Discussion of RRS Assumptions

Patricio Rocha Garrido
Sr. Engineer
Resource Adequacy Planning
01/26/2016

Assumptions to be discussed

- Impact of modeling DR in RRS
- Load Model Selection Process
- World Modeling (Capacity Benefit of Ties, CBOT)

Impact of Modeling DR in RRS

- Current Practice: No DR is modeled in the RRS
  - Current DR products are not available during the entire year
  - Difficult to forecast amount of DR three years ahead
- Procedure to Investigate Assumption
  - Add a certain amount of DR to an RRS case
    - Model as one large generator with 0% EEFORd
    - Model as multiple smaller generators with 0% EEFORd
  - Calculate IRM and FPR; compare to IRM and FPR without DR

- Results of Investigation
  - Using 1 large generator to model DR yields the same result as using multiple smaller generators.
  - Consider the following two sets of generators

Case 1

Unit	ICAP	EEFORd
Gen 1	100	0.05
Gen 2	80	0.07
DR 1	1000	0

Case 2

Unit	ICAP	EEFORd
Gen 1	100	0.05
Gen 2	80	0.07
DR 1	500	0
DR 2	500	0

Impact of Modeling DR in RRS

Case 1

Gen 1 = 100 MW
Gen 2 = 80 MW

Gen 1	Gen 2	Total Available Capacity	Prob
On	On	180	0.8835
Off	On	80	0.0465
On	Off	100	0.0665
Off	Off	0	0.0035

Gen 1 = 100 MW
Gen 2 = 80 MW
DR 1 = 1000 MW

Gen 1	Gen 2	DR 1	Total Available Capacity	Prob
On	On	On	1180	0.8835
Off	On	On	1080	0.0465
On	Off	On	1100	0.0665
Off	Off	On	1000	0.0035
On	On	Off	180	0
Off	On	Off	80	0
On	Off	Off	100	0
Off	Off	Off	0	0

The states that have non-zero probabilities are identical in Cases 1 and 2. This would be true even if Case 2 had added 1,000 units rated at 1 MW each with a 0% EEFORd.

Case 2

Gen 1 = 100 MW
Gen 2 = 80 MW

Gen 1	Gen 2	Total Available Capacity	Prob
On	On	180	0.8835
Off	On	80	0.0465
On	Off	100	0.0665
Off	Off	0	0.0035

Gen 1 = 100 MW
Gen 2 = 80 MW
DR 1 = 500 MW

Gen 1	Gen 2	DR 1	Total Available Capacity	Prob
On	On	On	680	0.8835
Off	On	On	580	0.0465
On	Off	On	600	0.0665
Off	Off	On	500	0.0035
On	On	Off	180	0
Off	On	Off	80	0
On	Off	Off	100	0
Off	Off	Off	0	0

Gen 1 = 100 MW
Gen 2 = 80 MW
DR 1 = 500 MW
DR 2 = 500 MW

Gen 1	Gen 2	DR 1	DR 2	Total Available Capacity	Prob
On	On	On	On	1180	0.8835
Off	On	On	On	1080	0.0465
On	Off	On	On	1100	0.0665
Off	Off	On	On	1000	0.0035
On	On	Off	On	680	0
Off	On	Off	On	580	0
On	Off	Off	On	600	0
Off	Off	Off	On	500	0
On	On	On	Off	680	0
Off	On	On	Off	580	0
On	Off	On	Off	600	0
Off	Off	On	Off	500	0
On	On	Off	Off	180	0
Off	On	Off	Off	80	0
On	Off	Off	Off	100	0
Off	Off	Off	Off	0	0

Impact of Modeling DR in RRS

- Results of Investigation
  - Adding DR in the RRS decreases the IRM but leaves the FPR unchanged
    - We ran an RRS case with 175,560 MW of generation only ICAP and an average EFORd of 0.0652.
      - The resulting single area IRM was = 18.1 while the FPR was 1.181 x (1-0.0652) = 1.1040
    - We then replaced 6,190 MW of generation with 7 DR resources modeled as generators with 100% availability (6 generators of 1,000 MW each and one of 190 MW). Total ICAP was 175,560 and average EFORd was 0.0613
      - The resulting single area IRM was = 17.5 while the FPR was 1.175 x (1-0.0613) = 1.1030

