

Effect of DG Installation on Customer Load Shapes

PRESENTED TO

Westar Energy

PRESENTED BY

The Brattle Group

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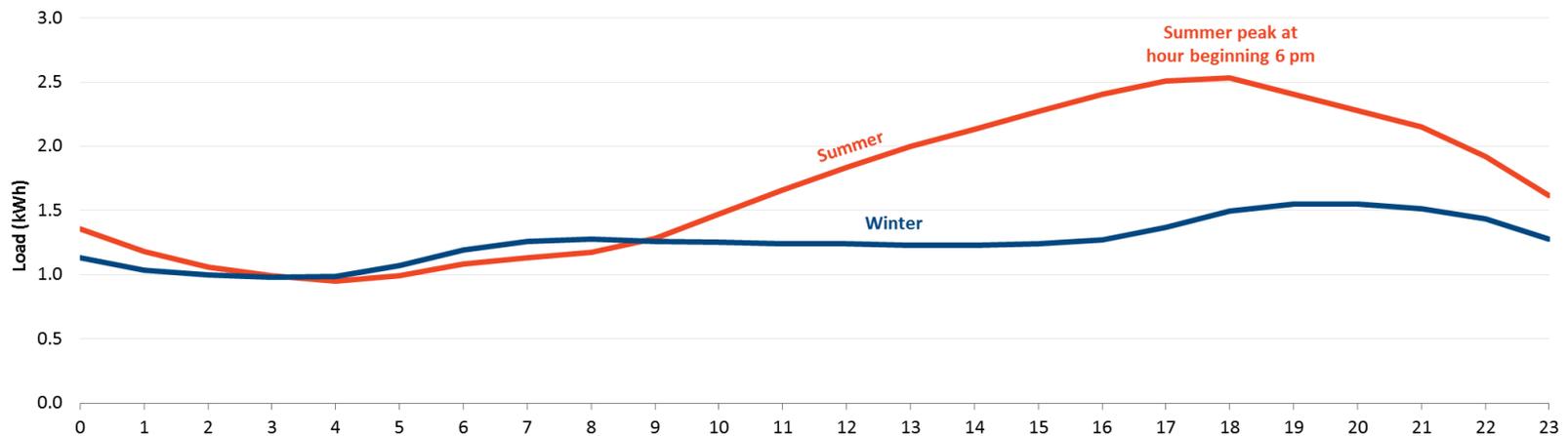
THE **Brattle** GROUP

Characteristics of non-DG customers

We analyze the load research data for the 188 customers for whom there is a full year of hourly observations

- The sample is broadly representative of the larger residential customer class
 - Average monthly energy consumption of **1,020 kWh**
 - Average monthly peak demand of **5.9 kW**
- Covers the period from October 1, 2013 through September 30, 2014

Residential Sample Load Shape



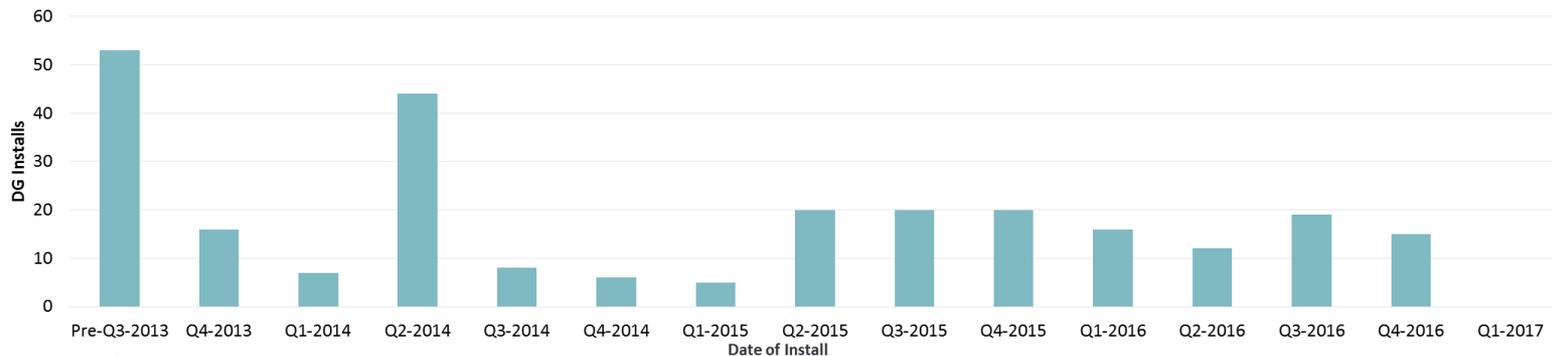
Source: Westar Energy.

