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Resource Adequacy and Capacity Markets: Overview, Trends, and Policy Questions

Prepared for:

New England Electricity Restructuring Roundtable
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Agenda

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Appendix

Resource Adequacy vs. Reliability

Estimates for U.S.-wide customer cost of power outages range from $20 billion to $150 billion per year.

For end users, "reliability" is a combination of three distinct components:

- Distribution system reliability
- Transmission system reliability
- Resource adequacy (bulk power supply vs. load)

Resource adequacy is only a minor factor in customer reliability:

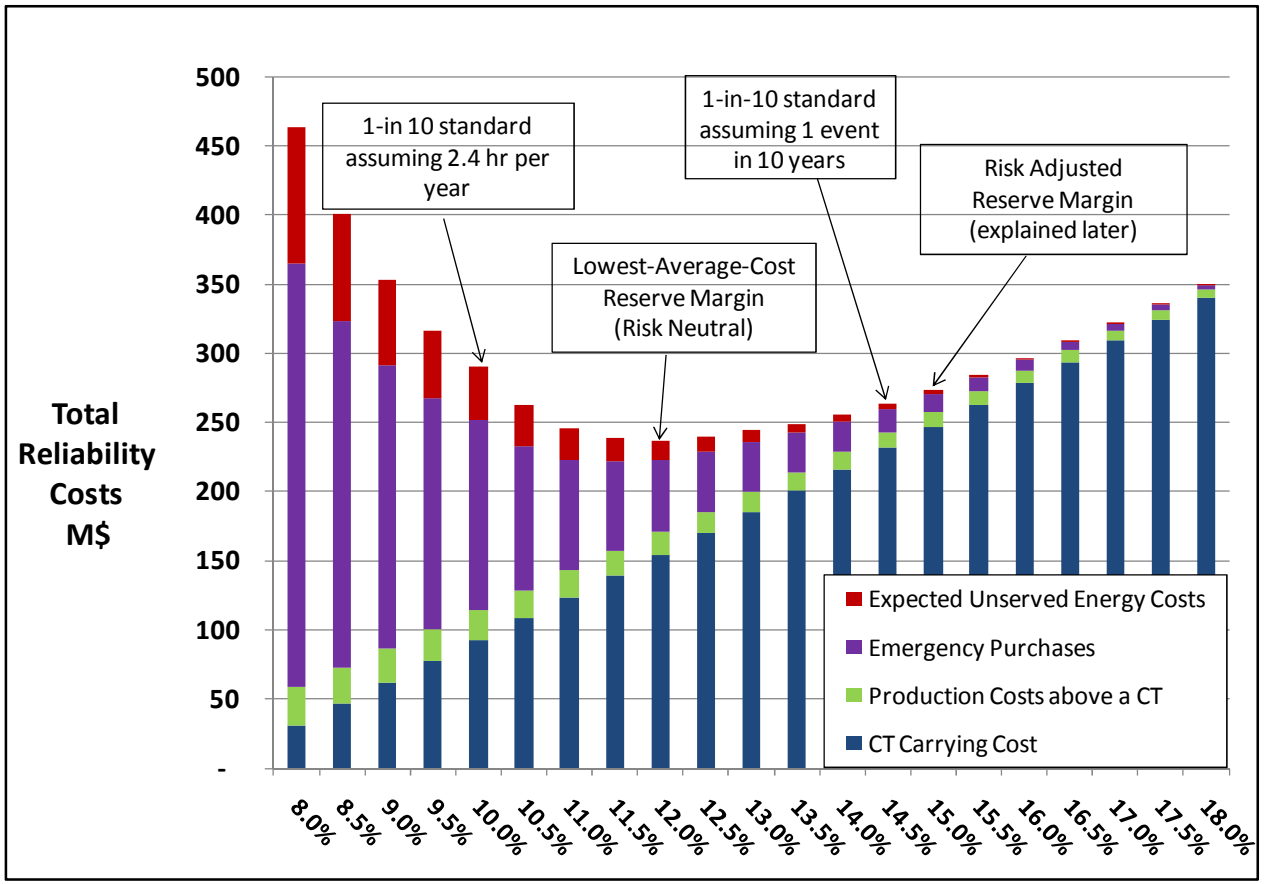
- Typical planning reserve margins yield less than 2,000 MWh of "expected unserved energy" and 2 minutes of average annual customer outages ➔ Stigma of "blackouts" disproportional to scope of impact
- Compare to 100-300 minutes of average annual customer outages at distribution level (1,000-10,000 minutes during years with major storms)

The 1-in-10 Standard vs. Resource Adequacy Costs

Current resource adequacy (planning reserve margin) requirements often based on "1-day-in-10-year" standard:

- Does not consider MW size of event nor size of system
- Does not consider duration of events
- Has not been updated in decades
- Is not defined and applied uniformly

Total costs first decrease but then increase with reserve margins (risks decrease)



Source: Carden, Pfeifenberger and Wintermantel, *The Economics of Resource Adequacy Planning: Why Reserve Margins Are Not Just About Keeping the Lights On*, NRRI Report 11-09, April 2011.

