Advance signals that can be used to foresee demand response days

PJM SODRTF - March 9, 2018

BGE
An Exelon Company

THAT'S SMART ENERGY℠

OVERVIEW

- BGE's load response programs are split between two programs – Peak Rewards and Smart Energy Rewards (SER).
  - Peak Rewards consists of controls on customer equipment which can reduce electric consumption on demand.
  - Smart Energy Rewards is a residential behavioral program. Customers receive advance notice of Energy Savings Days during which they can earn substantial bill credits for reducing their electric consumption.
- BGE feels that the SER program is most effective if customers receive day-ahead notice of Energy Savings Days.
  - Customers have sufficient time to alter their appliance use including adjusting air conditioner thermostats before they leave for work in the morning.
- BGE also benefits from advance notice.
  - Call center staffing
  - Press releases
- BGE's goal is to schedule Energy Savings Days in advance of PJM load response emergencies.
  - BGE looks for advance notice of conditions coincident with historic emergency load response events and prepares for those conditions.

BGE USES FOUR ADVANCE SIGNALS

- PJM short term load forecasts
- Weather forecasts
- PJM Hot Weather Alerts
- Day Ahead prices

PJM SHORT TERM LOAD FORECASTS

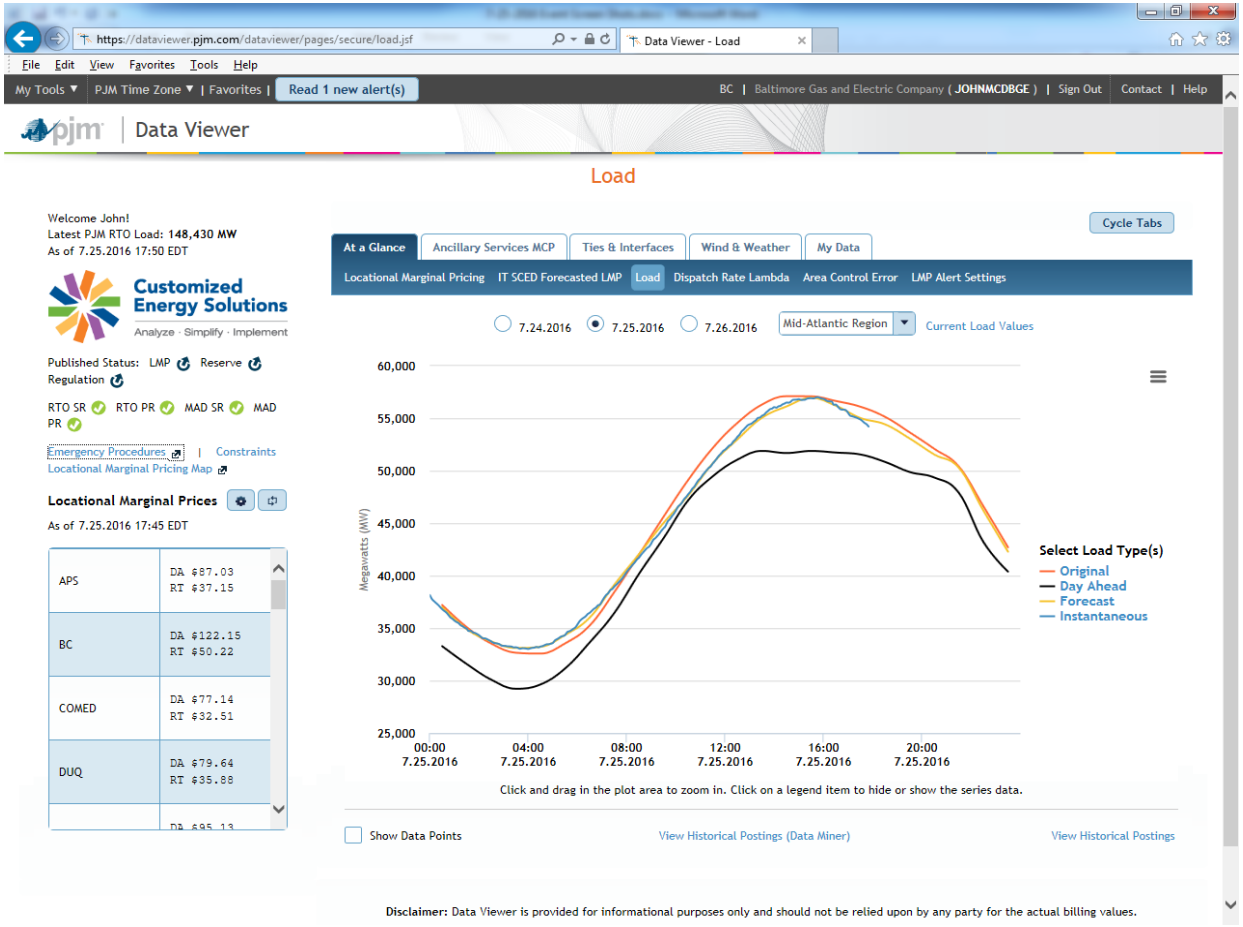
- PJM issues an hourly forecast for the current day plus the next six days.
  - The forecasts are for the RTO, regions (e.g. Mid-Atlantic and Western) and each zone
  - The forecasts are updated continuously in response to changing conditions and expectations
  - The current day forecast can change significantly during the operating day, the next day can change slightly and future days change modestly.
  - The forecasts are available at: http://oasis.pjm.com/doc/projload.txt

