RTO Governance and Capacity Market Outcomes

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The RTOGov Project

RTOGov: Exploring Links Between Market Decision-Making Processes and Outcomes

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Who makes decisions about the electricity that powers your home and business? How does that differ from region to region? Do those differences impact real-world outcomes like price, customer choice, air quality, and innovation?

Before the 1990s, most homes and businesses in the United States had one choice for electricity—a single electric utility with the monopoly franchise in their state or region. That utility owned most of the power plants generating its electricity, the long-distance wires transporting that power, and the local distribution lines and poles. But following the deregulation and restructuring of the telecommunications and railroad industries, Congress directed the Federal Energy Regulatory Commission (FERC) to introduce competition in the electricity sector.

Initially, FERC required monopoly utilities to open their transmission lines for use by third parties.[1] Then, FERC began to urge the formation of Regional Transmission Organizations (RTOs) and Independent System Operators (ISOs) to take control of incumbent utility transmission lines and manage them over larger geographic areas while running competitive auctions for the wholesale sale of electricity. Today, RTOs and ISOs are nonprofit entities

regulated by FERC as "public utilities" under the Federal Power Act.[2]

Proponents believed that competitive markets would reduce the market influence of individual power suppliers and promote efficient and reliable electric service.[3] "Effective wholesale competition" would also encourage "new entry and innovation."[4]

"Effective wholesale competition protects consumers by providing more supply options, encouraging new entry and innovation, spurring deployment of new technologies, promoting demand response and energy efficiency, improving operating performance, exerting downward pressure on costs, and shifting risk away from consumers." – FERC Order 719

[1] Promoting Wholesale Competition Through Open Access Non-discriminatory Transmission Services by Public Utilities, FERC Order 888, 75 FERC ¶ 61,080 (April 24, 1996).
[2] With one exception among the seven existing RTOs/ISOs—the Electric Reliability Council of Texas is regulated by the Texas Public Utility Commission.
[3] U.S. Government Accountability Office, Electric Restructuring: FERC Could Take Additional Steps to Analyze Regional Transmission Organizations' Benefits and Performance, GAO-08-987 (Sept. 2008).
[4] Wholesale Competition in Regions with Organized Electric Markets, FERC Order 719, 125 FERC ¶ 61,071 (Oct. 17. 2008).

https://nicholasinstitute.duke.edu/project/rtogov

Rules
How are market, planning and operational frameworks developed within RTOs?

Tools
What are the different economic and operational environments in which actors engage with the RTO and the physical grid?

Joules
What do market, system and operational outcomes look like?

The RTOGov Project

1. How have governance structures evolved in different RTOs, and what are the most significant structural differences?

2. How do governance structures influence market rules, parameters and ultimately market outcomes?

3. What do "good" governance structures look like, and how portable are they across RTOs or to areas without RTOs (like much of the WECC)?

PJM

"We are 20+ years into it. We're making it up as we go."

--PJM Stakeholder

Tension between PJM's stakeholder-driven nature and its critical missions
- Stakeholders have difficulty with market rules that are controversial
- Capacity market designs are particularly difficult
- Approximately 2% - 4% of PJM's excess capacity is likely due to the framework under which stakeholders determine rules

PJM Stakeholder Process Groups Diagram

Diagram contents:

- PJM Board of Managers
  - Members Committee
    - Markets & Reliability Committee
      - Operating Committee
        - Dispatcher Training Subcommittee
        - System Information Subcommittee
          - Data Management Subcommittee
          - System Operations Subcommittee (Transmission)
          - NERC Ratings Initiative Task Force
        - Reliability Standards and Compliance Subcommittee
        - Systems Operations Subcommittee (Generation)
        - System Restoration Coordinators Subcommittee
        - Metering Task Force
      - Planning Committee
        - Load Analysis Subcommittee
        - Relay Subcommittee
        - Relay Testing Subcommittee
        - Transmission & Substation Subcommittee
        - Resource Adequacy Analysis Subcommittee
        - Earlier Queue Submittal Task Force (EQSTF)
        - Designated Entity Design Standards Task Force (DEDSTF)
      - Market Implementation Committee
        - Credit Subcommittee
        - Market Settlements Subcommittee
        - Demand Response Subcommittee
        - Intermittent Resources Subcommittee
        - Underperformance Risk Management Senior Task Force (URMSTF)
      - Cost Development Subcommittee
      - Governing Document Enhancement & Clarification Subcommittee
      - Energy Market Uplift Sr. Task Force
      - Regional Planning Process Task Force
      - Generator Offer Flexibility Senior Task Force
      - Regulation Market Issues Senior Task Force (RMISTF)
      - Transmission Replacement Processes Senior Task Force (TRPSTF)
      - Seasonal Capacity Resources Senior Task Force (SCRSTF)

- Liaison Committee
- Enhanced Liaison Committee
- Market Monitoring Unit Advisory Committee*
- Audit Advisory Committee
- Transmission Expansion Advisory Committee
  - Sub Regional RTEP Committee (Mid Atlantic)
  - Sub Regional RTEP Committee (Southern)
  - Sub Regional RTEP Committee (Western)
- Nominating Committee

- Transmission Owners Agreement-Administrative Committee
  - TO/TOP Matrix Subcommittee
- Finance Committee
- Public Interests & Environmental Organizations User Group
- Nuclear Generation Owners/Operators User Group
- eDart User Group
- eDart XML User Group

Legend:

Click on a group to go to the corresponding page on PJM.com.

