2012 Economic Demand Response Performance Report:

Analysis of Economic DR participation in the PJM wholesale energy market after the implementation of Order 745

PJM Interconnection

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Disclaimer

All market rules are governed by the Tariff, Operating Agreement, Reliability Assurance Agreement, and PJM Manuals. The summary of the market rules contained in this report are meant to provide a brief overview. Please consult PJM governing documents for detailed market rules for PJM economic demand response resources.

Executive Summary

Economic Demand Response participation has grown significantly since the implementation of Order 745 rules that compensate Economic DR resources the full wholesale price when the wholesale price exceeds the monthly Net Benefits Threshold ($25.60/MWh in March 2013). The market rules prior to implementation of Order 745 compensated Economic DR resources based on the difference between the wholesale price (locational marginal pricing) and the retail price for Generation and Transmission services (G&T). Economic DR for the seven month period from April through October of 2012 for which compensation under Order 745 was in place generated $8.7 million of revenue from 133,466 MWh. In contrast, for the 41 month period from November 2008 through March 2012, for which Economic DR was compensated at (LMP-G&T) generated only $7.1 million of revenue from 166,276 MWh. The amount of Economic DR activity in the day-ahead energy market compared to real-time energy market has gone up significantly during the Order 745 period. Following the implementation of Order 745 44 percent of all load reductions were based on commitments made in the day-ahead market while only 11 percent were based on day-ahead market prior to Order 745.

Economic DR resources provided between 228 MW (average LMP = $68 MWh) and 305 MW (average LMP = $125 MWh) MW on each of the three non-emergency summer 2012 PJM peak days. This is much higher than during 2011 summer which ranged from 3 MW (average LMP = $89 MWh) to 62 MW (average LMP = $186 MWh) but comparable with 2010 summer which was between 175 MW (average LMP = $114 MWh) and 337 MW (average LMP = $131 MWh). The majority (86 percent) of all Economic DR activity in the energy market from April through October 2012 came from a small number of very large customers (>10 MW). Further 82 percent of all activity during this same period came from customers located in Eastern portion of PJM (MAAC and Dominion)

Although Economic DR activity has significantly increased relative to recent years the amount of participation is low relative to the overall Economic DR capability that has already be registered and approved to participate in the wholesale market. The total Economic DR capability in July 2012 was 2,300 MW but the average hourly load reduction, for hours where there was a load reduction was only 70 MW. This amounts to only 3 percent of the Economic DR resource capability utilized during the month of July. For the July non-emergency peak day 305 MW were delivered which is 13 percent of the total Economic DR capability. It is interesting to note that there are 6,539 MWs (almost three times more than the total amount registered as an Economic DR resource) of Emergency DR registered with capacity commitments that have not also registered as an Economic DR resource so that they may participate in the energy market.

Economic DR resources offer curve for July 16 from 3 to 4 p.m. indicates that approximately 500 MW could respond if real time prices were relatively low and close to the Net Benefits Test ($25 - $50/MWh) while an additional 400 MW could respond if prices were close the $300/MWh. This suggests that close to 900 MW could be available if real time prices were at or above $300/MWh. All the other Economic DR resources did not have an effective offer curve which indicates they were not interested in reducing their load although they could easily participate. This requires more analysis because it appears counterintuitive. This trend may indicate that Economic DR could not reduce load in the middle of a hot summer day or did not think the market would make it worthwhile to reduce their load at any price up to the energy offer price cap of $1,000 MWh.

Aggregate Economic DR performance has significantly improved after the implementation of Order 745 market rules. For April through October the monthly average performance in day-ahead and real-time energy markets has been between 80 percent and 110 percent where performance is measured as actual load reduction divided by the cleared day-ahead offer or real-time dispatch amount. Curtailment Service Provider's are doing a better job of determining

when their Economic DR resource can provide a load reduction and the quantity of load reductions they expect to deliver to the wholesale market.

In summary, the implementation of Order 745 rules has resulted in: significant increase in energy market participation (majority of load reductions are from very large customers located in MAAC and Dominion area); an increase in the amount of energy market activity in the day-ahead market, and better performance (actual delivered load reductions closer to amount dispatched in real-time market or cleared in day-ahead market. Further, there is the potential for a significant increase in Economic DR activity since most have not submitted offers into the real-time or day-ahead market and the majority of Emergency DR resources did not participate as an Economic DR resource.

Energy Market

Summary of Key Market Rules

Economic Demand Response (DR) resources may participate in the wholesale energy markets on a similar basis to traditional generation supply resources. An economic demand response resource is also referred to as a "registration" or "dispatch group". One registration may be comprised of one or more physical locations defined by a unique Electric Distribution Company (EDC) account number. One dispatch group may be comprised of multiple registrations. Each registration must be able to provide a minimum of 0.1 MW to the energy market and have appropriate hourly metering to measure and verify the load reductions.[1] A dispatch group was created and implemented with Order 745 on April 1, 2013 to allow a Curtailment Service Provider (CSP) to group registrations together that would like to be dispatched at the same time and under the same conditions. This allows a CSP to simplify the management and maintenance of offer curves and schedules for registrations with similar characteristics. This also allows deviations that determine Balancing Operating Reserve Charges and Make Whole payment to be based on the dispatch group which is an aggregation of individual registration performance.[2]

Economic DR resources are paid based on the wholesale market price if the wholesale market price is greater than or equal to the Net Benefits Test (NBT) price[3]. The NBT is the price at which an additional MW of demand response will result in wholesale market price decrease or "benefit" to load that will exceed the revenue paid for the economic DR resources. PJM publishes the NBT on a monthly basis, prior to each calendar month, based on a historic supply curve adjusted for forecast fuel prices for the next calendar month. Over the April 2012 through January 2013 period, the NBT has ranged from $22.99/ MWh to $25.97/MWh where the PJM load-weighted Locational Marginal Price (LMP) was greater than or equal to the NBT over 75 percent of all hours during such period. This implies Economic DR resources had the ability to participate in the wholesale market for at least ¾ of all hours over the 10 month period.[4]

The cost for Economic DR in the energy market is paid by Load Serving Entities (LSEs) and members that export from PJM in zone(s) where the LMP is greater than or equal to the NBT price. This cost allocation is done based on hourly load ratio share. Stakeholders agreed to allocate costs to these market participants since they should receive the "benefit" of reduced wholesale prices.

Economic DR may participate in the day-ahead energy market or be available to be dispatched by PJM in the real-time energy market. If the resource (registration or dispatch group) clears in the day-ahead market then it is expected to provide the load reductions offered and cleared in the market and is therefore not dispatched in real time for the

[1] Non-interval metered customers may participate in energy market on a pilot basis. The pilot is used to establish appropriate M&V protocols for participation.

[2] For example, one registration may deliver a little more than their commitment and another registration may deliver a little less than their commitment. Since a Dispatch Group aggregates performance to determine BOR and Make whole payments the dispatch group may avoid BOR and receive make whole payments in this situation.

[3] NBT detailed description and associated analysis is located at http://www.pjm.com/markets-and-operations/demand-response/net-benefit-test-results.aspx.

[4] PJM load weighted average LMP frequency distribution relative to the NBT is an approximation of opportunities to participate in the wholesale market. The actual percent may a little higher since most resource are located in Eastern portion of PJM and such LMPs are higher than the PJM load weighted average LMP.

same period of time. Each resource may provide an offer curve similar to a traditional generator that indicates the volume (MW) and price ($/MWh) at which the resource should be cleared in the day-ahead energy market or dispatched in the real-time energy market. Day-ahead offers must be submitted by noon the day before the operating day and real-time offers must be submitted either by noon or between 4 p.m. and 6 p.m. (rebidding period) the day before. CSPs have the flexibility to change the real-time market hourly availability for each resource up to three hours prior to the operating hour. This allows the CSP to manage the specific megawatt of load reduction which is available for real-time dispatch for each hour during the day based on each resource's availability. Many resources may have an offer but make the resource unavailable for dispatch. To be considered in the market for a specific hour the resource must have both a valid offer and be available to clear in the day-ahead market or be available for dispatch in the real-time energy market.

Compensation for Economic DR is comparable to compensation for a traditional generation unit. It is based on the higher of i) the load reduction multiplied by the relevant LMP and ii) the offer value or "make whole payment" which is based on the load reduction multiplied by the offer price.[5] The resource is only eligible for the make whole payment if the load reduction provided is within 20 percent (i.e.: between 80 percent and 120 percent) of the load reduction cleared in the day ahead market or dispatched in the real time market. The resource is also assigned Balancing Operating Reserve (BOR) charges[6] if outside the 20 percent deviation tolerance.

