

# Technical Issues

World Modeling Region: Topics and considerations when modeling neighboring regions.

## General Issues

### CBM value used in Study and associated CBOT

- The Capacity Benefit Margin used in the annual PJM adequacy study to assess forecast requirements, is based on a separate Emergency Import Capability Study (EICS). This EICS assessment uses Load Flow models and solution methods to assess imports at periods of peak demand. The results of the EICS guide an evaluation for the best CBM value to use in the annual resource adequacy study for forecast requirements. The PC makes a recommendation based on this technical evaluation.
- The CBM value is established in the Reliability Assurance Agreement (RAA) to be 3500 MW. The RAA, Schedule 4, sheet 29, does indicate the following for CBM.

#### Capacity Benefit Margin

The capacity benefit margin initially shall be 3,500 megawatts. Periodically, in consultation with the Members Committee, the Office of the Interconnection shall review and modify, if necessary, the capacity benefit margin to balance external emergency capacity assistance and internal installed capacity reserves so as to minimize the total cost of the capacity reserves of the Parties, consistent with the Reliability Principles and Standards. The Office of the Interconnection will reflect such modification prospectively in its development of the Forecast Pool Requirement for future Planning Periods.

- It is anticipated that a NERC ATC Standard, Mod-8, will require that if planners use CBM to reduce the IRM, then this CBM value shall be used to decrement TTC in OASIS postings done by Operations staff.
- The reported CBOT value is not the amount of assistance flowing in over the CBM. The reported value can be considered an “average” value over all states evaluated in the LOLE calculations. For some low probability states associated with high daily peak loads, the assistance is much higher than the report value. The PJM staff is investigating efforts to quantify and report out the many specific import values over the CBM used in the LOLE calculations. **The net result of the CBM is to eliminate the need for the reported CBOT amount of internal generation.**

### Certainty or likelihood of New Capacity

- Considering the 2008 RRS report, Figure II-14 is a good technical chart to assess and use for evaluation and impacts of World reserve levels. The World reserves are based on public data combined with review and oversight by known World region staffs. The public data can be assessed and evaluated, typically on an annual basis. The PJM Staff compile the values from the public data, and then address any concerns by contacting our network of planners known by our Interregional assessment efforts. Typically the values do have a valid range for expectation (based on various neighboring region staff feedback). That range, assuming that five percent of the projected resources (generation) is delayed or is withdrawn, can be expressed in MW, and might be as much as ~1, 888 MW overall. That would reduce the expressed reserves by 0.4 %. (giving a range  $\pm 0.4\%$ ). A summary of the forecast generation, by zone is shown below, but is

only for discussion purposes as it is not known that a 5% value is appropriate for considering the amount for delay is likely.

LR CODE	Source 2007 ES&D (Some values updated by neighboring region staff )	Region	Sub_Region	Generation addition by 2012 / 2013 delivery Year (MW)	Assume 5% of forecast resources are delayed ( MW )
DCSNC	Planned Capacity Resources	NPCC	NE	3,948	197
DCSNC	Planned Capacity Resources	NPCC	NY		
DCSNC	Planned Capacity Resources	NPCC	ONT	5,496	275
DCSNC	Planned Capacity Resources	SERC	ENT Old	2,717	136
DCSNC	Planned Capacity Resources	SERC	SOU	7,548	377
	Planned Capacity Resources	MRO	Old	3,317	166
	Planned Capacity Resources	TVA	Old	4,064	203
	Planned Capacity Resources	ECAR Other		5,135	257
	Planned Capacity Resources	MAIN Other		2,007	100
	Planned Capacity Resources	VACAR other		3,530	177
	<b>Assumed Total Variation</b>				<b>1,888</b>

Note:

Not represented in this summary is both the DLCO and the Hydro Quebec resources. Both regions do not have any generation additions in the model, and their data source is not the 2007 ES&D.

The above summary supports the Sept PC mtg. Agenda 6A presentation slide 9, regarding SERC areas forecast for new generation. The Study model shows a large amount of new generation for the SERC region. In general, the quantification of “planned Capacity Resources,” expressed with an associated likelihood or distribution is not typically known in the planning staff modeling.

#### Adequacy Assessments are for Annual / Seasonal assessments

- The historical data is shown in the 2008 RRS report on page 15, Figure II-2 and Table II-3. The data shows that in the past 11 years, the PJM RTO and World peaked in the same week 7 times. A significant effort of operation planning is focused on this 168 hour look ahead period, with the awareness that the forecast planning methods are attempting to predict seasonal requirements. More importantly, for these 7 data points, when the PJM RTO peaked, the World was above 98% of its peak load. The magnitude of the world peak at the time of the PJM RTO peak, 7 of 11 times, is the primary reason the conclusion is made that the World model and PJM RTO model need for assistance is highly correlated (there is little diversity). Looking at timing of hours of days, is an Operations type assessment not pertinent in this Adequacy report. Any assessment of Operations time periods of hours, would require much more detail and consideration of other data including weather, transmission constraints, transmission facility outages, generation outages, invocation of system emergency procedures, generator regulation and spinning requirements, etc. No attempt at this kind of assessment is part of the Adequacy report.

