

Agenda Item 10

PRISM and MARS Comparison Report

Resource Analysis Assessment Subcommittee (RAAS)

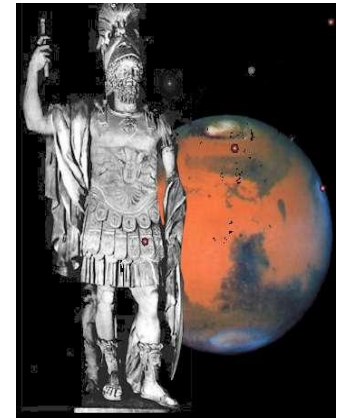
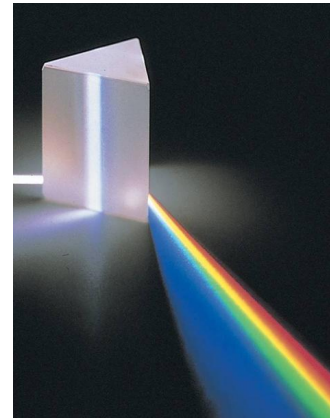
Final Report

PJM Planning Committee
March 10, 2011

- For many years, PJM has conducted annual Resource Adequacy and IRM studies using their own two-area model: the **Probabilistic Reliability Index Model (PRISM)**.
- By comparison, PJM's neighboring control areas, most notably the NYISO, ISO-NE and the MISO utilize a multiple-area program, the **Multi-Area Reliability Simulation (MARS)** developed by General Electric (GEI).
- The PJM Capacity Market is a \$6+ billion annual enterprise. Analytical results from Resource Adequacy studies are injected directly into market parameters.
- Stakeholders have long encouraged PJM to adopt MARS as the primary tool for resource adequacy modeling studies. Other stakeholders believe that PRISM fully satisfies PJM's resource adequacy.

Both PRISM and MARS have been known and proven in the electric industry for decades, however, the question remains:

What tool best determines resource adequacy requirements?



How it began ...

- Evaluation of this question began years ago.
- The RAAS launched a technical comparison in 2010.

PJM already uses MARS ...

- PJM has used both PRISM and MARS since 2005.
- This “blended” approach of using both is regarded as more beneficial.
- MARS incorporates operational database requirements and assessments.
- PJM relies more heavily on PRISM.
- PRISM enables efficient use of existing staff resources to achieve the best technical results at the least cost.

Objectives of this comparison ...

- Technical summary of both models, calculations, output, attributes, strengths and weaknesses.
- Cost and resource needs estimates.
- Recognize complementary aspects offered by both PRISM and MARS
- Establish groundwork for possible further study and future action.

- **The purpose of this report is to deliver an objective technical evaluation – not to endorse one modeling method over another** (per unanimous RAAS directive).

A. Comparing the Models

- Model Attributes (Table 1)
- Output Comparison Matrix (Table 2)
- Database Modeling Relationship Matrix (Table 3)



B. Comparing the Data & Calculations:

- “It’s all about the data!”
- PJM’s Applications for Reliability Calculations (ARC) GUI includes both models.

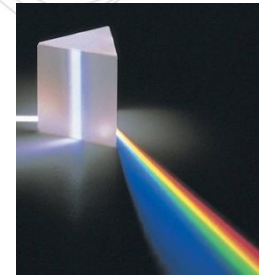
C. Comparing the Output:

- Both PRISM and MARS offer many detailed outputs to perform LOLE assessments.

The origins of the LOLE

- *This report provided an opportunity to review and document some of the history and evolution of reliability criteria governing resource adequacy, namely, Loss of Load Expectation (LOLE).*
- **Reliability Criterion ... 1 day in 10 years**
Origins of this reliability criterion explained in report



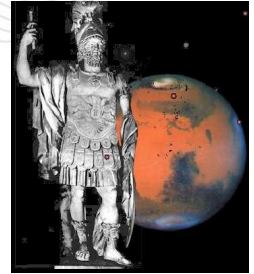


PRISM ...

