2018 Distributed Energy Resources (DER) that participate in PJM Markets as Demand Response

PJM Demand Side Response Operations

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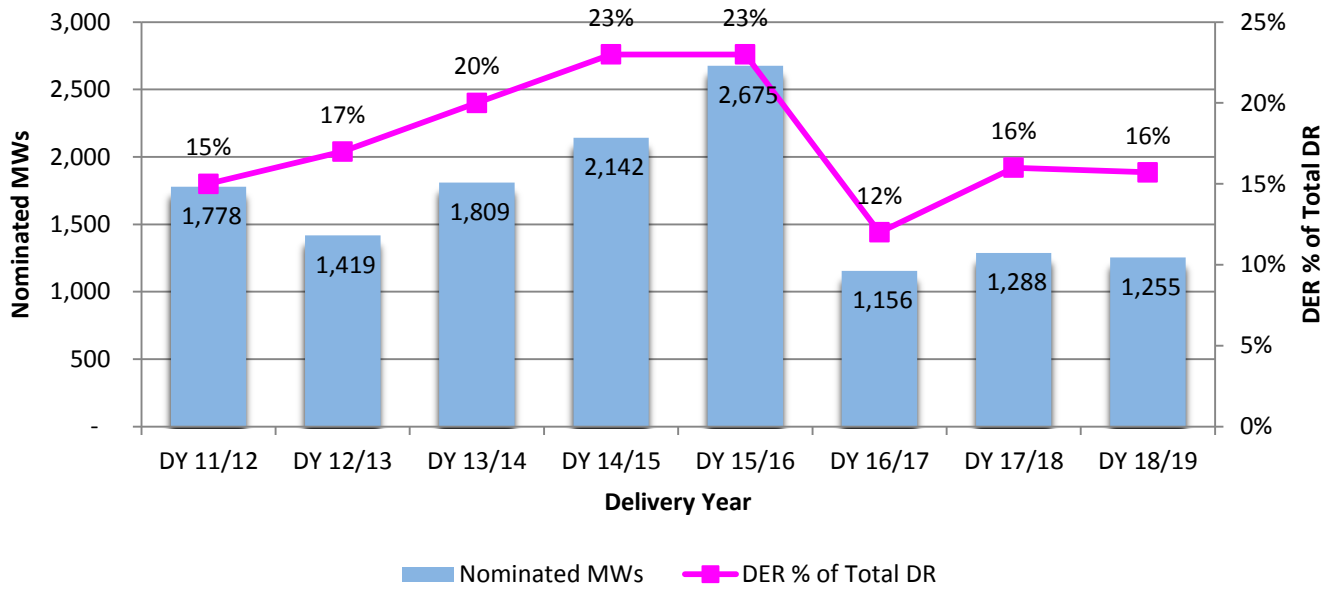
For the purposes of this report PJM will refer to behind the meter devices capable producing electricity in Demand Response as "DR DER".

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 over 50% in16/17 DY. For 18/19 DY the amount of DR DER went down by 33MW and its share of total DR remained unchanged from the previous delivery year.

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 NESHAP and NSPS provisions for Emergency Engines with the further guidance released by the EPA on April 15, 2016.

Figure 2: DER Capability in DR Programs (2018 for Economic and 18/19 DY for Load Management)