Impact of Modeling DR in RRS

- Results of Investigation
  - The IRM decreases from 18.1 to 17.5.
  - The FPR shows a mild decrease from 1.1040 to 1.1030 due to rounding
  - If the FPRs are applied to a 160,000 MW load forecast, the apparent reduction in FPR amounts to a decrease in the reliability requirement of 160 MW (0.001 x 160,000).
- Conclusion
  - Because the amount of DR is difficult to forecast and its impact on the FPR is negligible, we should continue our current practice of not modeling DR in RRS.

- Current Practice: LM is selected based on how well the annual peak distribution produced with a candidate LM matches the annual peak distribution (CP1) from the Load Forecast.
  - Approaches 1 and 2 (described in RRS Education Session 1) are used to produce annual peak distributions from candidate LMs
- Procedure to Investigate Assumption
  - Discussion of merits of current and alternative approaches

- Procedure to Investigate Assumption – Discussion of Current Procedure
  1. In a magnitude-order PRISM LM, such as those produced by PLOTS and used in the RRS, it is incorrect to assume that the annual peak can occur in a week other than the peak week.
  2. Should we compute the single-area IRM/FPR using the CP distributions instead of using the PRISM load model?
  3. If we continue to use the PRISM load model selection process, it is important to note that the CP1 distribution represents only one day. Its impact is limited to the distribution of the PRISM peak week. How do we choose the distributions for the other 51 weeks?

Load Model Selection Process

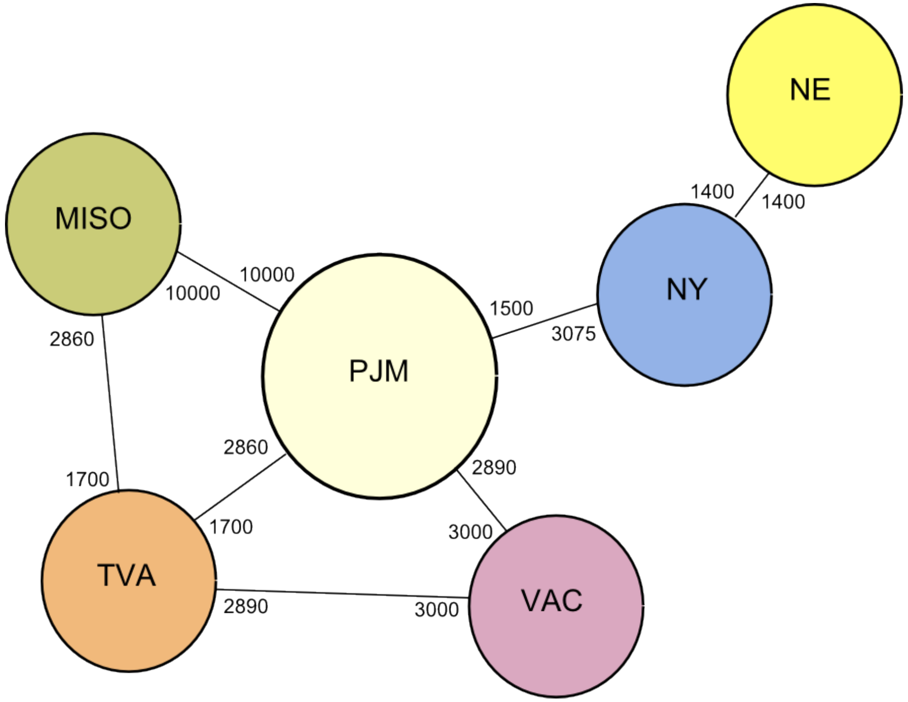
- Results of Investigation
  - Alternative Load Model Selection Processes
    - # 1: Retain current procedure (Approaches 1 and 2) but modify it to recognize that the annual peak can only occur on peak week
      - Impact on 2019 Single Area IRM: 0
      - Addresses point 1 in slide 9. Leaves other points unaddressed.
    - # 2: Use CPs from Load Forecast to calculate single area IRM/FPR
      - Impact on 2019 Single Area IRM: +0.1%
      - Addresses point 2 in slide 9. Rest of points do not apply
      - Significant software challenge since we use PRISM to compute CETOs (PRISM cannot use CP distributions)
      - To address the bullet immediately above, we could select a PRISM LM that produces the same single area IRM as the CP distributions (however, point 3 in slide 9 would be unaddressed)
      - CP distributions might not properly account for extreme events as Normal Distributions do (especially, in LDAs)

