Triennial Review, VRR Curve Shape Issue: Problem Investigation and Recommended Further Analysis (Part I)

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Overview of Presentation/Discussion

Part I: Problem Identification and Investigation

1. Identification of the problem; questions raised

2. Key scope issue: focus on BRA outcomes, or try to model DY?

3. Initial reaction to Brattle/PJM proposed changes to the VRR curve

4. Changes to VRR curve shape: objectives, impacts to consider

5. Additional analysis needed to evaluate candidate VRR curve shapes

Part II: Critique and Recommendations re: Brattle's Simulation Model

[in a separate presentation]

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1. Problem Identification

- Evidence of a problem for which changing the VRR curve shape or position could be a solution?

  – In base residual auction results?

    ▪ Volatility of RPM prices (at levels generally well below Net CONE)?

  – In delivery year reserve margin outcomes?

  – Other evidence?

- Theoretical arguments for existence of such a problem?

- Other arguments?

Problem Identification
(my attempt, based on Brattle/PJM materials)

The Problem?: Concern that due to unpredictable year-to-year variability of load forecasts, offered supply, etc., three-year-forward base residual auction ("BRA") cleared quantities and three-year-forward reserve margins ("RM3") may be relatively low more often than desirable.

- "Unpredictable" – because predictable changes lead to market responses (new capacity, deferred retirements, etc.)

- "Relatively low": measures used are: cleared quantity outcomes below the Reliability Requirement ("RR") established for the base residual auction; outcomes below RR-1%

- "More often than desirable": specific criteria have not been suggested

Problem Identification: Questions Raised

- When there have been incremental capacity needs:
  - Has the market anticipated them and offered incremental capacity?
  - How has the market responded to RPM price spikes when they have occurred?

- When cleared quantities and reserve margins are relatively low in the base residual auction:
  - Has this resulted in low delivery year reserve margins?
  - Has there generally been additional capacity available at later times before the DY?
  - If low three-year-forward cleared quantities are a concern, should PJM plan to seek to acquire additional capacity after the base residual auction if available?

- If we want to model this concern, how should the model be structured and how should the assumptions be developed?

2. Key Scope Issue: Focus on BRA Results (RM3) As In the Past, or Attempt to Estimate DY Outcomes?

- The RPM BRAs determine three-year-forward cleared capacity quantities (MW)

  – Can be communicated as a reserve margin (RM3) based on the three-year-forward load forecast

  – Can be compared to the three-year-forward target Reliability Requirement (RR) as determined based on the current peak load forecast and current target reserve margin from the current PJM Reserve Requirement Study

- The RPM BRAs do not determine Loss of Load Expectation ("LOLE")

  – Loss of load occurs in the delivery year ("DY"), depends upon DY RM ("RM0")

  – RM0 depends upon DY peak loads, DY committed capacity

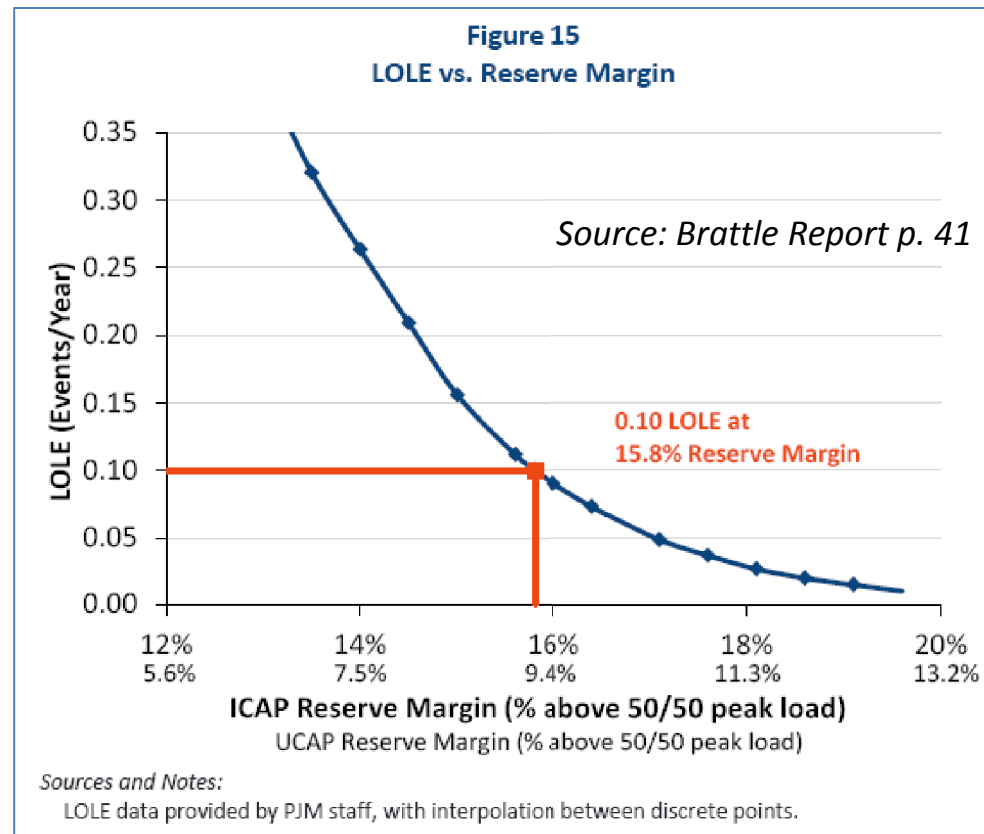 – Much can and does happen between the base residual auction and the DY.