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Market Design Options for Resource Adequacy

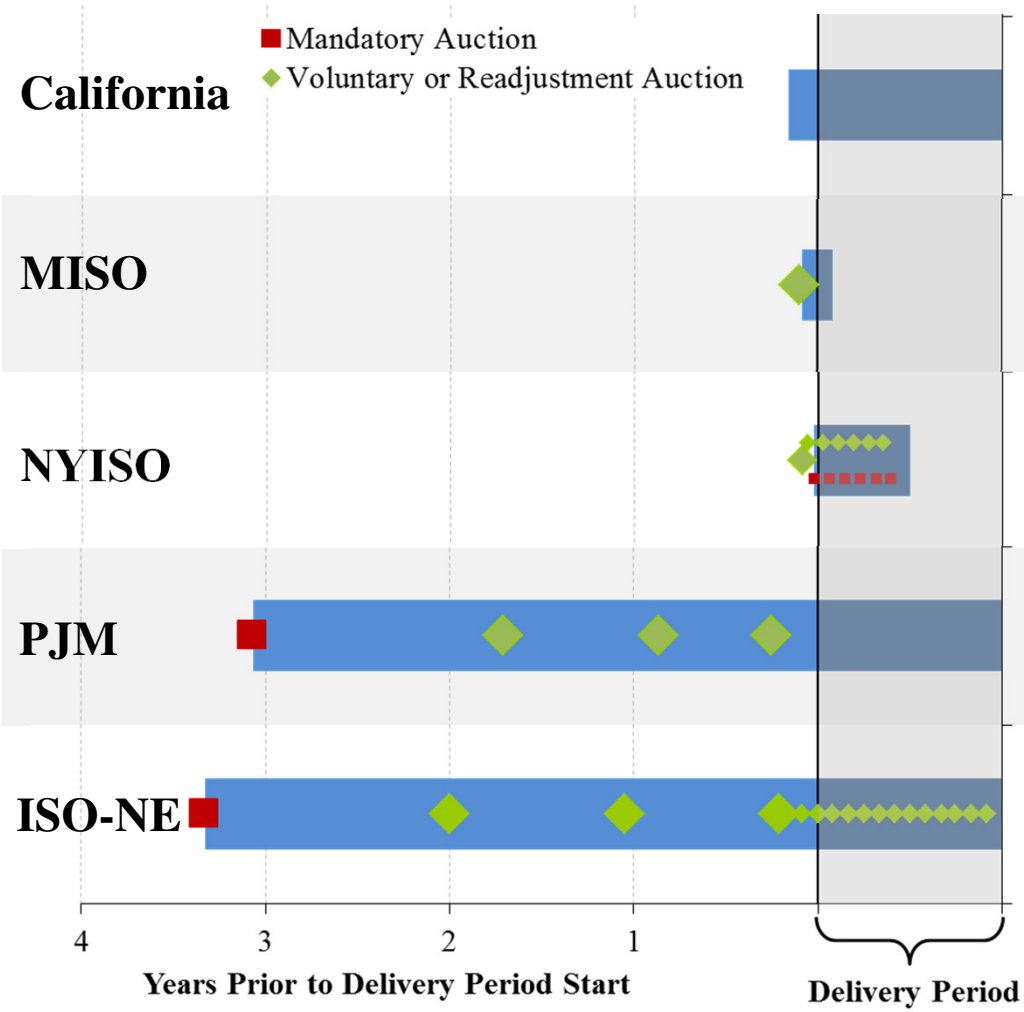
- **Administrative Mechanisms**
  - Resource adequacy achieved through administrative means
  - Examples: **Regulated utility planning**, administrative PPAs, administratively-determined capacity payments
  - Cost recovery through regulated approval or contract payments
  - Risk of uneconomic investment decisions borne by customers
- **Market-Based Mechanisms**
  - Utilize market forces to achieve resource adequacy
  - Examples: **Energy-only markets**, RA requirements for LSEs, near-term or forward **Capacity markets**
  - Challenge: achieve revenues to attract and retain supply when/where needed for resource adequacy; discourage investments during surplus
  - Risk of uneconomic investment decisions borne by suppliers (but increases investment and financing costs)
  - Price volatility and uncertainty are a key concern

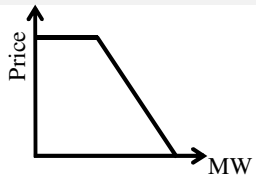
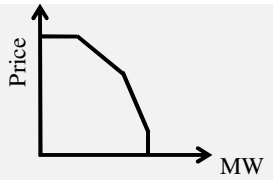
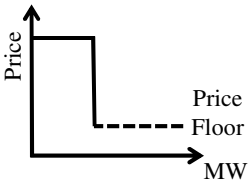
Market Design Options for Resource Adequacy

	Administrative Mechanisms (Customers Bear Risk)		Market-based Mechanisms (Suppliers Bear Risk)		
	Regulated Utilities	**PPAs or Capacity Payments**	**LSE RA Requirement**	**Capacity Markets**	**Energy-Only Markets**
Examples	SPP, BC Hydro, SaskPower, most of WECC, Southeast U.S.	Ontario, Argentina, Chile, Colombia, Peru, Spain, South Korea	California, MISO	PJM, NYISO, ISO-NE, Brazil, Australia's SWIS, Italy, Russia	Texas, Alberta, Australia's NEM, NordPool, Great Britain (current)
Resource Adequacy Requirement?	Yes (Utility IRP)	Yes/No (Yes through PPAs; No if relying on capacity payments)	Yes (Creates bilateral capacity market)	Yes (Mandatory near-term or forward capacity auction)	No (RA not assured)
How are Capital Costs Recovered?	Regulated retail rate recovery	Long-term PPAs or capacity payment plus energy market	Bilateral capacity payments and energy market	Capacity and energy markets	Energy market only

See also: Pfeifenberger & Spees (2009, 2010). Review of Alternative Market Designs for Resource Adequacy.