- - - - = Advisory
——— = Direct
= User Group
= Committee
= Subcommittee
= Task Force
= PJM Board of Managers
= Senior Committee
= Standing Committee

* The MMUAC is an independent group that does not report to the PJM Board or Members Committee.

PJM Stakeholder Process Groups Diagram

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Who Gets to Vote?

1) Members Committee (MC) is the top level committee in PJM which is open to all stakeholders

2) Voting membership by Industry Sector
   - Voting members in MC must identify with one of the five sectors:

   1. Generation owner (GO)
   2. Transmission owner (TO)
   3. Electric distributor (ED)
   4. End-use customer (EUC): Large industrial retail customers and state offices of consumer advocates
   5. Other supplier (OS): a member that is engaged in any PJM market and does not qualify for the other sectors

Electric Distributor 9%

End User Customer 4%

Transmission Owner 3%

Generation Owner 15%

Other Supplier 69%
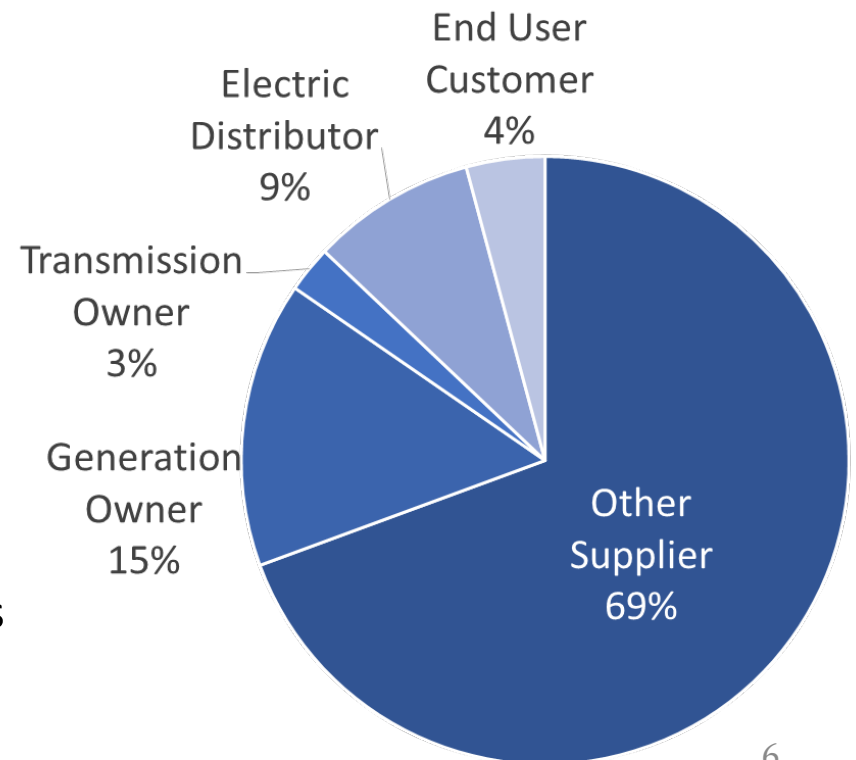
How Do They Vote?

3) Sector-weighted voting

$$\text{Total percentage in favor} = \sum_{i}\sum_{j=1}^{n_i} \frac{\delta_{ij}}{n_i}$$

$$\text{where } \delta_{ij} = \begin{cases} 1, & \text{if firm } j \text{ that is in sector } i \text{ vote yes} \\ 0, & \text{if firm } j \text{ that is in sector } i \text{ vote no} \end{cases}$$

$$n_i = \text{the number of voting firms in sector } i, \quad i = GO, TO, ED, EUC, \text{and } OS$$

Sector-weighted voting example

Sector	For	Against	Abstain	Total	Total - Abstain	% in favor
Transmission Owner	8	2	4	14	10	0.8
Generation Owner	15	0	1	16	15	1
Other Supplier	10	10	5	25	20	0.5
Electric Distributor	3	7	15	25	10	0.3
End Use Customer	12	2	0	14	14	0.857
					Total % in favor	3.457

Threshold = 3.335
(2/3 of total vote, .667 x 5 sectors)