RTO Forecast issued approximately 8 AM July 20, 2017

7/20/2017	am	103,082	96,139	91,955	89,116	87,920	90,560	95,643	103,188	110,942	118,971	127,579	135,063
	pm	141,602	146,036	149,181	150,876	151,402	150,923	148,566	143,754	138,792	133,801	124,856	114,457
7/21/2017	am	105,318	98,747	94,037	91,064	90,275	92,436	97,059	103,635	111,271	119,239	127,177	134,105
	pm	139,507	143,778	146,113	147,289	147,756	146,769	143,694	138,341	133,493	129,072	121,177	111,678
7/22/2017	am	100,398	94,008	89,377	85,910	84,032	83,675	84,004	88,043	95,651	103,803	111,431	117,737
	pm	122,448	125,954	128,206	129,995	130,880	130,597	128,379	124,214	119,961	116,361	109,935	101,854
7/23/2017	am	96,154	90,392	86,005	82,929	81,140	80,256	79,774	83,151	90,488	98,940	106,879	113,944
	pm	119,597	123,514	125,908	127,510	128,292	128,360	126,619	123,235	119,630	116,450	109,544	101,285
7/24/2017	am	93,478	88,212	84,659	82,699	82,729	85,654	90,815	97,248	103,476	109,511	115,600	120,685
	pm	124,933	128,267	130,251	131,205	131,488	130,700	128,200	124,159	120,046	116,193	108,203	99,186
7/25/2017	am	90,945	85,460	81,941	79,827	79,744	82,651	87,807	93,819	99,251	104,137	109,043	113,160
	pm	116,539	119,558	121,502	122,727	123,559	123,290	121,163	117,303	113,700	110,355	102,818	93,960
7/26/2017	am	85,494	80,331	76,985	75,108	75,181	78,135	83,191	89,110	94,446	99,543	104,675	109,231
	pm	113,166	116,737	119,433	121,299	122,534	122,615	120,407	116,521	112,864	109,788	102,317	93,504