Summary of RA and Capacity Market Constructs



Forward Period	Procurement	Demand Curve
California	Bilateral Only	n/a
MISO	Bilateral + Voluntary Auction	n/a
NYISO	Bilateral + Mandatory Auction	
PJM	Bilateral + Mandatory Auction	
ISO-NE	Bilateral + Mandatory Auction	

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Market Design Options

Market Design Trends and Policy Questions

1. Market design trends in the Northeast and elsewhere
2. Are capacity prices too uncertain?
3. Did capacity markets actually attract new resources?
4. Can capacity markets attract merchant generation?
5. Can capacity markets address retirement threats?
6. Do Markets Create an Over-Dependence on Natural Gas?
7. Will states support capacity markets as prices rise?

1. Market Design Trends in the Northeast

	PJM	NYISO	ISO-NE
MOPR	Widespread dissatisfaction, potential reform	Recent litigation	FERC requires MOPR a la PJM; maybe different exemptions
Ensuring Performance and Right Types of Capacity	IMM concerns, Dealt w/Limited DR		Revising performance requirements; "Tranching" idea
Demand Curves	CONE litigation		Introduce a demand curve?
Other Auction Parameters/Rules		Revisiting whether to transition to a forward construct	De-list thresholds

1. Market Design Trends Elsewhere

	MISO	CAISO	ERCOT
Status	New locational 1-year market to be implemented June 2013 but most of footprint builds according to traditional planning	Inefficiencies of disjointed processes for new and existing gen and DR have come to a head	Currently energy-only w/no RA requirement Declining reserve margins are forcing a reevaluation (by year end)
Hot Topics	Cross-border deliverability FERC ordered MISO to implement new auction without any MOPR	How to prevent premature retirements Need to retain/attract flexible capacity Once-through cooling Introduce Forward RA requirement?	What are the reliability objectives? What is the best market construct to achieve those objectives?