Generation owner

Transmission owner

End Use Customer

Other supplier

Electric Distributor

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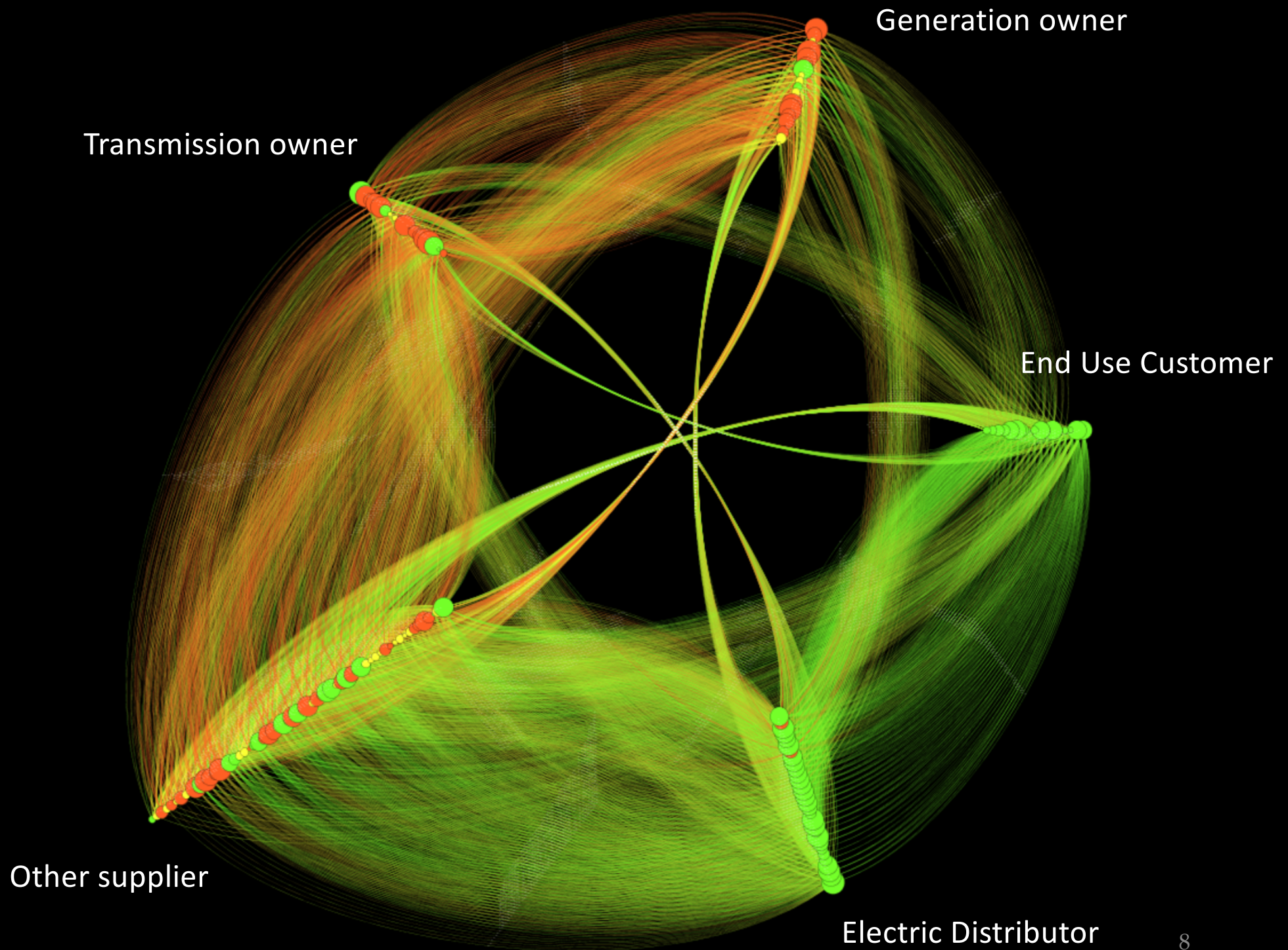
VRR curve proposals
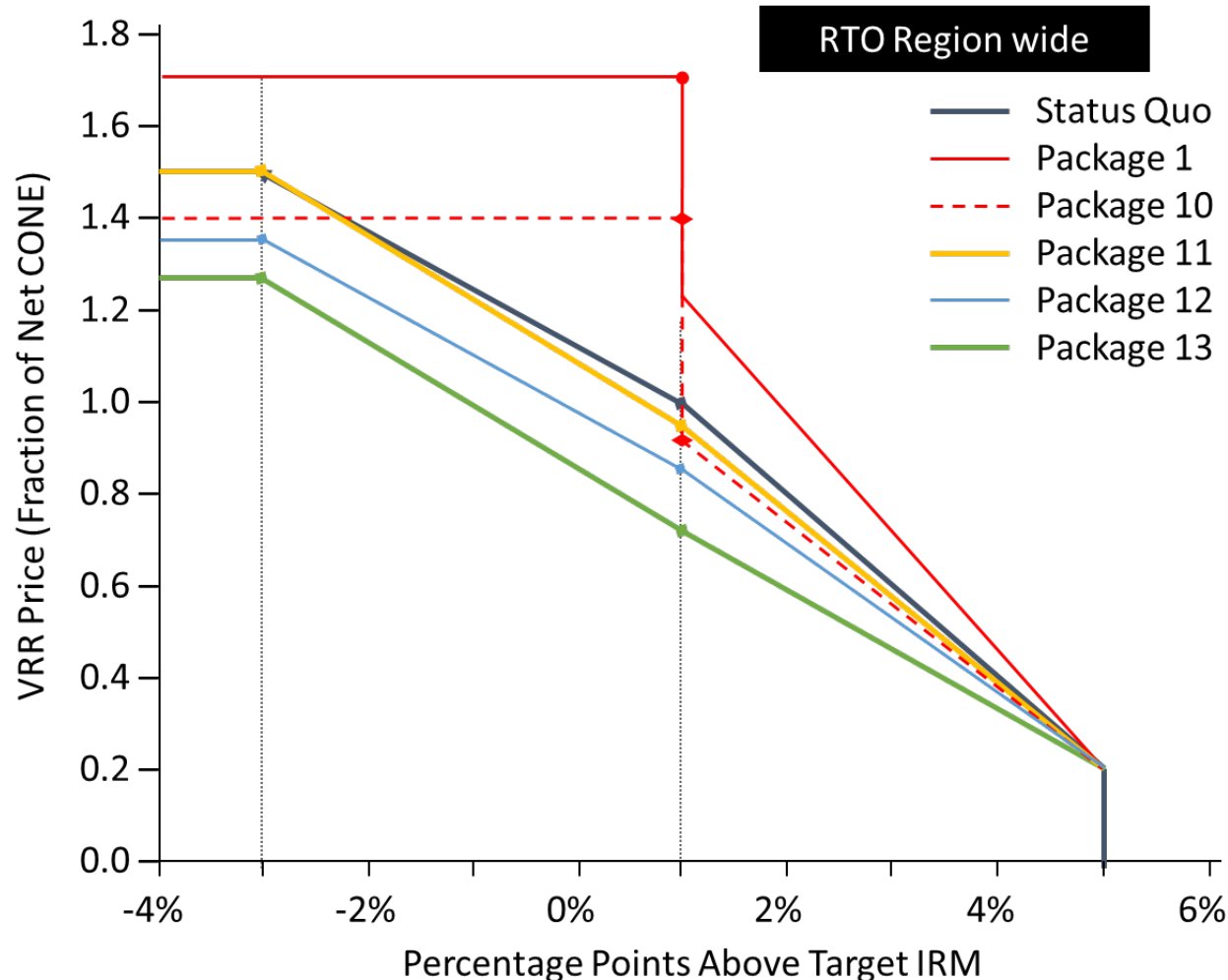
- In package 1 and 10, clearing price reaches quickly to price cap (level of point *a*) compared to package 11, 12, and 13 ➔ Point *a* is a critical feature

