

2016 Distributed Energy Resources (DER) that participate in PJM Markets as Demand Response

PJM Demand Side Response Operations

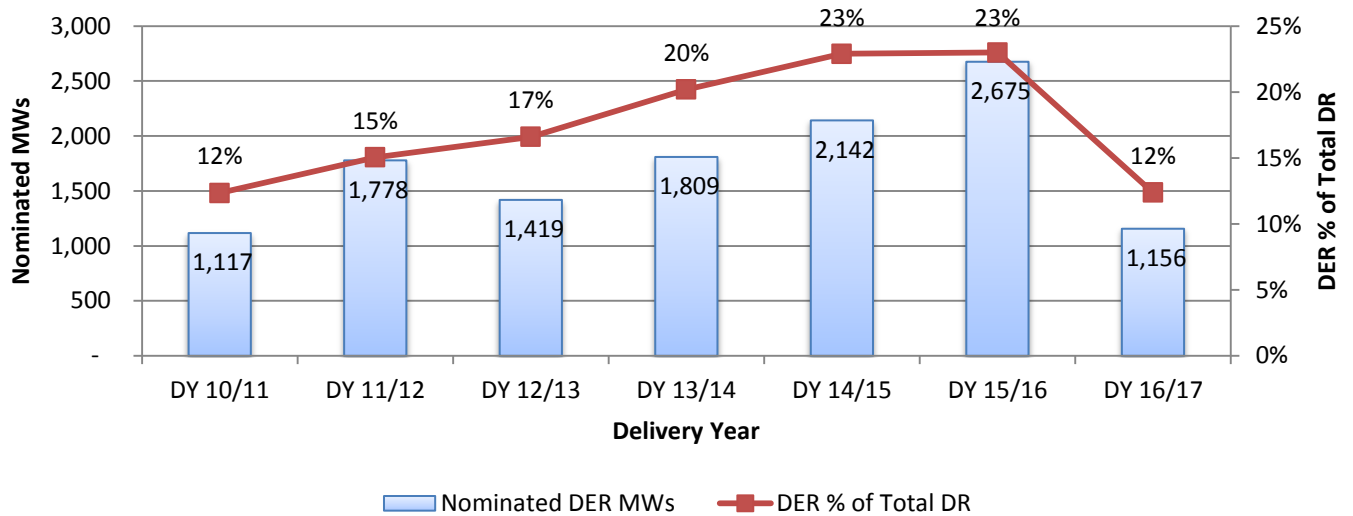
February, 2017



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For the purposes of this report PJM will refer to behind the meter devices capable producing electricity in Demand Response as “DR DER”.

Figure 1: Demand Response from DER in Capacity Market

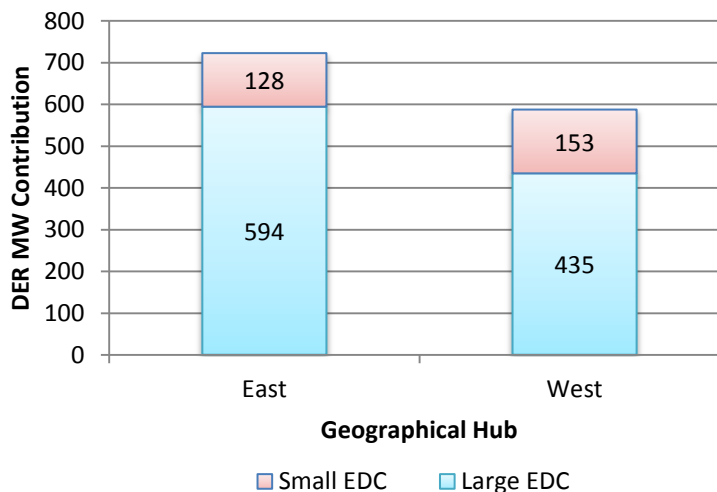


DER participation in the Capacity Market as Demand Response, represented here both in MW volume and as a percentage of overall Demand Response volume, showed steady growth through 15/16 DY and then dropped by almost 50% in 16/17 DY.

