RESPONSES TO STAKEHOLDER FEEDBACK

16) Stakeholder Feedback
"Request full documentation of the Hobbs simulation

Request full documentation of the Hobbs simulation, including: random economic growth assumption; random weather-related peak load uncertainty assumption; number of years forward between auction and delivery year; function relating E&AS prices and earnings to reserve margin; treatment of demand response in the model; function defining utility of profits and all parameter values; risk-adjusted forecast profit function and all parameters and weights; maximum new capacity additions function and all parameters; any other assumptions used in the model that are not documented in the 2011 report."

Response:

Relevant documents
The Hobbs simulation assumptions are all documented publicly in the documents listed below. Deviations from these assumptions are documented in 2008 and 2011 RPM Reports. The main simulations assumptions are again summarized below.

Hobbs, B. et al., "A Dynamic Analysis of a Demand Curve-Based Capacity Market Proposal: The PJM Reliability Pricing Model," *IEEE Transactions on Power Systems*, Vol. 22, No. 1, February, 2007
http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=4077111

Hu, Ming-Che and B. Hobbs, "Dynamic Analysis of Demand Curve Adjustment and Learning in Response to Generation Capacity Cost Dynamics in the PJM Capacity Market," *Power and Energy Society General Meeting – Conversion and Delivery of Electrical Energy in the 21st Century*, IEEE, July 2008
http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=4596163

Tab H, Affidavit of Professor Benjamin F. Hobbs, FERC Docket Nos. ER05-1410 and EL05-148, August 31, 2005
http://elibrary.ferc.gov/idmws/File_list.asp?document_id=4335755

Attachment C, Supplemental Affidavit of Benjamin F. Hobbs, FERC Docket Nos. EL05-148 and ER05-1410, September 29, 2006
http://www.pjm.com/~/media/committees-groups/committees/mrc/20110912/20110912-attachment-c-supplemental-affidavit-of-benjamin-hobbs.ashx

Model Flow:
See Fig 2 in Hobbs Affidavit (2005) for the flow chart of simulation steps.

Random economic growth assumption:
As Table 19 (p. 101) of the 2011 Brattle report indicates, the average growth in weather-normalized peak load (*load_growth)* was set at 1.3%. To add uncertainty to the weather-normalized load series, a random economic growth component is also introduced—the weather-normalized load (L_{WN}) in a given year (Y+1) is derived as:

$L_{WN,Y+1}=(1+ load\_growth)*(1+ERR_{WN})* L_{WN,Y}$

ERR_{WN} represents economic uncertainty and is a normally distributed random variable with mean 0 and a standard deviation of 1 %.

Delivery Year forecast peak load, $L_{F,Y} = L_{WN, Y-3} (1+ load\_growth)^3$. The three-year-ahead forecasts are used in the auction and the 1.3% average peak load growth is the basis for the forecast.

Random weather-related peak load uncertainty assumption:
Actual peak load in year y, $L_{A, y} = L_{WN, y} (1+ERR_A)$, where ERR_A is an independently distributed normal random variable with mean zero and standard deviation of 4%, which represents year-to-year weather variations.

Number of years forward between auction and delivery year:
The 2011 analysis modeled a three-year forward capacity auction.

Function relating E&AS prices and earnings to reserve margin:
Actual reserve margin is the UCAP/Actual peak load: $r_{A, y} = (1 – FOR) X_y/L_{A,Y}$ where X_Y = installed capacity in year Y, FOR is the average forced outage rate. The target unforced reserve margin assumed in the 2011 analysis was 1.0809.

Hobbs Affidavit (2005) and Hobbs (2007) explain in detail the relationship between gross margin ($/UCAP MW-year) and the ratio of actual UCAP to target UCAP, which was developed from 1999-2004 historical data. See discussion on pp. 24-26 and Fig 3 in Hobbs Affidavit (2005), Fig. 8 and discussion on pp.11-12 in Hobbs (2007). The 2011 analysis assumed fixed A/S revenues of $2,199/MW-yr (PJM OATT p. 2228) and a cap of $200,000/MW-yr on gross margin.

Treatment of demand response in the model:
Not modeled. The simulation model is limited to additions of the reference resource type (a CT).

Function defining utility of profits and all parameter values:
Profit in year Y, P_Y = capacity revenues + gross [E&AS] margin – fixed cost of CT (FC).
The profit is known exactly as a function of the capacity prices (for years prior to the BRA) and the actual gross [E&AS] margin (for current and historical years). Gross [E&AS] margins for future years are based on forecast reserve margin. For year y for which BRA is being held, the forecast reserve margin from the prior year auction is used to estimate the gross margin and capacity prices.

Utility function $U(P_Y) = a*(1-\exp(–c*P_Y))$, where a=1.225 and c=0.00002584.