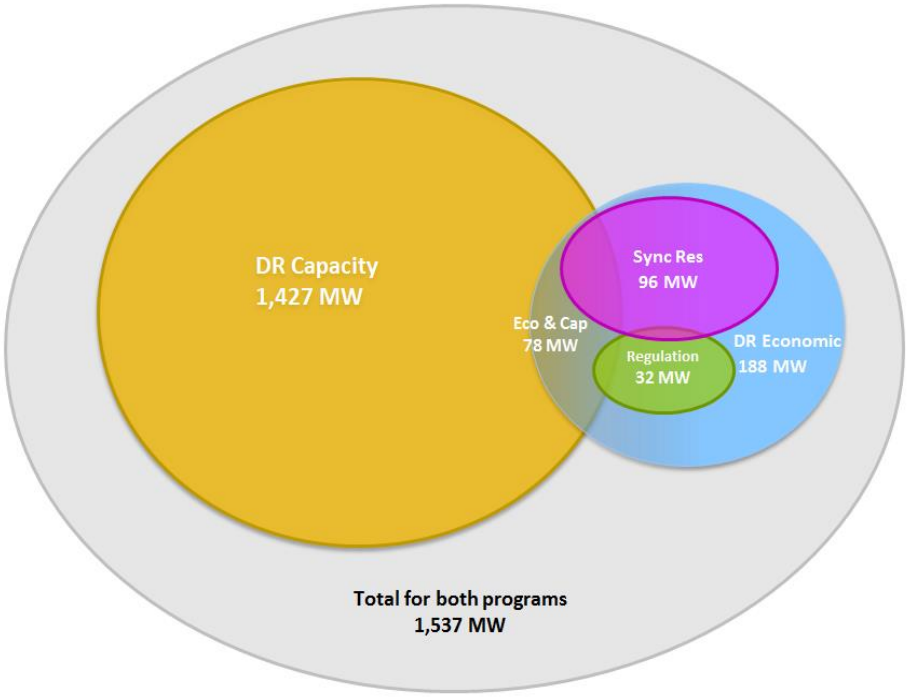
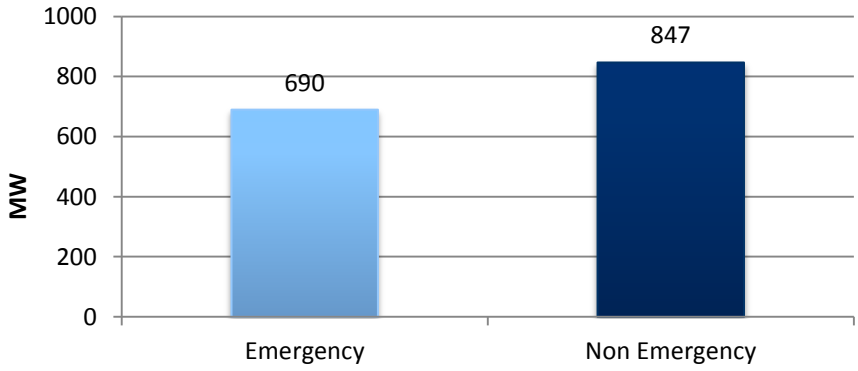


Figure 2 shows MW capability of DERs registered in Demand Response programs. Of 1,427 MW registered in capacity market only 78 MW also participate in economic programs. 110 MWs of capability are registered in economic programs only. This brings total DR DER capability to 1,537 MWs. The majority of DERs participating as economic DR have been certified to provide ancillary services (118 MW).

