

ITEM 1: Forecast Error Factor

The probabilistic load model used in the IRM Study captures only weather uncertainty. It does not account for the uncertainty associated with non-weather drivers of load such as economics or energy usage patterns. These factors are captured through use of a Forecast Error Factor (FEF). PJM currently uses an FEF of 1% across all forecast years.

To compute an appropriate FEF for use in the IRM Study, PJM performed the following analysis:

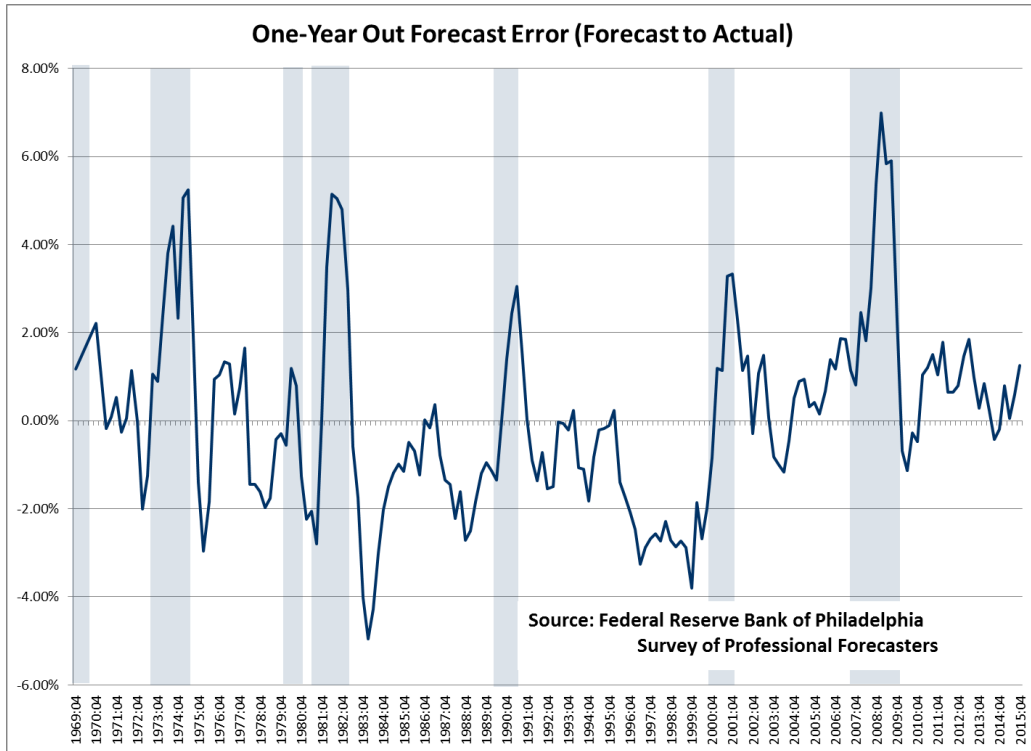
Seven forecast runs were conducted from 2009 to 2015 and were compared with weather normal peak values. Each forecast run was done using vintage data that would have been available at the time of the forecast. That is, a 2009 forecast used only load history through August 2008 as well as economics and equipment/appliance data from 2008.

		Ratio of Forecast to Weather Normal						
		Year						
Forecast Vintage		2009	2010	2011	2012	2013	2014	2015
	2009	1.01	1.00	1.03	1.05			
	2010		0.99	1.01	1.03	1.08		
	2011			1.00	1.01	1.06	1.07	
	2012				0.99	1.03	1.05	1.06
	2013					1.02	1.03	1.04
	2014						1.01	1.02
	2015							1.01

The root mean square error (RMSE) was then calculated by number of years out for the forecast (values of 0 to 3). RMSE is the square root of the average squared deviation, a common measure of accuracy.

Root Mean Square Error (RMSE)			
Forecast years out			
0	1	2	3
0.94%	2.16%	4.37%	6.65%

PJM also looked into economic forecast error, as this is a large contributor to perceived uncertainty. Unfortunately, there is not a lot of history in gauging the accuracy of long-term economic forecasts. The Federal Reserve Bank of Philadelphia conducts the Survey of Professional Forecasters, which captures the 5-quarter forecast (current quarter plus four quarters) of a wide range of economic indicators. Below is the accuracy of the 4 quarter out economic forecast.



Over history, there is no inherent bias (average error is 0.05%). However, in periods of recession (the shaded areas in the graph), there is a clear tendency for economic over-forecasting. The time period in which we currently have to evaluate the FEF is only over a period in which there tends to be over-forecasting.

PJM recommends maintaining the current FEF of 1% for the following reasons.