Observation: Based on discussions with CSPs, PJM believes the drop in 16/17 DY was due to U.S. Court of Appeals for the District of Columbia Circuit issuing a mandate (May 1, 2015) vacating specific RICE NESHP and NSPS provisions for Emergency Engines with the further guidance released by the EPA on April 15, 2016.

Note: Analysis includes all Load Management Products. DER MWs are included in All DR MWs.

Figure 2: DR DER Registered MW Capability (16/17 DY) Geographical Distribution by EDC Size

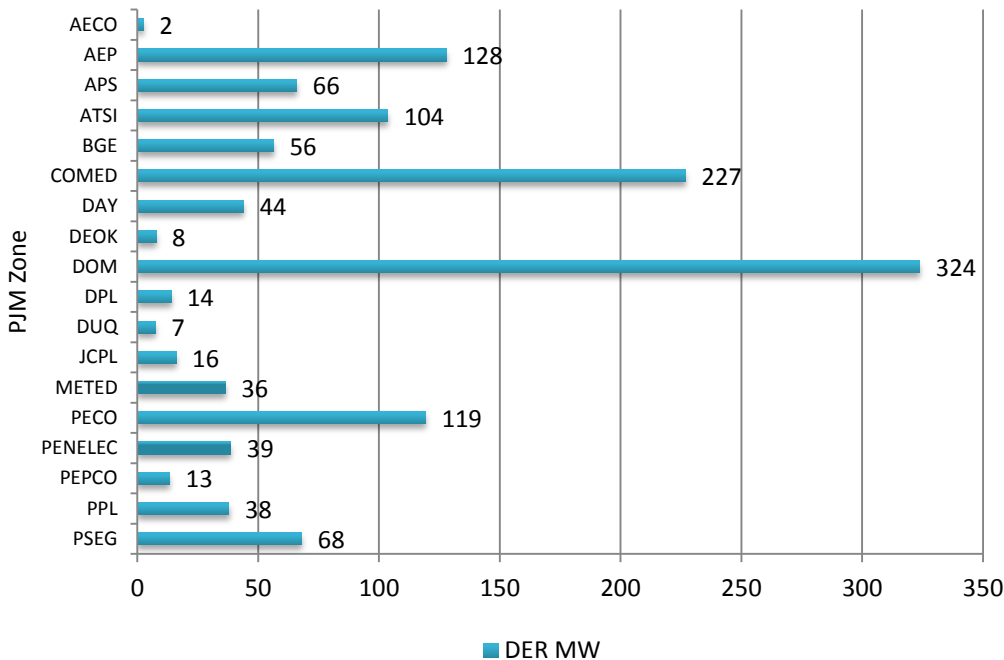


Geographical distribution of MW volume of DER participation in PJM Market as Demand Response shows the East with 722 MWs and the West with 588 MWs. Distribution by EDC shows Large EDCs make up 1,029 MWs whereas Small EDCs account for 281 MWs.

Notes:

- 1) "East" includes following companies: Atlantic City Electric, Baltimore Gas and Electric, Delmarva Power and Light, Jersey Central Power and Light, Metropolitan Edison, PECO Energy, Pennsylvania Electric, PPL Electric Utilities, Potomac Electric Power, Public Service Electric and Gas, Rockland Electric, UGI, Virginia Electric and Power, and Virginia Electric and Power. "West" includes: Allegheny Power, American Electric Power, American Transmission Service Inc (FE), Commonwealth Edison, Dayton Power and Light, Duke Energy Ohio and Kentucky, Duquesne Light, and East Kentucky Power Cooperative.
- 2) EDC size classification is determined according to the following criteria: "Large" are those EDC's with greater than 4 million Mwh per year; "Small" are those EDCs with less than or equal to 4 million Mwh per year.
- 3) Values are Nominated MWs for Load Management products and CSP reported load reduction MWs for economic participation. Locations that participate in both Load Management and Economic are included only once using the nominated values.

Figure 3: DR DER Registered MW Capability (16/17 DY) by Zone



Note: Values are Nominated MWs for Load Management products and CSP reported load reduction MWs for economic participation. Locations that participate in both Load Management and Economic are included only once using the nominated values.

