PJM Load Model Selection for 2018 RRS

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Background

- Analysis based on method approved at June 9, 2016 PC meeting (Appendix V in 2016 RRS Assumptions Letter)
- Based on 2018 Load Forecast Report. Focus is on 2022/23 Delivery Year.

Comparing PJM Load Forecast with PLOTS/PRISM

PJM Load Forecast

- Load history from 1998 -2017 used to develop daily peak load forecast regression models
- Uses 23 years of weather history to develop a range of forecasted loads
- Model based on Calendar Year
- Produces a median (50/50) load and seasonal distribution of daily peaks
- Relationship between 12 monthly peaks

PLOTS/ PRISM

- Uses 7+ years of historic hourly loads
- 12 monthly forecasted loads to obtain forecast monthly load shape of DY 2022/23
- Model based on Delivery Year (DY)
- Produces magnitude-ordered daily peak load distributions for each week

PJM Load Model Selection Criteria

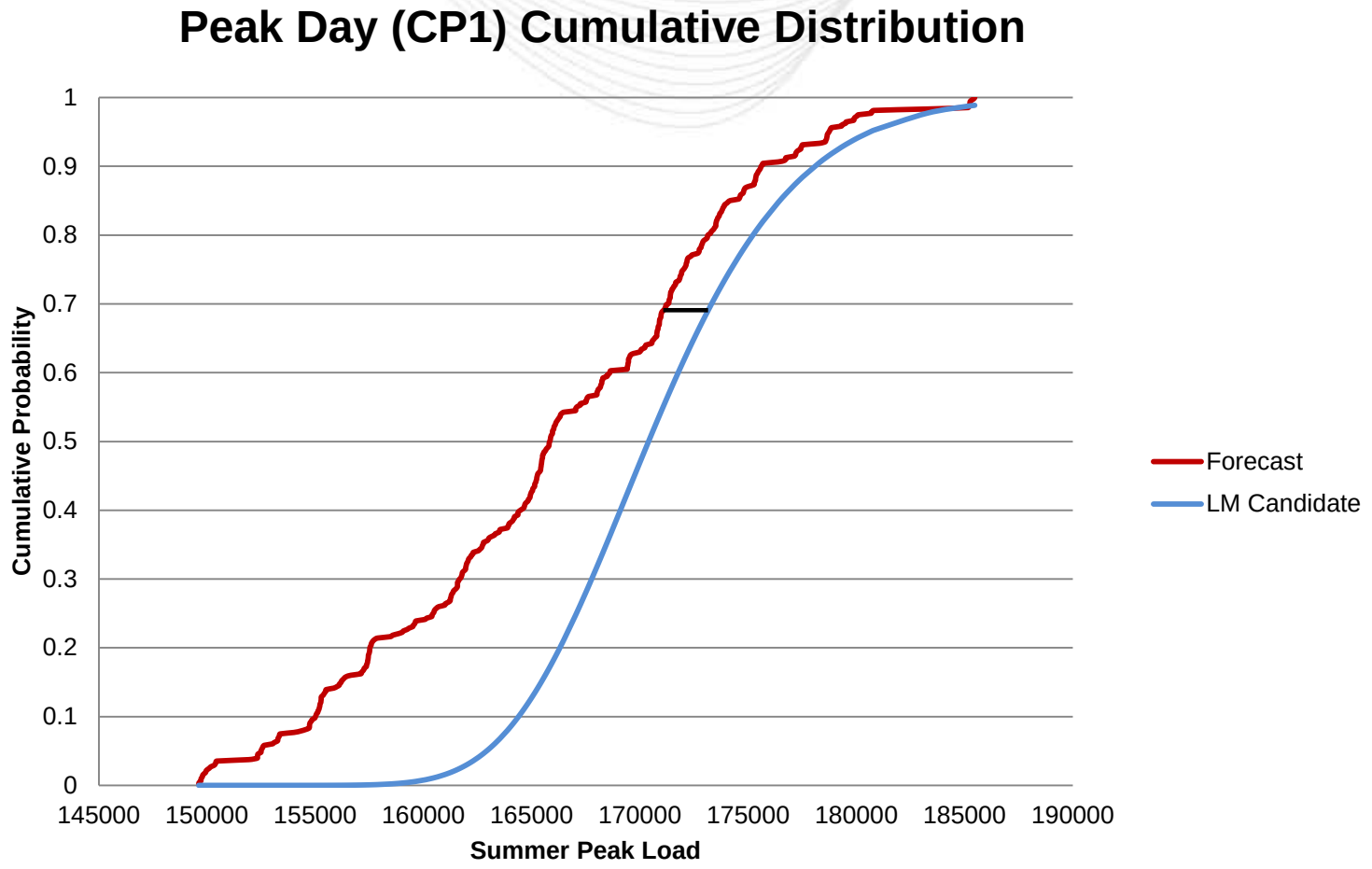
Criteria

- Include most recent data to capture load patterns
- Include more historical years to reduce sensitivity from abnormal years (e.g.: 2006)
- Choose IRM Study load models that are consistent with the Load Forecast Model distributions.
- Consider historical PJM/World load diversity

PJM Load Model Combinations to Assess

Load Model #	Description	Load Model #	Description
51790	1998-2015 18 Year LM	51751	2001-2010 10 Year LM
51791	1998-2014 17 Year LM	51752	2002-2011 10 Year LM
51792	1999-2015 17 Year LM	51753	2003-2012 10 Year LM
51793	1998-2013 16 Year LM	51754	2004-2013 10 Year LM
51794	1999-2014 16 Year LM	51755	2005-2014 10 Year LM
51795	2000-2015 16 Year LM	51756	2006-2015 10 Year LM
51796	1998-2012 15 Year LM	51757	1998-2006 9 Year LM
