Started w/ excess, supported by IRP	Started w/ and maintaining excess despite large retirements	Started w/ and maintaining excess; non-forward w/ flatter curve increases shortage risk	Started w/ and maintaining excess	Current excess supported by IRP
Price Volatility & Uncertainty	Not tested but non-forward w/ vertical curve likely to cause bi-modal pricing	Volatility from rule changes, fundamentals, and parameters (now improving)	Relatively predictable (flatter demand curve), voluntary forward auctions help	Prices stable at price floor (exception is Boston at price cap in 2016/17)	Not transparent but all-bilateral market likely prevents high volatility
Market Efficiency	Not tested but little direct competition between IRP and market alternatives	Strong performance from competition among all supply types	Competitive in short-term, but no competition at timing consistent with investment decisions	Price floor exacerbating supply surplus	Large price discrepancies between new, existing, & DR
Attracting Low-Cost Supplies	Not tested	Yes; large increases in DR, EE, imports, uprates, retrofits	Yes	Yes	No competition between new gen and low-cost alternatives
Environmental Retirements	Large risks from MATS, as yet not fully quantified	Effective market response to large MATS and NJ HEDD rules	Concern about potential Indian Point nuke shut down; less MATS exposure	Less MATS exposure	16,000 MW to retire or reinvest in next decade from once-through-cooling
Attracting Merchant Generation	No current need, but new merchant gen discouraged by low price cap, IRP preemption	Yes (4,500 MW of pure merchant generation in last 2 auctions ; e.g., LS Power and Calpine in 2015/16)	Yes (e.g. Bayonne Energy Center)	Yes (Salem Harbor in 2016/17 at $180/kW-y with 5-year lock-in)	No, market preempted by overbuild from IRP

Experience from Other Markets

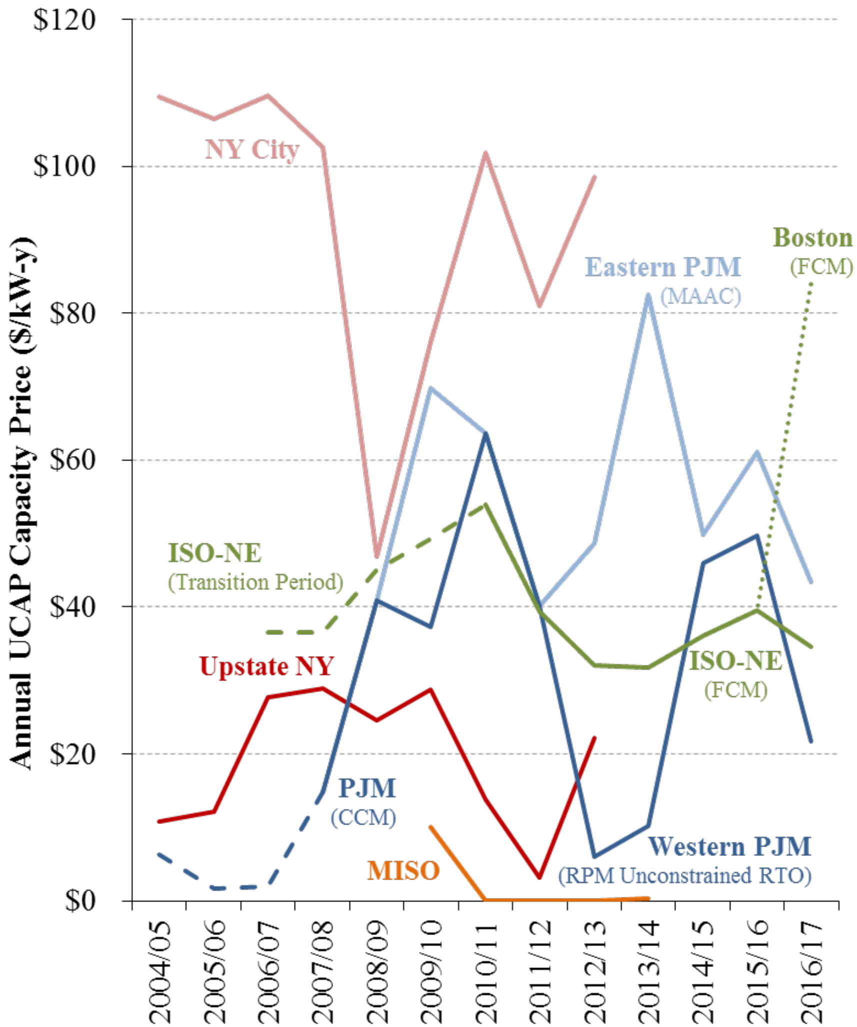
Impact of Transmission on U.S. Capacity Markets