> For example: a resource has an offer price of $100/MWh, and is available to provide 1 MW. The resource is dispatched by PJM for 1 MW for 1 hour, but provides 1.1 MW load reduction instead. The real-time LMP is $95/MWh, so the resource will receive the make whole payment and will not be assessed a balancing operating reserve charge: it will be paid 1.1 MW * $100 or $110 for the hour. However, if the resource provided 1.3 MW (which is not between 80 and 120 percent of the load reduction dispatched by PJM), then the resource will not receive the make whole payment and will be paid 1.3 MW * $95 or $123.50 for the load reduction and will also be assessed a balancing operating reserve charge.

Load reductions are determined by either (i) Customer Baseline (CBL)[7] minus the actual load during the economic event, or (ii) generation metered output that must be approved by PJM as an accurate way to quantify the Economic DR load reductions. The CSP must go through a CBL certification process when the specific locations are registered to ensure the CBL that will be used is reasonably accurate. PJM uses the hourly relative root mean square error RRMSE) between historic load data (actual) and CBL (estimate) as a benchmark for CBL accuracy[8]. PJM requires that the RRMSE be less than 20 percent for the CBL to be reasonably accurate. If the standard CBL[9] does not meet

[5] Make whole payment also takes into consideration, shutdown cost (one time cost to initiate the load reduction) and minimum run time (minimum amount of time the Economic DR resource needs to operate).

[6] BOR charges primarily represent the cost associated with providing make whole payments to suppliers where the economic revenue received from the market is less than the economic value of their offer. BOR charges are sometimes referred to as market uplift in other markets.

[7] CBL is an estimate of what the load would have been if the resource did not take specific actions to reduce load based on participation in the PJM energy market. The energy delivered by an Economic DR resource cannot be measured directly like a generator (i.e.: there is no way to meter a "load reduction").

[8] See PJM Manual 11, section 10 for additional details.

[9] Standard CBL is based on previous 5 non-event days which occurred over the last 45 days, where the day with the lowest event period usage is eliminated and each hour for each of the 4 days are averaged together. This unadjusted CBL is then adjusted based on the difference

the accuracy threshold, the CSP or PJM may propose an alternative CBL. The goal is to determine a reasonably accurate CBL prior to participation in the energy market but allow flexibility if a new CBL is developed that can be consistently administered for similar customer's loads in PJM.

Market Analysis

Over the last 6 years, market rules for Economic DR compensation changed three times. The three time periods are referred to here as the "incentive period", the "LMP - G&T period", and the "745 period". The incentive period started in 2006 and expired at the end of October 2007. During the incentive period, economic DR was paid either (1) the LMP minus the generation and transmission (G&T) portion of retail price if the wholesale price of energy was below $75/MWh, or (2) the full LMP at or above $75/MWh. The LMP-G&T period was in effect from November 2007 through March 2012. During the LMP-G&T period, compensation was based on the difference between the LMP and G&T portion of the retail price. The market structure, based on the difference between the wholesale (LMP) and retail price (G&T) was developed to foster customers with fixed retail prices to reduce load when wholesale prices were high. Without a price signal, retail customers have minimal financial motivation to reduce or shift their load since it may not result in a reduction in electricity costs for the customer. The 745 period began when FERC Order 745 took effect in April 2012 and remains the current market rule. Under 745, Economic DR is compensated at the full wholesale price (see Summary of Key Market Rules, above for more detail) when the wholesale price exceeds the Net Benefit Test.

The amount of energy provided by economic DR has varied substantially over the last 6 years (see Figure 1). The highest level of activity occurred in 2007 with a typical monthly energy settlement of 56,000 MWh and a monthly peak in August 2007 at 100,000 MWh. The difference between the summer (excluding August peak) and non-summer activity was not substantially different: an average of 58,000 MWh was settled in June, July and September while an average of 55,000 MWh was settled in the non-summer months. The level of economic DR activity remained at a similar level through the end of October 2007 when the incentive period expired.

Economic DR activity during the LMP-G&T period was low except for January through October of 2008 where wholesale prices were higher than in 2007 or 2009. The typical monthly energy settled from November 2008 through March 2012 was 3,500 MWh. Peak monthly settlements were over 17,000 MWh in July 2010 when the MWh weighted average LMP was $128. The July 2010 peak monthly energy settled was roughly 17 percent of the peak monthly MWh settled during the incentive period (August 2007) when the MWh weighted average LMP was $117 MWh and approximately 39 percent of the peak monthly MWh (43,531 in July 2012 when the MWh weighted average LMP was $86 MWh) settled during the 745 period to date. The lower quantity of energy settled during this period may in part be an artifact of two significant market changes (in addition to the change in compensation) that were implemented in 2008. The first market change which was implemented in June 2008 adjusted the CBL calculation from the high 5 of 10 method to the high 4 of 5 method. This adjustment resulted in a calculation with higher accuracy and lower bias. Because the previous CBL calculation was positively biased, the magnitude of load reduction was significantly lower on average under the new CBL calculation[10]. The second change in market rules included the implementation on a normal operations review to require supporting documentation for settlements submitted on a

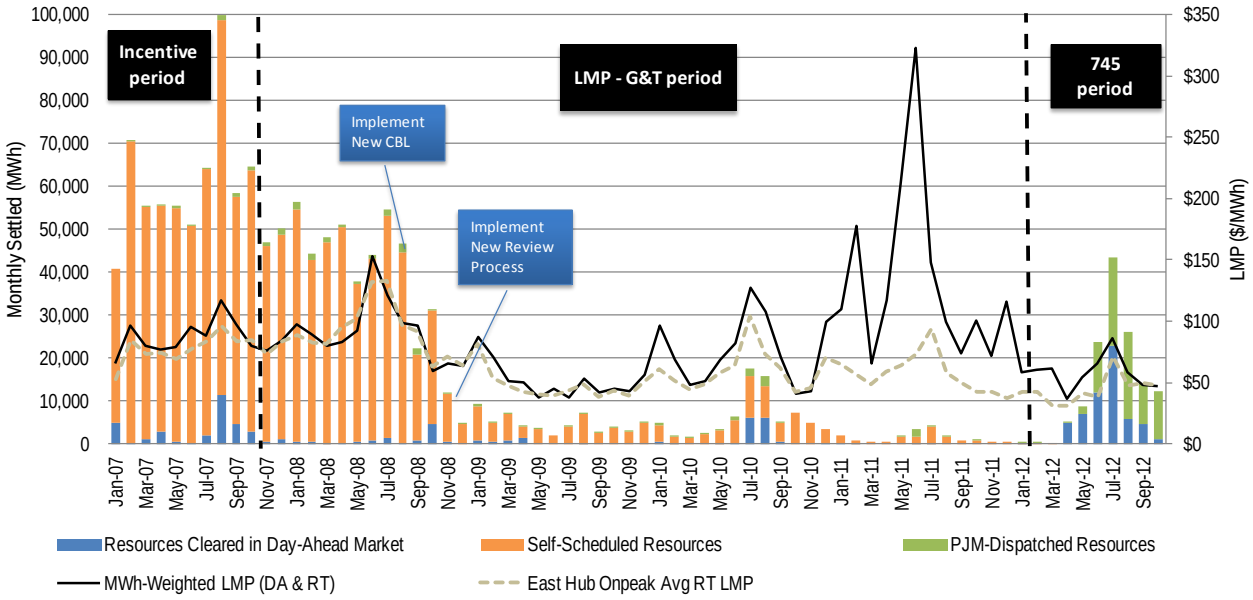
between actual usage on the event day prior to the event start and usage in the CBL for the same hours. This adjustment is referred to as Symmetric Additive Adjustment or "SAA"

[10] PJM presented and analysis of the impact of the new Economic CBL on the quantity of load reductions at the September 30, 2008 Demand Response Steering Committee. The analysis estimated that the quantity of load reductions were reduced by approximately 35 percent based on the new CBL methodology. In some cases, where the CSP was submitting settlements on a frequent basis the load reductions were reduced by 85 percent.

frequent basis to ensure that settlements are submitted only for load reductions in response to wholesale prices and not simply based on load reductions that are part of normal operations at the facility. This clarification and associated review process also reduced load reduction activity.

Economic activity has gone up significantly during the 745 period to date compared to the LMP-G&T period after October 2008. Over 40,000 MWh were settled in July 2012 when the weighted average LMP was $86 MWh. This is lower than settlement activity achieved during the incentive period or during the summer of 2008 during the LMP – G&T period but is difficult to compare given the other market changes that occurred between the two periods.