Key Scope Issue (continued)

- Prior Triennial Reviews evaluated VRR curve shape based on RM3 outcomes (did not purport to estimate RM0 or LOLE)

    - Reliability-related results reported: Average realized reserve margin minus target reserve margin; fraction of time cleared resources exceed reliability requirement

    - FYI in Brattle's simulation model with Brattle's assumptions, the average realized reserve margin under the current VRR curve <u>exceeds</u> the target reserve margin (Table 9 p. 58)

- Prior Triennial Review evaluated VRR curve shape using Hobbs Model

    - Nov. 2013 – March 2014: Triennial Review discussed at ten CSTF meetings; no suggestion of any need to apply a fundamentally different approach; was opportunity to discuss objectives, structure, methodology, assumptions

The Relationship Between BRA Outcomes and DY Outcomes is Complex and Has Not Been Modeled

- Load forecast can change (and is more likely to go down than up)

- The committed capacity quantity can also change over three years

    - PJM may buy or sell capacity: in incremental auctions ("IAs"), or under "backstop" provisions of tariff

    - Evidence to date: substantial quantities of additional capacity have been available at low prices after BRA

- Market participants might also take on additional capacity if a low DY RM is anticipated, to hedge risk or position to benefit from high E&AS prices

- Hobbs model can simulate only some of these post-BRA phenomena; Brattle simulation model does not attempt any of them.

The RM to LOLE relationship used by Brattle was provided by PJM staff and is based on the reserve requirement study. It is essentially a delivery year snapshot, no multi-year dynamics, etc.

Figure 15
LOLE vs. Reserve Margin

Source: Brattle Report p. 41

0.10 LOLE at
15.8% Reserve Margin

ICAP Reserve Margin (% above 50/50 peak load)
UCAP Reserve Margin (% above 50/50 peak load)

Sources and Notes:
LOLE data provided by PJM staff, with interpolation between discrete points.

Load Forecasts Can Change
# (and are more likely to go down than up)

- Recent history – consistently very large reductions

- PJM's position – going forward, reductions in capacity needs after the BRA remain more likely than increases for at least two reasons:

  1. Conservative planning parameters: "Over the three years leading to a Delivery Year, the net effect of all changes in planning parameter determinations seems more likely to move in a direction of lesser need for resource procurement than greater need for resource procurement" *PJM in ER14-1461, 3/10/2014, p. 8.*

  2. Optimistic economic forecasts used in load forecast: "Economic growth forecasts have actually been overly optimistic. This has been driving the forecast on load. It's been a systematic bias that has gone on for so long. I just don't see that changing" *Paul Sotkiewicz @ UBS,6/13/13, p. 16.*

# Load Forecast Reductions Substantially Increase DY RMs

Delivery Year	Had RPM BRA cleared @ RR - 1, the DY RM reflecting only peak load changes would have been:	Had RPM BRA cleared @ RR - 3, the DY RM reflecting only peak load changes would have been:
2009	RR + 5.8	RR + 3.6
2010	RR + 7.1	RR + 4.9
2011	RR + 9.3	RR + 7.1
2012	RR + 8.7	RR + 6.5
2013	RR + 8.9	RR + 6.8