	MISO	PJM	NYISO	ISO-NE	CAISO
					
Number of Zones	7 plus RTO	9 plus RTO	2 plus RTO (3 in 2014+)	3 plus RTO	10 plus RTO
Import Constraints	Yes	Yes	Yes	Yes	Yes
Export Constraints	Yes	No	No	Yes	No
Nested Zones	No	Yes	No	No	No
Locational Clearing	Zonal Min and Max	Pipes Model	Local Sourcing Requirement	Pipes Model	Local Sourcing Requirement
Border Pricing for Imports	No	No	Yes	Yes	No

Uncertain Market Prices for Capacity

- Price volatility and uncertainty are a concern in restructured markets without substantial bilateral forward contracting
- Several contributing factors:
  - *Market Fundamentals* – efficient result to have prices move with fundamentals, but the markets are structurally volatile due to steep supply and demand curves
  - *Rule Changes* – one-time design changes contribute to volatility, but impacts not persistent
  - *Ongoing Administrative Uncertainties* – uncertain administrative parameters are an ongoing concern (e.g. load forecast, Net CONE, transmission limits)
- Uncertainty has not deterred merchant investments

Capacity Prices Across RTOs



PJM Capacity Market Response to Retirements

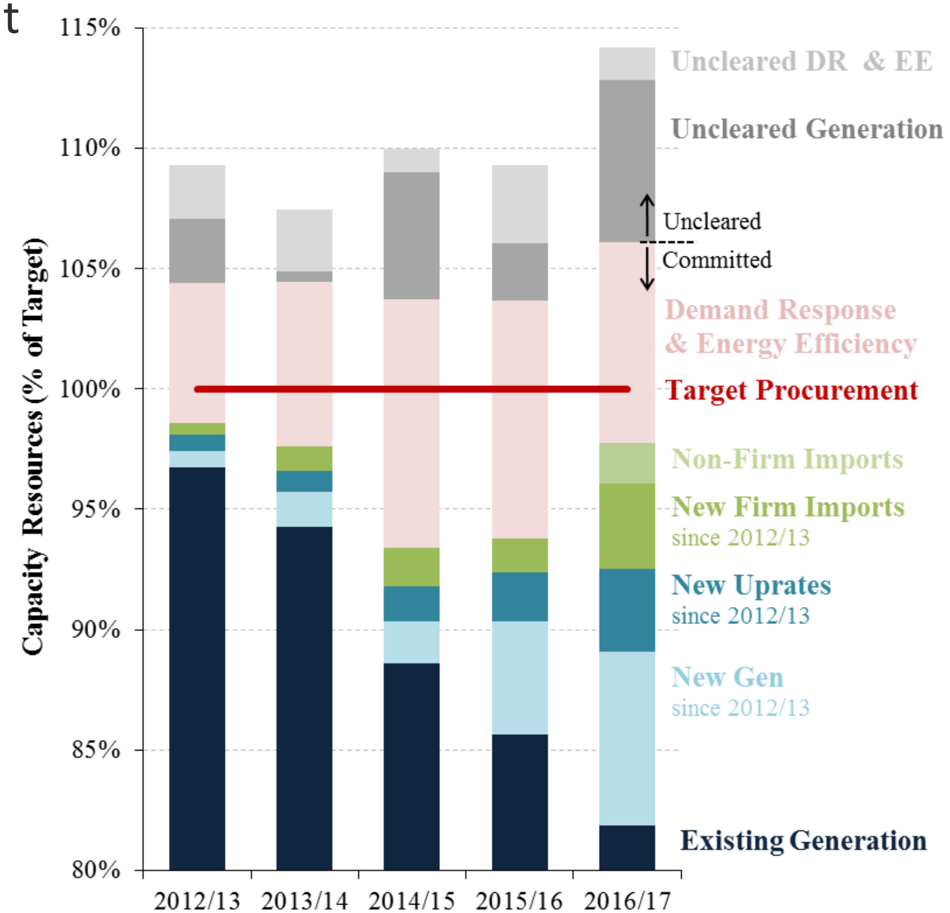
"Stress Test" of 25 GW Retirements

- PJM's capacity market passed an important test for robustness against environmental retirements
  - Moderate to low prices ($22-43/kW-yr) despite retirements
- Other markets face similar concerns, but may have less efficient response w/o forward capacity markets