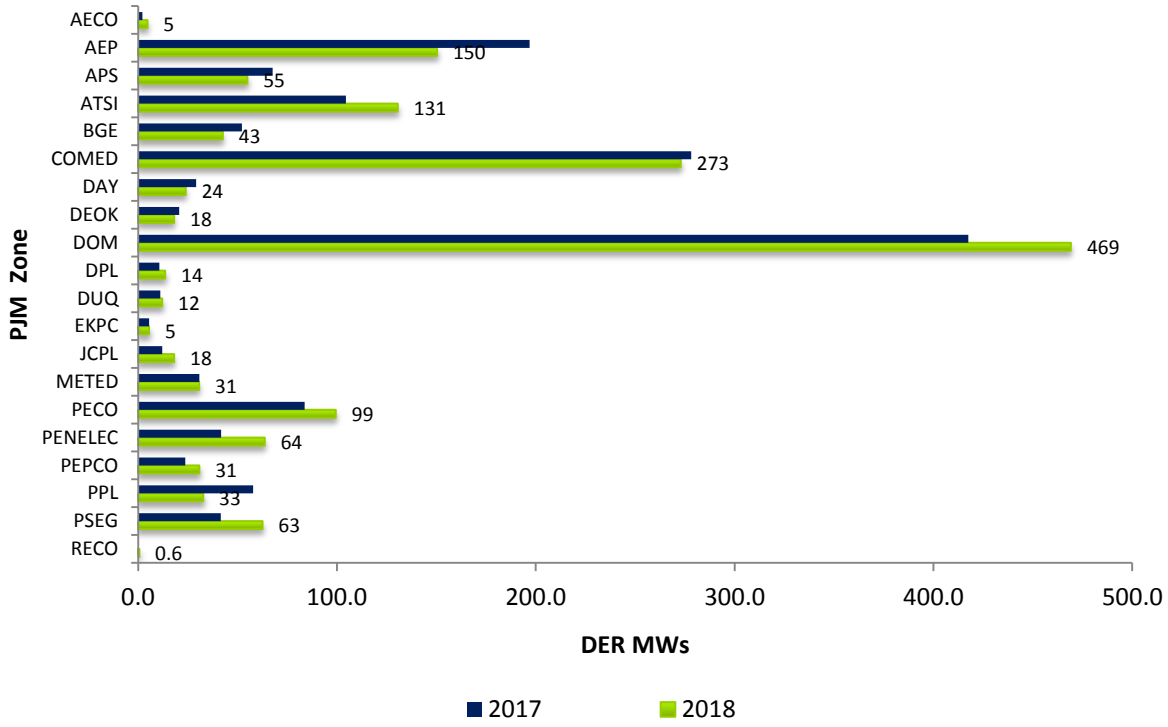
Notes: Values are CSP reported nameplate MWs for DER participation. These DER capability values may exceed nominated MWs for capacity resources because, in some cases, only partial capability may be offered. DER capability for economic registrations is captured as of 12/31/2018.

Figure 3: DER capability by generator permit type



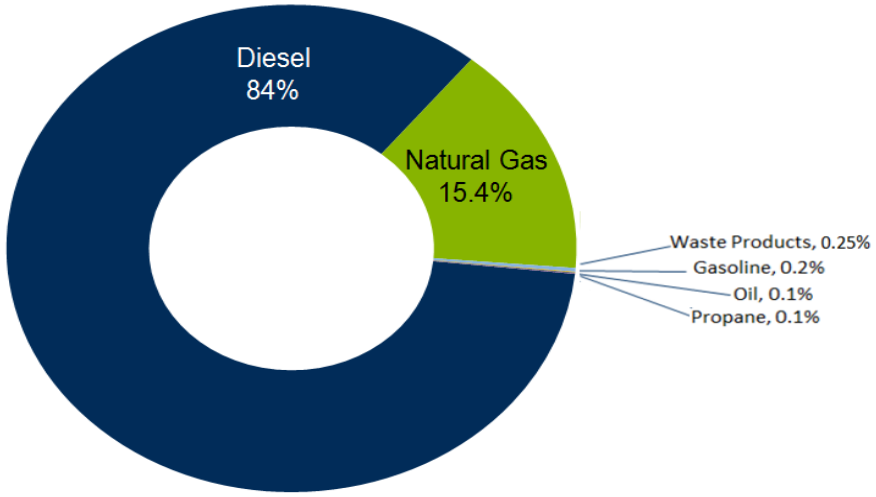
Emergency generators account for approximately 45% of total DER capability. Generators with an emergency permit can only operate during emergency conditions. Even if they have extra capability beyond their load they cannot use it unless they upgrade machine and/or upgrade emergency permit to non-emergency permit.