- Point *b* decide the slopes of the two segments ➔

- Among various parameters, point *a* and point *b* are the critical features

"Insanity is Doing the Same Thing Over and Over Again and Expecting Different Results"
(-Maybe Einstein, maybe Rita Mae Brown)

- A reform process for the capacity auction demand curve (VRR curve) in 2011 ended in a stalemate.

- Six options were voted on at the Member's Committee (including to keep the current auction design in place), *and all six failed*. This process basically repeated itself in 2014 and 2018.

Item	Date	Voting item	TO	GO	EUC	ED	Other	Results	
04b0	10/20/2011	No Change	0.083	0.071	0.083	0.043	0.056	0.336	Failed
04b1	10/20/2011	PJM Recommendation	0.8	0.833	0	0	0.667	2.3	Failed
04b2	10/20/2011	Package 10	0.75	0.714	0	0	0.323	1.787	Failed
04b3	10/20/2011	Package 11	0.167	0.08	0.909	0.913	0.235	2.301	Failed
04b4	10/20/2011	Package 12	0.167	0.231	1	0.913	0.25	2.561	Failed
04b5	10/20/2011	Package 13	0.333	0.267	1	1	0.513	3.113	Failed

A Model of Stakeholder Voting (Yoo, et al., HICSS 50, Yoo and Blumsack, *JRE* 2018)

- Prior work has shown that even if not all PJM stakeholders vote using a simple payoff model, it is basically impossible for them to pass *any* set of capacity market rules.

- In this paper, we use the voting model to investigate what might happen if PJM were to change the structure under which stakeholders vote on capacity market rules.

$$A = \begin{bmatrix} \dfrac{\partial U^1}{\partial x_1} & \cdots & \dfrac{\partial U^1}{\partial x_n} \\ \vdots & & \vdots \\ \dfrac{\partial U^m}{\partial x_1} & \cdots & \dfrac{\partial U^m}{\partial x_n} \end{bmatrix} \; or \; \begin{bmatrix} \lambda_1 \dfrac{\partial U^1}{\partial x_1} & \cdots & \lambda_1 \dfrac{\partial U^1}{\partial x_n} \\ \vdots & & \vdots \\ \lambda_n \dfrac{\partial U^m}{\partial x_1} & \cdots & \lambda_n \dfrac{\partial U^m}{\partial x_n} \end{bmatrix} \qquad y = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix} = \begin{bmatrix} dx_1 \\ dx_2 \\ \vdots \\ dx_n \end{bmatrix}$$

Payoff function   ***Level of point a and point b***

Modeling alternative voting systems

I.   NYISO voting rules

	PJM		NYISO	
Passage threshold	66.67%		58%	
Sector weights	Generation owners	20%	Generation owners	21.5%
	Other suppliers	20%	Other suppliers	21.5%
	Transmission owners	20%	Transmission owners	20%
	End-Use Consumers	20%	End-Use Consumers	20%
	Electric Distributor	20%	Public Power	17%

II.   Preferential voting: voters rank all candidates

1) **Instant runoff**: a candidate with the least vote count as a first choice is eliminated

2) **Coombs rule**: similar to IRV; eliminate a candidate with the most vote count as the last choice