PJM SHORT TERM LOAD FORECASTS

Mid-Atlantic short term forecast for July 25, 2017 as shown in Data Viewer



HOW BGE USES SHORT TERM FCSTS

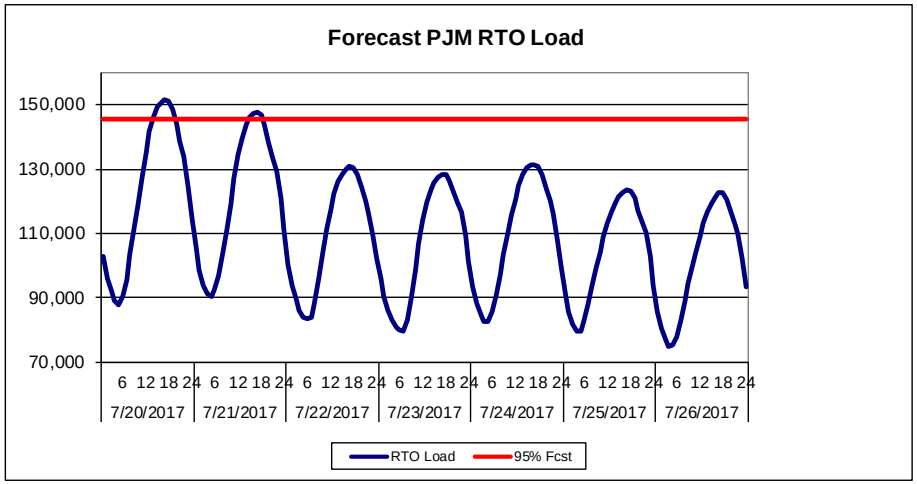
- Create a graph showing the RTO and Mid-Atlantic forecasts and a comparison versus the 50/50 seasonal forecast.
  - Our first signal.
  - BGE uses 95% of the forecast seasonal peak as a “worry point.” Below that, unless we know something significant, we do not feel days with peaks below this level are potential load response days.
  - Graphs show number of potential activation days coming up
  - Shows relative severity of one day versus another
  - BGE focuses on the RTO and Mid-Atlantic forecasts (as opposed to the BGE zone forecast) because we recognize the diversity across the system.

- Compare the current forecast peak with earlier forecasts for the same day.
  - If the forecast is inching up, we will keep monitoring it.
  - If the forecast drops it is a signal that the day is less likely to be a load response day

- Compare the forecast peak with the actual peak load for the day.
  - This tells us if the tool is useful

HOW BGE USES SHORT TERM FCSTS

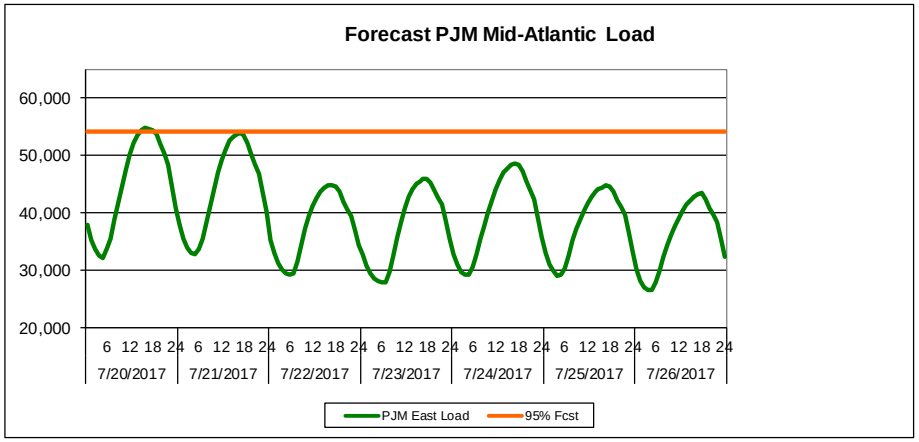
Graph showing RTO short term forecast issued July 20, 2017 compared with seasonal forecast



Date		Max Load	Hour	% of Fcst
Thursday, July 20, 2017		151,402	17	99%
Friday, July 21, 2017		147,756	17	97%
Saturday, July 22, 2017		130,880	17	86%
Sunday, July 23, 2017		128,360	18	84%
Monday, July 24, 2017		131,488	17	86%
Tuesday, July 25, 2017		123,559	17	81%
Wednesday, July 26, 2017		122,615	18	80%
7-Day Maximum		151,402		
PJM 50/50 Forecast		152,999		

HOW BGE USES SHORT TERM FCSTS

Graph showing Mid-Atlantic short term forecast issued July 20, 2017 compared with seasonal forecast



Date		Max Load	Hour	% of Fcst
Thursday, July 20, 2017		54,789	16	96%
Friday, July 21, 2017		54,002	17	94%
Saturday, July 22, 2017		44,942	17	79%
Sunday, July 23, 2017		46,063	18	81%
Monday, July 24, 2017		48,596	17	85%
Tuesday, July 25, 2017		44,791	17	78%
Wednesday, July 26, 2017		43,432	18	76%
7-Day Maximum		54,789		
PJM 50/50 Forecast		57,164		

