Brattle

MEMORANDUM

TO	PJM Market Implementation Committee
FROM	Kathleen Spees, Samuel A. Newell, Andrew W. Thompson, Xander Bartone
SUBJECT	Responses to Stakeholder Questions on Quadrennial Review Report VRR Curve
DATE	July 15, 2022

This memorandum responds to additional questions and feedback received on the report we recently published in the context of the Fifth Quadrennial Demand Curve Review, the "VRR Curve Study" report.[1]

STAKEHOLDER COMMENTER 1

1. **Question/Comment: Can you further clarify how Net Supply variability was modeled. BRA Reliability Requirement was modeled with parameters as developed in Table 11. BRA Total Supply variability is developed in Table 12 and Net Supply variability in Table 13. The text states "we therefore apply a correlation factor between supply and demand variability parameters", and the text also refers to Table 12 as showing "the supply variability we utilize in our modeling" and Table 13 "the BRA net supply variability size as implemented in our model." Could you clarify how the supply variability was implemented.**

   Response: From the VRR Curve Study, p. 49: "*In the RPM, there is a partial correlation between supply and demand.* […] *Separately estimating supply and demand variability without accounting for this correlation would overstate resulting variability in net supply (i.e. offered supply minus Reliability Requirement) that produces the effect of market price volatility. We therefore apply a correlation factor between supply and demand variability parameters to ensure that net supply variability produced by our simulation model exactly matches historically observed net supply variability.*"

[1] Spees *et. al.*, Fifth Review of PJM's Variable Resource Requirement Curve, April 19th, 2022 ("VRR Curve Study").

The demand (or Reliability Requirement) variability is modeled as the historical standard deviation (as shown in Table 11) multiplied by a random variable with a mean of zero and a standard deviation of 1. Demand variability is applied to increase or decrease the Reliability Requirement for use in the relevant model draw.

Variability in offered supply is calculated second and accounts for the correlation between offered supply and the Reliability Requirement. Conceptually, this reflects the idea that increases in market demand will attract more supply to offer capacity into the capacity market. Mathematically, we calculate the supply variability parameter as:

$$Supply\ Variability = (1 - cf)\sigma_S X + cf\sigma_D Y$$

EQ1

Where cf is a correlation factor between supply and demand variability; σ is the standard deviation of supply or demand (calculated from historical Reliability Requirements and capacity market offer data, prior to accounting for any correlation); and X and Y are random variables with zero mean and standard deviation of 1. We adjust the correlation factor (cf) until the standard deviation of modeled Net Supply is equal to the historically observed standard deviation in Net Supply shown in Table 13.

2. **Question/Comment: Could you clarify how the Additional Supply Offered in incremental auctions was determined, combining 53.8% of the BRA uncleared value, a normally distributed value based on Table 15, and minimum 1,000 MW.**

   Response: Supply offered in the incremental auctions is calculated in the following steps: (1) Incremental auction available supply is 53.8% of the Uncleared Supply after the BRA; (2) to this initial calculation, we apply the forward-to-prompt IA supply variability shown in Table 15 in the same manner as the demand variability (see answer to 1 above); and (3) if the resulting number is below 1,000 MW, offered supply is increased to the floor value of 1,000 MW. See also the "Additional Supply Offered" columns in the attached "brattle-model-results-2022-updated.xls" file.

3. **Question/Comment: With regard to the file "brattle-model-results-2022.xls", could you augment this with some additional details, per #2 above:**

   i. **Could you provide additional columns as necessary that show how the "BRA Total Supply Offers" value was determined, reflecting correlation with BRA variability.**

ii. **Could you provide additional columns as necessary that show how the incremental auction "Additional Supply Offered" value was determined, combining 53.8% of the BRA uncleared value, a normally distributed value based on Table 15, and minimum 1,000 MW.**

Response: See answers from Questions 1 and 2 and columns "BRA Total Supply Offers (Calculated Example)" and "Additional Supply Offered" in the attached "brattle-model-results-2022-updated.xls" file.

4. **Question/Comment: Sensitivity Analysis: Tables 16, 17 and 18 provide sensitivity analysis to the Candidate Curve. Could we get that same sensitivity analysis for the Alternative curves. And could we also get it for the IMM's proposal, and I would also request it for the pink, "steeper curve" shown in Figure 8, which was shifted to create Alternative 1 ("hereafter, "pink curve"). Table 19: Could we also have this table augmented with results for the IMM curve and the pink curve.**

   Response: See the attached "brattle-additional-sensitivity-analyses-2022.xls"'

5. **Question/Comment: I can match the regressions in tables 11, 12 and 13, but not in table 14 (column D) and table 15 (column C). Is there something different going on here that I am missing?**

   Response: The linear regressions for Tables 14 and 15 are based on the historical data for 2012-2021. To recreate the regression (in column D) for Table 14, the 2012 Historical BRA Reliability Requirement (133,732 MW) and 2012 Historical Final IA Reliability Requirement (125,234 MW) from the 2012/13 Base Residual Auction Planning Parameters and the 2012/13 Third Incremental Auction Planning Parameters (respectively) need to be added to the data series. To recreate the regression for Table 15 (in column C), the 2012 Historical BRA Total Supply Offers (145,373 MW) from the 2021/2022 RPM Base Residual Auction Results, Table 6 needs to be added to the data series.

6. **Question/Comment: Can you further elaborate on how you determine what supply is chosen in IAs. I see that when the final clearing is below the reliability requirement, there are many instances of over 1,000 MW uncleared supply in the IAs.**

   Response: The IA procurement is modeled to reflect PJM's current IA procurement approach as described in Manual 18, Section 3.5, which compares the current Reliability Requirement to the previous Reliability Requirement and procures or releases capacity up

to the amount of the difference in the two Reliability Requirements depending on whether the reliability requirement increases or decreases.

See also footnote 41: "*We note that PJM's current approach pursues IA procurements based primarily on changes to the Reliability Requirement, rather than on the absolute need for capacity after accounting for the volumes that have already cleared in prior auctions."* […] "*The current approach to determining IA procurement volumes is described in Manual 18, Section 3.5, October 20, 2021."*

7. **Question/Comment: p. 50 states "In our simulation sensitivity analyses we test a large range of parameters to illustrate the implications to our estimated results if net supply variability is substantially larger or smaller than under our base assumptions." Is this referring to the sensitivity analysis in the report or additional sensitivity analysis that was done, if the latter can you share it.**

   Response: This is referring to the Sensitivity to Supply and Demand Variability in Appendix E as summarized by Table 16.

8. **Question/Comment: Can you clarify what Col B in Table 15 shows.**

   Response: Column B in Table 15 shows the Historical Final IA Total Supply, meaning the total remaining supply after all of the auctions have run. This is determined by taking the uncleared supply from the corresponding BRA, calculating the Net Supply Increase or Decrease as of the final IA, and adding the two terms. Table 3 provides these two terms for all auctions years. For example for 2018, the 10,778 MW of Final IA Total Supply is calculated from Table 3 by taking the cumulative uncleared supply from the 2018/2019 BRA (13,054 MW) in column [i] and adding the Net Supply Increase/Decrease as of the 2018/2019 Final IA (-2,276 MW) from column [j].