Figure 4: DR DER Registered MW Capability by Zone



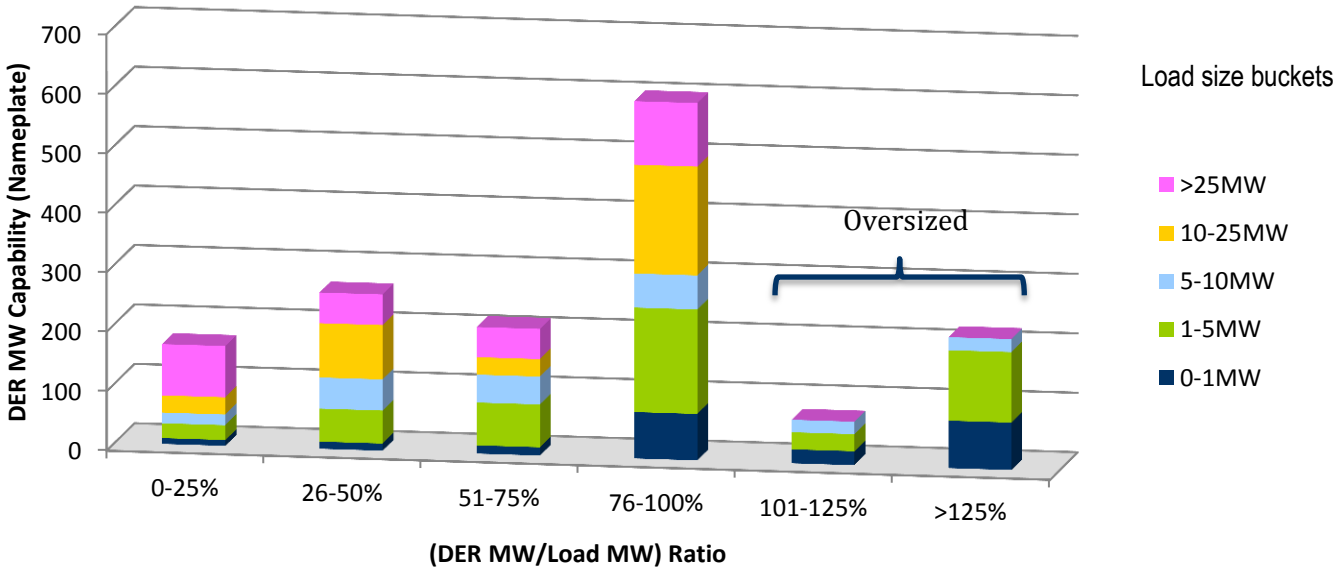
Note: Values are CSP reported nameplate MWs for DER participation. Locations that participate in both Load Management and Economic are included only once.

Figure 5: DR DER Registered MW Capability (18/19 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 2018/19 predominantly consists of diesel (84%) and decreased by 10% from the last delivery year natural gas (15.4%) which make up a combined 99.4% of the total fuel types.

Figure 6: DR DER Registered MW Capability by Size and ratio of Size/Load



	Total Nameplate DER MWs by Customer Load (PLC)						
	Load Size Buckets (MW)						
DER Nameplate/PLC Ratio	0-1MW	1-5MW	5-10MW	10-25MW	>25MW	Grand Total	%
0-25%	10	25	18	29	86	168	11%
26-50%	12	56	52	91	52	263	17%
51-75%	14	72	47	29	51	213	14%
76-100%	78	176	57	183	107	601	39%
101-125%	23	29	21	0	0	73	5%
>125%	80	118	22	0	0	220	14%
Grand Total	216	475	218	332	296	1537	100%

Figure 6 and associated Table display DER capability (as represented by the nameplate MWs) broken down by the size of the peak load and the ratio of DER MW to the peak load MW. The ratio of DER MW output to peak load MW provides an indication of the size of the DER relative to peak load. For example, the 0-25% category represents DER capacity that is less than 25% of the peak load. Said another way, if the DER is activated it can only offset less than 25% of the peak load. Each bar on the graph represents the total amount of DR broken out by the size of the peak load (as represented by the PLC). Approximately 293MW (73+220) of the 1,537 total MW have DER nameplate capacity sized to cover over 100% of the peak load. Of that 293MWs, 250 MWs are DER with less than 5MW peak load (add 4 numbers in the columns with 0-5MW for two rows where DER/PLC ratio is >101%). In other words, the majority of oversized DERs MWs are comprised of the sites where the peak load is less than 5MW. At the same time, the proportion of locations with PLC <1MW is the highest for oversized DERs. In other words, smaller locations tend to be oversized more often that the larger ones.

Note: "DER size" in this analysis is a DER nameplate capacity, "Peak Load" is a Peak Load Contribution which is typically based on the customers load during the PJM summer peak days. DER/Load ratio illustrates DER generation capability relative to the locations peak load.