Characteristics of DG customer data

We analyze the sample of DG customer data for the 266 residential customers with valid data

- Covers the period from October 1, 2013 through February 5, 2017
- Pre-DG load levels are slightly larger than the original load research sample
 - Average monthly energy consumption of **1060 kWh**
 - Average monthly peak demand of **6.2 kW**

DG Installations Over Time



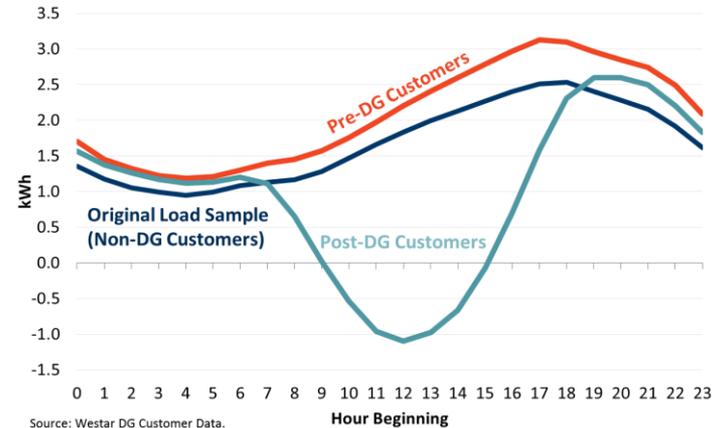
Source: Westar Energy.

DG customer load shape comparison

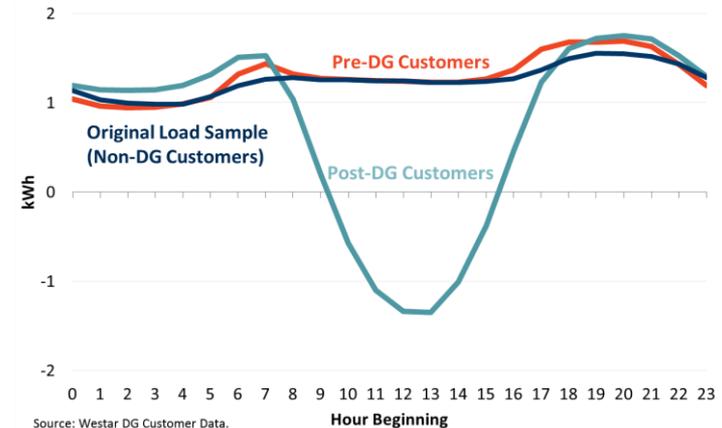
DG installation significantly changes customer load shape

- We use regression analysis to compare average load and load shapes before and after DG installation, and also compare to the load research sample
- Pre-DG installation, load shapes for the DG sample are similar to the original load sample, though somewhat higher in the summer
- We find DG reduces net energy consumption by half from **1060 kWh** to **530 kWh**
- However, average monthly peak demand is virtually unchanged
- In the summertime, **DG reduces** average residential customer monthly peak load from **6.8 kW** to **6.5 kW**
- Average net monthly peak export to the grid is **4.0 kW** in the summer and **5.4 kW** in the winter