51797	1999-2013 15 Year LM	51758	1999-2007 9 Year LM
51798	2000-2014 15 Year LM	51759	2000-2008 9 Year LM
51799	2001-2015 15 Year LM	51760	2001-2009 9 Year LM
51800	1998-2011 14 Year LM	51761	2002-2010 9 Year LM
51801	1999-2012 14 Year LM	51762	2003-2011 9 Year LM
51802	2000-2013 14 Year LM	51763	2004-2012 9 Year LM
51803	2001-2014 14 Year LM	51764	2005-2013 9 Year LM
51804	2002-2015 14 Year LM	51765	2006-2014 9 Year LM
51805	1998-2010 13 Year LM	51766	2007-2015 9 Year LM
51806	1999-2011 13 Year LM	51767	1998-2005 8 Year LM
51807	2000-2012 13 Year LM	51768	1999-2006 8 Year LM
51808	2001-2013 13 Year LM	51769	2000-2007 8 Year LM
51809	2002-2014 13 Year LM	51770	2001-2008 8 Year LM
51810	2003-2015 13 Year LM	51771	2002-2009 8 Year LM
51811	1998-2009 12 Year LM	51772	2003-2010 8 Year LM
51812	1999-2010 12 Year LM	51773	2004-2011 8 Year LM
51813	2000-2011 12 Year LM	51774	2005-2012 8 Year LM
51814	2001-2012 12 Year LM	51775	2006-2013 8 Year LM
51815	2002-2013 12 Year LM	51776	2007-2014 8 Year LM
51816	2003-2014 12 Year LM	51777	2008-2015 8 Year LM
51817	2004-2015 12 Year LM	51778	1998-2004 7 Year LM
51818	1998-2008 11 Year LM	51779	1999-2005 7 Year LM
51819	1999-2009 11 Year LM	51780	2000-2006 7 Year LM
51820	2000-2010 11 Year LM	51781	2001-2007 7 Year LM
51821	2001-2011 11 Year LM	51782	2002-2008 7 Year LM
51822	2002-2012 11 Year LM	51783	2003-2009 7 Year LM
51823	2003-2013 11 Year LM	51784	2004-2010 7 Year LM
51824	2004-2014 11 Year LM	51785	2005-2011 7 Year LM
51825	2005-2015 11 Year LM	51786	2006-2012 7 Year LM
51826	1998-2007 10 Year LM	51787	2007-2013 7 Year LM
51827	1999-2008 10 Year LM	51788	2008-2014 7 Year LM
51828	2000-2009 10 Year LM	51789	2009-2015 7 Year LM