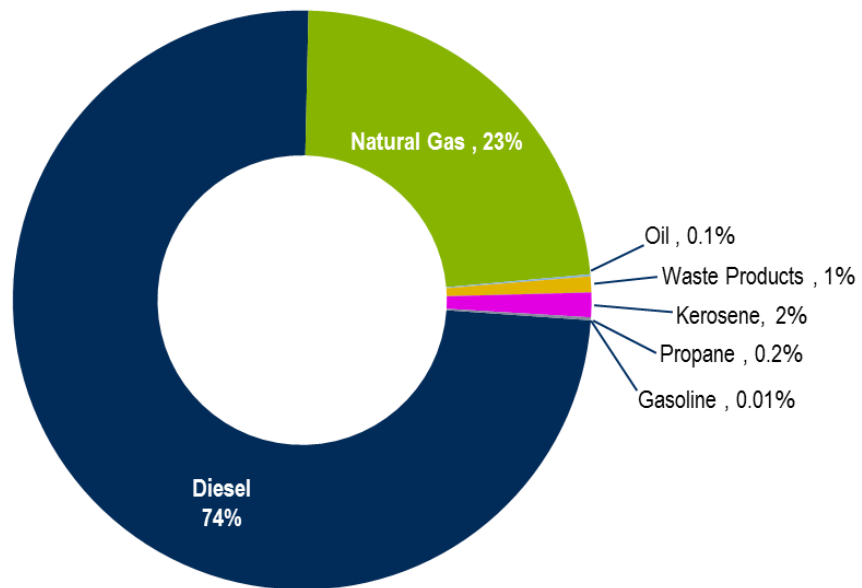
Figure 4: DR DER Registered MW Capability (16/17 DY) from Non-retail and Retail Behind the Meter Generation (BTMG)

DER position (DY 16/17)	MWs	# Locations
Retail BTMG	1,138	1,293
Non-retail BTMG	172	18
Grand Total	1,310	1,311

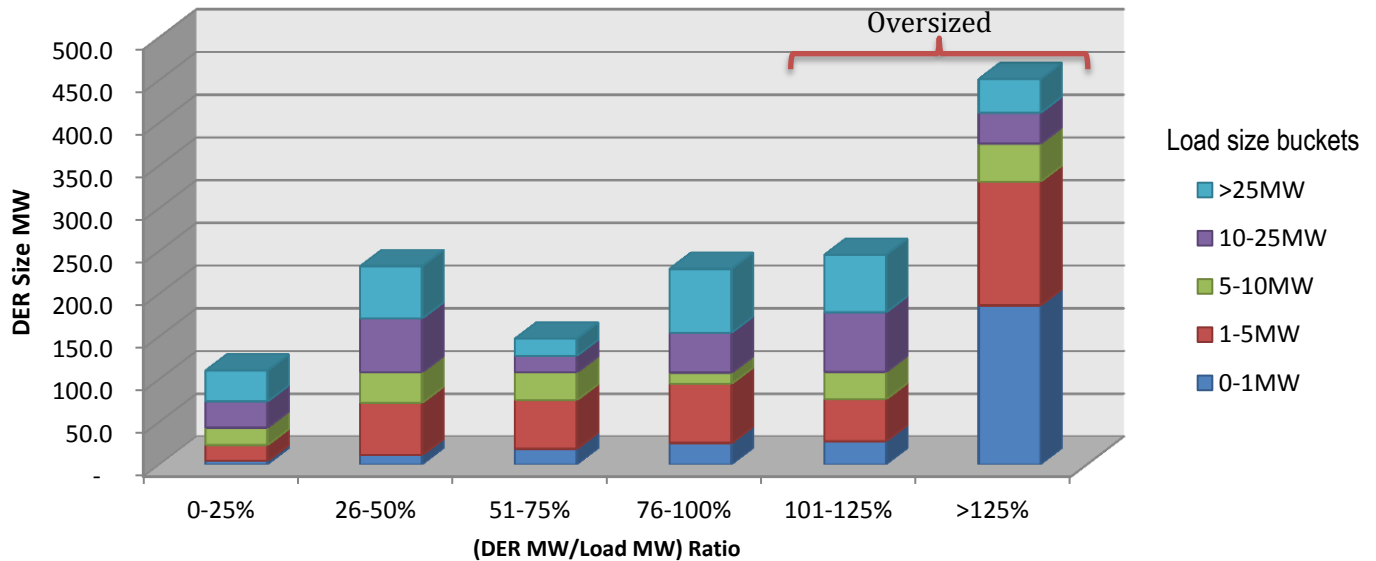
DER participation as Demand Response in the Capacity Market shows a significant MW volume and number of locations with Retail BTMG as contrasted with the volume and number of locations with Non-retail BTMG. Non-Retail usually indicates generation resources at a Municipal or Cooperative Electrical Area. Retail usually indicates generation that is not behind a Muni/Coop.