- Results of Investigation
  - Alternative Load Model Selection Processes
    - #3: Use a LM that includes all available load history (from 1998 on)
      - Impact on 2019 Single Area IRM: -0.4%
      - CP1 distribution would become irrelevant
      - This approach would address point 3 on slide 9

World Modeling (CBOT)

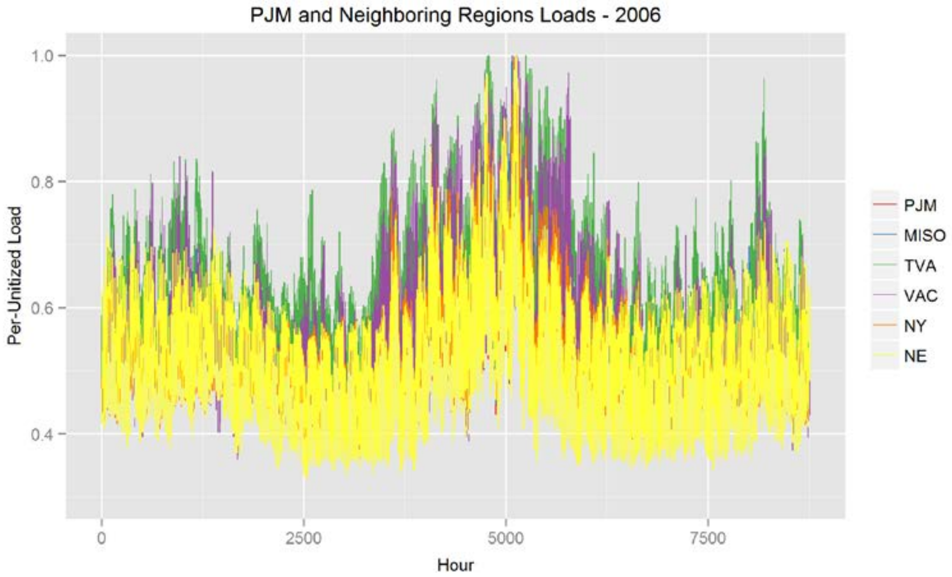
- Current Practice: Neighboring regions (NYISO, TVA, VACAR, MISO, ISO-NE) are grouped into a single region called World
  - Simplified technique that could potentially overlook some load diversity between the regions
  - CBOT values in last 5 RRS have ranged between 1.6% and 1.9%
- Procedure to Investigate Assumption
  - Use GE-MARS to model PJM and each of the 5 neighboring regions separately.
  - Calculate resulting PJM CBOTs by using single-year load shapes over the period 2002-2013