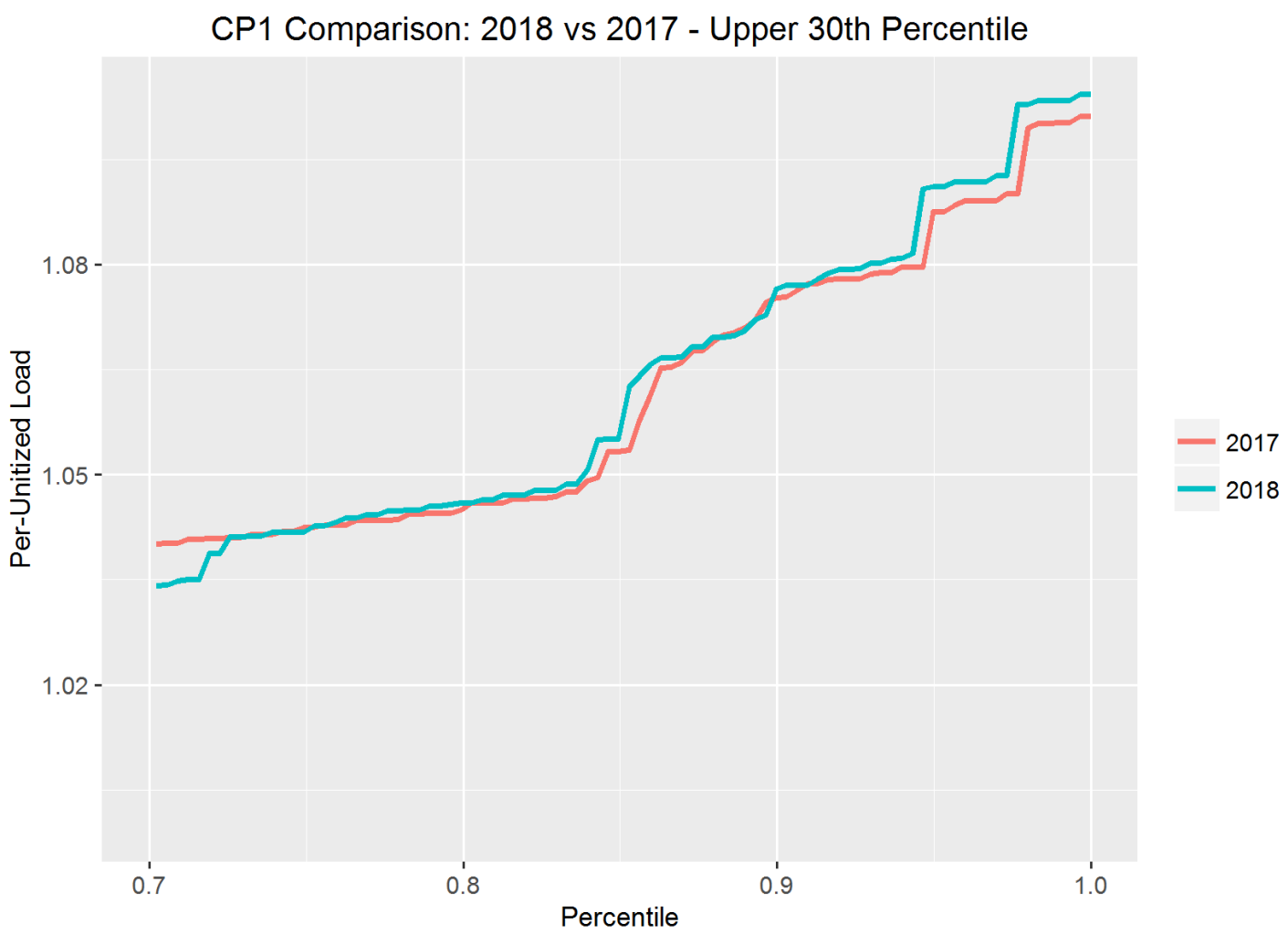
Rationale Behind Load Model Selection Approach



PJM Load Model Selection

- For each PLOTS Load Model Candidate:
  - Calculate weekly parameters using:
    - PLOTS mean and std. deviations
    - PJM forecasted monthly loads for 22/23 DY
    - Forecast Error Factor (FEF)= 0.01