Note: Values are Nominated MWs for Load Management products and CSP reported load reduction MWs for economic participation. Locations that participate in both Load Management and Economic are included only once using the nominated values.

Figure 5: DR DER Registered MW Capability (16/17 DY) Fuel Mix with Behind the Meter Generation



Fuel mix for behind the meter generation that participates in Capacity Market as Demand Response for DY 2016/17 predominantly consists of diesel (74%) and natural gas (23%) which make up a combined 97% of the total fuel types.

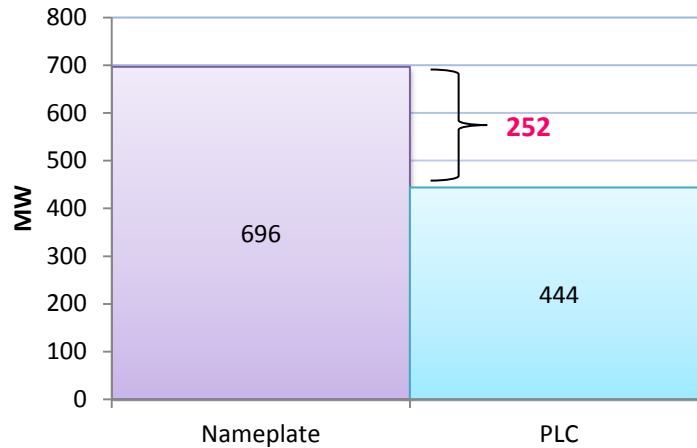
Figure 6: DR DER Registered MW Capability (16/17 DY) by Size and ratio of Size/Load


DER Nameplate/PLC Ratio	Total Nameplate DER MWs by Customer Load (PLC)					Grand Total	%
	0-1MW	1-5MW	5-10MW	10-25MW	>25MW		
0-25%	4.3	18.5	20.4	30.6	36.1	110.0	8%
26-50%	11.1	61.2	35.8	62.9	61.1	232.2	16%
51-75%	18.4	57.0	32.5	19.4	20.0	147.3	10%
76-100%	25.3	69.3	13.0	46.8	74.7	229.1	16%
101-125%	27.4	49.1	32.0	69.8	67.2	245.4	17%
>125%	186.3	144.8	44.5	36.0	39.5	451.1	32%
Grand Total	272.8	400.0	178.1	265.5	298.6	1,415.0	100%

The Figure and Table above display DER capacity (as represented by the nameplate MWs) broken down by the size of the load (as represented by peak load contribution or “PLC”) and the ratio of DER MW to the load MW. The ratio of DER MW output to load MW provides an indication of how big the DER is relative to the load. For example, the 0-25% category represents DER output that is less than 25% of the load. Said another way, if the DER is activated it can only offset less than 25% of the load. Each bar on the graph represents the total amount of DR and broken out by the size of the load (as represented by the PLC). Approximately 49% of all applicable locations have their DERs nameplate capacity sized to cover over 100% of the max load. Locations with DER less than 1MW (relatively small DER), had 78% (213/272 MW) of the DER MWs oversized relative to the load.