Figure 1: Economic DR settled energy by month (Jan. 2007 - Oct. 2012) [11]



Since 745 was implemented, Economic DR MWh delivered are up and large portion were committed in day-ahead market.

Figure 1 also illustrates the major change from economic DR activity in the real-time energy market through a self schedule by the CSP to economic DR activity in the day-ahead market or dispatched by PJM in the real-time market. This major change is the result of market rule changes that were implemented as part of FERC Order 745 where the self scheduling option was eliminated. The correlation between monthly MWh settled and MWh weighted average LMP was 82 percent during the incentive period, only 9 percent during the LMP – G&T period and 94 percent during the 745 period. The higher positive correlation of monthly MWh settled to wholesale prices means we can expect more MWh to be settled when wholesale prices are higher and that this relationship is a little better during the 745 period than during the incentive period although this is based on limited number of month observed.

[11] MWh-Weighted LMP represents the weighted average LMP of all MWh settled in day-ahead or real-time market. For example, if 90 MWh are settled at $100/MWh and 10 MWh are settled at $200/MWh this would mean a weighted average LMP of $110/MWh. East Hub Onpeak Average real-time LMP provides a simply average LMP to provide a reference to overall market prices where most of the active DR is located.

Implement New CBL – Previous High 5 of 10 CBL was eliminated since it overestimated load reductions and new High 4 of 5 CBL with other modification was implemented

Implement New Review process – PJM implemented a registration and settlement review process to ensure CSPs only submitted settlements for load reductions that were in response to price and not based on normal operations at the facility.

Table 1 below summarizes revenue received by CSPs from January 2007 – October 2012. In 2007, during the incentive period, CSPs accrued almost $45 million for the year (~$4.4 million per month). Revenue received during the LMP-G&T period was lower, ranging from $0.01 million to $4.7 million per month for average of $0.7 million per month. Revenue increased to $1.2 million per month during the 745 period through October 2012. The trend in revenue across the month follows the same pattern as the MWh settled in Figure 1.

Table 1: Economic DR energy revenue by year by period (Jan. 2007 - Oct. 2012)

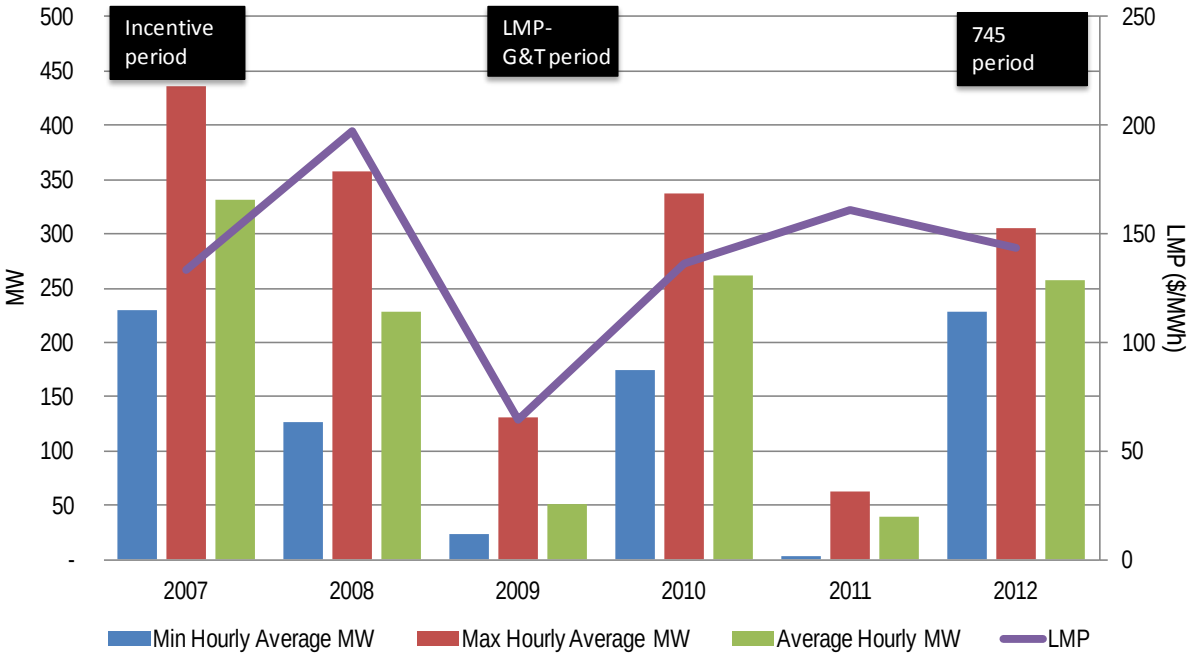
Time	Period	Energy (MWh)	Energy (Monthly average MWh)	Revenue	Revenue (Monthly average)	East Hub Onpeak Avg RT LMP ($/MWh)
2007 (Jan - Oct)	Incentive	616,308	61,631	$44,315,231	$4,431,523	$78
2007 (Nov - Dec)	LMP - G&T	97,221	48,611	$4,691,260	$2,345,630	$78
2008	LMP - G&T	453,263	37,772	$27,084,044	$2,257,004	$92
2009	LMP - G&T	57,048	4,754	$1,389,136	$115,761	$47
2010	LMP - G&T	74,070	6,172	$3,088,049	$257,337	$61
2011	LMP - G&T	17,398	1,450	$2,052,996	$171,083	$57
2012 (Jan - Mar)	LMP - G&T	1,030	343	$30,406	$10,135	$39
2012 (Apr - Oct)	745	133,466	19,067	$8,717,697	$1,245,385	$46
Grand Total		1,449,805	20,712	$91,368,820	$1,305,269	

Since 745 was implemented, Economic DR monthly revenue was $1.2 million (Average LMP = $46) compared to less than $0.258 (Average LMP = $39 to $61) in prior three years.

Figure 2 below illustrates a summary of economic energy load reductions done on PJM peak days over the last 6 years. The maximum average hourly reduction delivered on a PJM non-emergency 5 coincident peak days was 437 MW on 8/2/07. During the 745 period, the maximum average load reduction was 305 MW on 7/5/12. The load reduced on peak days during the 745 period (summer 2012) was comparable to load reduction during the summer of 2010 when economic DR was paid based on LMP – G&T but much higher than load reductions received in 2011 or 2009.

Figure 2 also shows LMP and quantity of load reduced. Since the underlying compensation structure was different between the incentive period and the LMP-G&T period it makes sense that load reductions were less in 2008 than in 2007 while LMP was significantly higher in 2008 than in 2009. The very low response in 2011 given the relatively high LMP is difficult to explain.

Figure 2: Peak Day Analysis – Average hourly Economic DR settled between noon and 8 p.m. on PJM five coincident peak days without Emergency DR Events



On average 250 MW were delivered on non-emergency peak days by Economic DR resources since 745 was implemented.

Table 2 below provides the specific non-emergency five coincident peak days used for the economic DR peak day analysis and the associated average megawatt delivered from noon to 8 p.m. on each day. This table provides the detailed information used to illustrate peak day behavior in Figure 2.

Table 2: Peak Day Analysis – Average hourly Economic DR Settled between Noon and 8 p.m. on PJM five coincident peak days without Emergency DR event(s)