Source: PJM load forecast reports. Delivery year RMs based on actual weather-normalized peak. Actual DY RMs were generally lower due to PJM capacity sales in incremental auctions.
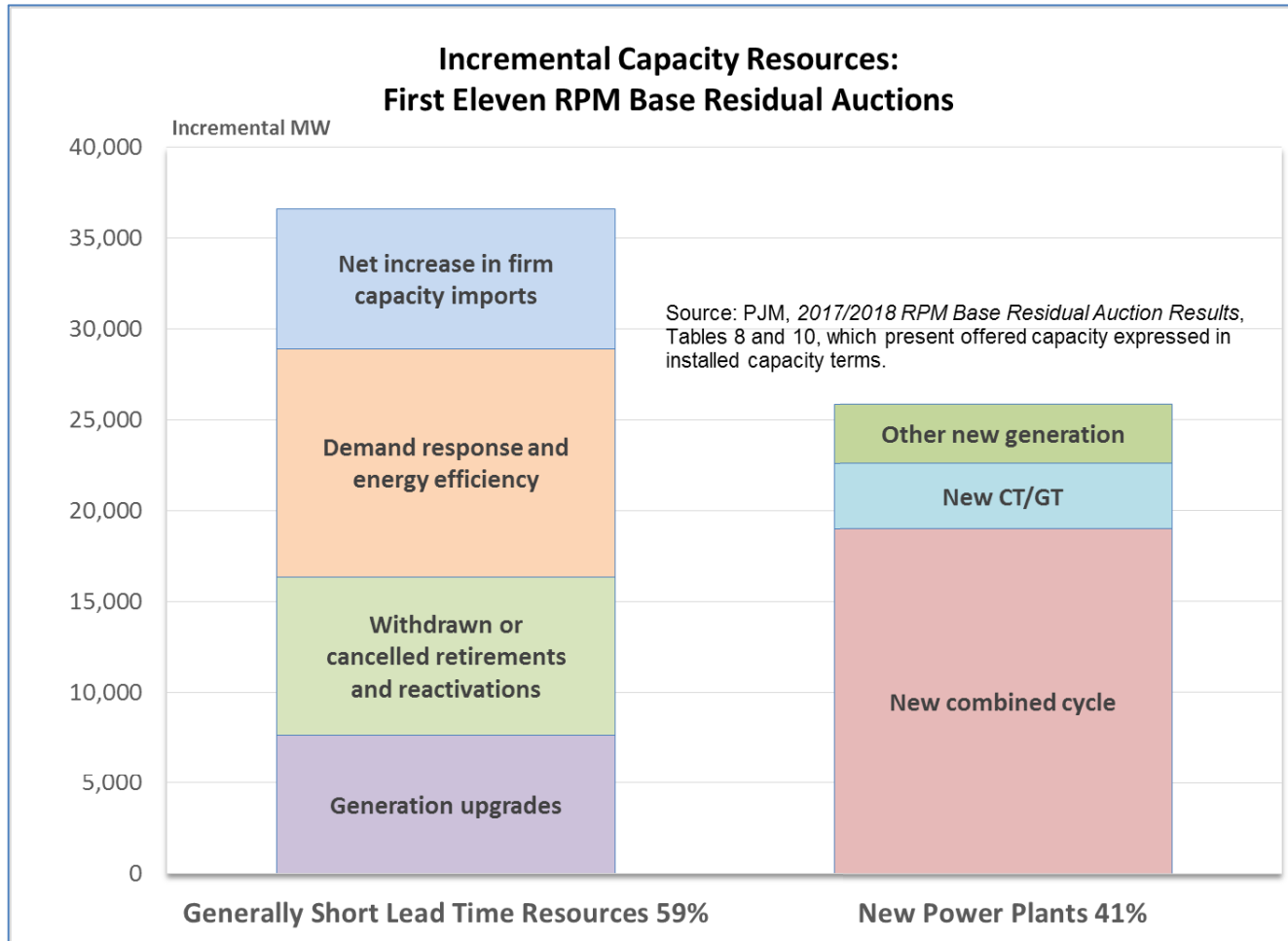
Base Residual Auction Reserve Margin and Delivery Year Actual LOLE
(reflecting actual delivery year peak load, and assuming no change in committed capacity)