Note: “DER size” in this analysis is a DER nameplate capacity, “Load” is a Peak Load Contribution. DER Size/Load ratio illustrates DER generation capability relative to the locations load.

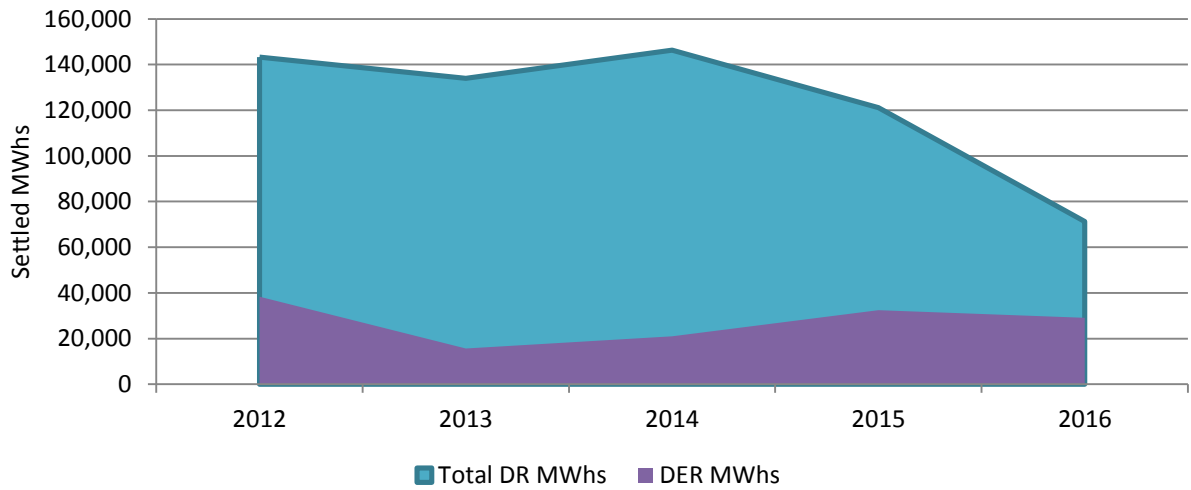
Figure 7: DR DER Registered MW Injection Capability (16/17 DY)



Extracting the Nameplate Capacity MWs and load MWs from the previous figure (see Figure 6) for those locations sized to cover over 100% of max load, reveals that those DER are capable of potentially injecting an additional 252 MW into the grid. Most of these locations have loads less than 10 MW.

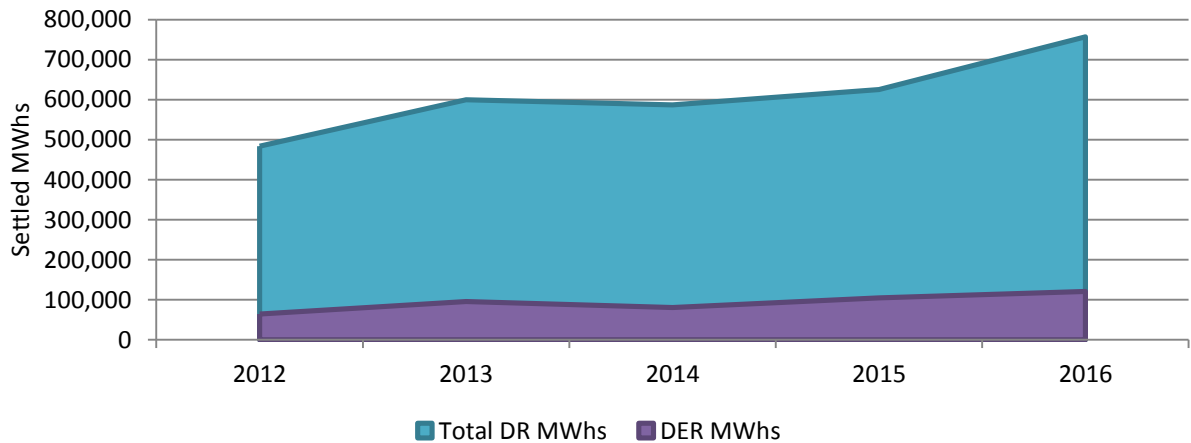
Note: DER MWs for locations where Nameplate MWs exceed max load MWs

Figure 8: PJM Demand Response Economic Energy Settled MWs Trend



While the total DR Economic Energy settled MWs volumes declined over time, the share of DER participating as Demand Response remained steady, thus, driving the DER/Total DR ratio up to 41% in 2016 meaning that 41% of settled DR MWs were from DER participation.