DG Load Shape During Summer



DG Load Shape During Winter

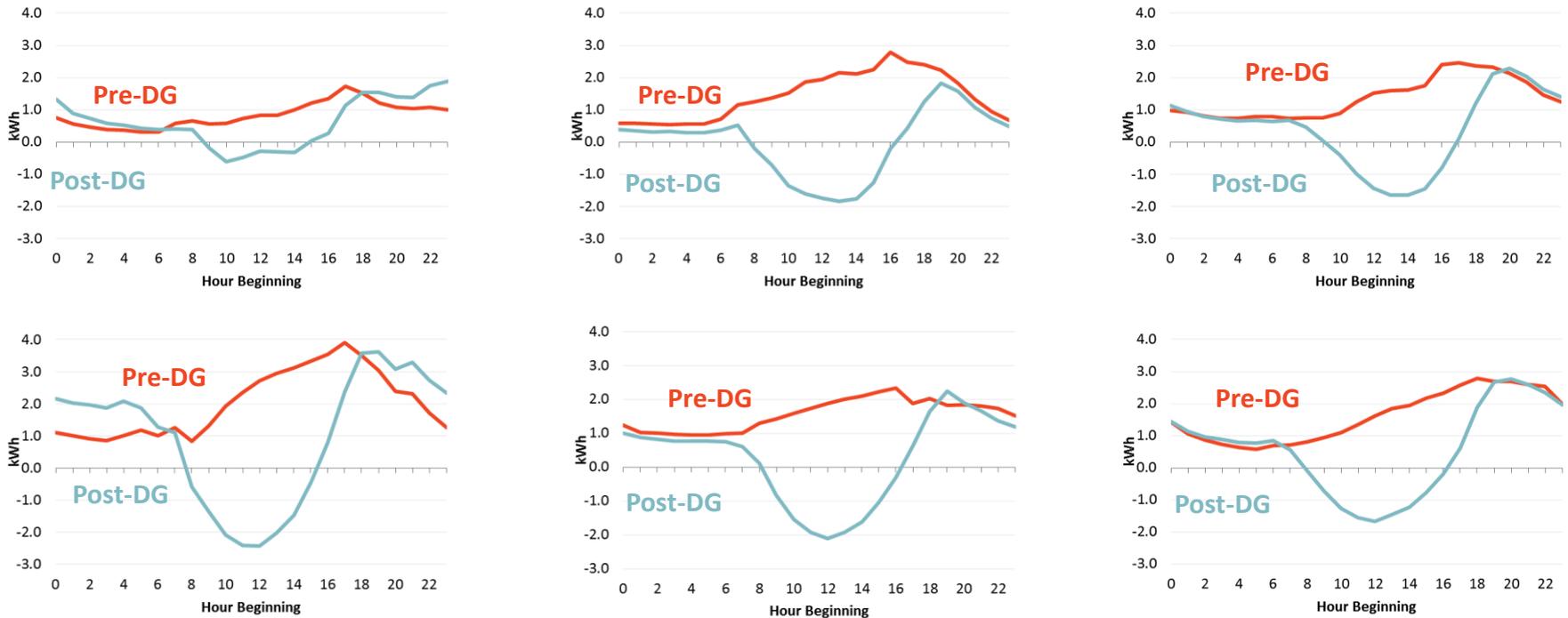


Note: Summer defined as June – September | brattle.com
Winter includes all other months

Individual customers show similar patterns

Individual customers with Pre-DG and Post-DG data had similar patterns as observed on average across DG customers

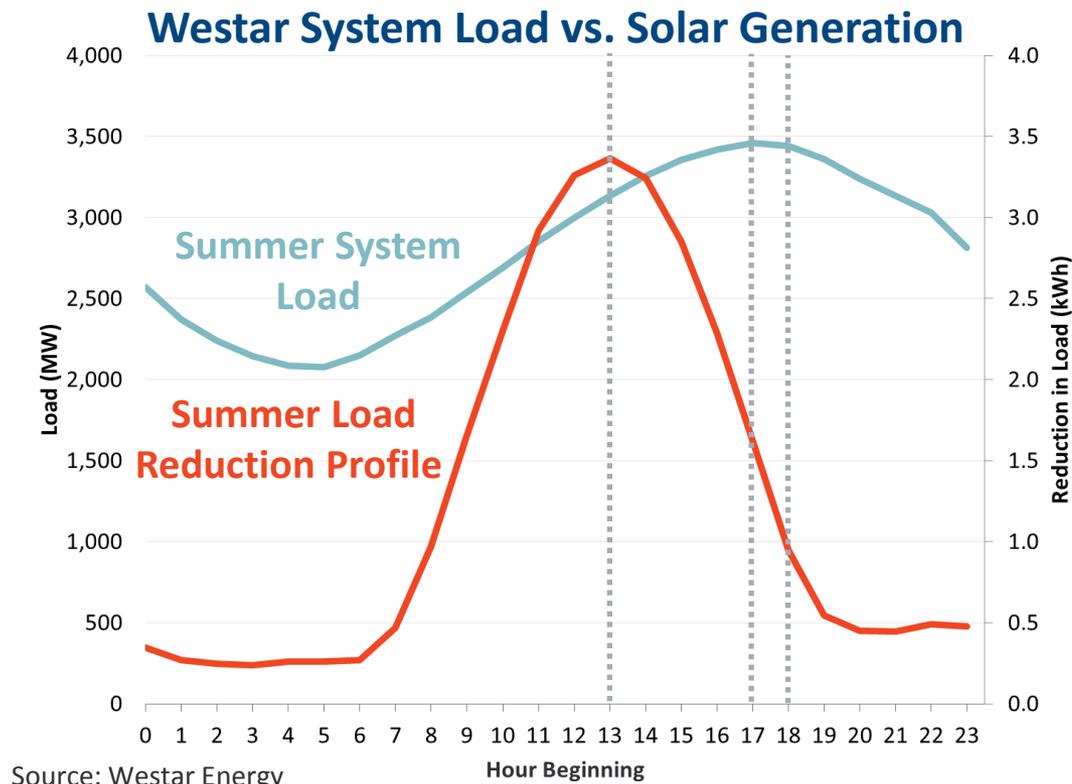
Examples of Individual Customers Load Shapes During the Summer