Figure 7: DR DER Registered MW Injection Capability

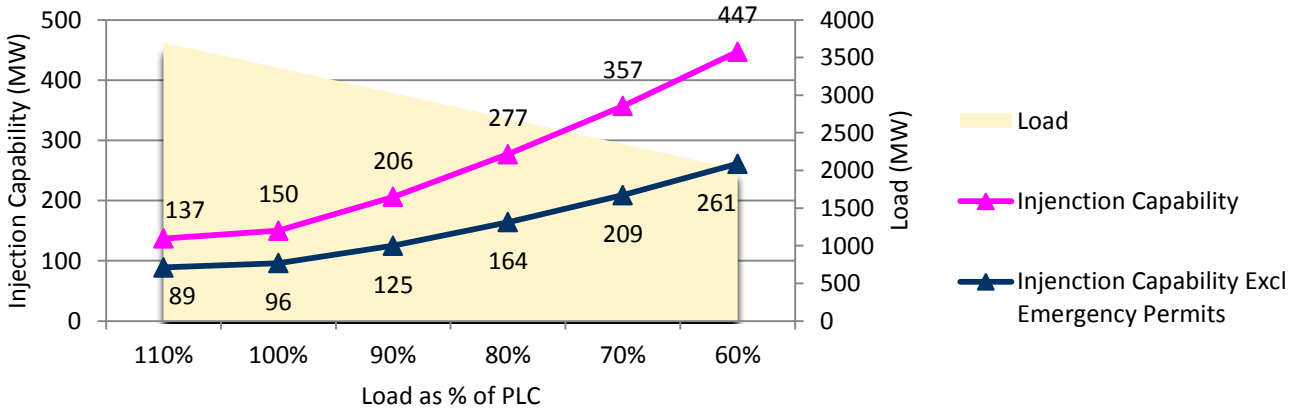
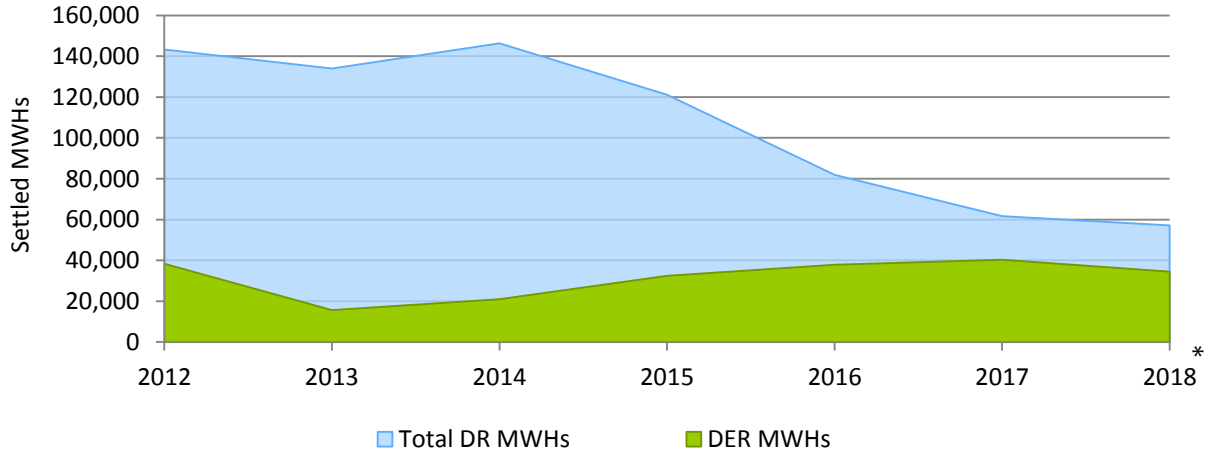


Figure 7 shows the DERs injection capability relative to the customers load (for all DER and for part of DERs that hold non Emergency permits (excluding Emergency)). To illustrate this point we looked at customers' load as a percentage of their PLC. For example, if the load is at 80% of PLC, the total injection capability is approximately 277MW for all resources and 164MW excluding emergency permit holders. The lower the load (as % percentage of PLC) the more DERs become oversized compared to their load and, consequently, the higher the injection capability. Majority of the weather dependent buildings are not loaded at the full PLC level most of the days in a year, thus increasing their potential to inject.