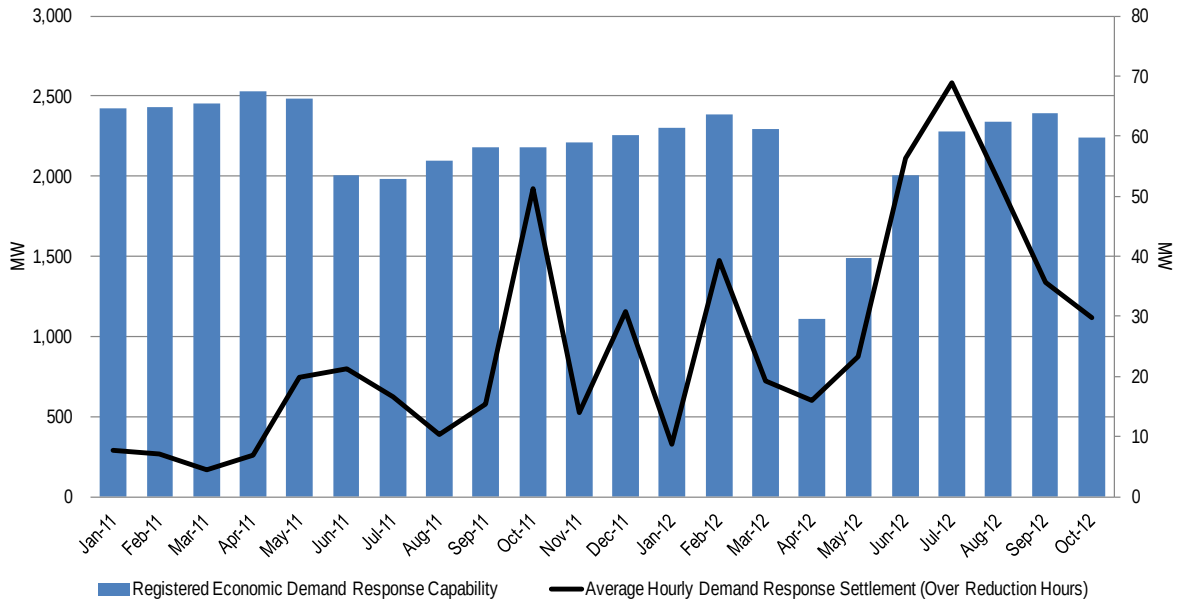
2007			2008			2009			2010			2011			2012		
Date	LMP Avg ($/MWh)	MW	Date	LMP Avg ($/MWh)	MW	Date	LMP Avg ($/MWh)	MW	Date	LMP Avg ($/MWh)	MW	Date	LMP Avg ($/MWh)	MW	Date	LMP Avg ($/MWh)	MW
6/27/07	$122	230	6/9/08	$243	231	8/10/09	$71	132	7/6/10	$162	271	6/8/11	$198	51	7/5/12	$125	305
7/9/07	$137	370	6/10/08	$269	358	8/11/09	$57	28	7/23/10	$115	175	7/19/11	$89	3	7/6/12	$237	241
8/2/07	$140	437	7/17/08	$137	200	8/17/09	$63	24	8/10/10	$132	337	7/20/11	$171	45	7/16/12	$68	228
8/7/07	$134	291	7/18/08	$155	227	8/18/09	$65	32				7/21/11	$186	62			
			7/21/08	$181	126	8/20/09	$65	39									

Maximum (non-emergency peak day) Economic DR was 437 MW on 8/2/2007 when average LMP = $140 (incentive period with old CBL rules, and Minimum of 3 MW on 7/19/2011 when LMP was $89 (LMP-G&T period with revised CBL rules).

Figure 3 below compares the total Economic DR capability to the actual average hourly load reductions delivered in the energy market. The Economic DR capability is based on the amount of economic DR that has been registered by

CSPs and therefore allowed to offer into the energy market. The overall DR capability has consistently been between 2,000 and 2,500 MW before and after Order 745 provisions became effective in April with the exception of April and May when registrations that were renewed under new market rules adopted as part of 745 that required a CBL certification process as part of the registration process. While the average megawatt settled during the 745 period has significantly grown (approximately 20 MW last summer to over 60 MW this summer) the average MWs that were delivered are still only a very small fraction (~3 percent) of the overall DR capability. Clearly, the level of wholesale prices experienced during the summer of 2012 was not high enough for the vast majority of customers to be incented to reduce demand.

Figure 3: Economic DR registered capability versus actual reductions (Jan.2011 – Oct. 2012) [12]

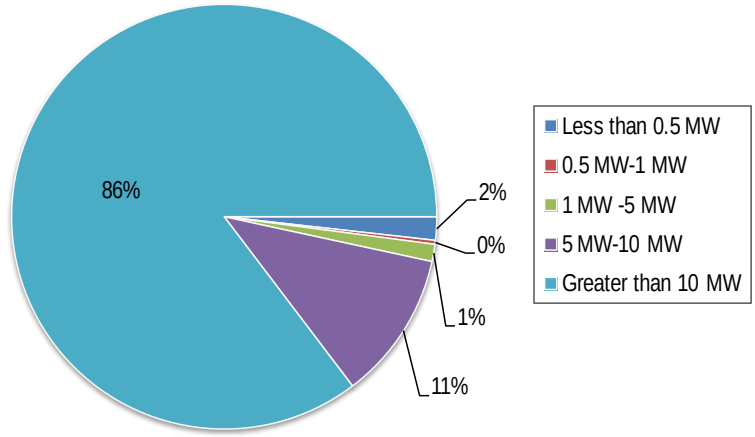


On average only 70 MW of Economic DR was dispatched and settled in July 2012, while approximately 2,300 MW were registered.

The vast majority (86 percent) of all Economic DR activity in the energy market from April to October 2012 has come from a small number of very large customers (greater than 10MW) as illustrated in Figure 4 below. Customers greater than 5MW delivered almost all (97 percent) of the energy delivered by Economic DR resources following the implementation of Order 745 rules. Small customers (less than 0.5 MW) actually delivered more energy than medium-sized customers (0.5 to 5 MW) to the wholesale market during this time period. Payments for Economic DR energy activity followed a very similar distribution across the customer segments.

[12] Average Hourly Demand Response Settlement (BLACK LINE) is based on MW axis on right side of figure (second Y axis).

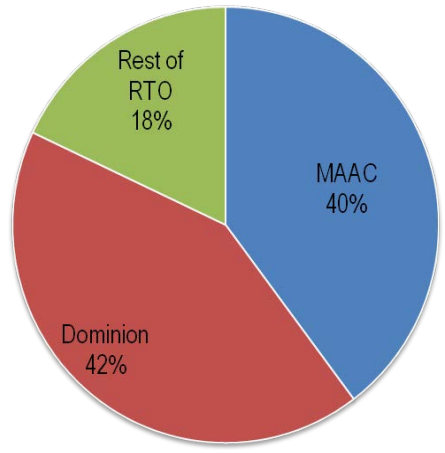
Figure 4: Economic DR percentage of MWh settled by size of customer (Apr. - Oct. 2012)



97 percent of all MWh delivered by Economic DR in post-745 period came from large customers (load greater than 5 MW).

Eighty two percent of all Economic DR load reductions from April 2012 through October 2012 were delivered by resources located in MAAC and the Dominion zone. The Dominion zone itself comprised 42 percent of all load reductions during this period while the rest of RTO only comprised 18 percent of load reductions. Although the level of LMP does help drive some of the difference in the location of the activity, the Dominion zone still has a relatively high amount of load reductions which is primarily attributed to some large resources with a high frequency of activity.

Figure 5: Economic DR percentage of MWh settled by location in PJM (post 745, Apr.- Oct. 2012)



82 percent of all MWh delivered by Economic DR in post-745 period came from Eastern portion of PJM (MAAC + Dominion).

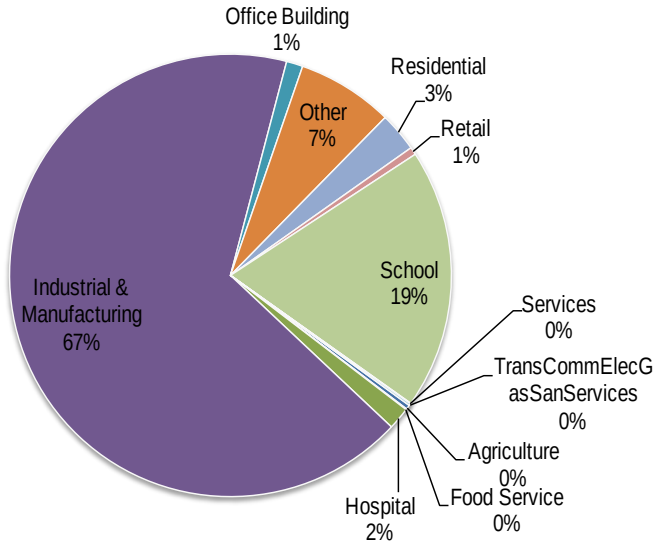
While most economic load reductions originated from the MAAC and Dominion areas, the underlying resources that provided the load reductions vary. The resources in Dominion are very large and the average energy settled per hour per resource was 32.1 MW. This compares to average hourly energy reductions of 2.2 MW in MAAC and 3.8 MW in Rest of RTO. Also note that the percentage of capability utilized in average aggregate settlement hour was 27 percent in the Dominion zone which is much higher than that achieved in MAAC (1.1 percent) and rest of RTO (2.7 percent). A low percentage indicates that resources were capable but did not actively participate due to level of wholesale prices.