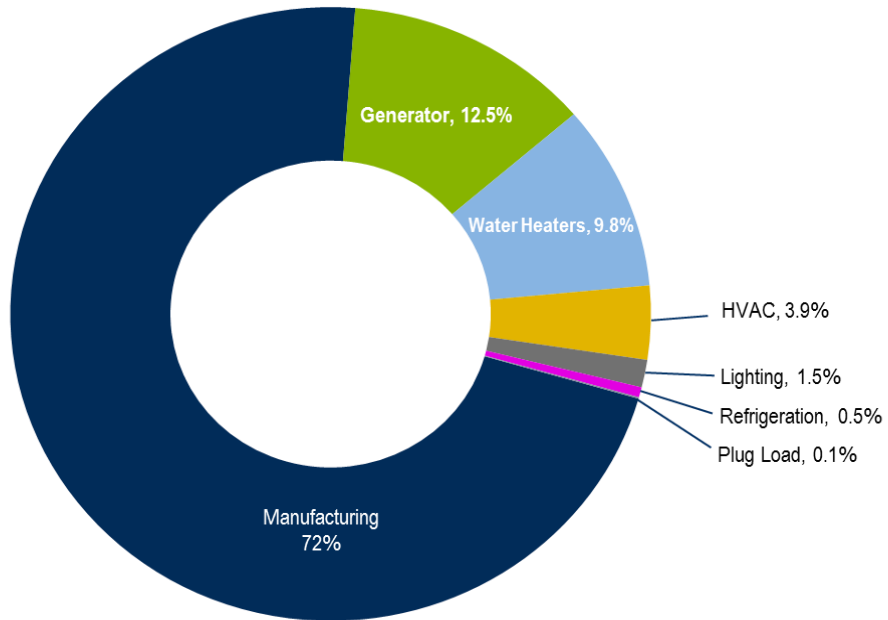
Figure 9: PJM Demand Response Synchronized Reserves Settled MWs Trend



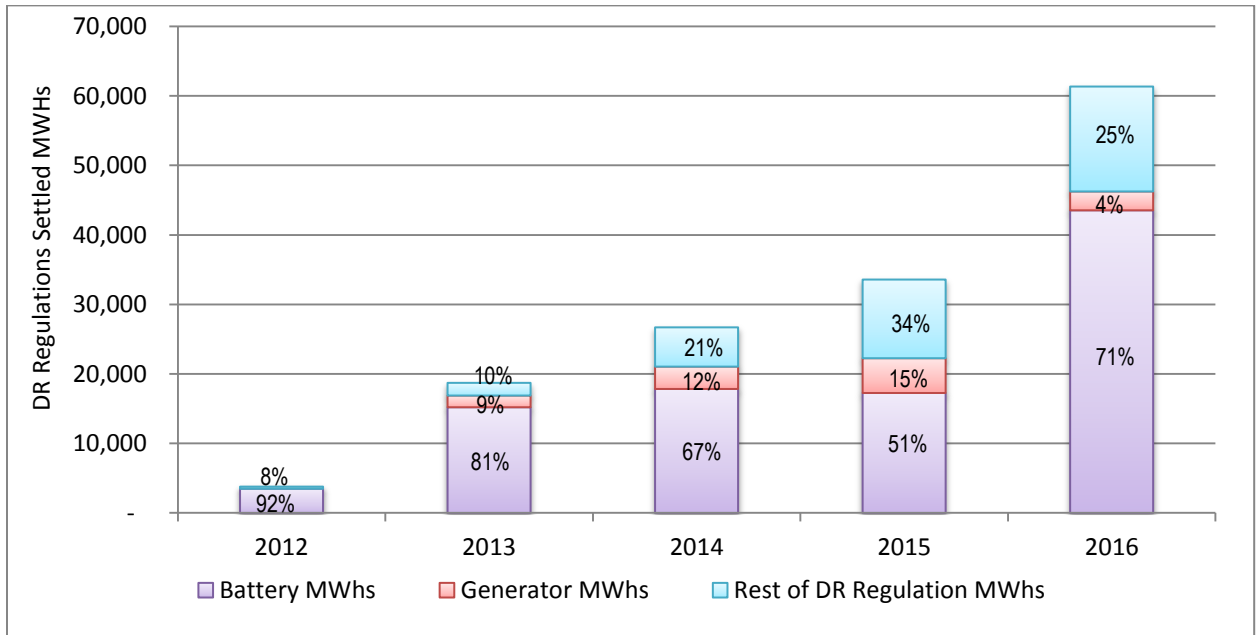
DR Synchronized Reserves settled MWs trend showed steady growth over time for both DER and other resources participating as Demand Response. Thus, the DER/Total DR SR ratio remained relatively steady.