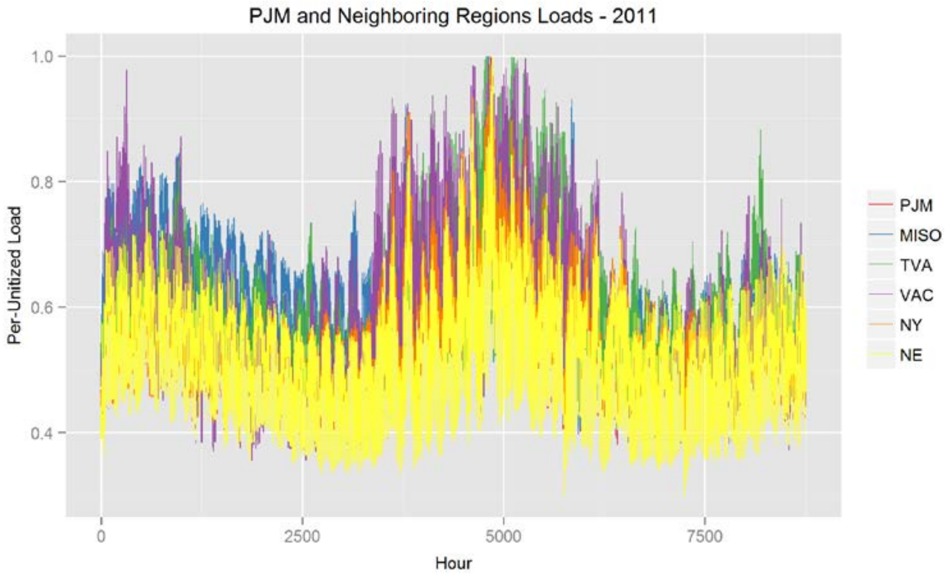
- Procedure to Investigate Assumption - Overview



- Simultaneous transfer limits per NPCC CP-8 WG model (larger than PJM's Capacity Import Limit Study)
- Simultaneous PJM imports limited to 3500 MW (CBM)
- ICAP for each region per 2015 RRS
- Load Forecast Uncertainty (LFU) for each region sampled from PLOTS Load Model time period used in 2015 RRS
- Each area is solved to 1 in 10
- Assistance priority within pool first (then, in the following order: PJM, MISO, TVA, VAC, NY, NE)

- Procedure to Investigate Assumption – Load Shapes
  - We calculated CBOTs for Load Shapes from individual years in the period 2002-2013





- Results of Investigation

Load Shape Year	CBOT
2002	1.2
2003	2.3
2004	1.2
2005	0.6
2006	0.3
2007	1.3
2008	2.1
2009	1.6
2010	1.5
2011	1.9
2012	0.8
2013	0.5
Average	**1.3**

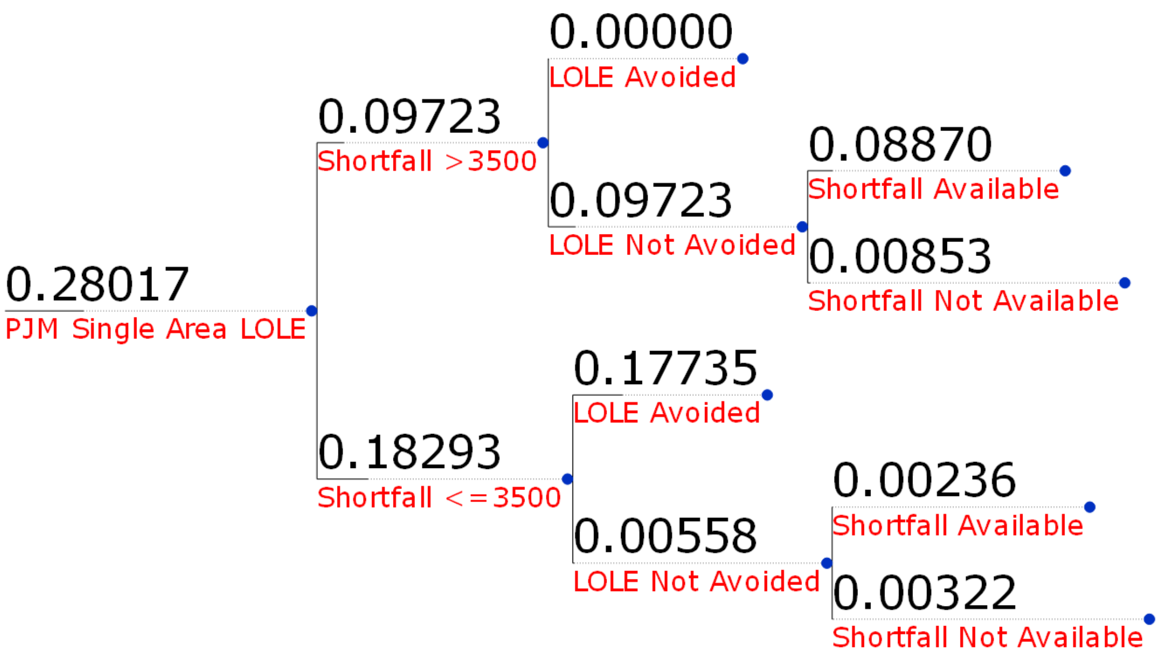
As a reference, these are the historical CBOTs in the past 11 RRS.