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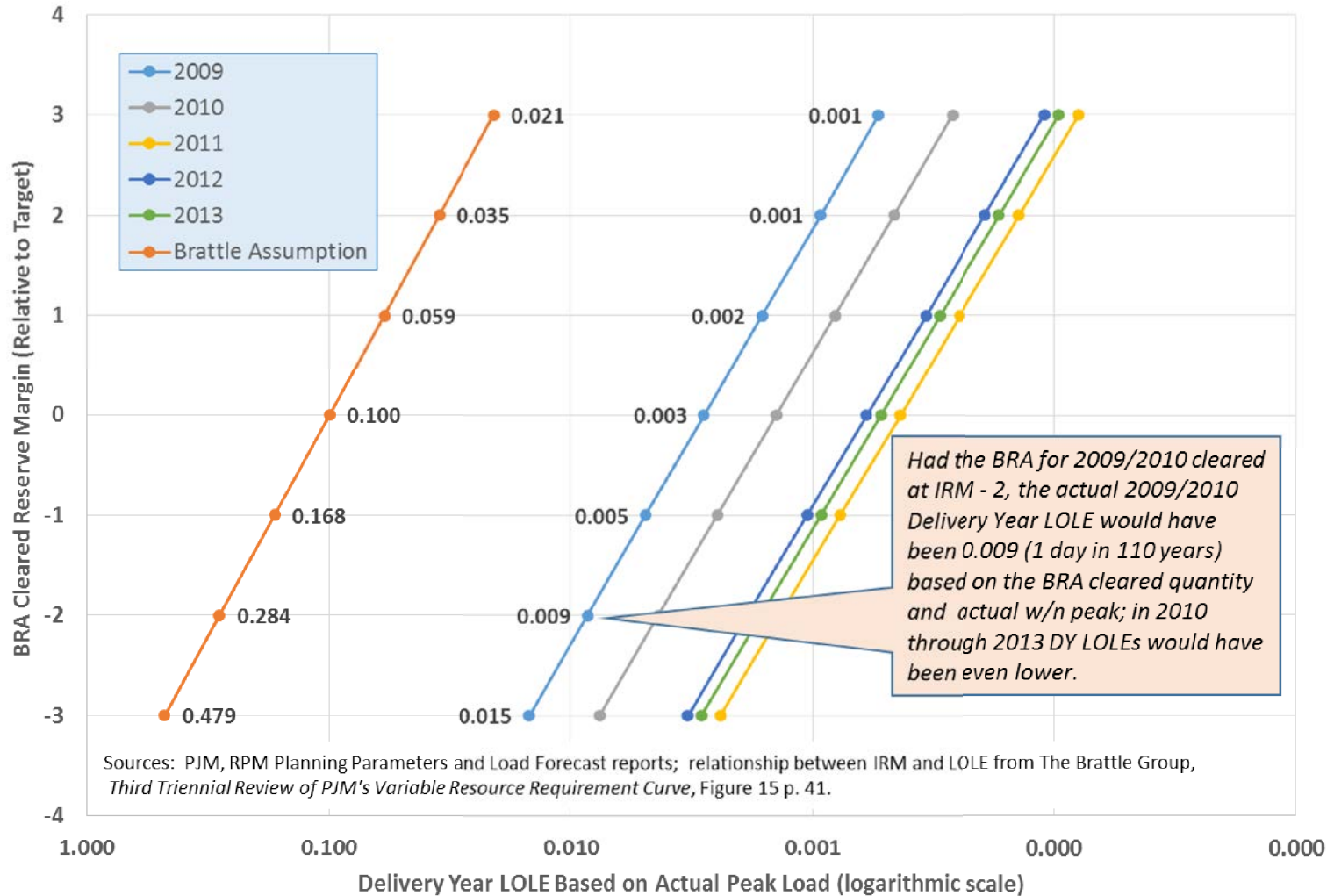
Substantial Additional Capacity Has Been Offered and Cleared in RPM Incremental Auctions