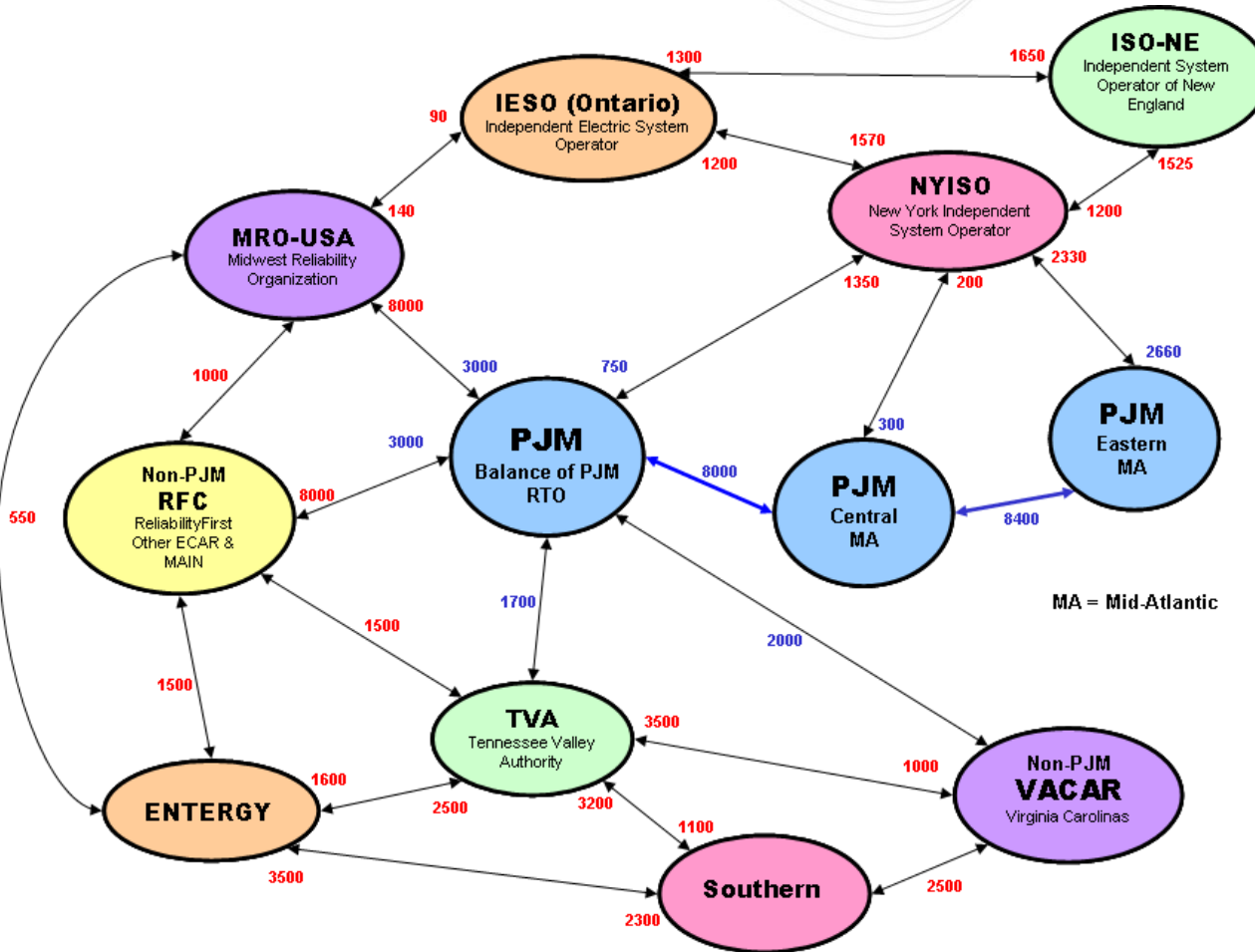
- Two-area simulation model
- Probabilistic load distribution
- Probabilistic capacity modeling (as does MARS)
- Deterministic transmission system modeling (as does MARS)
- Few statistical parameters that incorporate the full model
- Probabilistic forecast load model
- Fast solution time
- Requires no additional PJM staff to complete a resource adequacy assessment.
- **Cannot perform Hourly assessments or hourly metrics.**
- **Cannot satisfy new NERC reporting requirements for LOLH and EUE**
 - Loss of Load Hours (LOLH) and Expected Unserved Energy (EUE)
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MARS ...