RRS	CBOT
2015	1.7
2014	1.9
2013	1.6
2012	1.9
2011	1.8
2010	1.8
2009	1.8
2008	1.2
2007	1.2
2006	1.8
2005	1.9
Average	**1.7**

Appendix

- Results of Investigation – 2003 CBOT = 2.3%

mars2003, Avg. Shortfall = 3012.5 MW

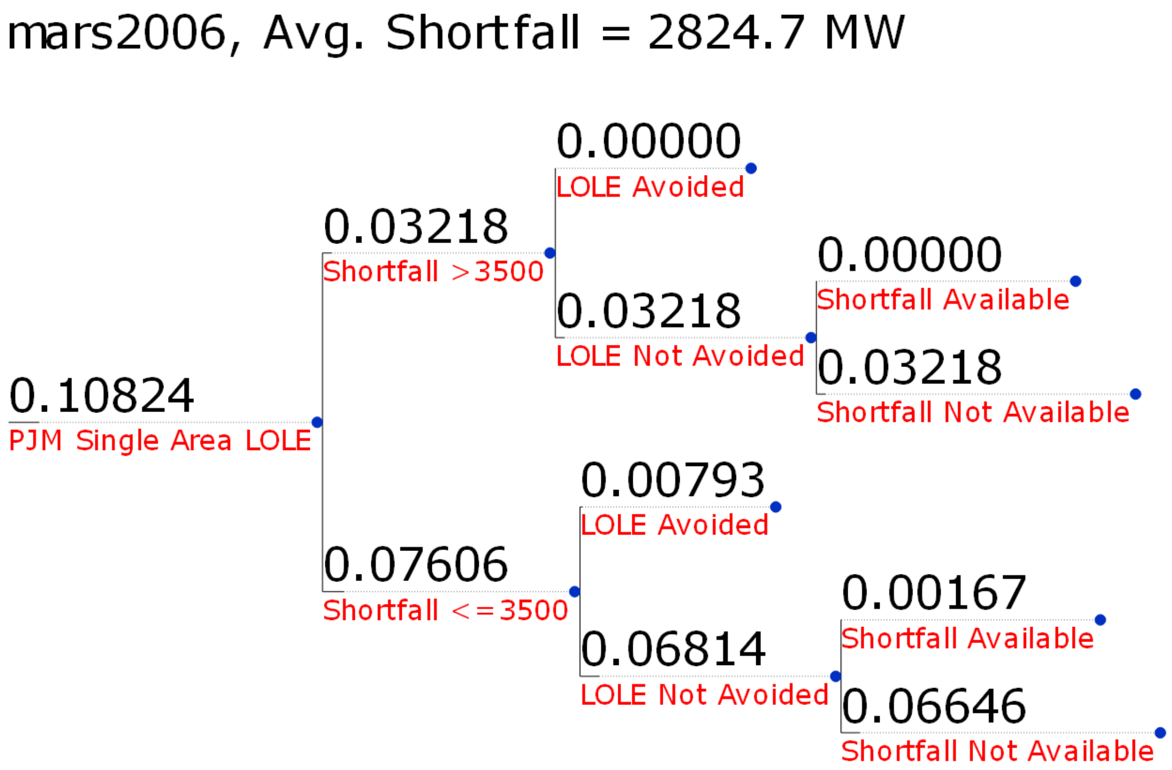


Around 65% of LOLE is attributable to events where shortfall is less than or equal to 3500 MW.

Of these events, LOLE was avoided 97% of the time.