#### Using Minimum of Forecast reserves or 1D/10 YR Criteria reserves

- The minimum value for World reserves can be the forecasted level or the 1D/10 YR value. In one historic RRS report (2001?), using the restricted loads for the reserve level, the forecast reserves were below the 1d/10yr criteria level. This necessitated the World to be represented at the low forecast reserve value. In looking at the 2007 ES&D information, that might have been the case in this study as the public data source has negative reserves for some of the world regions modeled in the 2008 Study. The forecast reserves may or may not be the best indicator for the PJM RTO planning purposes. There is an underlying data quality question of these data

which is difficult to measure or verify by the PJM staff. However, there is confidence that our neighboring regions will be at the 1d/10 year requirement, especially now that mandatory compliance per Adequacy Standards has started. In addition, this assessment has used restricted loads for determining if the World area is above the 1D/10Yr mark. If the assessment uses the unrestricted loads this would have indicated that several historic studies should have used the lower than 1d/10 yr forecast reserve level.

- The evaluation of the World Reserves has historically been done by considering the World restricted load level. This puts the reporting of World forecast reserves on the same basis as those reported for the PJM RTO. However, that reporting is not intended to imply that we expect our neighboring regions to invoke load management in their emergency operating procedures for the benefit of PJM or other regions. For assessment of what would be available, at the time of the PJM RTO need, one might consider the unrestricted peak load of the World region.
- The modeling of “the lesser of” is consistent with what other regions implement in their efforts to establish reserve requirements. The PJM staff has contacted and initiated dialog concerning this issue with NYISO, ISONE, IESO, MISO, CAISO, SERC, ERCOT, SPP, and BPA. We have verified that our assumption for external assistance is in line with methods used at NYISO, ISO-NE, IESO, MISO, and CAISO. In general, there are different approaches, based on the specific model differences, which allow for appropriate but limited reliance on external resources. Issues involved in this modeling include not having any call/authority on external resources while recognizing that there is a benefit of the interconnected grid.

#### Supplying “correct” level for operation of bulk power system

- Although the current IRM value, for the 2011 /12 Delivery year is 15.5 %, the RPM capacity market secured reserves above that requirement (18.6%). This level of reserves is what is used when we look at actual operating experience. As such, the PJM staff is in process to update Section 2 of the “Technical Methods” report, assessing if actual experience matches with the intent of having a loss-of-load event once every ten years. The staff did assess things back in 2003, noting in the Technical Methods reported experiencing a voltage reduction 3 in 13 years. For the one occurrence, on average, once every ten years, a large period of time should be used for establishing a representative population. Typically the load forecasting efforts use 30 to 40 years worth of data in the load forecasting methods. The PJM staff is in process to update this assessment, gaining a larger data population, to compare actual operation experience with the probabilistic criteria of one event, every ten years. The intent is to establish a FPR, using the calculated IRM, that sends the correct signal to the marketplace so that the correct amount of reserves are provided to meet this criteria. Even though there are more reserves than the requirement, the thinking is that if operating experience is in line with the criteria, then things are working as planned. In this modeling the World region has a 1D/10 Yr reserve level.

#### **Specific issues to address in a single area for the World Region modeling**

- Modeling a large world region has several related issues to contend with in modeling the World Reserves. The contention in Appendix E of the 2008 RRS report and its discussion is that this modeling has an undetermined impact to the resulting IRM. This modeling has a few “point” vs. “counter point” **items that seem to balance, which neither increase nor decrease, the overall impact to the calculated IRM.** These points include the following:

1. The regions are geographically diverse and the diversity within this single world area is expected to be significant. However, an investigation into the hourly loads of the individual sub-regions(10 in total), needs to be performed to quantify and measure the amount of diversity. Although the PJM RTO has a similar characteristic, the zones within the RTO have significant diversity, the assessment of the RTO loads allows using a more structured and complex method. For the hourly loads of the 10 sub-regions that make up the composite world, a spreadsheet approach will be used as we do not have the same level and magnitude of modeling data for the World area as we do for the PJM RTO. Developing a PLOTS composite hourly world model has been done for many years. However, the new assessment work to quantify and identify various regions' impact to diversity might allow an increase to the reported composite reserves. The use of a composite world area coincident peak(CP), attempts to recognize the diversity of the large geographic region **thus decreasing the PJM IRM** (more help to give at the time of PJM need), when compared to just a summation of the peaks within a region(NCP). However any new diversity factors identified, could reduce the monthly and annual NCPs further, thus increasing the reserves and **thus decreasing the PJM IRM further**.
  - A sub issue in this is that the monthly forecast load shape is applied to the daily peak load shape, reported out on a weekly basis. If a change in the world area load shape, due to applying new diversity factors causes the world to need increased reserves(IE have a higher IRM) because it has a forecast flatter shape, there will be more help to give PJM and again help to decrease the PJM IRM further. If the forecast monthly peak is peaky, a very high peak in just one month, then the World reserves would decrease and there would be less help to give PJM, increasing the PJM IRM.
  - For the public data, the monthly peaks are assumed to be coincident, however one should look at the various 10 regional monthly peaks, per the hourly data, and apply any applicable diversity factors. Application of any applicable diversity factors can only cause the composite monthly peak values to be reduced.
2. Deliverability of all the reserves, from all the areas, is not clear and has not been assessed and evaluated. In determining the reserves in the model for the areas directly connected to the PJM RTO, those aggregated reserves are about 16.2%, slightly below the 1D/10 Yr level. These areas include the NYISO, TVA, ECAR Other, MAIN Other, VACAR Other, and the Hydro Quebec resources that can be imported into the NYISO system thru the HVDC system. This is in-line with the 1d/10 Yr reserves shown in the Study. However, this deliverability also has operations related aspects so that coordination and assessments might need to involve close review by the PJM operations staff. This would reduce the reserves available to the PJM RTO at the time of need thus increasing the PJM IRM. The current model has no constraints, **thus causing the PJM IRM to be reduced**.
  - Related to the deliverability issue is what is the best size for the surrounding world region. Sensitivity analysis typically done for each Study indicates that there is an impact to the calculated IRM value up to a given size of the World. We see that adding the SPP region to our world model does not significantly affect the calculation, and if we only model the directly connected regions, not modeling Southern, Entergy, New England, Hydro Quebec, there is an impact to the calculated

IRM. The thinking is that at some periods when PJM RTO has a need for emergency assistance, the resources contributing to this assistance might come from, via wheeling, a remote region. It was thought that because the Eastern Interconnect is tightly interconnected that reserves can flow throughout the regions, thus making a bigger area model more representative of forecast reserves at the PJM RTO borders. Also, by modeling a large region, any issues of reserve sharing agreements among all regions in the Eastern Interconnection are handled as all regions, regardless of sharing of reserves, are modeled. A bigger region is thought to have less coincidence for timing of needs between PJM and the World (Increase diversity). If correct, this would reduce the PJM IRM as there would be help to give at the time of the PJM need. However, in recent modeling of a smaller World region we found more diversity between PJM and the World; thus, causing the PJM IRM to be reduced for a smaller World footprint and the bigger region **caused the PJM IRM to be increased.**

- The evaluation of load deliverability within the PJM RTO is done by the CETO/CETL test. This testing is not possible for the large world region, thus requiring engineering judgment to be used, in the context of the mathematical methods deployed, in determining the region to be modeled. This has been debated and assessed, ultimately base on a subjective choice of the stakeholders involved and current Industry issues. However, if a method and resources were put into place to identify constraints, this would reduce the help that the world area could give, thus increasing the PJM IRM. Currently this modeling assumes no constraints that allow a larger set of resources to help PJM **thus reducing the PJM IRM.**
3. The reserves within the World regions serve the 10 sub region needs 1<sup>st</sup>, before serving the PJM RTO. This is a result of the 2 area model that is used in PRISM. A review of the operating agreements in place between PJM RTO and its neighbors and forecasting how much will be available at the times of PJM need to be the focus. In this, an assessment of how the sub regions expect to help its neighbors might need to be investigated, but that relies on the cooperation of many other organization staffs. The current model allows the World regions to help each other first, before any assistance is available to PJM over the CBM tie. If the PJM RTO does have Reserve Sharing Agreements in place to share the outside reserves as a priority, **this modeling then causes the PJM IRM to be increased.** However, the nature of the agreements may not reflect that the direction and location of the imports is typically critical for any priorities to impact the IRM.
  4. In modeling a single World region, we give this region a benefit similar to the members of the PJM RTO. A larger region will in general reduce the need for internal reserves compared to each individual sub-region. This assumes similar load and generation characteristics. Although we know that each sub region operates and expects to stand on its own to meet the 1d/10 yr criteria, we assume that everyone will share with its neighbors at their neighbor's time of need. In general, each region needs to establish its own requirements, appropriately assessing how it can meet the 1D/10 Yr criteria on an individual basis. In that, the reserve requirements of the World region would be expected to be greater than our model demonstrates. However, the intent of the study is not to assess or determine the requirement of any region other than the PJM RTO. If each region holds its reserves to serve its own

requirements, then this modeling assumes more sharing than available. This modeling **causes the PJM IRM to be reduced.**