3) **Borda count**: a candidate who received the highest score sum wins

Modeling Procedure
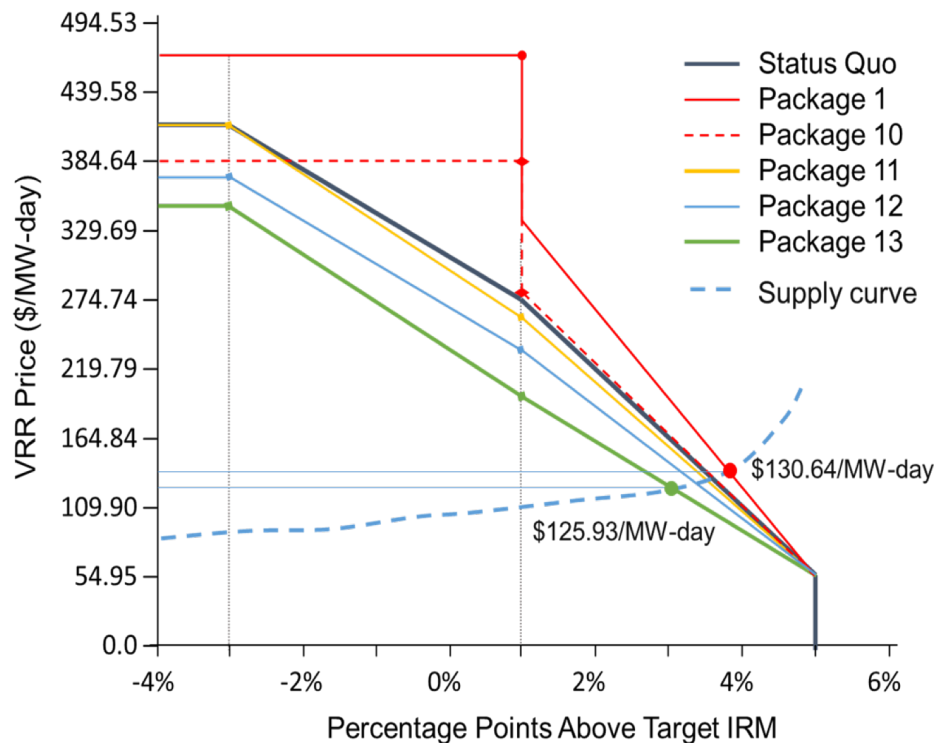
- Use detailed voting data from PJM capacity market votes, and build a capacity supply curve using information from PJM and IMM reports.
- For each voter, model a preference order over VRR curves.
- Determine the "winning" VRR curve.
- Calculate impact on capacity market clearing.

PJM MC voting data

- Information on voters: company sector, line of business, net buyer or seller, size of assets, voting records