Load Forecast Model CP1 Distribution - 2017 vs 2018

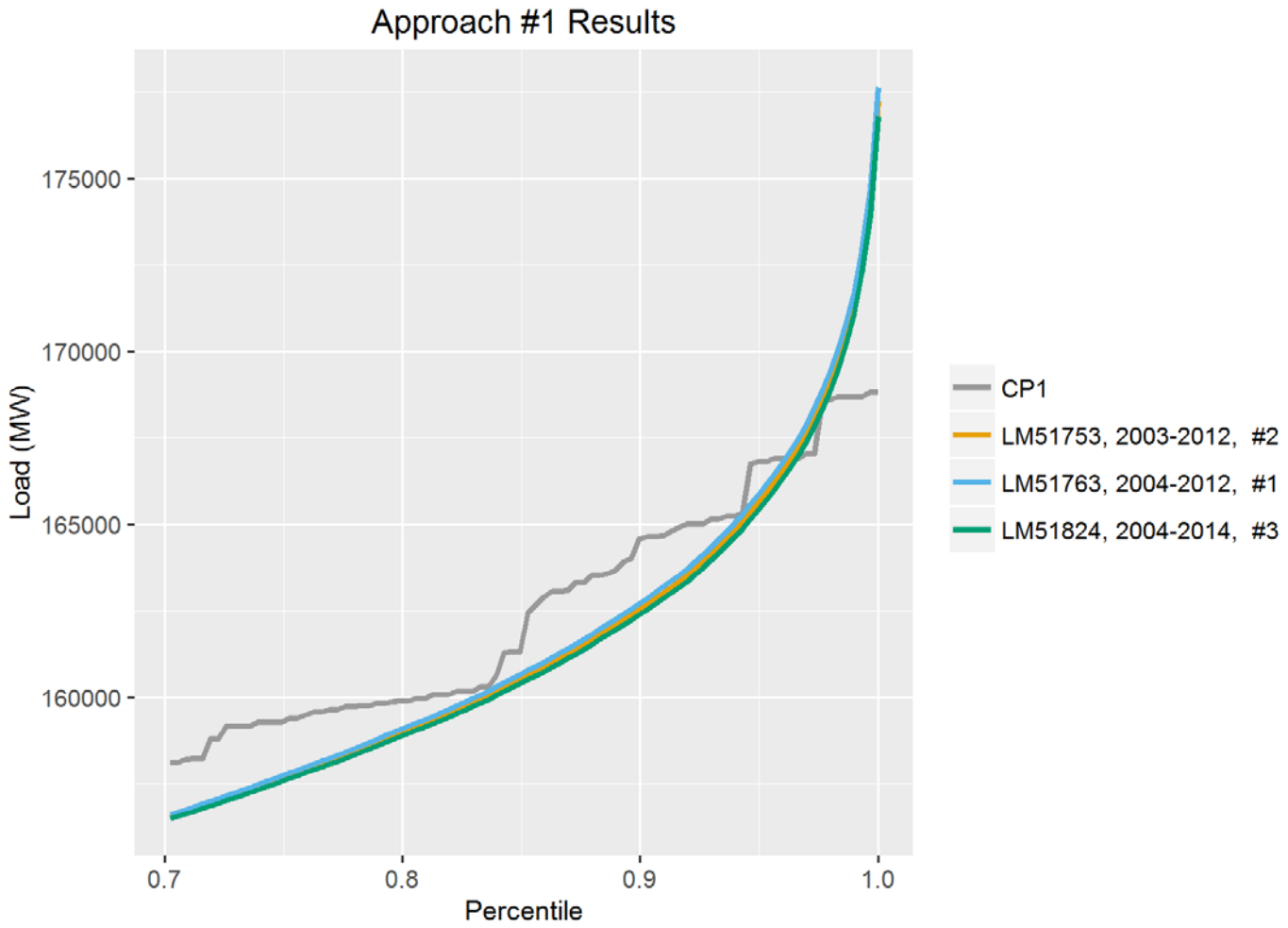


PJM Load Model Selection – Approach 1

Approach 1 – Summer Seasonal Peak CDF

- 5 random draws from peak week to represent weekday daily peaks
- Calculate highest load from 5 weekdays - Seasonal Peak
- Generate 299 scenarios and develop CDF