HOW BGE USES SHORT TERM FCSTS

Compare the current forecast peak with previous forecasts for the same day

			Forecast Issued											
Date	Actual Load		7/10/2017	7/11/2017	7/12/2017	7/13/2017	7/14/2017	7/15/2017	7/16/2017	7/17/2017	7/18/2017	7/19/2017	7/20/2017	7/21/2017
7/10/2017	124,736		128,685											
7/11/2017	130,274		138,156	139,421										
7/12/2017	135,618		141,860	144,579	143,893									
7/13/2017	135,396		138,244	140,081	145,483	143,935								
7/14/2017	125,779		128,615	126,997	131,741	125,990	126,162							
7/15/2017	116,033		115,775	119,463	115,664	113,256	115,527							
7/16/2017	117,191		118,949	117,437	120,161	117,962	114,371							
7/17/2017	130,713			126,311	130,908	130,979	128,152			127,856				
7/18/2017	138,613				135,793	135,374	133,476			134,236	135,982			
7/19/2017	145,637					142,398	142,138			141,395	143,083	145,978		
7/20/2017	145,329						145,669			149,759	147,410	150,396	151,402	
7/21/2017	141,870									143,607	143,656	146,759	147,756	145,206
7/22/2017	126,909									132,281	127,475	137,232	130,880	136,277
7/23/2017	120,877									128,358	129,688	129,230	128,360	124,527
7/24/2017	125,203										137,668	132,508	131,488	130,283

RTO daily peak forecasts from mid-July 2017

HOW BGE USES SHORT TERM FCSTS

Compare the forecast peak with the actual peak load for the day

	Variation								Absolute value of variation						
Date	0	1	2	3	4	5	6		0	1	2	3	4	5	6
7/10/2017	3%			-1%	0%	-1%			3%			1%	0%	1%	
7/11/2017	7%	6%			-2%	1%	2%		7%	6%			2%	1%	2%
7/12/2017	6%	7%	5%			-7%	-2%		6%	7%	5%			7%	2%
7/13/2017	6%	7%	3%	2%			-6%		6%	7%	3%	2%			6%
7/14/2017	0%	0%	5%	1%	2%				0%	0%	5%	1%	2%		
7/15/2017		0%	-2%	0%	3%	0%				0%	2%	0%	3%	0%	
7/16/2017			-2%	1%	3%	0%	2%				2%	1%	3%	0%	2%
7/17/2017	-2%			-2%	0%	0%	-3%		2%			2%	0%	0%	3%
7/18/2017	-2%	-3%			-4%	-2%	-2%		2%	3%			4%	2%	2%
7/19/2017	0%	-2%	-3%			-2%	-2%		0%	2%	3%			2%	2%
7/20/2017	4%	3%	1%	3%			0%		4%	3%	1%	3%			0%
7/21/2017	2%	4%	3%	1%	1%				2%	4%	3%	1%	1%		
7/22/2017		7%	3%	8%	0%	4%				7%	3%	8%	0%	4%	
7/23/2017			3%	6%	7%	7%	6%				3%	6%	7%	7%	6%
7/24/2017	2%			4%	5%	6%	10%		2%			4%	5%	6%	10%
June	1%	0%	-1%	-2%	-3%	-2%	0%		2%	2%	3%	3%	5%	5%	6%
July	2%	2%	1%	2%	2%	1%	2%		3%	3%	3%	3%	3%	3%	4%
August	1%	0%	0%	0%	1%	0%	0%		2%	2%	3%	3%	3%	5%	6%
September	1%	1%	2%	4%	7%	6%	4%		3%	3%	5%	6%	7%	8%	9%

WEATHER FORECASTS

- BGE gets a 10-day forecast of hourly drybulb and dewpoint for BWI Airport.
  - Previous day's actual, current day plus eight future days
  - BGE combines it with the actuals from the next previous day to create a string of eleven days.

- BGE calculates a Weighted Temperature Humidity Index (WTHI)for each hour.
  - The "THI" accounts for increased human discomfort at higher humidity levels
  - The "Weighted" accounts for the effects of heatwaves on air conditioning use

- BGE creates a graph comparing forecast weather with activation standards.
  - Low (82 WTHI)– below this, BGE does not expect conditions to be severe enough for load response activations
  - Moderate (83 WTHI) – a signal that a day should be watched
  - High (84 WTHI) – a sign that load response potential should be considered for that day