2. Are Capacity Prices Too Uncertain?

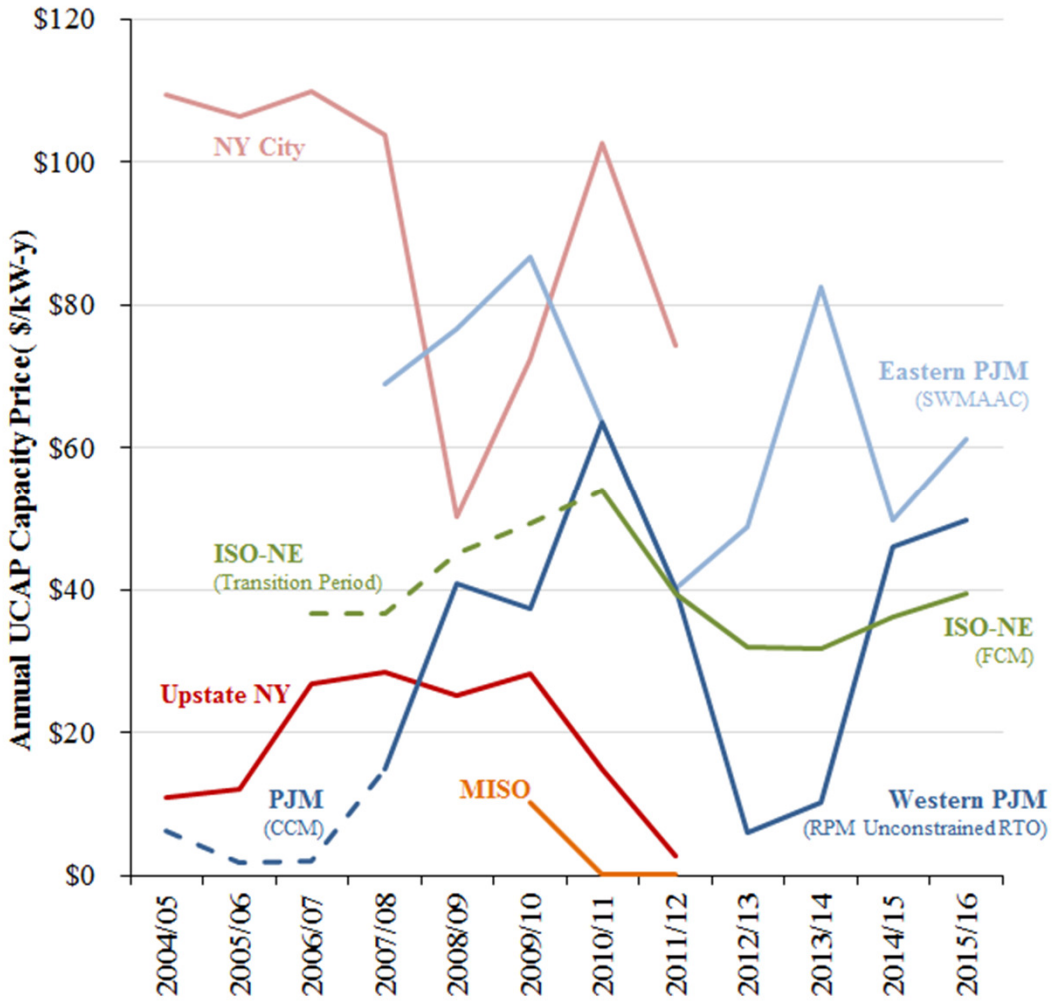
Example: our PJM review

- Single biggest concern for all stakeholder sectors was price volatility and uncertainty
- Related concerns about the lack of long-term hedging options

Causes of price uncertainty:

- **Market Fundamentals** – not a concern, prices should move with market fundamentals
- **Previous Design Changes** – design improvements contributed to volatility, but not a persistent concern
- **Ongoing Administrative Uncertainties** – uncertain administrative parameters is an ongoing concern

Capacity Price Comparison Across RTOs



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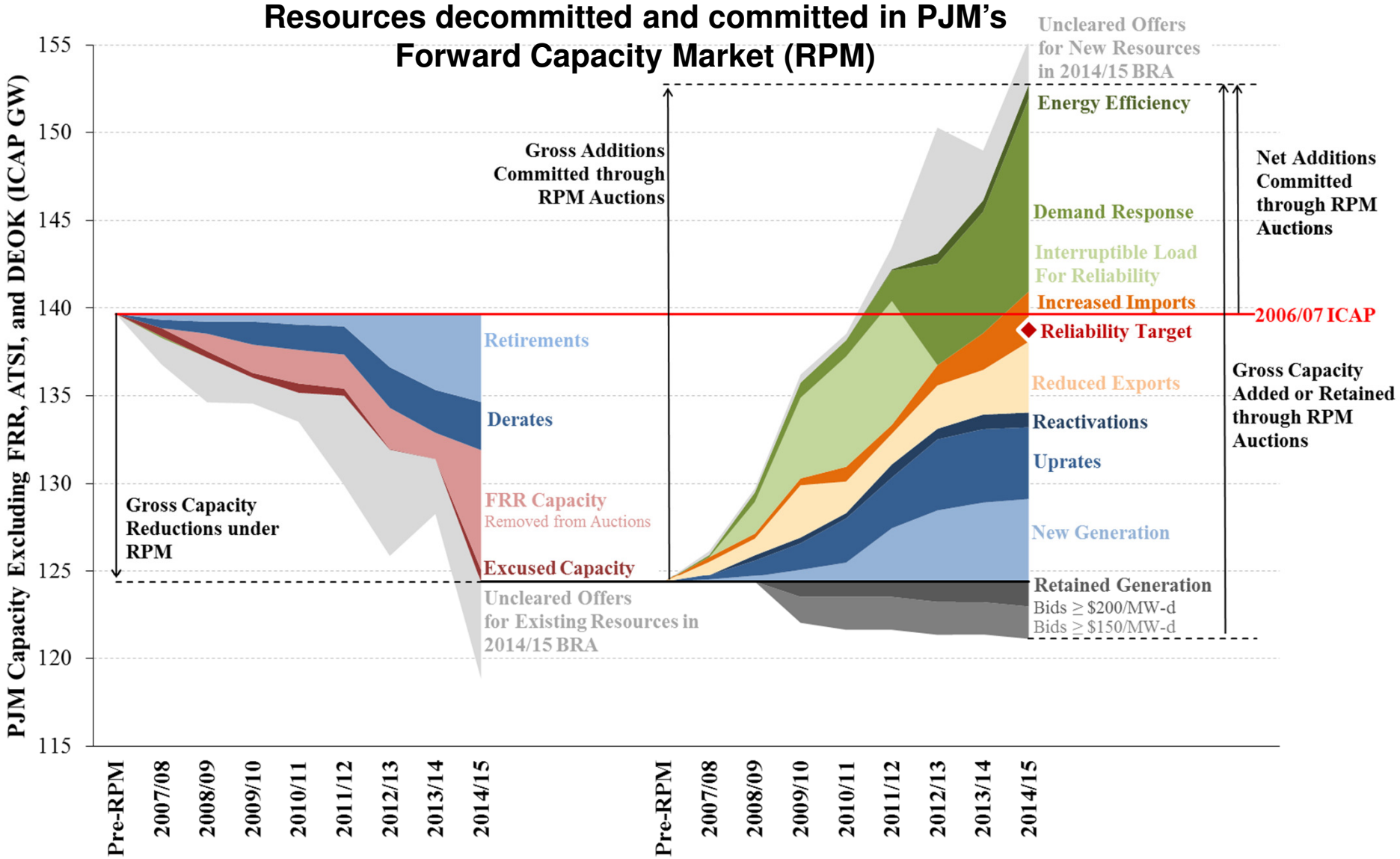
3. Did Capacity Markets Actually Attract New Resources?