| Company Name (in PJM CRM system)	04b0	04b1	04b2	04b3	04b4	04b5	Company Sector	Company Line of Business	Parent Name (in PJM CRM system)	Buyer-Seller	Generation	Transmission	Load Server
Air Liquide Industrials U.S., L.P	No	No	No	Yes	Yes	Yes	End User Customer	Industrial	Air Liquide Industrials U.S., L.P	Buyer	Zero	Zero	Zero
Air Products & Chemicals, Inc	No	No	No	Yes	Yes	Yes	End User Customer	Industrial	Air Products & Chemicals, Inc	Seller	Zero	Zero	Zero
Allegheny Electric Cooperative, Inc	No	No	No	No	No	Yes	Transmission Owner	Transmission Owner	Allegheny Electric Cooperative, I	Buyer	Small	Small	Small
Ameren Energy Marketing Company	No	Yes	Yes	No	No	No	Other Supplier	Power Marketer	Ameren Energy Marketing Comp	Buyer	Small	Zero	Small
American Municipal Power, Inc	No	No	No	No	Yes	Yes	Generation Owner	Muni/Co-op	American Municipal Power, Inc	Buyer	Small	Zero	Small
Appalachian Power Company	No	Yes	Yes	No	No	No	Transmission Owner	Transmission Owner	Appalachian Power Company	Buyer	Large	Large	Large
ArcelorMittal USA LLC	Yes	No	No	Yes	Yes	Yes	End User Customer	Retail Energy Supplier	ArcelorMittal USA LLC	Seller	Zero	Zero	Zero
ArcLight Energy Marketing, L.L.C	No	Yes	Yes	No	No	No	Other Supplier	Power Marketer	ArcLight Energy Marketing, L.L.C	Buyer	Zero	Zero	Zero
Atlantic Grid Operations A, LLC	Abstain	Yes	Abstain	Abstain	Abstain	Abstain	Other Supplier	Transmission Owner	Atlantic Grid Operations A, LLC	Buyer	Zero	Zero	Zero
Baltimore Gas and Electric Company	No	Yes	Yes	No	No	No	Transmission Owner	Transmission Owner	Baltimore Gas and Electric Com	Buyer	Large	Medium	Medium
Beacon Power Corporation	No	Yes	No	No	No	No	Other Supplier	Financial Trader	Beacon Power Corporation	Buyer	Zero	Zero	Zero
Black Oak Energy, LLC	Abstain						Other Supplier	Financial Trader	Black Oak Energy, LLC	Seller	Zero	Zero	Zero
Blue Ridge Power Agency, Inc	No	No	No	Yes	Yes	Yes	Electric Distributor	Muni/Co-op	Blue Ridge Power Agency, Inc	Buyer	Zero	Zero	Small
Borough of Butler, Butler Electric Divisio	No	No	No	Yes	Yes	Yes	Electric Distributor	Retail Energy Supplier	Borough of Butler, Butler Electric	Buyer	Zero	Zero	Zero
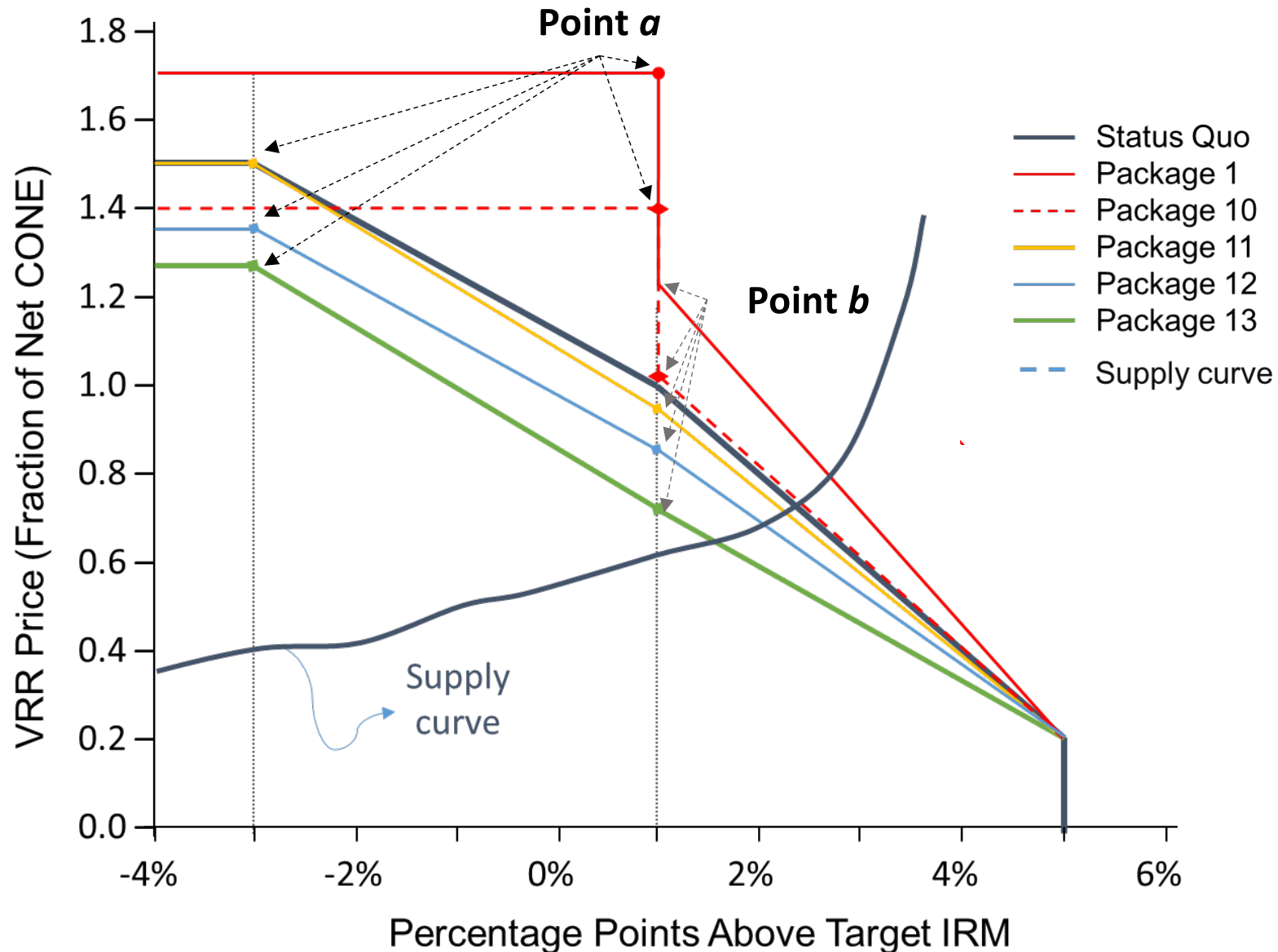
Modeling voter preference orderings

❑ Consumer's preference:

package 13 > package 12 > package 11 > status quo > package 10 > package 1

❑ Supplier's preference:

package 1 > package 10 > status quo > package 11 > package 12 > package 13

❑ Some voters are hard to characterize because of abstentions, or their voting suggests inconsistent preferences. We used a Monte Carlo approach to generate preference orders for these voters.
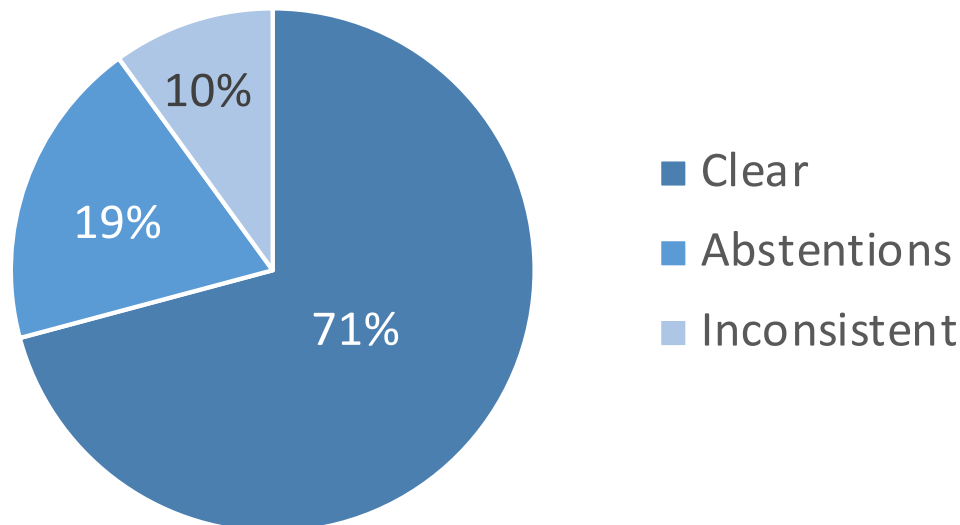
*Capacity market votes by preference types*