WEATHER FORECASTS

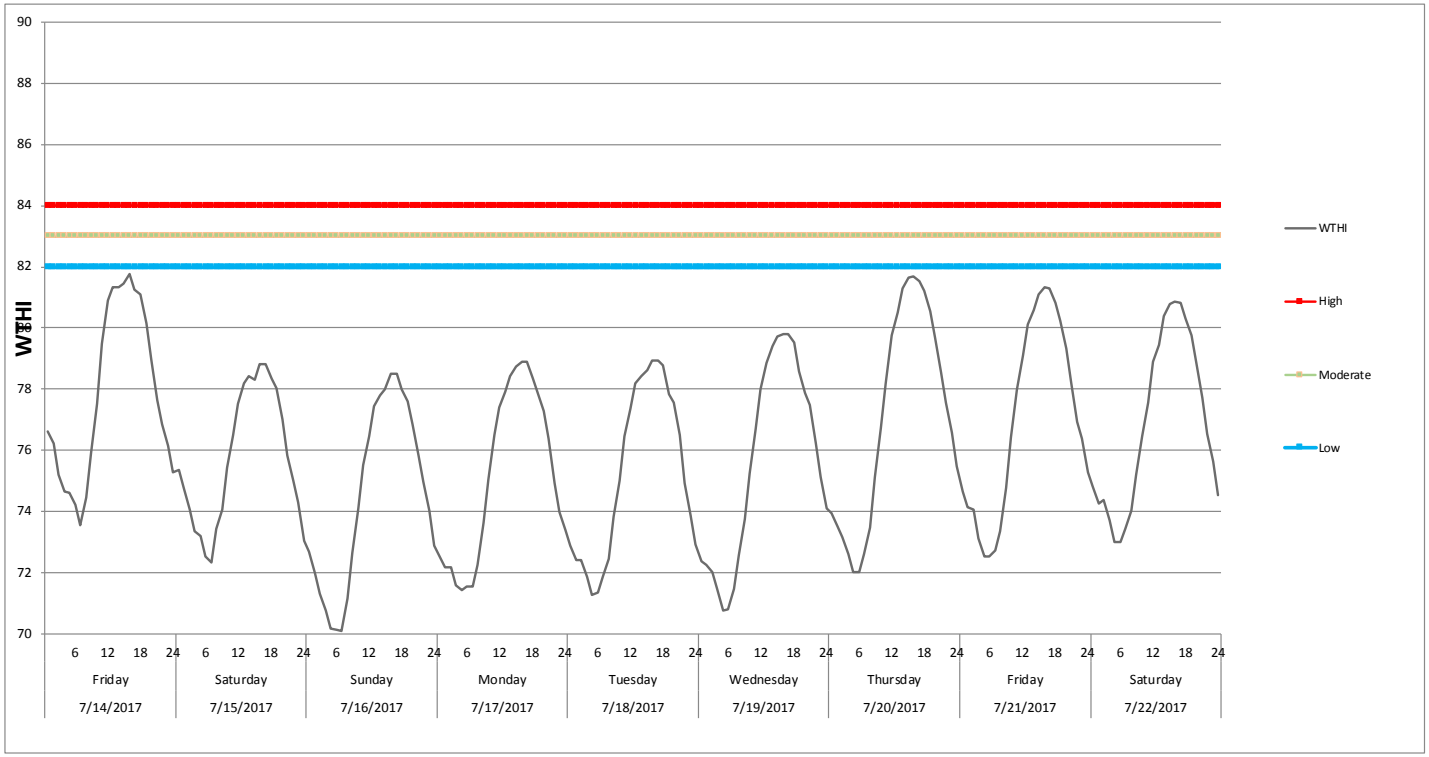
Eleven days of drybulb and dewpoint for BWI Airport