Note: PJM findings are based on extrapolation of DR capability by load reduction method submitted by curtailment service provider. PJM does not know what load reduction method was deployed in any given event.

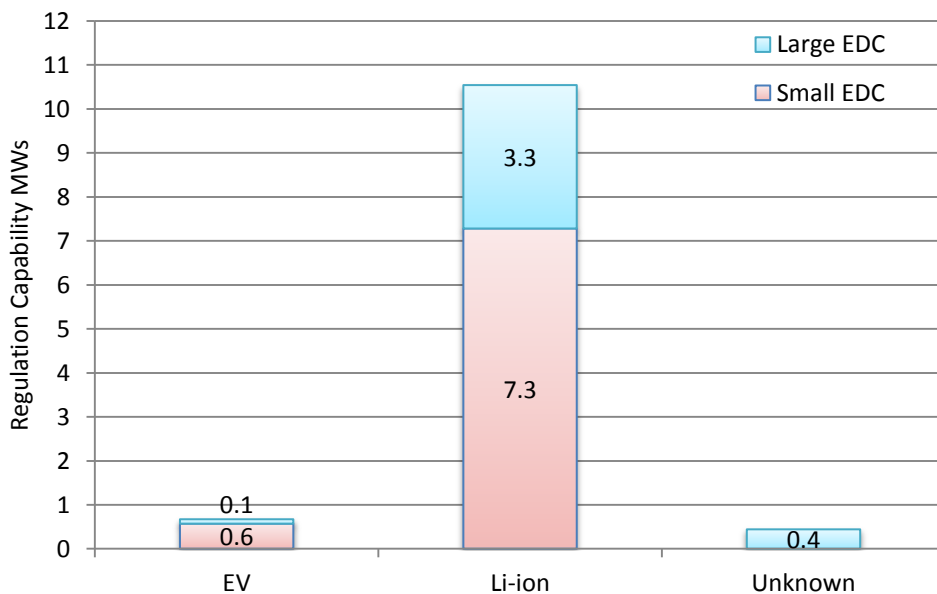
Figure 10: 2016 PJM Demand Response Confirmed Synch Reserve Registrations Load Reduction Methods



Behind the meter generators represent only 12% of total Synchronized Reserves participating as Demand Response while the manufacturing sector leads with 72%.

Figure 11: PJM Demand Response Regulation Settled MWhs trend for DER


Behind the meter battery storage technology experienced the largest growth in Demand Response Regulation settled MWhs in 2016, followed by electrical water heaters which make up a majority of Rest of Regulation MWhs. At the same time behind the meter generators showed a slight decline.

Figure 12: DR DER Registered Regulation Capability from Batteries by EDC size by Technology


There are two main battery storage technologies types currently in PJM Demand Response Regulations market – stationary installations of lithium ion batteries and electric vehicle built-in batteries with their charging stations.