Expected Market Clearing Results by Voting Procedures

| Voting Procedures		Voting Outcome	**Simulation results*** PJM (NYISO)	Clearing Price ($/MW-day)	% changes in Price compared to Status quo
Original PJM voting rule		No outcome**			
NYISO voting rule		**Package 13**	**100%**	125.93	-2.30%
Preferential voting	IRV	**Package 13**	**100% (100%)**	125.93	-2.30%
	Coombs	**Package 13**	**100% (100%)**	125.93	-2.30%
	Borda Count	Package 11	1% (4%)	128.54	-0.28%
		Package 12	11% (14%)	126.42	-1.92%
		Package 13	**88% (82%)**	125.93	-2.30%

* Numbers in parenthesis are results under NYISO voting rules
** After failing to get agreement in the stakeholder process, PJM made a filing with FERC based on its original proposal (package 1) and FERC accepted. [Docket No. ER14-2940-000] https://www.ferc.gov/CalendarFiles/20141128172749-ER14-2940-000.pdf

Sensitivity to Price Cap Level
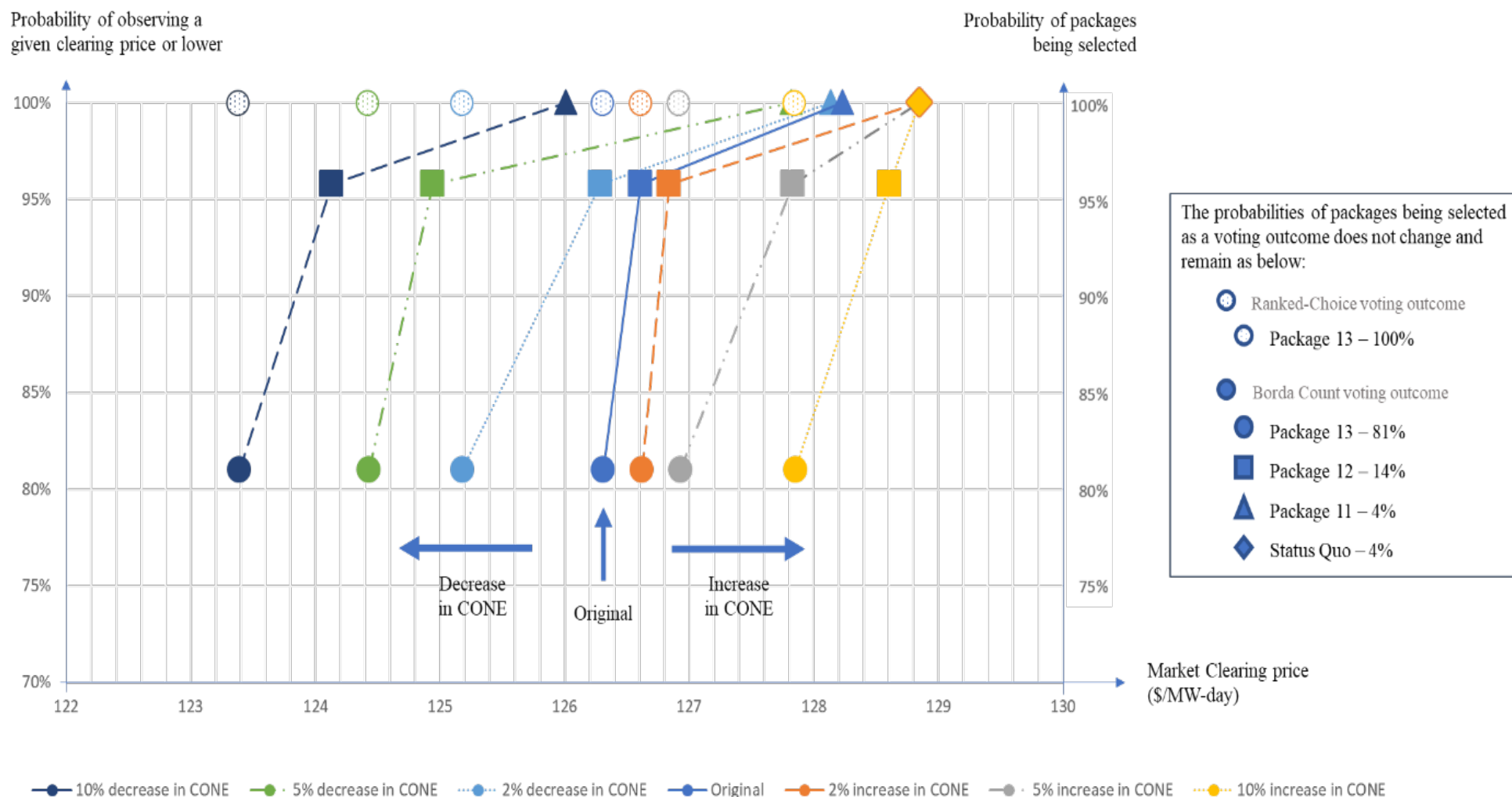
Sensitivity to Supply Elasticity