Total Participant Cleared Sell Offers in RPM Incremental Auctions

Source: PJM reports on incremental auction results.
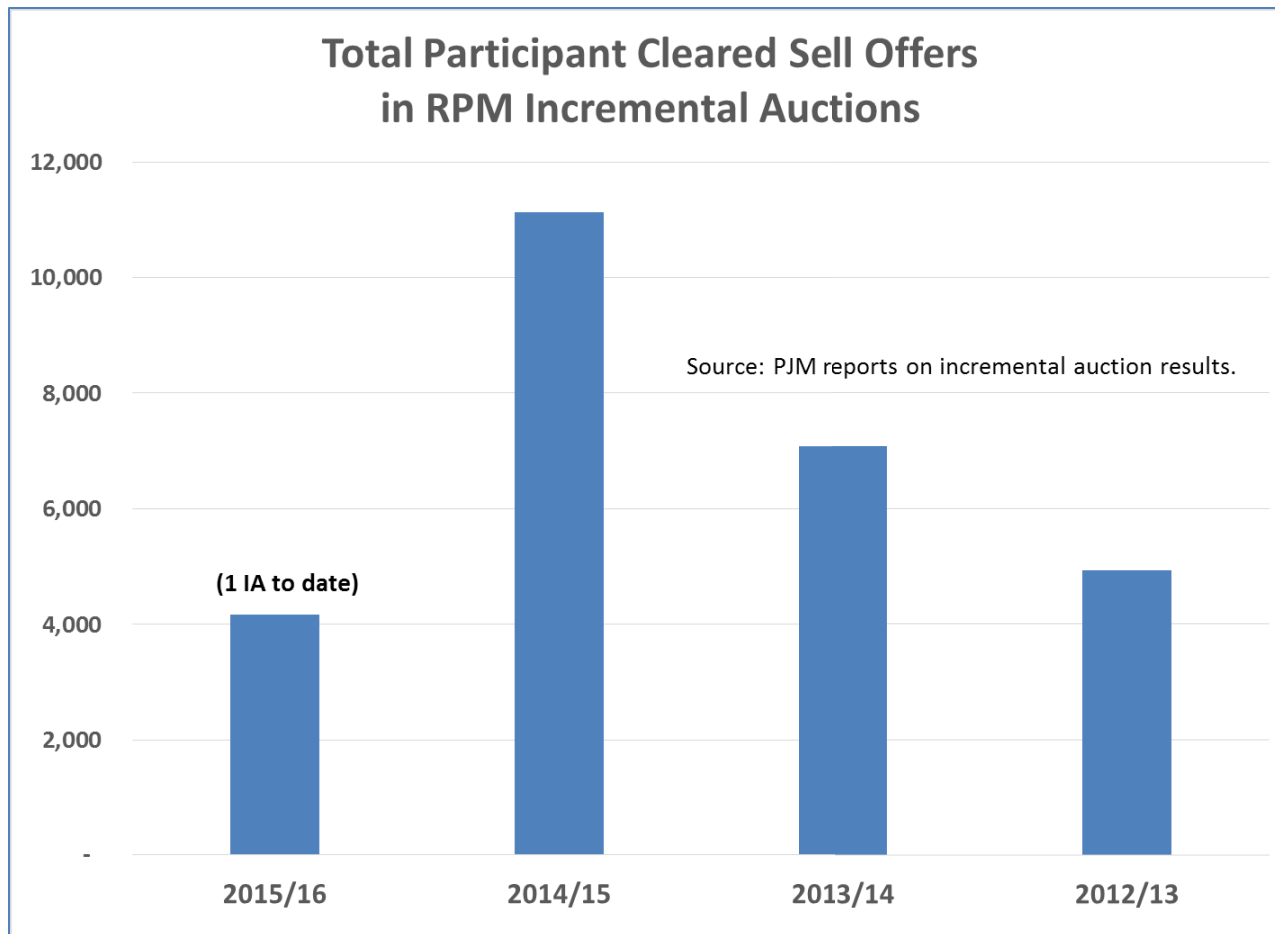
A Large Percentage of Incremental RPM Capacity Has Been of Types Likely Available With Short Lead Time

Incremental Capacity Resources:
First Eleven RPM Base Residual Auctions

Incremental MW

Source: PJM, *2017/2018 RPM Base Residual Auction Results*, Tables 8 and 10, which present offered capacity expressed in installed capacity terms.

Left bar (Generally Short Lead Time Resources 59%), from top to bottom:
- Net increase in firm capacity imports
- Demand response and energy efficiency
- Withdrawn or cancelled retirements and reactivations
- Generation upgrades

Right bar (New Power Plants 41%), from top to bottom:
- Other new generation
- New CT/GT
- New combined cycle

Y-axis: 0, 5,000, 10,000, 15,000, 20,000, 25,000, 30,000, 35,000, 40,000

Generally Short Lead Time Resources 59%   **New Power Plants 41%**

Additional Modeling and Analysis Would Be Required to Estimate DY RM0, LOLE Outcomes *(not recommended!)*

- Model changes to load forecast; biased in downward direction

- Model changes in the transmission system and import capacity

- Model resources available after the BRA, both uncleared in BRA and short lead time

- Model PJM capacity acquisitions (in IAs, also backstop rules) and consider changes to those rules

Due to load forecast adjustment and capacity purchases, RM0 will often be much improved over RM3 whenever RM3 is low.

The Brattle work does not do this modeling; it reports LOLE based on simply assuming RM0 = RM3.

The fact that the current rules do NOT call for PJM to attempt to acquire additional capacity in IAs if clearing below target in the BRA indicates stakeholders are comfortable with such outcomes occurring at times.