- **Multiple-area model; this is a tremendous advantage.**
- **Deterministic load distribution.**
- **Probabilistic capacity modeling (as does PRISM)**
- **Deterministic transmission system modeling (as does PRISM)**
- **Can perform hourly calculations including direct Operational parameters.**
- **Time-intensive data collection and maintenance of inputs**
- **Monte Carlo simulator (can involve longer solution times)**
- **Supported, refined and updated by GE technical staff.**
- **Gained industry-wide acceptance and usage throughout North America.**
- **Can be used to comply with NERC reporting for new metrics (LOLH and EUE)**



MARS World Interface Topology Map



This World Interface Topology Map represents the possible individual areas that could be modeled using MARS

The NYISO, ISO-NE, IESO and other areas can be represented in further detail (at least 10 subareas comprise each region shown).

The calculations are done on an area basis, for each load level specified, at each EOP level on an hourly basis.

If this determines that an area needs assistance to avoid an LOLE state for this hour, assistance is considered from the other areas in the model.

- **Current Reserve Study Models**
(6 pages)
 - Descriptions of PRISM and MARS
 - Complementary Aspects of PRISM and MARS
 - Ongoing LOLE Assessment Work
- **Model Calculation Processes**
(18 pages)
 - In-depth model Calculation Processes
 - Historical Continuity
- **PJM's Recent Comparison Efforts**
(6 pages)
- **Comparison of Attributes Documentation**
(21 pages)
- **Resource & Cost Assessment**
(10 pages)
- **Frequently Asked Questions (FAQs)**
(11 pages)
- **Interregional Assessments**
(3 pages)
- **Glossary**
(10 pages)
- **References**
(4 pages)



- Appendix A – MARS Model vs. PRISM Model Overview PJM Staff presentation (10 pages)
- Appendix B – Translation from PLOTS to LOD-UNCY table (3 pages)
- Appendix C – Load Modeling Comparison Issues (1 page)
- Appendix C1 – Load distribution granularity (2 pages)
- Appendix C2 – Baldwin Paper (3 pages)
- Appendix C3 – ISO-NE's Comparison of Westinghouse Model and MARS (15 pages)
- Appendix D – MARS public solution techniques (7 pages)
- Appendix E – Transparency of process to perform LOLE calculations (7 pages)
- Appendix F – Details of Input Parameter Requirements (10 pages)
- Appendix G – Items for possible future investigation (1 page)



Table 1 – Model Attributes / Application Comparison Matrix

Comparison	PRISM		MARS	
	Strength	Weakness	Strength	Weakness

- | | |
|--|---|
| <ol style="list-style-type: none"> 1. Developer/ Owner 2. Technology 3. Current Users 4. Underlying data requirements 5. Solution Basis 6. Capacity Benefit Margin (CBM) 7. Reporting LOLE results 8. Simultaneous Study Areas 9. Interface Transfer Ties 10. Modeling Style 11. Planning Horizon 12. Data Input Requirements 13. Modeling specifics of interest 14. Load Model Type 15. Load Shape 16. Load Model Shape 17. Peak Load Assessment | <ol style="list-style-type: none"> 18. Forecast Error Factor (FEF) 19. Expected Weekly maximum (EWM) 20. Load Forecast Uncertainty (LFU) 21. Monthly Forecast Loads 22. Load Management Assessment 23. Capacity Modeling 24. Forced Outages 25. Equivalent Forced Outage Rate on Demand (EFORd) 26. Transition Rate 27. Wind Unit Performance 28. Other Intermittent Capacity Resources 29. Transmission System Modeling 30. Modeling Resources (Staff) 31. Solution Runtime 32. Runtime Characteristics 33. Hourly Data Assessment |
|--|---|

	Task Description	PRISM Resources				MARS Resources			
		FTE (hours)		COST		FTE (hours)		COSTS	
		DEV	PROD	DEV	PROD	DEV	PROD	DEV	PROD
1	Annual Reserve Requirement Study		1795		\$\$\$	3547	2100	\$\$\$\$\$	\$\$\$\$
2	Capacity Emergency Transfer Objective (CETO) Analysis		728		\$\$	3020	968	\$\$\$\$\$	\$\$\$
3	Short-Term MARS Investigations						700		\$\$
4	Winter Weekly Reserve Target Analysis	2680	112	\$\$\$\$	\$		72		\$
5	Ambient Derate Analysis		1160		\$\$\$		544		\$\$
6	“World Region” Multiregional Analysis						624		\$\$
7	Intermittent Resources						948		\$\$\$