Amount of reserves available for assisting PJM can be broken down into modeling categories:

- Total amount of reserves.  
The total amount of forecast reserves does impact if the neighboring region can help PJM at its time of need. A lower level of world region reserves will cause the PJM IRM to be increased. Most planners are prudent in reliance on other regions, as plans can and do change as those changes are not immediately known. Typically many sensitivities are performed based on future plans, to quantify impacts on changes to planned levels in a neighboring region. Planning for outside areas to meet the 1D/10YR requirement has been historically proven.
- Availability of identified reserves.  
The availability or sharing identified extra reserves is assumed in the model. All reserves in the world area are assumed that they will help PJM, regardless of Operations or Market type considerations. No restrictions are given to any available World reserve level. Assuming that all excess World area reserves are available to help PJM, causes the PJM IRM to be reduced.
- Modeling of neighboring region reserves for setting of IRM by other ISOs, State Commissions;  
Many ISOs' model a limited amount of assistance from their neighbors. Typically an appropriate amount is modeled, considering firm contracts, firm transmission rights, historic patterns, and forecast patterns compared to actual infrastructure building (Generation, Transmission, load management). This type of modeling is used for assessing IRM requirements on a regional basis, by organizations such as IESO, NYISO, ISO-NE, MISO(RFC & MRO), and CALISO.

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General Modeling issues – applicable to all modeling including the single World region

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Recognition of significance of small values used in LOLE assessment

- The LOLE risk, concerning load diversity, is not concentrated into a single week. Looking at the 2008 RRS modeling data, there are 7 weeks that contribute to the LOLE. Care must be taken when extracting small value values, from a general figure, such as Figure II -12. The following is a summary of the weekly LOLE values from the base case, PRISM # 4162 and the single area case, PRISM # 4009:

PRISM #	DY	Wk #	LOLE	EWM
4162	2012	1	0.0000E+00	0.6714844
4162	2012	2	0.0000E+00	0.6932801
4162	2012	3	0.0000E+00	0.7200970
4162	2012	4	0.0000E+00	0.7975483
4162	2012	5	5.0422E-12	0.8458879
4162	2012	6	5.6704E-09	0.8824509
4162	2012	7	2.3467E-04	0.9256941
4162	2012	8	3.2446E-08	0.8742969
4162	2012	9	3.1898E-05	0.8929288
4162	2012	10	1.7651E-02	1.0000000
4162	2012	11	7.7799E-04	0.9381332
4162	2012	12	1.1868E-04	0.9082132
4162	2012	13	1.1138E-03	0.9510364
4162	2012	14	7.3427E-05	0.8687019
4162	2012	15	3.1507E-15	0.8310452
4009	2012	1	0.0000E+00	0.6714844
4009	2012	2	0.0000E+00	0.6932801
4009	2012	3	0.0000E+00	0.7200970
4009	2012	4	0.0000E+00	0.7975483
4009	2012	5	1.7878E-10	0.8458879
4009	2012	6	8.4687E-08	0.8824509
4009	2012	7	4.2644E-04	0.9256941
4009	2012	8	3.6180E-07	0.8742969
4009	2012	9	7.5321E-05	0.8929288
4009	2012	10	1.7921E-02	1.0000000
4009	2012	11	7.3010E-04	0.9381332
4009	2012	12	5.3623E-05	0.9082132
4009	2012	13	7.7094E-04	0.9510364
4009	2012	14	3.6984E-05	0.8687019
4009	2012	15	6.7102E-14	0.8310452

Data Modeling Accuracy

- Any implied accuracy issues that the data do not follow the established Study assumptions, have not been identified and reasonable efforts are in place to have the highest modeling accuracy in the PJM Industry models. The Study assumptions were established at the 5-21-08 PC meeting. The underlying data quality, and methods, adheres to a high standard, passing all audits, so that the Study assumptions are fulfilled.

Characteristics of model drive the results – not the size/magnitude

- In the modeling, the underlying characteristics of the load, generation and transmission interconnection are the primary influences on the Study results. The actual amount of generation or load, is not as important as the characteristics. As such, capturing the load characteristics and the generator characteristics of the surrounding region is very important. The ability to capture the load characteristics and generator characteristics of such a large region is unique to the PJM model. The characteristics for the loads are based on the daily demand pattern while the generation characteristics are based on the type of unit (Fossil, Hydro, Nuclear, Combined Cycle, Diesel, Combustion Turbine, etc.) at the time of demand. The large region affords a comprehensive evaluation/assessment of all patterns and characteristics that can legitimately influence the surrounding regions' ability to provide assistance.