Table 3: Economic DR MWh and credits settled by location in PJM (post 745, Apr.- Oct. 2012)

Area	Capability (MW)	Reduction (MWh)	Credits ($)	Site Hours	Aggregate Reduction Hours	Average aggregate Reduction per hour (MW)	% of Capability utilized in average aggregate settlement hour	Average Reduction per site per hour (MW)
MAAC	1,643	53,047	3,450,869	23,723	2,817	18.8	1.1%	2.2
Dominion	242	56,358	3,768,808	1,758	864	65.2	27.0%	32.1
Rest of RTO	527	24,062	1,498,020	6,405	1,666	14.4	2.7%	3.8

The breakdown of energy delivered during the post 745 period (April – October 2012) by business segment is in Figure 6. Industrial and Manufacturing was the largest contributor, delivering 67 percent of economic energy, followed by schools at 19 percent. The revenue allocation by business segment is very similar to the MWh distribution in Figure 6.

Figure 6: Percent of economic energy settled by business segment during the 745 period (Apr. – Oct. 2012)



86 percent of all MWh delivered by Economic DR in post-745 period came from Industrial & Manufacturing facilities or Schools.

Table 4 provides a detailed summary of the energy and revenue settled by business segment. The largest business segment, Industrial & Manufacturing, had an average hourly reduction of 9.1 MW for each site. There were 113 registrations with at least one hour of energy settlement. This segment had 89,538 MWh of settlements for close to $6 million. The total number of site hours settled was 9,861 where a site hour is the number of hours settled for all sites– if there were two sites that settled for one hour each that would equate to two load reduction site (hours) in the table. The schools business segment had the second highest amount of activity in the energy market with an average reduction of 2 MW per site which indicates that the schools participating are large (college, university campus).

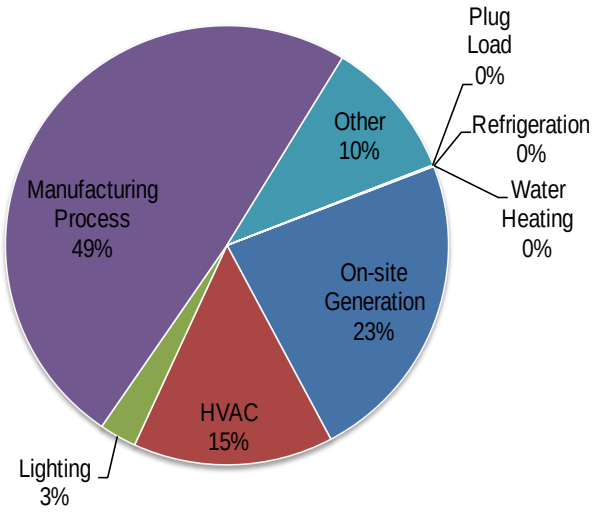
Table 4: Economic energy MWh/credits settled by business segment during the post 745 period (Apr. - Oct. 2012) [13]

Segment	Load reduction site (hours)	credits ($)	Load reduction (MWh)	Number of registrations with at least one hour of load reduction	Average reduction by site (MW)
Agriculture	1,558	$49,913	425	57	0.3
Food Service	120	$7,599	73	2	0.6
Hospital	1,451	$151,642	2,184	13	1.5
Industrial & Manufacturing	9,861	$5,931,968	89,538	113	9.1
Office Building	3,548	$107,838	1,606	36	0.5
Other	1,607	$450,634	9,407	4	5.9
Residential	694	$482,202	3,832	53	5.5
Retail	258	$56,102	745	6	2.9
School	12,577	$1,440,800	25,404	182	2.0
Services	113	$7,840	58	2	0.5

Industrial and manufacturing average load reduction by site was 9.1 MW while agriculture was 0.3 MW.

The breakdown of energy delivered during the post 745 period (April – October 2012) by load type is in Figure 7. The load reduction type indicates that type of activity used to effectuate the load reduction at each end use customer location. The largest contributor by end-use was manufacturing process, delivering 49 percent of the energy. On-site generation was next, delivering 23 percent of the MWh. The revenue allocation by load reduction type is very similar to the MWh distribution in Figure 7.

Figure 7: Percent of economic energy settled by load reduction type during the post 745 period (Apr. - Oct. 2012)



Load reductions were primarily done through change in manufacturing process (49 percent) or use of on-site generation (23 percent).

[13] Average reduction by site is the average reduction for each site except in the case of residential segment where it is all sites on the registration. This is why the average reduction per site is so high for residential segment. TransCommElecGasSanService = Transportation, Communication, Electric and Gas Utilities, and Sanitation Services.

Table 5 presents a more detailed summary of the energy delivered and associated revenue during the post 745 period by load reduction type. This is similar information presented in Table 4 above except that it breaks down activity by load reduction type. HVAC was used in the highest number of registrations (352) while water heating was used in the lowest (only 5 registrations). Similar to the business segment analysis, load reductions created by changing a manufacturing process, had the largest average reduction by site (11.05 MW) compared to all the other load reductions types.

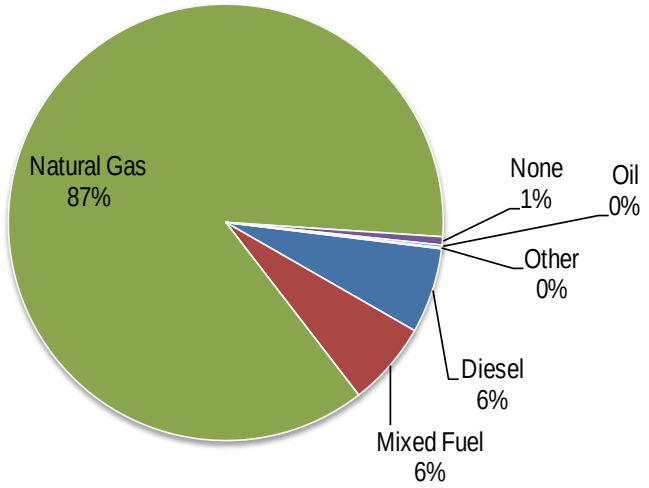
Table 5: Economic energy MWh/credits settled by load reduction type (post 745 period – Apr. – Oct. 2012)

Load Reduction Type	Load reduction site (hours)	Credits ($)	Load reduction (MWh)	Number of registrations with at least one hour of load reduction	Average reduction by site (MW)
On-site Generation	12,341	$1,806,819	30,749	93	2.49
HVAC	16,956	$1,531,954	19,570	352	1.15
Lighting	12,203	$218,794	3,630	259	0.30
Manufacturing Process	5,940	$4,438,960	65,620	91	11.05
Other	8,434	$706,345	13,749	43	1.63
Plug Load	2,757	$7,080	60	52	0.02
Refrigeration	1,012	$7,554	87	48	0.09
Water Heating	230	$190	1	5	0.01

Average load reduction per site that came from a change in a Manufacturing process was 11.05 MW and average load reduction per site that came from a change in water heating was 0.01 MW.

Load reductions during the post 745 period that came from on-site generation are estimated to predominately have come from generation that uses natural gas (87 percent). Diesel and mixed fuel (predominantly natural gas and oil) are each estimated at 6 percent.

Figure 8: Economic energy percent MWh on-site generation settled by fuel type (post 745 period – Apr. – Oct. 2012)



Eighty-seven percent of load reductions came from on-site generation that primarily used natural gas.

Tables 6 and 7 provide information to examine the overlap, or lack of overlap, between end use customers that participate as economic and/or emergency resources. There were 1,890 MW registered as both an economic and an emergency capacity resource, 6,549 MW registered as only an emergency capacity resource and 474 MW registered as only an economic resource. If all current emergency capacity resources also registered as an economic resource this would almost triple the economic DR capability in the PJM wholesale energy market. This implies that there is significant economic DR capability readily available but not currently participating.

Table 6: DR Registration Capability by type of registration (Aug. 2012)

Registration Type	Number of registrations	Registered DR capability (MW)
Economic with no Emergency	170	474
Emergency with no Economic	7,993	6,549
Economic and Emergency	843	1,890
Total Economic	1,013	2,364
Total Emergency	8,818	8,548
Grand Total	9,006	8,912

Over 6,500 MW of Emergency DR has not registered as Economic DR which may imply it is not worthwhile for customers to reduce load based on revenue from the energy market.

Economic load reduction from resources that only had an economic registration accounted for 43 percent of the activity during the post 745 period (April – October 2012). These resources tend to be large and were comprised of 67 registrations. Economic load reductions from capacity resources (i.e.: registered both as economic and emergency resource) accounted for 57 percent of the activity and were comprised of 448 registrations.