4. Can Capacity Markets Attract Merchant Generation?

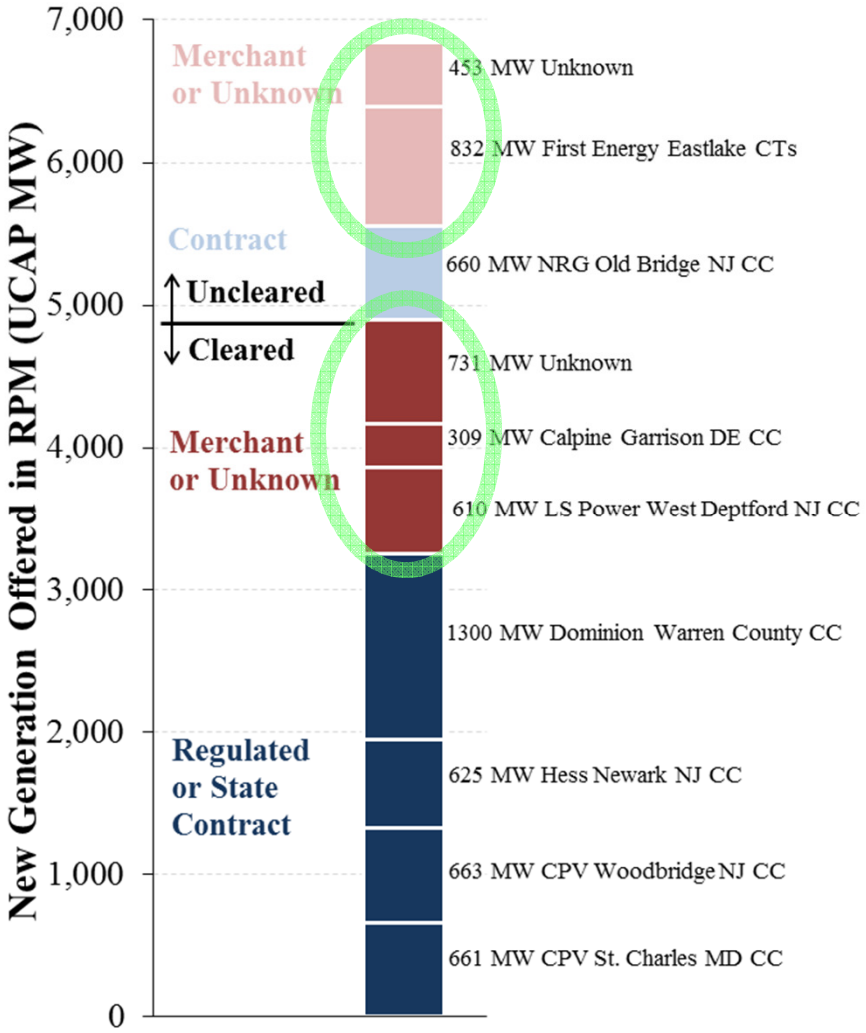
PJM's 2015/16 auction shows "YES"

- 4,899 MW of new generation cleared:
  - 3,259 MW of regulated or state contracts
  - 1650 MW Merchant and other new builds
- Prices cleared far below estimated Net CONE (almost exactly Net CONE in ATSI)
- 1,945 MW uncleared at higher offer prices

State contracts well above market

- 1,949 MW cleared, 660 MW uncleared
- Cleared with cost-based MOPR mitigation
  - Clearing price: $167/MW-d (equal to $61/kW-yr)
  - MOPR price: $242/MW-d (90% of CC Net CONE)
  - Exemptions allowed lower cost-based offer prices
- NJ contract prices far above market:
  - $220/MW-d Hess Newark (rising to $260 by 2030)
  - $286/MW-d CPV Woodbridge (rising to $433 by 2030)

New Generation in 2015/16



Sources and Notes: PJM 2014/15 BRA Results, SNL Energy; Capacities may be inexact, reported in UCAP where available.