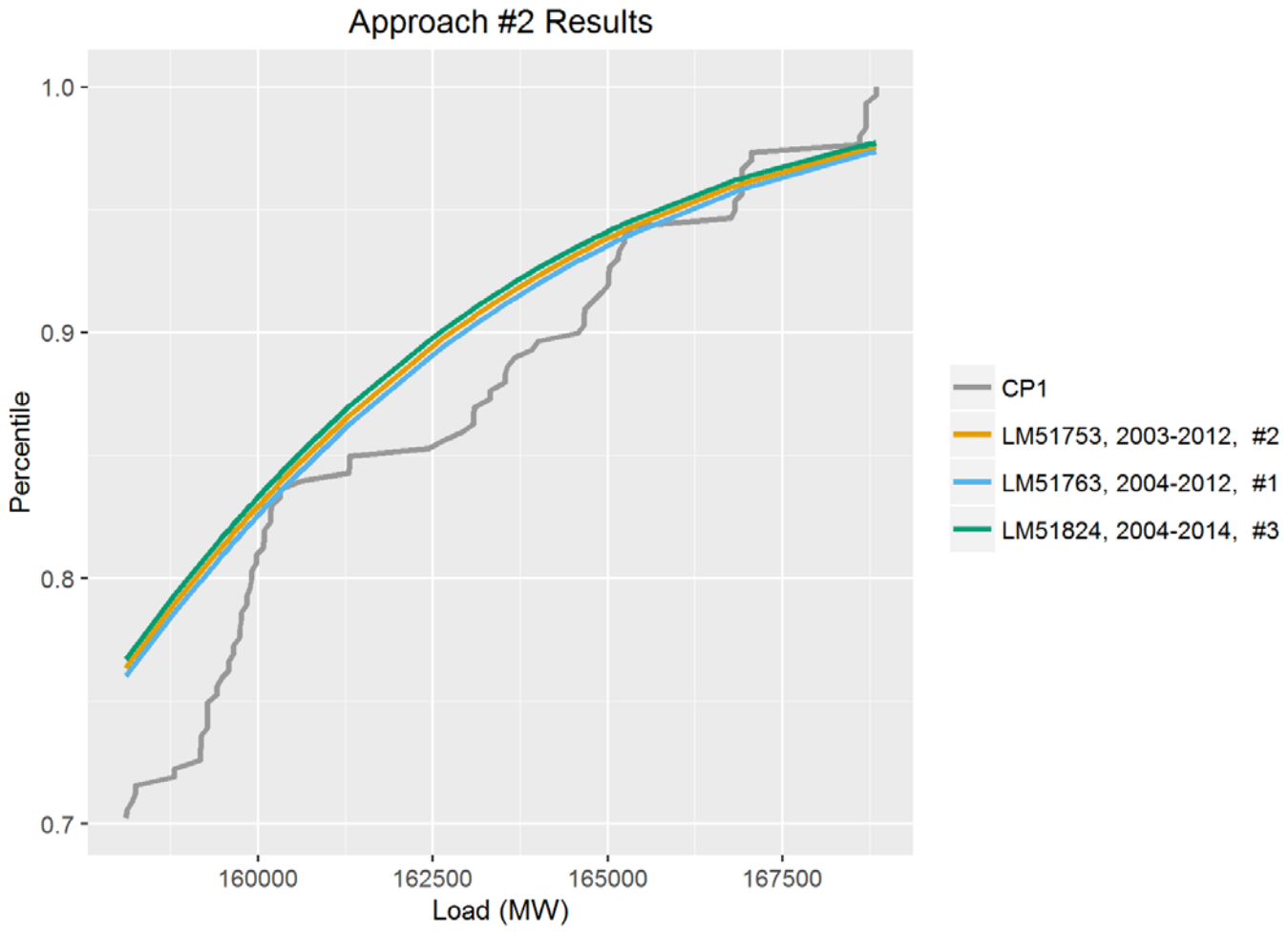
PJM Load Model Selection – Approach 1



Approach 2

- Use 299 summer seasonal peak loads from load forecast and associated cumulative probability (CDF of CP1)
- For each PLOTS load model
  - Use peak week distribution
  - Calculate probability of drawing a value less than or equal to each of the 299 seasonal peaks from the peak week distributions
  - Calculate absolute error between the above computed probability and the respective probability in the CP1 CDF

PJM Load Model Selection – Approach 2



PJM Selected Load Models

- Load Model (LM) Choices
  - 51763: 2004-2012 9 YR LM
  - 51753: 2003-2012 10 YR LM
  - 51824: 2004-2014 11 YR LM
- Last year's selected LM (2003 – 2012) is one of the top candidates this year.
  - It is a close second place under both approaches
  - It includes an additional year worth of load data compared to the best ranked LM (2004 – 2012)

World Load Models

- World Load Models were created using PLOTS program, observing the same historic time periods. In so doing, we consider the PJM/World diversity.
  - Uses historic Coincident Peak pattern
  - World defined as MISO, NY, TVA, and VACAR.