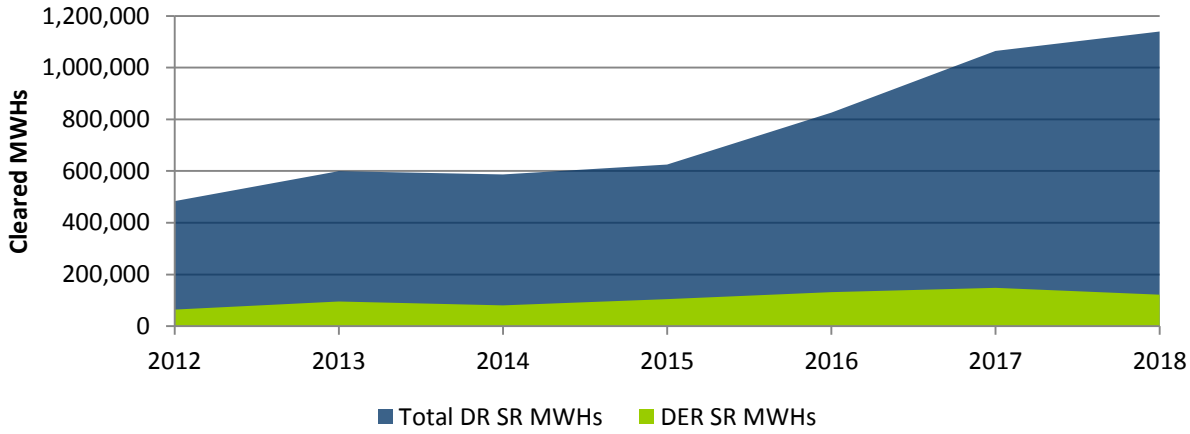
Figure 8: PJM Demand Response Economic Energy Settled MWhs Trend



The share of DER participating as Demand Response gradually increased from 2013 level, thus, driving the DER/Total DR ratio up to 68% in 2017 and declined slightly (by 2%) in 2018. This means the majority of economic DR activity in the energy market in 2018 came from DER.

*Note: 2018 settled MWHs number may increase when all settlements for events in November /December get confirmed. The final number will be reflected in 2019 DER report.

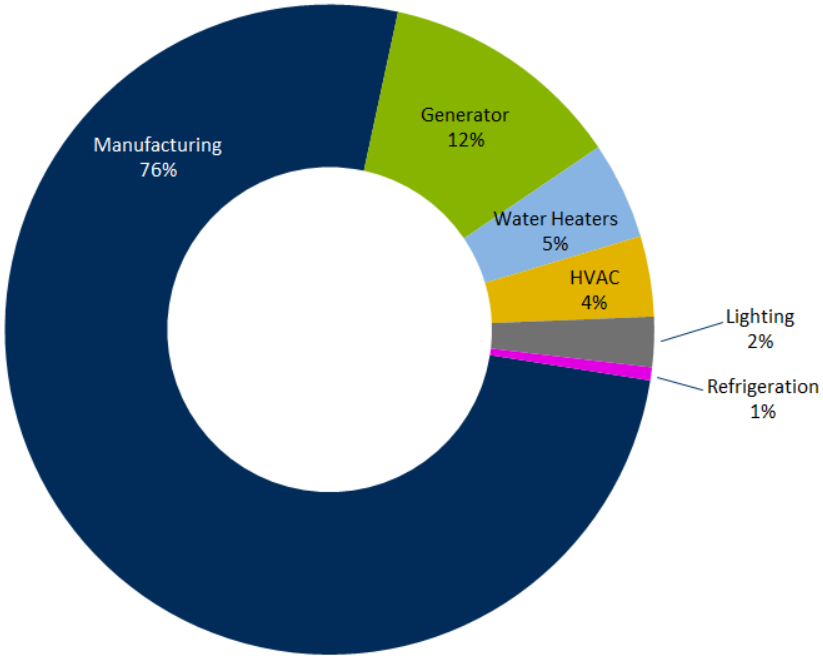
Figure 9: PJM Demand Response Synchronized Reserves Cleared MWhs Trend



DR Synchronized Reserves settled MWhs trend showed significant growth starting from 2015. DER share of Total DR decreased slightly from the previous year.