5. Can Capacity Markets Address Retirement Threats?

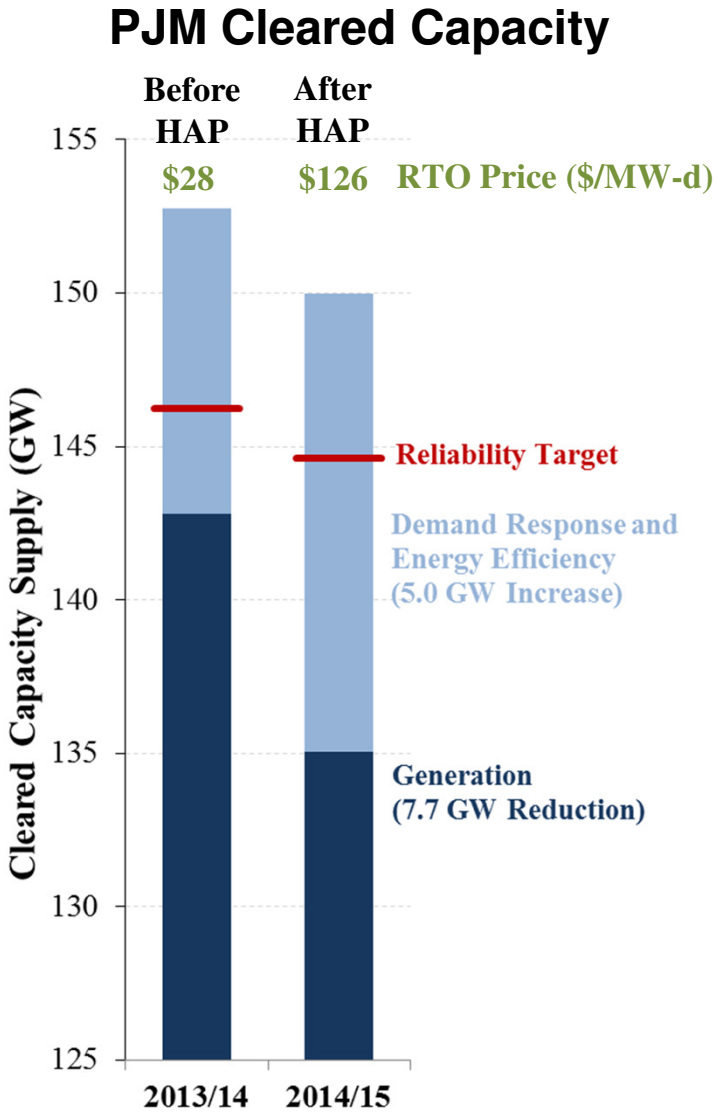
Yes, especially with forward markets

PJM 2014/15 auctions successful

- HAP rule was an important "stress test"
- PJM prices increased substantially (still below Net CONE)
- Some uncleared generation (from coal likely to retire), partly offset by DR increases

Remaining concerns

- Retirements may be co-located in unmodeled subzones
- Shorter-term markets yet to pass test



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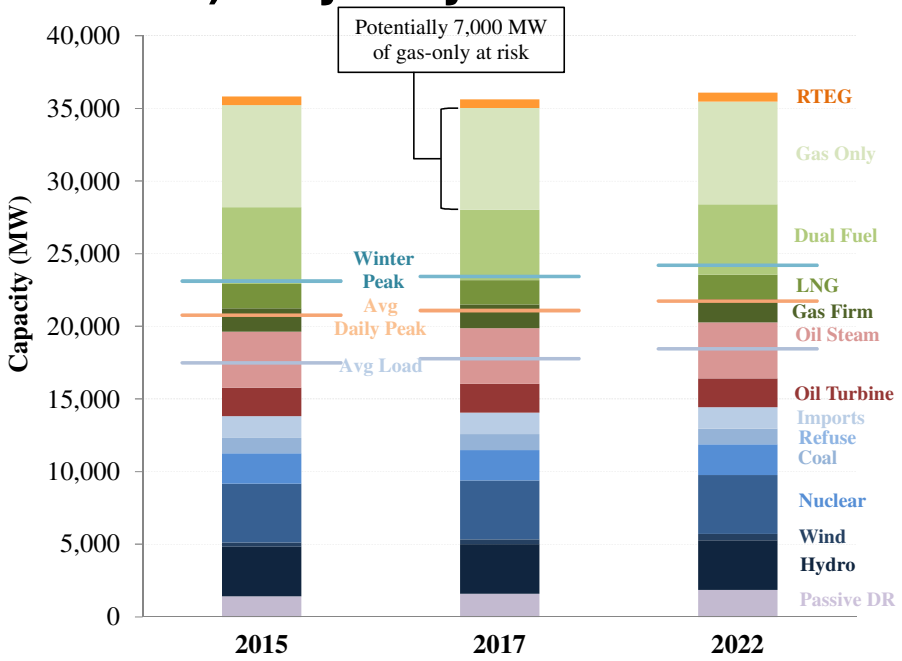
6. Do Markets Create an Over-Dependence on Natural Gas?

Recent ISO-NE and MISO studies highlight:

- Concern that resources built in wholesale market are mostly natural gas,
- Reliability challenge feared due to limited natural gas pipeline capacity during coinciding winter peak loads for heating and electricity use

Dual-fuel capability of the natural gas fleet (mostly ignored in these studies) may fully address these concerns, if operational:



Market Region	Total Capacity	Gas Fired Capacity	% Total Gas	Dual Fuel Capacity	% Dual Fuel Gas
	(GW)	(GW)		(GW)	
Alberta ISO	12	4.6	39%	0.06	1%
California ISO	62	37	60%	6.0	16%
ERCOT ISO	88	54	62%	22	41%
IESO (Ontario)	33	9.4	28%	2.4	26%
Midwest ISO	132	39	29%	17	42%
ISO-NE	32	15	48%	7.5	49%
New York ISO	41	21	50%	18	89%
PJM ISO	186	53	28%	27	52%
SPP	69	32	47%	14	44%

Focus should be on standards for and reliability of dual-fuel capability (along with scheduling, coordination, and other operational challenges)

7. Will States Support Capacity Markets as Prices Rise?

Capacity market prices have a "PR challenge"

- (Mis)perceptions:
  - Not a "real" market, just a regulated construct
  - Only provides a windfall to existing generators
  - Keeps "dirty" old plants around without attracting new resources
- Transparency makes total costs more visible than bilateral markets

Observed price signals are efficient; discrimination wouldn't work

- It is efficient for new generation, existing/uprates/retrofits, and DR to compete on the same basis
- Price discrimination undermines market, deters merchant entry, and causes uneconomic retirements
- Prices of state-sponsored long-term contracts turned out to be well above market

Improving market design helps increase efficiency and reduce the price of resource adequacy

- Enable price-setting DR and improve scarcity pricing
- Correct impact of out of market commitment on energy and A/S prices
- Ensure all types of capacity resource can compete, even if different operationally
- Review resource adequacy standard? Lower target reserve margin?