LM #51763 (2004-2012) - PJM vs World Assessment

Month	WK #	**PJM RTO** LM #51763 9 Yr Load Model - 2004 - 2012 Per-Unitized Peak	**World Region** LM #51841 Per-Unitized Peak
June	5	0.8429	0.8815
June	6	0.9236	0.9458
June	7	0.9420	0.9586
July	8	0.8597	0.9121
July	9	0.8998	0.9530
July	10	1.0000	1.0000
July	11	0.9261	0.9706
August	12	0.9696	0.9958
August	13	0.9453	0.9514
August	14	0.8515	0.8739
August	15	0.8186	0.8652

LM #51753 (2003-2012) - PJM vs World Assessment

Month	WK #	**PJM RTO** LM #51753 10 Yr Load Model - 2003 - 2012 Per-Unitized Peak	**World Region** LM #51842 Per-Unitized Peak
June	5	0.8279	0.8775
June	6	0.9420	0.9463
June	7	0.8913	0.9586
July	8	0.8734	0.9071
July	9	0.9033	0.9556
July	10	1.0000	1.0000
July	11	0.9303	0.9738
August	12	0.9696	0.9958
August	13	0.9454	0.9543
August	14	0.8685	0.8877
August	15	0.8373	0.8687

LM #51824 (2004-2014) - PJM vs World Assessment

Month	WK #	**PJM RTO** LM #51824 11 Yr Load Model - 2004 - 2014 Per-Unitized Peak	**World Region** LM #51843 Per-Unitized Peak
June	5	0.8441	0.8823
June	6	0.9099	0.9464
June	7	0.9420	0.9586
July	8	0.8744	0.8891
July	9	0.9001	0.9282
July	10	1.0000	1.0000
July	11	0.9228	0.9446
August	12	0.9696	0.9958
August	13	0.9401	0.9845
August	14	0.8475	0.9016
August	15	0.8145	0.8701

Historical Peak Load Coincidence PJM / World

Year	PJM Peak - Actual Date	World Peak - Actual Date	Peak Coincidence?
1998	21-Jul-98	21-Jul-98	Yes
1999	30-Jul-99	28-Jul-99	No
2000	9-Aug-00	31-Aug-00	No
2001	9-Aug-01	8-Aug-01	No
2002	1-Aug-02	1-Aug-02	Yes
2003	21-Aug-03	14-Aug-03	No
2004	3-Aug-04	2-Aug-04	No
2005	26-Jul-05	3-Aug-05	No
2006	2-Aug-06	1-Aug-06	No
2007	8-Aug-07	8-Aug-07	Yes
2008	9-Jun-08	21-Jul-08	No
2009	10-Aug-09	10-Aug-09	Yes
2010	7-Jul-10	4-Aug-10	No
2011	21-Jul-11	20-Jul-11	No
2012	17-Jul-12	17-Jul-12	Yes
2013	18-Jul-13	18-Jul-13	Yes
2014	7-Jan-14	7-Jan-14	Yes
2015	28-Jul-15	28-Jul-15	Yes
2016	11-Aug-16	21-Jul-16	No

In the last 19 years, PJM and the World **have not peaked** on the same day 11 times.

LM #51753 (2003-2012) - Switching of World peak week

Month	WK #	**PJM RTO** LM #51753 10 Yr Load Model - 2003 - 2012 Per-Unitized Peak	**World Region** LM #51842 Per-Unitized Peak
July	8	0.8734	0.9071
July	9	0.9033	0.9556
July	10	1.0000	0.9738
July	11	0.9303	1.0000

World peak week is now on Week 11. Originally, it was in Week 10.

2018 RRS Load Model Recommendation

- PJM recommendation to RAAS on selection of historical time period for load model:
  - **Use 10yr (2003-2012, #51753) Load Model for 2018 RRS Base Case and switch World peak to a different July week so that PJM and World peak on the same month but not on the same week.**
    - It was used in the 2016 RRS and 2017 RRS
    - It is a close second place under both approaches but it includes more load data than the load model occupying the first place
    - Switch in World peak week is performed to match historical diversity observed between PJM and World