Table 7: Economic DR settlement MWh/credits by type of registration (post 745, Apr. – Oct. 2012)

Registration type	Load Reductions (MWh)	Load Reduction (% of MWh)	Credit ($)	Number of registrations
Economic with no Emergency	57,987	43%	$4,034,879	67
Economic and Emergency	75,479	57%	$4,682,818	448
Total	133,466	100%	$8,717,697	515

Close to half of the MWh delivered came from Economic DR that does not also participate as a capacity resource (Emergency DR).

A good indication of a healthy competitive market is the number of active participants (both buyers and sellers) in the markets. Table 8 lists the number of CSPs (sellers) active in the market, MWh of load reduction activity for their economic resources, and cumulative percentage of energy market activity. The top five CSPs normally[14] accounted for over 90 percent of the load reductions delivered in the energy market. The number of CSPs active in the market expanded from 20 to 22 during the incentive period, declined to 14 during the period where compensation was solely

[14] 2009 was the exception were top seven CSP accounted for over 90 percent of activity.

based on LMP minus G&T and has again increased to 22 CSPs in the post-745 period. The table excludes CSPs with active economic registration and no settlement activity.

Table 8: Concentration of CSP economic settled MWh (2007 – 2012)

	2007		2008		2009		2010		2011		2012	
	MWh	cum %	MWh	cum %	MWh	cum %	MWh	cum %	MWh	cum %	MWh	cum %
CSP1	259,105	36%	209,886	46%	22,275	39%	40,595	55%	7,807	45%	57,926	43%
CSP2	227,959	68%	161,095	82%	8,321	54%	14,175	74%	3,790	67%	31,193	66%
CSP3	86,383	80%	25,565	87%	7,596	67%	12,386	91%	2,409	81%	17,887	80%
CSP4	43,632	86%	11,151	90%	6,274	78%	4,246	96%	2,294	94%	13,110	89%
CSP5	30,171	91%	9,590	92%	3,259	84%	1,928	99%	333	96%	3,368	92%
CSP6	18,165	93%	7,832	94%	2,955	89%	235	99%	306	97%	2,062	93%
CSP7	13,798	95%	6,327	95%	2,264	93%	118	99%	139	98%	1,927	95%
CSP8	8,677	96%	5,856	96%	864	94%	106	100%	120	99%	1,797	96%
CSP9	5,641	97%	5,627	98%	863	96%	94	100%	61	99%	1,360	97%
CSP10	5,621	98%	4,016	99%	709	97%	59	100%	53	100%	1,049	98%
CSP11	3,769	99%	2,820	99%	451	98%	52	100%	31	100%	865	99%
CSP12	3,707	99%	1,092	99%	410	99%	29	100%	19	100%	348	99%
CSP13	2,725	99%	776	100%	352	99%	24	100%	18	100%	347	99%
CSP14	1,971	100%	654	100%	253	100%	11	100%	17	100%	251	99%
CSP15	1,148	100%	450	100%	133	100%	9	100%			221	99%
CSP16	733	100%	380	100%	39	100%	3	100%			220	100%
CSP17	297	100%	58	100%	28	100%					186	100%
CSP18	21	100%	32	100%	3	100%					181	100%
CSP19	4	100%	31	100%							98	100%
CSP20	3	100%	14	100%							88	100%
CSP21			11	100%							10	100%
CSP22			1	100%							2	100%
Total	713,530		453,263		57,048		74,070		17,398		134,496	

Five CSPs were responsible for 92 percent of the MWh delivered in 2012.

Table 9 provides a summary of the CBLs used for approved Economic DR resources in 2012. Forty-seven percent of the registered DR Capability (71 percent of the registration) utilize the three day type with Symmetric Additive Adjustment which is often referred to as the "high 4 or 5 method with Symmetric Additive Adjustment". This method is the default CBL assigned to each registration.[15] Thirty-two percent of the DR Capability is non-interval metered customers that rely on dynamic statistical samples or load research and switch operability studies. Eleven percent of the DR capability use the Max Base Load CBL which is used for variable load economic DR resources that are difficult to predict and therefore quantify the load reductions.

[15] The 3 day type with SAA method became the default CBL with the implementation of Order 745 on April 1, 2012 and supported by a comprehensive empirical review of CBLs by a KEMA analysis which was initiated by the PJM Markets and Implementation Committee.

Table 9: Economic DR resource CBL summary (2012)[16][17]

Customer Baseline	MW	MW (%)	Registration (Count)	Registration (%)
3 Day Types with SAA (high 4 of 5)	1,122	47%	748	71%
Non-hourly metered sites DLC	768	32%	79	8%
MBL(Max Base Load)	270	11%	170	16%
Manual	140	6%	28	3%
3 Day Types (high 4 of 5)	107	4%	23	2%
7 Day Types with SAA (3 day average)	4	0%	3	0%
7 Day Types (3 day average)	0.1	0%	1	0%
3 Day Types with WSA (high 4 of 5)	-	0%	0	0%
Metered Generation	-	0%	0	0%
	2,411	100%	1,052	100%

The standard CBL (3 day type with SAA) is being used for the majority (68%) of hourly metered customers.

Offer Analysis – Post 745 Rules

The vast majority of Economic DR resources use a one or two point offer curve for the day-ahead and/or real-time energy market. Economic DR resources that would like to clear for several hours participate in the day-ahead market with a minimum shutdown time greater than two hours.

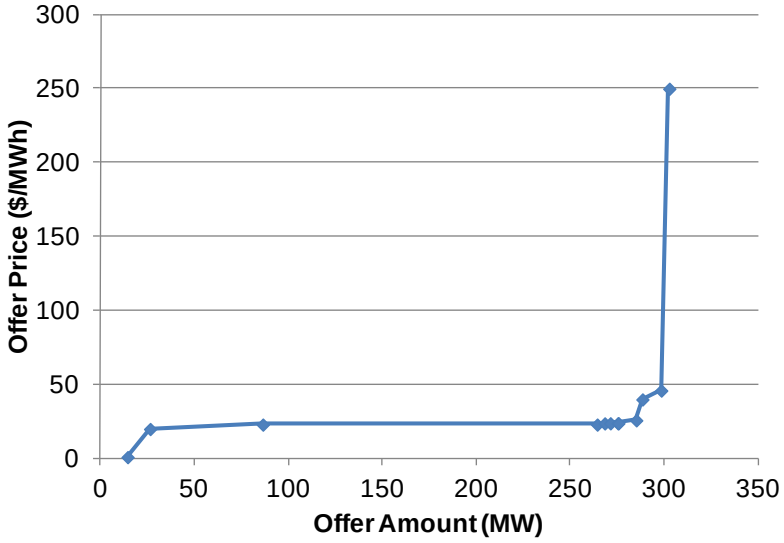
> For example, if a DR resource must reduce load for at least four hours when they do reduce load then such resource normally participates in the day-ahead market. Economic DR resources that are more flexible tend to participate in the real-time market with a notification time less than one hour and a minimum shutdown time two hours or less. For example, these resources only require one hour notice to reduce load and are available to reduce load for only one or two hours. Shutdown cost for economic DR resources are normally very low.

Figures 9 and 10 illustrate the overall Economic DR day-ahead and real-time energy market supply curves on a PJM system peak day with high wholesale prices and an Emergency DR event in AEP and Dominion (July 17, 2012, hour beginning 16). For the day-ahead market the vast majority of megawatts offered (285 out of 305 MW) were offered below $26 MWh which is very close the NBT price. Only 5 MW were offered above $50 MWh.

[16] See manual 11, section 10.4.2 for detailed description of existing CBL methods.

[17] Non-hourly metered sites DLC that participate as Economic DR resource will primarily use load research and associated switch operability study to determine energy reduction.

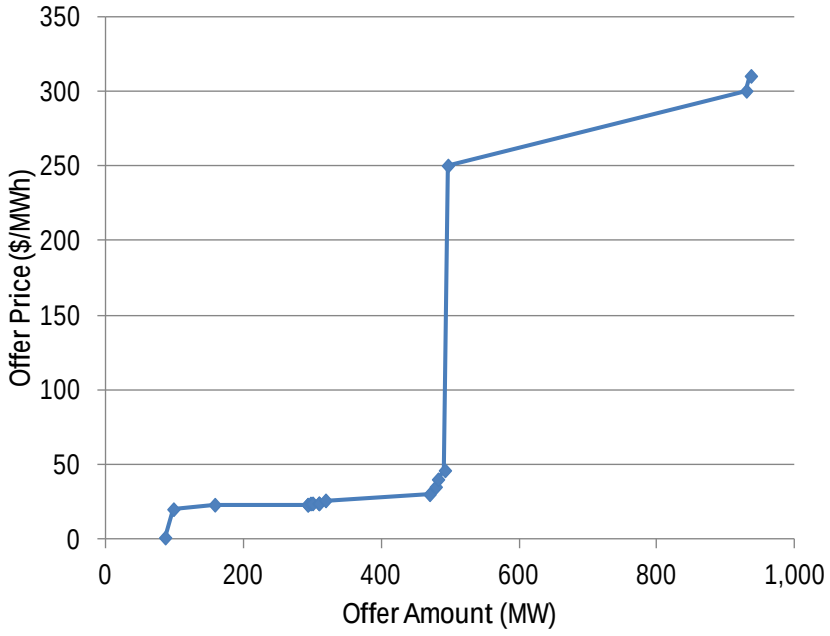
Figure 9: Economic DR day-ahead supply curve (7/17/12, houring beginning 16:00)



Almost all the Economic DR MWs (~300 MW) were offered into the day-ahead market at a price less than $50 MWh on the 2012 PJM system peak hour.