BWI	Actual	Drybulb	20170712	79	76	77	77	76	76	75	74	79	80	84	87	86	86	89	87	86	87	90	89	88	83	82	77
BWI	Actual	Dewpoint	20170712	70	70	70	69	70	70	71	72	71	68	70	71	71	71	72	72	72	74	72	74	75	75	75	75
BWI	Actual	Drybulb	20170713	78	77	80	77	77	77	74	77	81	84	89	91	93	91	92	94	92	92	93	90	89	87	84	82
BWI	Actual	Dewpoint	20170713	75	75	74	73	73	73	72	73	73	72	72	72	72	72	72	72	73	73	74	73	73	74	72	71
BWI	Forecast	Drybulb	20170714	83	83	78	78	78	77	76	77	79	82	85	88	89	90	90	90	89	88	85	83	80	79	78	77
BWI	Forecast	Dewpoint	20170714	70	69	73	72	72	72	73	74	74	75	75	74	73	72	71	72	73	74	74	74	74	74	75	75
BWI	Forecast	Drybulb	20170715	77	76	75	74	74	73	73	75	76	79	81	83	85	86	86	87	87	86	86	84	82	80	78	75
BWI	Forecast	Dewpoint	20170715	75	74	74	73	72	71	71	71	70	68	66	65	63	62	61	61	62	62	62	63	63	64	66	67
BWI	Forecast	Drybulb	20170716	74	73	72	71	70	70	70	72	75	78	81	83	85	86	87	88	88	87	86	84	82	80	78	76
BWI	Forecast	Dewpoint	20170716	67	66	66	66	65	66	66	66	67	66	66	65	65	64	63	63	63	63	64	66	67	68	68	68
BWI	Forecast	Drybulb	20170717	75	74	74	73	73	73	73	74	76	79	82	84	85	86	87	87	87	86	85	84	82	79	77	76
BWI	Forecast	Dewpoint	20170717	69	71	72	72	72	73	73	73	74	73	72	71	70	70	69	69	69	69	69	69	70	70	71	72
BWI	Forecast	Drybulb	20170718	75	74	74	73	72	72	73	74	76	78	81	83	85	86	87	88	88	88	86	85	83	80	78	76
BWI	Forecast	Dewpoint	20170718	72	72	72	72	71	71	72	72	73	73	72	71	70	68	66	65	65	65	65	67	67	67	67	67
BWI	Forecast	Drybulb	20170719	75	75	74	73	72	72	73	75	77	80	83	86	88	90	91	91	91	90	88	86	85	83	81	79
BWI	Forecast	Dewpoint	20170719	67	67	68	68	67	67	68	69	69	69	68	67	66	64	63	63	63	64	65	66	68	68	68	68
BWI	Forecast	Drybulb	20170720	79	78	77	76	75	75	76	77	80	83	86	89	91	93	94	94	94	93	92	90	87	85	83	81
BWI	Forecast	Dewpoint	20170720	68	68	69	69	69	69	69	70	71	71	70	70	68	67	66	66	65	66	66	67	68	69	70	70
BWI	Forecast	Drybulb	20170721	79	78	78	76	75	75	75	76	78	81	84	86	88	89	90	91	91	90	89	87	85	82	81	79
BWI	Forecast	Dewpoint	20170721	70	70	70	70	70	70	70	70	71	71	71	70	70	69	69	68	68	68	68	69	69	70	71	71
BWI	Forecast	Drybulb	20170722	78	77	77	76	75	75	76	77	79	81	83	86	87	89	90	90	90	89	88	86	84	82	80	78
BWI	Forecast	Dewpoint	20170722	72	72	73	73	72	72	72	72	72	72	71	70	69	69	68	68	68	68	68	69	69	69	69	69

Assembled July 14, 2017

WEATHER FORECASTS

Nine-day BWI Weather Forecast



WTHI weather forecast for July 14 – 22, 2017

HOW BGE USES WEATHER FCSTS

- Weather forecasts are used in conjunction with PJM short-term load forecasts.
  - Severe weather in the BGE zone combined with an expectation of peak loads in either the RTO or Mid-Atlantic regions will cause BGE to consider a load response event.

- Weather graphs are distributed every weekday morning to affected functional areas to show conditions affecting the BGE zone.
  - A day with a moderate or higher weather ranking will be discussed in more detail.

PJM HOT WEATHER ALERTS

- Hot Weather Alerts appear in the Emergency Procedures which are accessible through the Data Viewer tool.

- Official definition:
  The purpose of the Hot Weather Alert is to prepare personnel and facilities for expected extreme warm weather conditions. As a general guide, PJM can initiate a Hot Weather Alert across the RTO or on a Control Zone basis when the forecasted/actual weather conditions approach 90 degrees Fahrenheit (93F within the DOM/Southern Zone) or above. PJM can initiate a Hot Weather Alert at lower temperatures if PJM anticipates increased humidity or if PJM projects a portion of gas fired capacity is unable to obtain spot market gas during load pick-up periods. PJM will initiate the Hot Weather Alert for the appropriate region(s) in advance of the operating day based on historical experience, information supplied by the pipelines and/or information supplied from the generator owners.