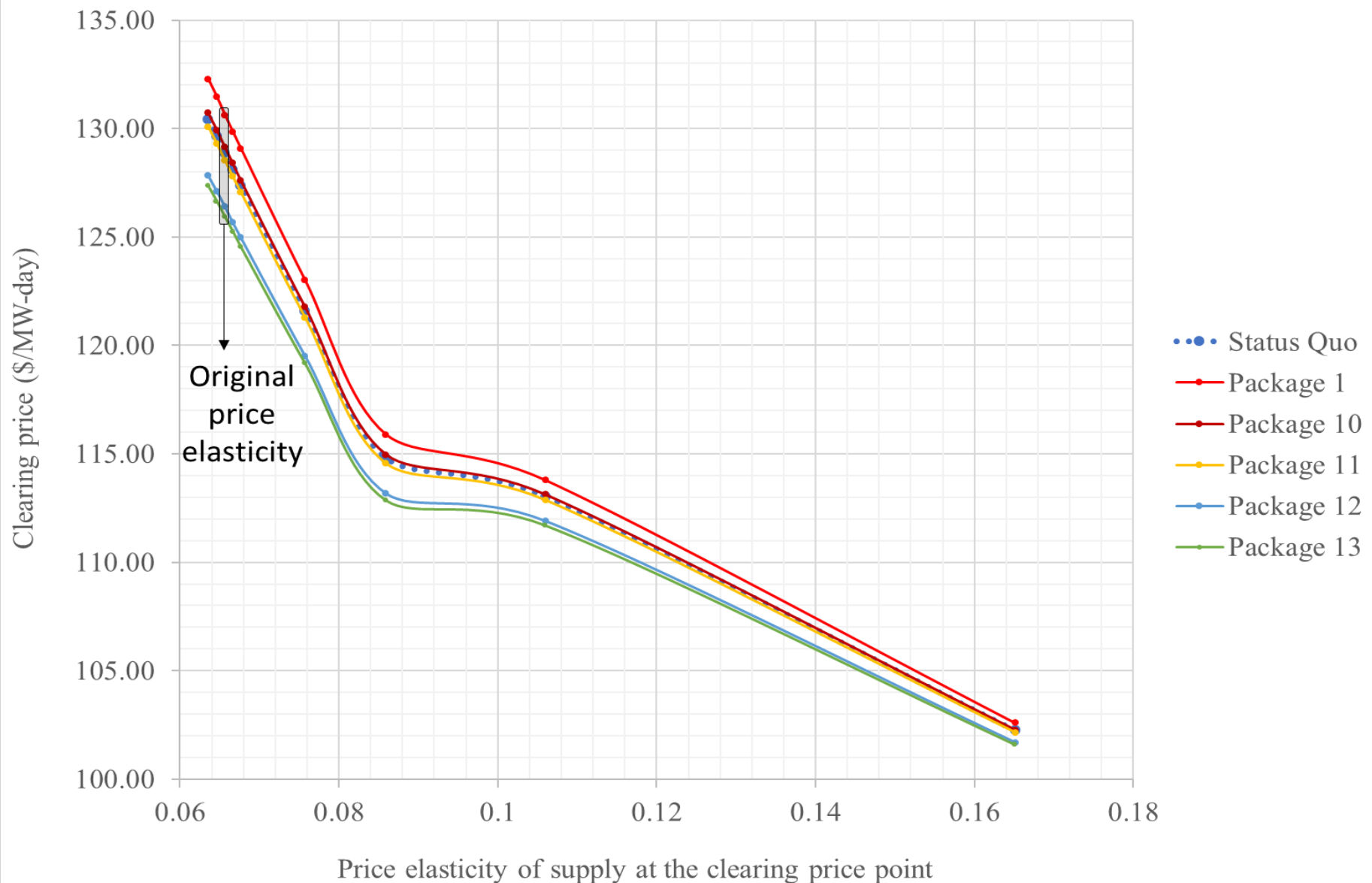
Conclusion

- The current stakeholder structure and choice process in PJM basically makes capacity market reform impossible. This leaves PJM to make those market design choices as per its preferences.

- Changing the choice process would drive capacity market rules towards the preferences of end-users and utilities -> lower prices but also lower reserve margins.

- At least with respect to capacity market parameters, PJM's expressed preferences have been different than those embodied in its stakeholder process. This probably explains 2% - 4% of the excess installed capacity in PJM.

What Next?

- Cross-RTO voting comparisons (or cross-issue comparisons)

- Issues other than capacity markets that cut across RTOs? (e.g. Order 841?)

- Capture other layers of the stakeholder process besides top-level voting (lower level committees, tariff vs BPM)

Thanks!

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