Any New Reliability-Related Criterion Should Be Discussed and Agreed by Stakeholders Incl. the States

- The Brattle Report introduces new criteria related to the reported LOLE values

  - "Primary design objective: Average LOLE (based on simulation) > 0.1 (p. 48)

  - "Very low" reserve margin outcomes (defined as IRM -1, or 1-in-5) should occur "very infrequently" (p. 46)

- If any new reliability-related criteria are to be introduced and applied they should first be vetted with stakeholders including the States

3. PJM Recommended VRR Curve

VRR Curve Comparisons
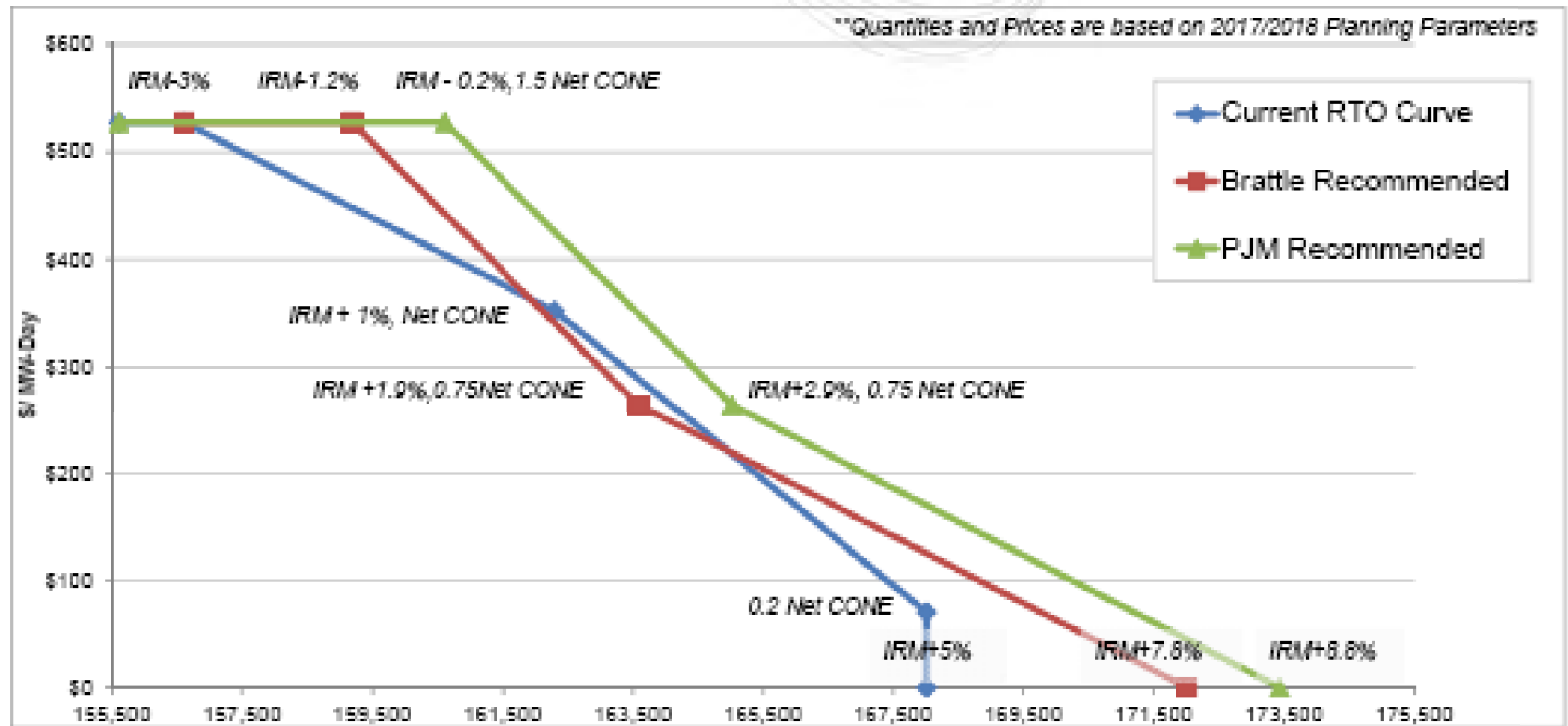
PJM Recommended Curve

The Brattle/PJM recommendation can be understood as making three changes to the current curve:

1. Shift "point A" to the right, steepening the curve at price levels above Net CONE;

2. Shift "point C"/foot of curve to the right, clearing higher quantities at higher prices when clearing at prices below 0.6 x Net CONE;

3. Shift the entire curve an additional 1% to the right, clearing higher quantities at higher prices at all price levels.