- Generally issued one or two days in advance of the operating day

- Frequency
  - 18 in 2017
  - 8 in 2011

HOW BGE USES HOT WTHR. ALERTS

- It is BGE's belief that there has never been a PJM load response emergency without there first being a hot weather alert.

- The amount of advance notice can make a difference in the usefulness of a hot weather alert.
  - Two or more days is very helpful – it is our signal that PJM sees conditions approaching their worry point
  - A one-day notice is less useful. Generally, we decide on an activation around 8 AM on the day before an activation day. We have a final confirmation decision at 1 PM. The hot weather alerts generally come around 9 AM so we can use them to support that final confirmation decision.

- BGE is aware that Hot Weather Alerts are not just heat related.
  - Alerts for 9/25/2017 and 9/26/2017 were for not particularly hot days, but they followed the shortage pricing day (9/21/2017)

DAY AHEAD PRICES

- Day Ahead prices are an indicator of the energy market's expectations of serving load
- They are released at 1 PM the day before an operating day
- Day Ahead prices can reflect recent real-time experiences

DAY AHEAD PRICES

BGE Zone Day Ahead prices for select 2017 days

Hour		7/19/2017	7/20/2017	7/21/2017		9/25/2017	9/26/2017
1		$ 24.21	$ 26.73	$ 27.54		$ 23.48	$ 23.70
2		$ 23.05	$ 24.60	$ 25.62		$ 21.94	$ 22.40
3		$ 21.84	$ 23.05	$ 23.75		$ 20.30	$ 20.80
4		$ 20.85	$ 22.17	$ 22.62		$ 20.04	$ 19.84
5		$ 21.03	$ 22.17	$ 22.44		$ 20.49	$ 20.51
6		$ 22.24	$ 23.13	$ 23.67		$ 22.09	$ 22.67
7		$ 23.60	$ 25.00	$ 25.76		$ 29.56	$ 29.97
8		$ 25.12	$ 27.57	$ 27.79		$ 29.46	$ 30.66
9		$ 27.92	$ 32.09	$ 32.00		$ 33.35	$ 32.58
10		$ 32.30	$ 37.96	$ 35.58		$ 40.20	$ 32.74
11		$ 36.48	$ 48.28	$ 45.37		$ 44.13	$ 37.29
12		$ 43.90	$ 53.44	$ 53.84		$ 48.47	$ 41.72
13		$ 47.56	$ 59.01	$ 58.99		$ 71.21	$ 46.76
14		$ 49.85	$ 71.49	$ 65.00		$ 107.87	$ 56.58
15		$ 53.23	$ 82.21	$ 73.62		$ 160.58	$ 68.16
16		$ 57.52	$ 100.00	$ 82.39		$ 202.44	$ 72.71
17		$ 67.60	$ 116.80	$ 97.24		$ 237.91	$ 81.28
18		$ 65.19	$ 122.68	$ 83.05		$ 190.36	$ 68.10
19		$ 54.15	$ 88.05	$ 68.17		$ 96.11	$ 50.00
20		$ 48.53	$ 64.02	$ 56.10		$ 69.97	$ 50.00
21		$ 44.88	$ 54.88	$ 49.78		$ 61.21	$ 44.47
22		$ 39.82	$ 49.44	$ 45.27		$ 43.83	$ 38.18
23		$ 32.67	$ 37.70	$ 35.54		$ 35.88	$ 32.77
24		$ 28.89	$ 32.27	$ 30.96		$ 27.91	$ 25.76

HOW BGE USES DAY AHEAD PRICES

- The timing of their release severely limits their use
  - BGE has already decided whether to have a load response event by the time the prices are released at 1 PM.

- The prices are more of a confirmation of BGE's decisions
  - Lately, BGE has used the low Day Ahead Prices (relative to history) as a signal that our scheduled economic load response events will not become emergency load response events.

- A potential problem is the prices are released once each day
  - Consider the shortage pricing event on 9/21/2017 – it occurred around 2 PM – 3 PM – well after the Day Ahead prices for 9/22 were determined. The Day Ahead prices could not be used as a signal for the 9/22/2018 operating day.