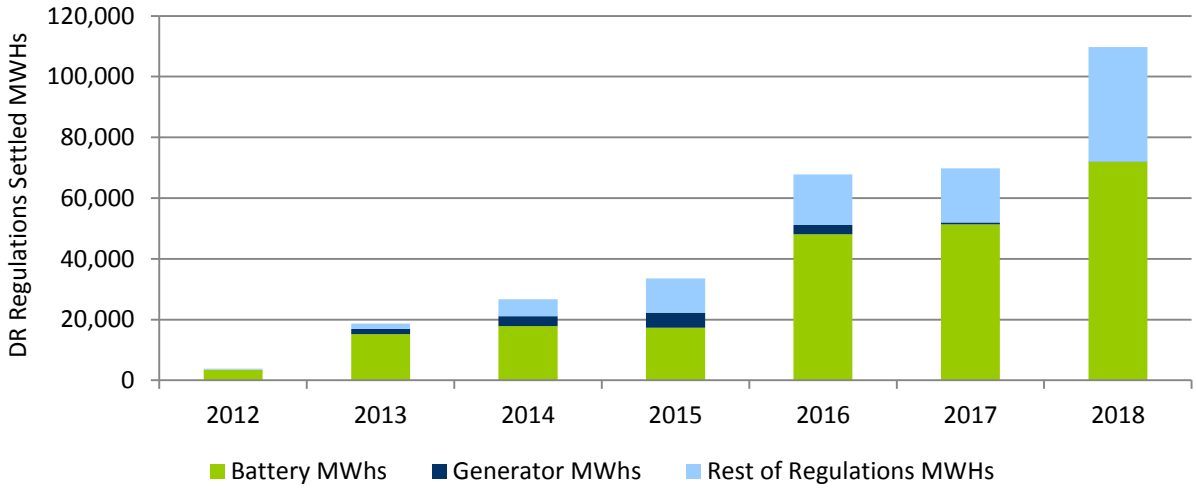
Note: PJM finding are based on extrapolation of DR capability by load reduction method submitted by curtailment service providers. PJM does not know what load reduction method was deployed in any given event.

Figure 10: 2017 PJM Demand Response Confirmed Synchronized Reserve Registrations Load Reduction Methods



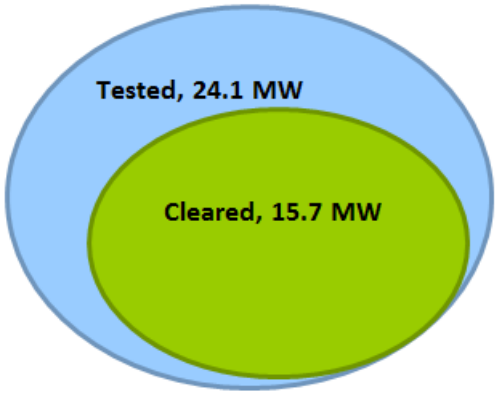
Behind the meter generators represent only 12% of total Synchronized Reserves participating as Demand Response while the load reduction from the adjustment of a manufacturing process leads with 76%.

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



Behind the meter battery storage remains the primary resource for DR regulation market in 2018. Batteries provided 65% of the Demand Response in the regulation market in 2018. While the proportion of batteries contribution in DR regulation market decreased by 9% from previous year (74% in 2017), total MWHs batteries participation increased by 40% to 72,000MWHs. Electrical water heaters contributed to the remaining 35% of regulation participation in DR in 2018.

Figure 12: 2018 DR DER Regulation MW participation



DERs cleared volume in regulation market was at about 60% of the tested capability. Cleared capability is a sum of the highest amount cleared for each resource during 2018.