Risk-adjusted forecast profit (RAFP) function and all parameters and weights:
The $RAFP_Y$ for capacity added in Delivery Year Y is the inverted weighted utility, WU_Y. WU_Y is the weighted sum of utilities of profit for each year from Y-7 to Y, with the auction for delivery in Y occurring in year Y-3 (analogous to the process show in Fig 2 of Hobbs Affidavit (2005)). The utility of profit for each year is calculated using the utility function $U(P_Y)$. The weights are determined using a decay coefficient of gamma=0.8, starting with the weight for utility of profit from year Y at 0.2403. That is, it is assumed that the weight given to utility of profit in year Y-1 is gamma=80% of the weight assigned to utility of profit in year Y and so on. All weights sum up to 1.

Maximum new capacity additions function and all parameters:
The maximum new capacity additions are determined by the following equation:

$$\min(a*0.07,0.07*\max(0,(WU_y+(load\_growth/0.07))))* L_{F,Y}$$

where $L_{F,Y}$ is the delivery year forecast peak load discussed earlier and a is the parameter from the utility function $U(P_Y)$.

Any other assumptions used in the model that are not documented in the 2011 report.
See the articles and affidavits listed above for more details.

20) Stakeholder Feedback

"Hobbs – support previous request for additional information and were the 2.5% and IA procurement included in the simulation"

Response:

Please see response to #16 above for request for additional information. Neither IAs nor the 2.5% holdback were included in the simulations. The model does not distinguish between short-term and other resources, nor does it consider bidding behavior and offer mitigation and, as a consequence, cannot provide substantive insights as to the impact of these RPM design elements.

21) Stakeholder Feedback

"When failing to meet the reliability requirement and making direct procurement – what impact does that have on the overall model results?"

Response:

As per Section 16.2 of the PJM OATT, if the total capacity committed in a BRA is more than one percentage point lower than the approved IRM then PJM will investigate the cause of the shortage and recommend corrective action, including, without limitation, adjusting the CONE to the extent determined necessary by such investigation. No Reliability Backstop Auction will be conducted to address such a shortfall unless it occurs in the BRA for three consecutive Delivery Years. The model does not simulate potential corrective actions, including increasing CONE, nor does it simulate Reliability Backstop Auctions. Not including these backstop-procurement or Net CONE adjustment provisions in the simulations will likely overstate levels of and differences in resource adequacy risks for the various VRR curve shapes but will not affect the relative performance ranking of the different VRR curve shapes.

42) Stakeholder Feedback

–Please re-run the Hobbs simulation using the following modified assumptions:

1. Set the assumed long-term average load growth assumption to 0.86%/year. Based on the 2011 load forecast report, the average rate of growth is 0.86%/year for the RTO (its lower for MAAC) over the period from 2015 (the first year for which capacity is not already acquired) through 2026 (end of the forecast period).

2. Set the assumed random economic growth assumption to reflect just one year of such random growth between the auction and delivery year. This would be consistent with PJM practice as documented in the Reserve Requirements Study (p. 19, FEF value). This is appropriate because in both the modeling behind the Reserve Requirements Study and the Hobbs model, RPM incremental auctions, which are held to adjust capacity commitments as necessary after the base residual auction, are not modeled."

Response:

1. As Table 19 (p. 101) of the 2011 Brattle report indicates, the average growth in weather-normalized peak load was set at 1.3% for the 2011 analysis. A range of different parameter values, including various load growth rates, have already been modeled in the 2005, 2008, and 2011 analyses. For example, the load growth assumption was 1.7% in the 2005 analysis, 1.4% in the 2008 analysis, and 1.3% in the 2011 analysis. The results and relative performance of the different demand curves were unaffected by these variances in assumed load growth. Setting the average growth to 0.86 % will not change the overall conclusions of the simulation analyses.

2. The requested change in the model implementation of economic growth uncertainty is not necessary. For the purposes of settling the forward auction, the model only relies on the annual *average* growth in weather-normalized peak load (that is, the parameter discussed in point 1 above). The relevant details are discussed in Hobbs Affidavits (2005, 2006) and Hobbs (2007, 2008).

   Delivery Year forecast peak load ($LF_{,Y}$) is calculated as:

   $$LF_{,Y} = L_{WN,Y-3} * (1+load\_growth)^3$$

   The three-year-ahead forecasts are used in the auction and the 1.3% average peak load growth is the basis for the forecast. The weather-normalized load (L_{WN}) in a given year (y+1) is derived as:

   $$L_{WN,\, y+1} = (1+load\_growth) * (1+ERR_{WN}) * L_{WN,\, y}$$

   ERR_{WN} is a normally distributed random variable with mean 0 and a standard deviation of 1 %, which represents economic uncertainty. Therefore, the economic uncertainty parameter is only used once—to derive weather-normalized load for the auction year (Y-3); it is not applied to any year after that to forecast peak load in the delivery year (Y).