Figure 10 represents the real time supply curve for the same hour. The real-time supply curve is similar up to approximately 500 MW (most offers close to the NBT price) and then has close to 500 MW additional supply available near $300/MWh. In total there were over 900 MW to be available for dispatch in the real-time energy market or more than three times the amount offered into the day-ahead market.

Figure 10: Economic DR real-time supply curve (7/17/12, houring beginning 16:00)

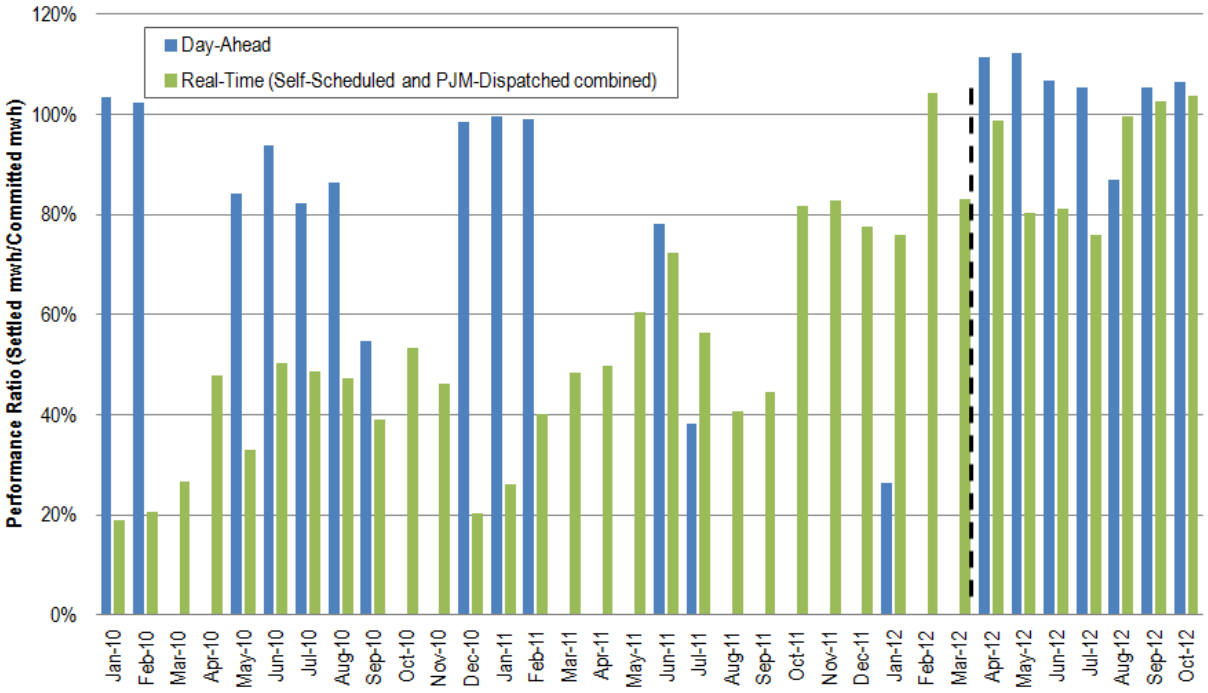


On the 2012 PJM peak hour, approximately half of Economic DR MWs available to be dispatched in real-time market had a strike price less than $50 MWh while the other half had a strike price of greater than $250 MWh

Performance Analysis

Economic DR monthly performance as measured based on the ratio of settled MWh to committed MWh has dramatically improved in the 745 period when compared to activity prior to the implementation of Order 745. This is primarily a function of the market rule changes which were implemented under order 745 which eliminated self scheduling, assigned Balancing Operating Reserve charges and eliminated make whole payments for hours with significant deviations from committed amount and ability for CSP to accrue debit for activity during the day.[18] Prior to Order 745, day-ahead performance was typically between 80-100 percent while real time performance was much less accurate, typically ranging from 30 to 80 percent. Day-ahead performance was typically between 100 and 110 percent in the post 745 period, which means the CSP delivered more MWh that cleared in day ahead market because their offers were based on a more conservative estimate of their real time operational capability. Real-time market performance typically ranged from 80 to 100 percent in the post 745 period, which is a dramatic improvement from the prior period. July 2012 performance was a little lower than normal during the post-745 period and may have been the result of more frequent activity in the market which included economic resources that typically do not participate unless energy prices high.

Figure 11: Economic DR monthly Performance (Jan. 2011 – Oct. 2012)



Economic DR performance has significantly improved in post-745 period.

While overall monthly performance in the market improved, individual registration performance was mixed. The following two figures represent a summary of performance for registrations prior to 745 and after 745. Performance is determined by the MWh delivered/MWh committed and is represented by 3 strata: greater than 1.2 (significant over-delivery), 0.8 – 1.2 (delivered amount close to committed amount) and less than 0.8 (significant under-delivery).

[18] A brief summary of market rules is contained in the beginning of this report. Prior to Order-745 if a CSP incurred debits for a day, they would not be charged.

Table 10 represents a count of the number of registration that fall into the different performance strata by period (pre and post 745 period) and market (day-ahead or real-time). During the pre-745 period a greater proportion (43 percent) of registrations fall close to the day-ahead commitment than during the post-745 period (27 percent); however, a larger proportion of registrations underperformed in the day-ahead market during the pre-745 period (57 percent) than during the post-745 period (47 percent). Registrations in the real-time market did appear to perform slightly better in the post-745 period than during the pre-745 period. Seventy percent of registration under-delivered in post 745-period whereas 91 percent under-delivered in the pre-745 period.

Table 10: Registration count performance by period by day-ahead vs. real-time market (Jan. 2011 – Oct. 2012)

	Registration Count				Percent of Registration			
	Day-Ahead		Real-Time		Day-Ahead		Real-Time	
	Pre-745	Post-745	Pre-745	Post-745	Pre-745	Post-745	Pre-745	Post-745
Greater than 1.2	0	12	24	41	0%	27%	4%	9%
Between 0.8 and 1.2	3	12	30	95	43%	27%	5%	21%
Less than 0.8	4	21	553	324	57%	47%	91%	70%

Approximately one quarter of Economic DR registrations that participated in the day-ahead and real-time market delivered between 80 percent and 120 percent of their committed amount during the post-745 period – most under delivered and did not over deliver.

The result in the prior table summarized of the number of registration by performance strata; Table 11 summarizes how the energy associated with each registration falls into each of the strata. The overall performance is significantly better when analyzing the MWh distribution since the registrations with large MWh reduction and/or frequently settlement activity perform better than registration that are smaller or have limited settlement activity. While 21 percent of the registrations in the post 745 period delivered MWh close to their commitment – these registrations comprised 63 percent of all MWh delivered for that period and energy market.

There is only a minor difference in the distribution of MWh by performance strata between the pre- and post- 745 period. The objective is to maximize the MWh in the 0.8 to 1.2 strata which indicate the MWh committed are close to the MWh delivered. Both the day-ahead and real-time markets had slightly better results in the pre-745 period but day-ahead had significantly more under-delivery than in the post-745 period. This is an interesting contrast to the overall aggregate performance across CSP where performance significantly improved in the post-745 period. A potential reason for the lack of improvement in the performance may be attributed to the use of more dynamic CBLs which make it more difficult to predict load reductions in advance and therefore more difficult for the CSP to determine their offer amount in the day-ahead or real-time energy market.