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Appendix

- References and Additional Reading
- ERCOT Resource Adequacy Results
- Causes of Outage Events
- About The Brattle Group
- Speaker Bio and Contact Information

References and Additional Reading

Harris, Pfeifenberger, Spees, “Italian Capacity Market Design: Efficient Market Signals for Resource Adequacy,” The Brattle Group, forthcoming.

Newell, Spees, Pfeifenberger, Mudge, DeLucia, Carlton, “ERCOT Investment Incentives and Resource Adequacy,” The Brattle Group, June 1, 2011.

Carden, Pfeifenberger and Wintermantel, *The Economics of Resource Adequacy Planning: Why Reserve Margins Are Not Just About Keeping the Lights On*, NRRI Report 11-09, April 2011 http://www.nrri.org/pubs/electricity/NRRI_resource_adequacy_planning_april11-09.pdf.

Carden, Pfeifenberger and Wintermantel, “The Value of Resource Adequacy: Why Reserve Margins Aren’t Just About Keeping the Lights On,” *Public Utilities Fortnightly*, March 2011.

Pfeifenberger, Spees, “Best Practices in Resource Adequacy,” PJM Long Term Capacity Issues Symposium, January 27, 2010.

Newell, Spees, Hajos, “The Midwest ISO’s Resource Adequacy Construct: An Evaluation of Market Design Elements,” The Brattle Group, January 19, 2010.

Pfeifenberger, Spees, Schumacher, “A Comparison of PJM's RPM with Alternative Energy and Capacity Market Designs,” *The Brattle Group*, September 2009.

Hines, Apt, Liao, and Talukdar, *The Frequency of Large Blackouts in the United States Electrical Transmission System: An Empirical Study*, Carnegie Mellon, 2006.

Lave, Apt and Morgan, *Worst Case Electricity Scenarios: The Benefits & Costs of Prevention*; CREATE Symposium, University of Southern California, August 2005.

LaCommare and Eto*, Understanding the Cost of Power Interruptions to U.S. Electricity Consumers*, Ernest Orlando Lawrence Berkeley National Laboratory, September 2004.

Primen, *The Cost of Power Disturbances to Industrial and Digital Economy Companies*, EPRI TR-1006274, June 29, 2001.

Swaminathan and Sen, *Review of Power Quality Applications of Energy Storage Systems*. Sandia National Laboratories, SAND98-1513, July 1998.

Electric Power Research Institute, "Estimating the Cost of Power Quality." *IEEE Spectrum*, 30 (6), 1993.

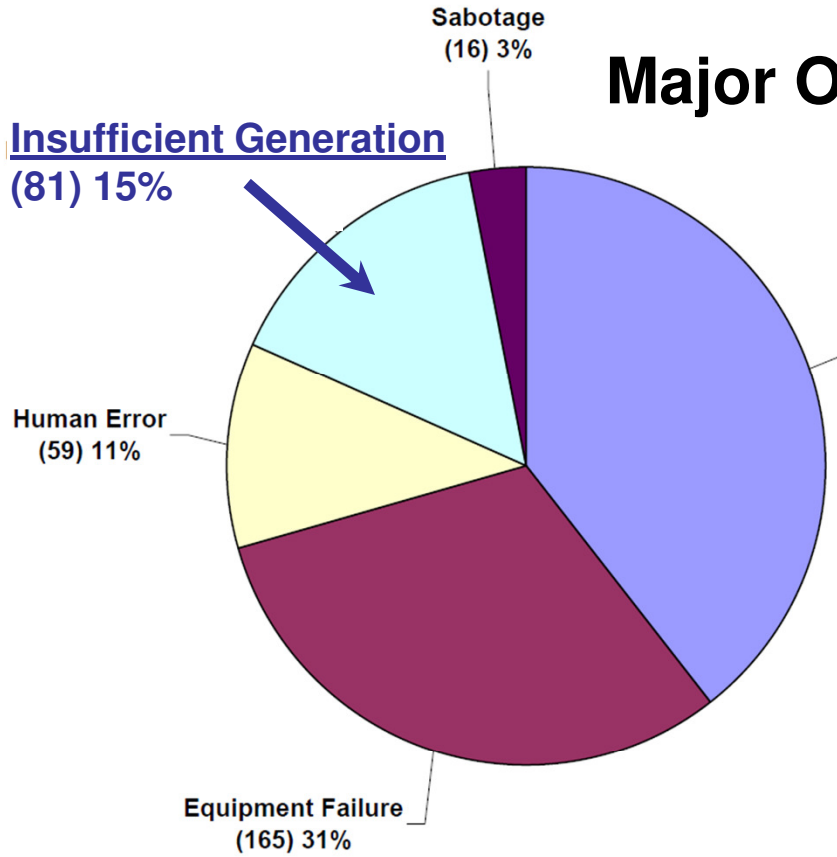
Appendix: ERCOT Resource Adequacy Results