- We do not have an adequate sample by which to anchor expectations of future error.
- Even though the data would perhaps indicate the appropriateness of a higher FEF, the error has not been symmetric. It does not make intuitive sense to increase the IRM due to recent over-forecasting of load.
- The existence of incremental auctions allows for a restatement of parameters. In the year of the final incremental auction (corresponding to the zero-year out forecast), the implied FEF is approximately 1%.

ITEM 2: IRM if PJM peaks on the same week as World

The IRM would depend on the time period selected to construct the load model. The CBOT, however, would drop to 0.7%-0.9% (in the 2015 RRS, the CBOT was 1.7%). This CBOT seems rather low given our recent MARS analysis which resulted in a 1.3% average CBOT.

Note that this low result (0.7%-0.9%) is impacted by the weekly nature of PRISM, which uses a single normal distribution to model the 5 weekdays in a week.

ITEM 3: Annual Peak Coincidence between PJM and World

PJM vs WORLD

YEAR	HOUR?	DAY?	WEEK?	PJM PEAK	WORLD PEAK	DIFF
2002	no	yes	yes	8/1/2002 17:00	8/1/2002 16:00	1:00:00
2003	no	no	no	8/21/2003 17:00	8/14/2003 16:00	7 days, 1:00:00
2004	no	no	yes	8/3/2004 17:00	8/2/2004 18:00	23:00:00
2005	no	no	no	7/26/2005 16:00	8/3/2005 16:00	8 days, 0:00:00
2006	no	yes	yes	8/2/2006 17:00	8/2/2006 16:00	1:00:00
2007	no	yes	yes	8/8/2007 16:00	8/8/2007 17:00	1:00:00
2008	no	no	no	6/9/2008 17:00	7/21/2008 16:00	41 days, 23:00:00
2009	yes	yes	yes	8/10/2009 16:00	8/10/2009 16:00	0:00:00
2010	yes	yes	yes	7/7/2010 17:00	7/7/2010 17:00	0:00:00
2011	no	yes	yes	7/21/2011 17:00	7/21/2011 16:00	1:00:00
2012	no	yes	yes	7/17/2012 17:00	7/17/2012 16:00	1:00:00
2013	no	yes	yes	7/18/2013 17:00	7/18/2013 16:00	1:00:00

PJM vs MISO

YEAR	HOUR?	DAY?	WEEK?	PJM PEAK	WORLD PEAK	DIFF
2002	no	yes	yes	8/1/2002 17:00	8/1/2002 16:00	1:00:00
2003	no	no	no	8/21/2003 17:00	6/24/2003 17:00	58 days, 0:00:00
2004	yes	yes	yes	8/3/2004 17:00	8/3/2004 17:00	0:00:00
2005	no	no	no	7/26/2005 16:00	8/3/2005 16:00	8 days, 0:00:00
2006	no	no	yes	8/2/2006 17:00	7/31/2006 16:00	2 days, 1:00:00
2007	no	no	yes	8/8/2007 16:00	8/7/2007 17:00	23:00:00
2008	no	no	no	6/9/2008 17:00	7/29/2008 16:00	49 days, 23:00:00
2009	no	no	no	8/10/2009 16:00	6/25/2009 16:00	46 days, 0:00:00
2010	no	yes	yes	7/7/2010 17:00	7/7/2010 16:00	1:00:00
2011	no	no	yes	7/21/2011 17:00	7/20/2011 17:00	1 day, 0:00:00
2012	no	no	no	7/17/2012 17:00	7/23/2012 16:00	5 days, 23:00:00
2013	no	yes	yes	7/18/2013 17:00	7/18/2013 16:00	1:00:00

PJM vs NE

YEAR	HOUR?	DAY?	WEEK?	PJM PEAK	WORLD PEAK	DIFF
2002	no	no	no	8/1/2002 17:00	8/14/2002 15:00	12 days, 22:00:00
2003	no	no	yes	8/21/2003 17:00	8/22/2003 15:00	22:00:00
2004	no	no	no	8/3/2004 17:00	8/30/2004 15:00	26 days, 22:00:00
2005	no	no	yes	7/26/2005 16:00	7/27/2005 15:00	23:00:00
2006	no	yes	yes	8/2/2006 17:00	8/2/2006 15:00	2:00:00
2007	no	no	no	8/8/2007 16:00	8/3/2007 15:00	5 days, 1:00:00
2008	no	no	yes	6/9/2008 17:00	6/10/2008 17:00	1 day, 0:00:00
2009	no	no	no	8/10/2009 16:00	8/18/2009 15:00	7 days, 23:00:00
2010	no	no	yes	7/7/2010 17:00	7/6/2010 15:00	1 day, 2:00:00
2011	no	no	yes	7/21/2011 17:00	7/22/2011 15:00	22:00:00
2012	yes	yes	yes	7/17/2012 17:00	7/17/2012 17:00	0:00:00
2013	no	no	yes	7/18/2013 17:00	7/19/2013 17:00	1 day, 0:00:00