PJM Replacement Supplies

- Excess generation will not be replaced
- Additional retirements replaced by increased new generation, uprates, increased DR, and imports

PJM Committed Capacity



Sources: BRA results and parameters. *Brattle* 2011 RPM Review.

Renewables in Capacity Markets

Derated (but non-zero) Capacity Value

- All capacity markets recognize that intermittent wind and solar have some capacity value, but apply a substantial derate from nameplate
- Approaches are conceptually similar, including for ERCOT

Capacity Payments

- Intermittent suppliers earn capacity payments, but only on that "derated" capacity value
- Typically only a few percent of total revenues (dominated by RECs, PTC, and energy)

	Wind	Solar	Notes
CAISO	~5-30%	~1-90%	• Monthly values based on 3-year fleet-wide average availability • Can request unit-specific values
MISO	13.3%	Unit-specific	• Solar: unit specific historical summer peak output (3-15 yrs) • Wind: annual simulation to estimate Effective Load Carrying Capability (ELCC), unit-specific apportionment
NYISO	Onshore: 10% Summer/ 30% Winter Offshore: 38%	36-46% Summer/ 0-2% Winter	• Unit-specific availability in peak hours in the most recent summer/winter • New units based on fleet-wide seasonal defaults by technology
PJM	13%	29%	• Once unit is installed for 3 years, use historical capacity factor during summer peak
ISO-NE	Unit-specific	Unit-specific	• 5-year average of unit-specific summer peak availability

Notes:
Reported values are default or fleet-wide values for recent years, from RTO or CPUC manuals.

Energy and A/S Market Impacts

- Increased energy market volatility; higher A/S prices; higher value for flexible resources

Experience from Other Markets

Scarcity Pricing and Demand-side Integration

	RA Construct	Price Cap	Offer Cap	DR	Reserves Shortage	Other
Alberta	Energy-Only	$1000/MWh	$999.99/MWh	DR bids	n/a	n/a
Australia	Energy-Only	$12,900/MWh (AUD) Adjusted Annually	Price cap (considering peak period restrictions on dominant generators)	DR bids	n/a	• Administrative ex-post pricing corrects for interventions • Cumulative Price Threshold limits persistent high prices
ERCOT	Energy-Only	None (but exceeding $4,500 unlikely)	$4,500/MWh for suppliers <5% market share, increasing to $9,000/MWh in 2015	DR bids in day-ahead	Dispatched at prices from $120 up to offer cap	Peaker Net Margin limits persistent scarcity pricing
CAISO	Reliability Requirement and Planning	None (But exceeding $2,000 unlikely)	$1,000/MWh or lower w/ mitigation	DR bids in day-ahead and real-time	Additive $100-$700 penalty factors	n/a
MISO	Reliability Requirement and Planning	$3,500/MWh (Based on Residential VOLL)	$1,000/MWh or lower w/ mitigation	DR bids in day-ahead and real-time	Additive penalty factors and function of VOLL·LOLP	n/a
ISO-NE	Forward Capacity Market	$2,000 to $2,250/MWh by location	$1,000/MWh or lower w/ mitigation	DR bids in day-ahead and real-time	Additive $50-$850 penalty factors by location and type	n/a
PJM	Forward Capacity Market	$1,000/MWh in 2012, increasing to $2,700/MWh by 2015	$1,000/MWh or lower w/ mitigation	• DR bids in DA and RT • Emergency DR can set price	Additive $850 penalty factors for spin and non-spin	Emergency imports can set price
NYISO	Prompt Capacity Market	$1,850 to $2,750/MWh by location	$1,000/MWh or lower w/ mitigation	• DR bids in DA • Emergency DR at $500	Additive $25-$500 demand curves	n/a