Our recent resource adequacy and investment incentive review for ERCOT (a 70,000 MW market) estimated:

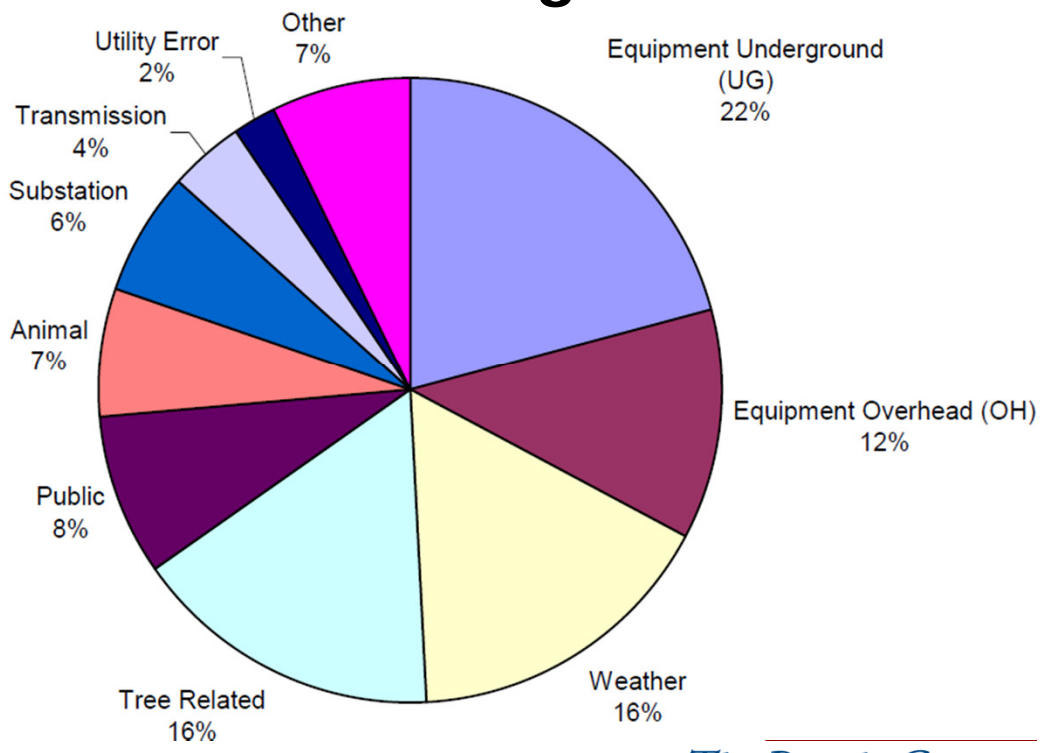
Planning Reserve Margin	**10%**		**15%**	
Resulting resource adequacy	24 hours in 10 years		1 event in 10 years	
Reliability statistics	**Average** (15 yrs)	**Worst** (2011)	**Average** (15 yrs)	**Worst** (2011)
Loss of load events (LOLE)	**0.95** events/yr	**14** events/yr	**0.1** events/yr	**1.5** events/yr
Loss of load hours (LOLE)	**2.4** hours/yr	**35** hours/yr	**0.18** hours/yr	**2.7** hours/yr
Exp. Unserved Energy (EUE)	**2,700** MWh	**40,000** MWh	**130** MWh	**2,000** MWh
Average customer outage due to resource adequacy	**2.8** min/yr/cust	**42** min/yr/cust	**0.1** min/yr/cust	**2.0** min/yr/cust
Compare to: Distribution-level customer outage w/o major storms:	**100 – 300** minutes per year per customer			
….with major storms:	**1,000 – 10,000** min/year/customer (e.g. 2008)			

Causes of Outage Events

Major Outage Events



All Retail Service Outages



Source: Lave, Apt and Morgan, *Worst Case Electricity Scenarios: The Benefits & Costs of Prevention*, CREATE Symposium, University of Southern California, August 2005.

About *The Brattle Group*

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

We combine in-depth industry experience, rigorous analyses, and principled techniques 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:

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- Environmental Compliance
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- Retail Access and Restructuring
- Risk Management
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- Market-Based Rates
- Market Design and Competitive Analysis
- Mergers and Acquisitions
- Transmission

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Note:

The views expressed in this presentation are strictly those of the presenter and do not necessarily state or reflect the views of *The Brattle Group, Inc.*

Johannes (Hannes) Pfeifenberger is 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 published widely, assisted clients and stakeholder groups in the formulation of business and regulatory strategy, and submitted expert testimony to the U.S. Congress, courts, state and federal regulatory agencies, and in arbitration proceedings.

Hannes has extensive experience in the economic analyses of electricity wholesale markets and transmission systems. His recent experience includes reviews of RTO capacity market and resource adequacy designs, testimony in contract disputes, and the analysis of transmission benefits, cost allocation, and rate design. He has performed market assessments, market design reviews, asset valuations, and cost-benefit studies for investor-owned utilities, independent system operators, transmission companies, regulatory agencies, public power companies, and generators across North America.

Hannes received an M.A. in Economics and Finance from Brandeis University and an M.S. in Power Engineering and Energy Economics from the University of Technology in Vienna, Austria

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