Of the events where the LOLE shortfall was greater than 3500 MW, in 91% of the cases there was enough capacity in the World. However, the 3500 MW CBM limit prevented this capacity from getting to PJM.

- Results of Investigation – 2006 CBOT = 0.3%

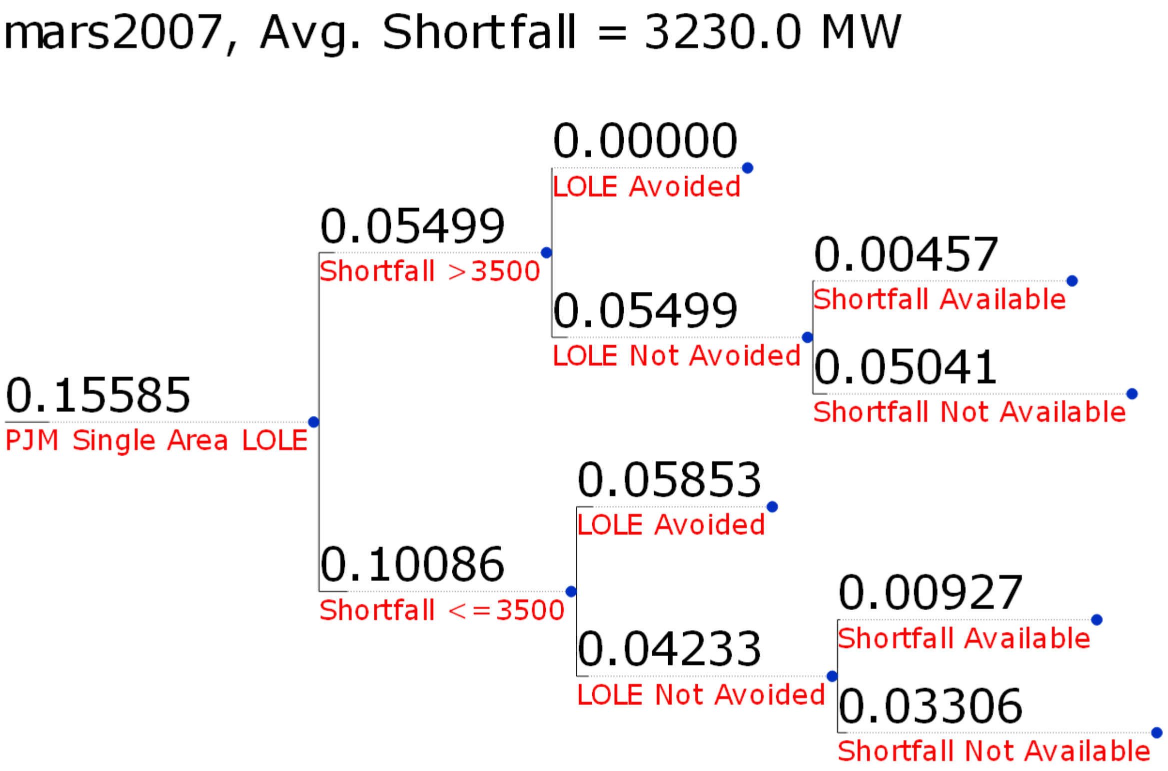


Around 70% of LOLE is attributable to events where shortfall is less than or equal to 3500 MW.

Of these events, LOLE was avoided 10% of the time. LOLE was not avoided in 90% of the cases (mostly, 98%, due to insufficient capacity in the World)

Of the events where the LOLE shortfall was greater than 3500 MW, in 0% of the cases there was enough capacity in the World.

- Results of Investigation – 2007 CBOT = 1.3%



Around 65% of LOLE is attributable to events where shortfall is less than or equal to 3500 MW.

Of these events, LOLE was avoided 58% of the time. LOLE was not avoided in 42% of the cases (mostly, 78%, due to insufficient capacity in the World)

Of the events where the LOLE shortfall was greater than 3500 MW, in 8% of the cases there was enough capacity in the World. However, the 3500 MW CBM limit prevented this capacity from getting to PJM.