Westar system load

Westar System Load Peaks between 5 PM and 6 PM (hour beginning 17)

- Peak output from DG customers occurs at 1 PM (hour beginning 13)
- At system peak, DG output is **48%** of peak solar output
- However, the residential class peaks at 6 PM (hour beginning 18) when DG output is only **28%** of peak solar output



All customers are dependent on the grid

The installation of DG does not make customers independent from the grid

- After installation of DG, customers are still **reliant on the grid for 99.2% of 15-minute intervals** (i.e., power is flowing either to the customer or from the customer back to the grid)
- This number may be understated due to some customers with missing data for several days or even months
 - After removing customers-months with no load data for the full month, we found that customers are **relying on the grid 99.8% of the time**

This finding is consistent with previous results that show DG customers are still heavily reliant on the distribution infrastructure

Key takeaways

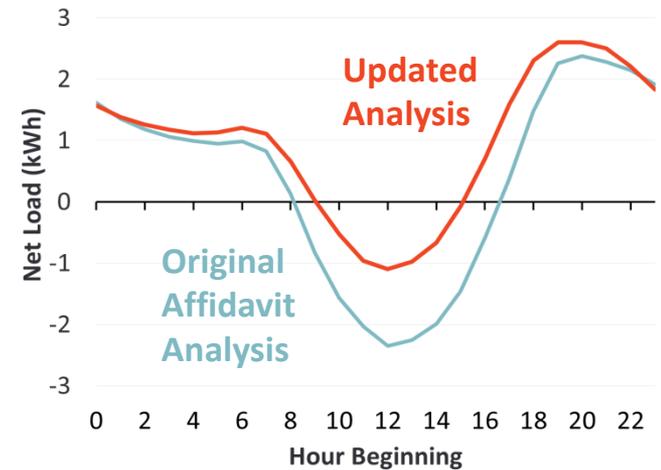
The installation of DG by a residential customer results in a substantially different load profile

- After DG installation, customers reduced their monthly energy consumption by **49% in the summer**, but only reduced their peak demand by **4.9% during the same months**, resulting in a **significantly lower load factor**
- Although the DG sample had somewhat higher overall energy consumption than the original load research sample before installing DG, their load shapes and usage patterns were relatively similar
- Most individual customers within the DG sample followed the same patterns as observed in the average load shapes of DG customers

Appendix: Comparison to original affidavit

- The solar data we modeled using NREL's SAM has higher solar output likely driven by our higher average system size estimates
 - Assume 6.5 kW in our modeling which is based on an assumption that DG offsets 80% of a customer's load
 - Westar's average residential DG installation is closer to 5.7 kW
- Overall, the qualitative arguments used in the testimony remain unaffected: **Net load shape after DG installation is substantially different than observed for the typical residential customer**

Summer Net Load Comparison



Summer Solar Comparison