PJM vs NY

YEAR	HOUR?	DAY?	WEEK?	PJM PEAK	WORLD PEAK	DIFF
2002	no	no	yes	8/1/2002 17:00	7/29/2002 17:00	3 days, 0:00:00
2003	no	no	no	8/21/2003 17:00	6/26/2003 17:00	56 days, 0:00:00
2004	no	no	no	8/3/2004 17:00	6/9/2004 17:00	55 days, 0:00:00
2005	no	yes	yes	7/26/2005 16:00	7/26/2005 17:00	1:00:00
2006	no	yes	yes	8/2/2006 17:00	8/2/2006 14:00	3:00:00
2007	no	yes	yes	8/8/2007 16:00	8/8/2007 17:00	1:00:00
2008	yes	yes	yes	6/9/2008 17:00	6/9/2008 17:00	0:00:00
2009	no	no	no	8/10/2009 16:00	8/17/2009 16:00	7 days, 0:00:00
2010	no	no	yes	7/7/2010 17:00	7/6/2010 17:00	1 day, 0:00:00
2011	no	no	yes	7/21/2011 17:00	7/22/2011 16:00	23:00:00
2012	no	yes	yes	7/17/2012 17:00	7/17/2012 16:00	1:00:00
2013	no	no	yes	7/18/2013 17:00	7/19/2013 16:00	23:00:00

PJM vs TVA

YEAR	HOUR?	DAY?	WEEK?	PJM PEAK	WORLD PEAK	DIFF
2002	no	no	no	8/1/2002 17:00	8/5/2002 17:00	4 days, 0:00:00
2003	no	no	no	8/21/2003 17:00	1/24/2003 7:00	209 days, 10:00:00
2004	no	no	no	8/3/2004 17:00	7/13/2004 17:00	21 days, 0:00:00
2005	no	yes	yes	7/26/2005 16:00	7/26/2005 15:00	1:00:00
2006	no	no	no	8/2/2006 17:00	7/19/2006 17:00	14 days, 0:00:00
2007	no	no	no	8/8/2007 16:00	7/4/2007 20:00	34 days, 20:00:00
2008	no	no	no	6/9/2008 17:00	1/25/2008 8:00	136 days, 9:00:00
2009	no	no	no	8/10/2009 16:00	1/16/2009 9:00	206 days, 7:00:00
2010	no	no	no	7/7/2010 17:00	8/4/2010 17:00	28 days, 0:00:00
2011	no	no	yes	7/21/2011 17:00	7/19/2011 17:00	2 days, 0:00:00
2012	no	no	no	7/17/2012 17:00	6/29/2012 18:00	17 days, 23:00:00
2013	no	no	yes	7/18/2013 17:00	7/17/2013 17:00	1 day, 0:00:00

PJM vs VAC

YEAR	HOUR?	DAY?	WEEK?	PJM PEAK	WORLD PEAK	DIFF
2002	no	no	yes	8/1/2002 17:00	7/30/2002 16:00	2 days, 1:00:00
2003	no	no	no	8/21/2003 17:00	8/27/2003 16:00	5 days, 23:00:00
2004	no	no	no	8/3/2004 17:00	6/17/2004 13:00	47 days, 4:00:00
2005	no	no	yes	7/26/2005 16:00	7/27/2005 17:00	1 day, 1:00:00
2006	no	yes	yes	8/2/2006 17:00	8/2/2006 15:00	2:00:00
2007	yes	yes	yes	8/8/2007 16:00	8/8/2007 16:00	0:00:00
2008	no	yes	yes	6/9/2008 17:00	6/9/2008 15:00	2:00:00
2009	no	no	no	8/10/2009 16:00	2/5/2009 8:00	186 days, 8:00:00
2010	no	no	no	7/7/2010 17:00	12/15/2010 8:00	160 days, 15:00:00
2011	no	no	yes	7/21/2011 17:00	7/22/2011 16:00	23:00:00
2012	no	no	no	7/17/2012 17:00	7/26/2012 16:00	8 days, 23:00:00
2013	no	no	no	7/18/2013 17:00	8/12/2013 15:00	24 days, 22:00:00

SUMMARY

	WORLD	MISO	NE	NY	TVA	VAC
Hour	2	1	1	1	0	1
Day	8	4	2	5	1	3
Week	9	7	8	9	3	6

The above summary suggests that PJM and the World tend to peak on the same Week/Month.