These three changes should be evaluated individually and collectively.

PJM Recommended Changes: Initial Reaction

1. Shift "Point A" to the right:

   - Will increase incentive and ability to economically withhold to raise price

   - Will contribute to price spikes and higher cost, even without withholding

   - Sends exaggerated "price signal" when clearing just below RR, especially considering likelihood of load forecast reductions, possible IA purchases

2. Shift "Point C"/foot of curve to the right:

   - Will contribute to higher consumer cost due to clearing higher quantity/price, with little or no useful reliability impact (does improve "averages")

   - Results in muted price signal for resource exit when there is excess capacity

   - Given forecast load growth of about 1%/year, can clear an excess that will require years to work down at relatively high prices; discourages entry of new resources (at recent average price of $100/MW-day, clears ~ 5 years excess)

PJM Recommended Changes: Initial Reaction (cont'd)

3. Shift entire curve an additional 1%:

   ▪ Further raises prices, cleared quantities and consumer cost at any price level

   ▪ Larger committed quantities depress E&AS prices and revenues, shift resource earnings from the real markets (E&AS) to the administrative capacity market (where prices/revenues may be discounted by investors, further raising cost)

   ▪ Works against long-term goal of fully compensatory E&AS markets and no "missing money"

   Note: PJM states that it is "required to plan" to the 1 event in 10 years standard by RFC (CSTF, 6/30/14). This is not true; BAL-502-RFC-02, approved by FERC, only requires that PJM perform a <u>study</u> applying that standard.

4. Considering Changes to VRR Curve Shape/Position: Impacts to Evaluate (my list)

1. <u>Reliability</u>: Impact on cleared quantities (RM3)   (not RM0, LOLE)

2. <u>Consumer Cost</u>: Impact on capacity cost; indirect impact on E&AS

3. <u>Market Power Incentives</u>: Impact on incentives, ability to raise RPM prices, and likely consequences for cost and reliability

4. <u>Clearing Large Excesses</u>: Impact on market dynamics, entry and exit, of clearing very large excesses

5. <u>Broader/Longer-Term Vision for PJM Markets</u>: Impact of shifting cost recovery between E&AS and capacity

6. Other impacts?

Impacts to Evaluate: #1 Reliability

- Brattle Report: Presents simulation model of supply and demand "shocks" and resulting cleared quantities and prices assuming long-term equilibrium, various other simplifying assumptions

- Initial review (more details in Part II of presentation):

  – Simulation model is oversimplified and inappropriate for this application

  – Brattle's analysis substantially overstates likely frequency of low RM3 outcomes

Impacts to Evaluate: #1 Reliability (continued)

- Brattle incorrectly reports LOLE based on RM3, and applies new criteria to LOLE that have not been discussed with stakeholders

- The new reliability-related criteria are very conservative and inconsistent with Brattle's work for FERC, which suggests that the "economically optimal" reserve margin is several points <u>below</u> the "one in ten" level (Sept 2013 report for FERC, *Resource Adequacy Requirements: Reliability and Economic Implications*, Fig. 14 p. 46, p. 40 Fig. 12; "one in ten" is 15% reserve margin, economically optimal is 10%)

Impacts to Evaluate: #1 Reliability (continued)

- Recommended further analysis (details in Part II of presentation)

    – Run simulation model with alternative, more realistic assumptions

    – Run additional sensitivity analyses requested by stakeholders

    – Provide simulation model for stakeholders to examine, validate, run

Impacts to Evaluate: #2 Consumer Cost Impacts

● Brattle Report: Does not evaluate potential cost impacts of shifting the VRR curve

– Assumes under any VRR curve shape/position the average RPM price will equal Net CONE; this assumes away the main driver of cost impacts – changes in price

– Under Brattle's assumption that any curve will result in the same average price, the only cost difference reflects only small differences in cleared quantities

– In addition, Brattle does not evaluate the indirect E&AS impacts of changes in capacity acquisition (or any other actual DY impacts)

Impacts to Evaluate: #2 Consumer Cost Impacts (cont'd)

● Price and cost impacts can be large; market participants may not respond as Brattle assumes, or may not respond for years

  – The market may in aggregate offer an amount of capacity that reflects views of the PJM system's true capacity needs (demand v. supply; anticipated RM).