Codes: FTE = Full-time equivalent hours for labor resource estimates; DEV = Development environment where all initial efforts are performed; PROD = Production environment (typical operations)

Cost Key: \$ (Very Small) < \$10,000; \$\$ (Small) \$10,000 to \$55,000; \$\$\$ (Medium) \$55,000 to \$150,000; \$\$\$\$ (Large) \$150,000 to \$250,000; \$\$\$\$\$ (Very Large) > \$250,000

Category 1: MARS as the primary LOLE tool

- Q1. What factors most concern PJM for replacing PRISM with MARS? What impacts would be seen in time and economic resources?

- Q2. Why is PJM reluctant to replace PRISM with MARS?

- Q3. Please recap the discussion at the December 3, 2010 RRAWG (predecessor to RAAS) meeting concerning the MARS solution process.
 - A. How does MARS' "pipe" values come into play for transmission limits? Please relate this to FCITC values determined in load flow assessments.

 - B. How does MARS address or model diversity in its assessment?

 - C. Are there any tools or techniques for choosing the 8760 hourly load values?

 - D. How does MARS uses its linear program algorithm to reach a solution? Explain how it performs reserve sharing but not load loss sharing.

 - E. From an academic viewpoint, theoretically, can MARS have more than one unique solution for a large regional model?



Category 1: MARS as the primary LOLE tool (cont.)

Q4. What steps are needed to encourage adoption of MARS as the LOLE tool of choice, going forward?

Category 2: MARS resource needs and computing speed

Q5. Does running MARS take more “horsepower”, including computing power and manpower, to perform studies?

Q6. Could MARS runs be processed faster (with fewer resources) than what GE or PJM has already indicated? – (As shown in the Resource and Cost Assessment Section)

Q7. Why does MARS can have long run times?

Q8. What are the details of why MARS requires much more staff time than PRISM?

Q9. What activities are done for the hours listed in the MARS Resource and Cost Assessment section? They seem way too large?

Q10. What incremental efforts are meant to be done by PJM related to items listed in the MARS Resource and Cost Assessment section?



Category 3: MARS Advantages

- Q11. Does MARS represent a big advantage due to its obvious multi-area capability?
- Q12. Would the full implementation of MARS enhance PJM's contribution to the interregional planning initiatives such as the Interregional Planning Stakeholders Advisory Committee (IPSAC)?
- Q13. What is MARS' biggest advantage?

Category 4: Clarify MARS limitations

- Q14. Why is the MARS output in flat text files (which have to be cut and pasted into Excel) for further assessment efforts?
- Q15. Why is MARS limited to a 5 year look-ahead?
- Q16. Why does MARS have many more input tables compared to PRISM?

Category 5: PRISM Advantages

- Q17. What is PRISM's biggest advantage? .
- Q18. What are the specifics concerning PJM's blended approach in using both PRISM and MARS? When is each tool is used for the identified task at hand?



Items from Appendix G:

1. Detail / explain MARS current analysis efforts with PRISM
2. Explore PRISM's ability to assist MARS in determining Load Forecast Uncertainty
3. Explore MARS' ability for high ambient conditions on generation performance.
4. Develop analytical MARS output reporting process
5. Analyze MARS hourly load shape
6. Investigate neighboring RTO/ISO's reporting of IRM with MARS.
7. Enter Non-Disclosure Agreements (NDAs) with neighboring systems

Items from the Resource and Cost Assessment section:

8. Assess treatment of Emergency Operating Procedures (EOPs)
9. Assess specific path-related contracts
10. Assess load forecast uncertainty values
11. Assess transmission pipe (interface tie) sizes
12. Assess "severe case" assumptions and sensitivities
13. Aggregate and evaluate individual assessments (items 8-12)



RAAS Work Efforts & Direction Going Forward

- RAAS Drafting Team addressed more than 80 comments over the course of a one-year drafting effort, including numerous presentations and updates.
- RAAS endorsed this report at the February 17 meeting.
- Report posted to PJM website including other related technical summaries.
- Further action would have to be developed within the guidelines of PJM's Governance Assessment Special Team (GAST) process. This would involve the development of a "Problem Statement" with specific objectives and scope of work.



Questions

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