Table 11: Registration MWh performance by period by day-ahead versus real-time market (Jan. 2011 – Oct. 2012)

	MWh				% of MWh			
	Day-Ahead		Real-Time		Day-Ahead		Real-Time	
	Pre-745	Post-745	Pre-745	Post-745	Pre-745	Post-745	Pre-745	Post-745
Greater than 1.2	-	15,793	2,841	10,968	0%	27%	16%	15%
Between 0.8 and 1.2	176	35,731	13,149	47,475	73%	61%	72%	63%
Less than 0.8	65	6,819	2,198	16,681	27%	12%	12%	22%

Close to two-thirds of Economic DR MWh delivered in the day-ahead and real-time market were between 80 percent and 120 percent of their committed amount during the post-745 period – over delivery vs under delivery were similar.

Table 12 provides a summary of all MWh settled stratified by the absolute value of the percent error for the actual hourly load reduction compared to the hourly cleared offer or real time dispatch amount[19]. This summary analyzes hourly performance of Economic DR to get a better idea of how close hourly actual load reductions are to the amount cleared in day-ahead market or dispatched in real-time market on an hourly basis. The absolute value is used to get a better representation of the true hourly error when the values are placed into Strata. While the absolute value represents the hourly expected error, the actual average errors are significantly lower because one hour of over-delivered megawatts may be offset by one hour of under-delivered megawatt when summarized across time (i.e.: more than one hour).

Since day-ahead activity was so low in the Pre-745 period it is difficult to compare with the Post-745 period. For the very limited day-ahead activity in the Pre-745 period the performance was much better than during the Post-745 period. Eighty seven percent of all day-ahead MWh settled in the Pre-745 period had an APE of less than or equal to 20 percent compared to only 44 percent during the post-745 period.

Table 12: Distribution of MWh settled by hourly Absolute Percent Error (APE) Strata

	Day-Ahead (MWh)		Real-Time (MWh)		Day-Ahead (%)		Real-Time (%)	
APE Strata	Pre-745	Post-745	Pre-745	Post-745	Pre-745	Post-745	Pre-745	Post-745
<=20%	209	25,810	5,103	41,976	87%	44%	28%	56%
>20% and <=40%	15	10,147	5,476	12,986	6%	17%	30%	17%
>40% and <=60%	9	5,760	2,326	7,690	4%	10%	13%	10%
>60% and <=80%	7	4,165	1,736	2,611	3%	7%	10%	3%
>80% and <=100%	1	3,106	284	2,047	0%	5%	2%	3%
> 100%	(0)	9,355	3,263	7,813	0%	16%	18%	10%

About half of the Economic DR MWh settled in post-745 period were within +/- 20 percent of the committed amount.

[19] Absolute Percent error = Absolute Value of [(actual load reduction MW/cleared DA offer MW or RT dispatch MW) – 1]

Table 13: Distribution of number of hours settled by hourly Absolute Percent Error (APE) Strata

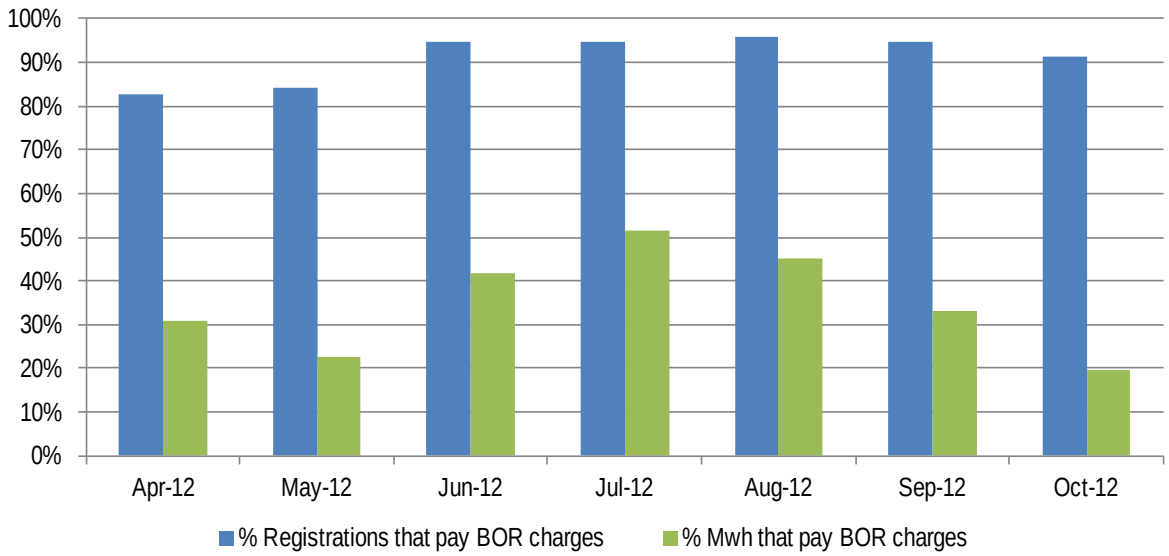
	Day-Ahead (hours)		Real-Time (hours)		Day-Ahead (%)		Real-Time (%)	
APE Strata	Pre-745	Post-745	Pre-745	Post-745	Pre-745	Post-745	Pre-745	Post-745
<=20%	33	1,931	519	4,156	37%	24%	2%	17%
>20% and <=40%	4	1,306	493	2,704	4%	17%	2%	11%
>40% and <=60%	4	1,005	584	2,418	4%	13%	2%	10%
>60% and <=80%	4	816	588	2,074	4%	10%	2%	8%
>80% and <=100%	44	1,108	21,411	7,672	49%	14%	88%	31%
> 100%	1	1,729	764	5,904	1%	22%	3%	24%

The vast majority (~80 percent) of Economic DR hours settled had errors beyond +/-20 percent of committed amount during the post-745 period.

Balancing Operating Reserve Summary

Balancing Operating Reserve charges are assigned to megawatts delivered if amount delivered is greater than +/-20 percent deviation from amount cleared in day-ahead market or dispatched in real-time market. Almost all registrations have incurred Balancing Operating Reserves changes since the implementation of Order 745 in April 2012. In fact, 83 to 96 percent of registrations have incurred Balancing Operating Reserves charges on a monthly basis. The total monthly MWh settled that were assigned Balancing Operating Reserves charges ranged from a low of 20 percent in October 2012 to a high of 51 percent, or more than half, of the settled MWh in July 2012. It should be noted Economic DR must use a CBL to determine the load reduction, which is an estimate and therefore includes error that can contribute to deviations that result in Balancing Operating Reserves charges. This is different from a generator where the output in easily metered and therefore measured.

Figure 12: Percentage of Registrations and MWh that paid Balancing Operating Reserve Charges



The total monthly MWh settled that were assigned Balancing Operating Reserves charges ranged from a low of 20 percent in October 2012 to a high of 51 percent in July 2012

Balancing Operating Reserves paid by Economic DR resources from April through October 2012 totaled $207,880. Total Balancing Operating Reserves paid during this period was two percent of the total Economic DR revenue received from the energy market. Balancing Operating Reserves cost as a percentage of total revenue ranged from 1 to 3 percent.

Table 14: Balancing Operating Reserve cost allocated to Economic DR resources

Month Yearr	Total BOR Cost to DR	Total DR Revenue	BOR cost % of DR Revenue
Apr. 12	$3,572	$195,598	2%
May 12	$5,264	$484,756	1%
Jun. 12	$34,871	$1,454,015	2%
Jul. 12	$103,947	$3,770,971	3%
Aug. 12	$40,417	$1,521,648	3%
Sep. 12	$14,003	$704,712	2%
Oct. 12	$5,806	$585,997	1%
	$207,880	$8,717,697	2%

Economic DR paid over $200,000 (or ~2 percent of revenue) for Balancing Operating Reserves during the post-745 period

Make Whole Payment Summary

The same criterion used to determine if Balancing Operating Reserves charges should be allocated is also used to determine if the Economic DR resource should receive a "make whole" payment. An energy offer make whole payment is made if the amount of revenue received from the market is less than the offer value. This typically occurs if an economic DR resource is dispatched in real-time market when actual LMP is lower than initially expected. Make whole payments from April through October 2012 were $259,292 which represents approximately 2.5 percent of total revenue paid to Economic DR resources.

Table 15: Energy Offer "make whole" payments to Economic DR resources

Month	Make whole payments to DR (Retail-time market)	Make whole payments to DR (Day-ahead market)
Apr. 12	$3,773	
May 12	$24,272	
Jun. 12	$29,978	$871
Jul. 12	$168,741	$1,213
Aug. 12	$23,915	$11,213
Sep. 12	$8,613	$4,733
Oct. 12		$29
	$259,292	$18,059

Economic DR received over $275,000 for make whole payments from the energy market.