  – The market may in aggregate offer an amount of capacity largely in response to recent and forecast E&AS prices and earnings (focus on the "real" markets, discounting potential capacity revenues)

● Rough estimate of near term market cost impact of shifting VRR curve (based on PJM sensitivity analysis of recent auctions):

  – Brattle recommendations (Point A, Point C): $ 1 bil./year

  – PJM additional recommendation (1% shift): Additional $1 bil./year

  – In higher price ranges impacts could be smaller or much larger

Impacts to Evaluate: #2 Consumer Cost Impacts (cont'd)

● The Brattle simulations suggest substantially higher RTO capacity price levels under the PJM proposed curve than have been seen to date

    – 11 Delivery Years to date: 8 of 11 <= $120/MW-day, average $93/MW-day

    – UBS, 5/28/14: New combined cycle profitable @ $120/MW-day

    – Brattle simulation of PJM curve: clearing prices exceed $130/MW-day in **99.6%** of draws despite assumed steep supply curve, overstated "shocks"

Impacts to Evaluate: #2 Consumer Cost Impacts (cont'd)

- Suggested analysis to estimate potential consumer cost impacts:

  - Evaluate annual cost impact assuming no market reaction to VRR curve shift

  - Evaluate cost impact assuming market adapts and moves to new "equilibrium" offer quantity over a five year period *(The Brattle Report acknowledges that supply curves are "relatively fixed" in the short term; p. 61)*

  - Also evaluate long-term cost impact of shifting generation cost recovery to capacity and away from E&AS; approach?

  - Other ideas?

Impacts to Evaluate: #3 Market Power

- Brattle Report: Recommends shifting "Point A" to the right, steepening the VRR curve at high prices, but provides no discussion or analysis of the market power impacts of the proposed change.

- Commenters (e.g. UBS) suggest that capacity sellers are increasingly exercising available flexibility to offer capacity at higher prices

- Suggested analysis to explore market power impacts:
  - Report potential clearing price change per 1,000 MW withholding (maximum potential; and reflecting recent supply curve slope; RTO and LDAs)
  - Determine minimum portfolio size to make withholding profitable
  - Determine fraction of PJM capacity held in portfolios of at least this size
  - Other ideas?

Impacts to Evaluate: #4 Clearing Large Excesses

- Brattle Report: Recommends shifting "foot" of curve out to accomplish convex shape but provides no discussion of cost or other impacts of clearing large excesses at higher prices

- Suggested analysis to explore impact of clearing large excesses:

  – Report, for a few price levels, the resulting excess cleared quantity, expressed in years of load growth (assuming load forecast is accurate) and cost impact

  – Estimate impact on E&AS expectations of potential for large cleared excesses

  – Perhaps survey developers for their reactions to large cleared excesses

  – Other ideas?

Impacts to Evaluate: #5 Long Term Vision of PJM Markets

- Brattle Report (and PJM recommendation): Shift part or all of VRR curve to the right, resulting in larger cleared quantities and, presumably, more DY capacity; but no discussion or analysis of potential impact of this on E&AS prices and revenues, generator revenue mix (E&AS v. capacity), or long term impacts.

- Suggested analysis to explore impacts of shifting generator revenue to capacity and away from E&AS:

  – Estimate impact on E&AS prices and Net CONE of larger capacity quantities

  – Survey developers on reactions to the E&AS/capacity revenue split, whether they discount capacity revenues, and how much (ISO-NE assumption: 50%)

  – Revisit goal of eliminating the "missing money", and how to get there

Value of "Convex" Shape?

- Brattle Report: Convex shape is good because it aligns with incremental reliability value (pp. 48-49)

- Reactions:

    1. The "incremental reliability value" Brattle presents pertains to delivery year RMs (RM0) not three year forward RMs (RM3); as discussed above, the connection between RM3 and DY reliability is complex

    2. The incremental reliability value is likely far below the VRR curve at all price levels (Brattle report to FERC: economically optimal reserve margin is ~ 10%)

    3. Other more specific considerations about VRR curve shape (reliability, consumer cost, market power impacts, etc.) are more important

Brattle proposed a convex curve in New England, but ISO-NE and stakeholders reached consensus on a non-convex curve (ER14-1639)

5. Summary: Additional Analysis Is Needed to Evaluate Proposed Changes to VRR Curve Shape/Position

- Further investigation, clarification of whether there is a problem, nature of problem, scope of possible solutions

- Further analysis as suggested in above slides to evaluate impacts on consumer cost, market power

- Further work on reliability/reserve margin impacts of curve shape/position:

  - Validate structure and assumptions of model to be used (Part II of presentation)

  - Focus on what the model(s) actually do – three year forward reserve margins

  - Further study of connection between three-year-forward cleared quantity and delivery year reserve margin, including rules for PJM to acquire additional capacity at times, would be valuable