Portland General Electric
121 SW Salmon Street · Portland, Ore. 97204

February 12, 2020

Via Electronic Filing

Public Utility Commission of Oregon
201 High Street, S.E., Suite 100
P.O. Box 1088
Salem, OR 97308-1088

Attn: Commission Filing Center

Re: UM 1827 Navigant Evaluation of PGE's Multifamily Water Heater Pilot Summer 2019

Enclosed is Navigant's evaluation of Portland General Electric Company's (PGE's) Multifamily Water Heater (MFWH) Pilot for the Summer 2019 demand response (DR) season. PGE committed to providing an evaluation to the Commission in Q1 2020 in PGE Advice No. 19-33. PGE contracted with a third-party evaluation company (Navigant) to identify potential improvements to the pilot process for winter and summer seasons through September 2019. As part of the 2019 summer evaluation, Navigant's primary focus analyzed impacts of hourly advanced metering information (AMI) data, whereas the winter evaluations included recruitment, enrollment, data management, installation, and event management. Navigant's evaluation report is enclosed.

The previous Navigant evaluation, which evaluated the Winter 2018-2019 season[1], identified key findings, several of which were addressed during the Summer 2019 season. The following is a list of findings from the previous evaluation that were addressed in the Summer 2019 season:

- **Improved connectivity rates** with new cell-enabled technology. Given the poor connectivity rate (~60%) of the Wi-Fi switches in the Winter 2018-2019 season, PGE worked with a new vendor to design a cell-enabled switch to achieve a more acceptable rate (90%) of controllable switches per event. Cell-enabled switches were introduced after the Summer season due to overseas manufacturing schedules. During the Summer 2019 season, there was an increase of connected devices by almost 15% (i.e., the Winter 2018-2019 average connectivity rate was 68% and the Summer 2019 rate was 82.7%).
- **Improved tenant communications** with both current tenants and those that move in after the installation. Going forward, PGE will provide property managers with a program one-pager to be included in new-tenant paperwork. PGE will also send annual program emails to all tenants in partnership with property management.

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[1] Filed November 1, 2019 in UM 1827.

- **Streamlined system integrations** between PGE and various vendors. The change to work on development protocols concurrently instead of subsequentially has streamlined the amount of time required to develop, test, and implement solutions. As a result, future system integrations will be more predictable and at a lower cost.
- **Implemented operation and maintenance best practice** for Wi-Fi networks to improve connectivity and callability. For example, PGE's implementation vendor increased field hours to: 1) support offline equipment; 2) enhance tenant awareness to reduce the number of tenant-caused outages; and 3) leverage lessons learned to maximize router and repeater configurations.
- **Increased statistically significant events** by changing event-calling from intra-hour to hourly intervals. Events started and stopped on the hour so both telemetry and AMI data are in alignment and results can be better evaluated. PGE will continue to explore moving meter readings to 15-minute intervals to offer more program flexibility. This procedural change ensured that event results are valid, quantifiable, and statically significant. During the Summer 2019 season, almost 86% of events were statistically significant (i.e., 60 out of 70 events were statically significant compared to 4 out of 58 in the Winter 2018-2019 season).

In addition to those stated above, the Summer 2019 evaluation report included the following:

- **Increase in enrolled devices by 40%:** The pilot had 2,995 total devices on the first day (June 1) and 4,192 on the last day (September 30th) of the Summer 2019 season.
- **Positive Demand Reduction:** Navigant found the average aggregate reduction for the summer 2019 season was 106.9 kW with a maximum of 224.3 kW. This was a significant increase from the non-measurable reduction in the previous Winter season.
- **Increase of Devices Controlled by 10%:** Winter 2018-2019 had 36% control of devices per event, while Summer 2019 increased to 46%.[2]
- **Positive Impact Per Controlled Device:** During the Summer season the pilot included a positive impact of an average of 0.15 kW per controlled device with a maximum impact of 0.80 kW, as opposed to an average impact of -0.04 kW and a maximum of 0.27 kW in Winter 2018-2019. Impact results are trending in the right direction and the spread between planning values and actual results are narrowing. On average, the plan for summer is 0.4 kW per device per event whereas winter is 0.6 kW per device per event.

PGE has made significant changes to the pilot using the key findings identified in the Winter 2018-2019 evaluation leading into Summer 2019. These programmatic enhancements were prioritized to maintain a positive customer experience, ensure that event data is valid and quantifiable, develop sustainable practices for system integrations, and drive market adoption to increase overall demand response value. This resource is critical to PGE's decarbonization strategy as well as its commitment to better serve, and offer opportunities to, our multifamily customers.

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[2] For more information, see Figure 5 on page 5 of the enclosed evaluation.

If you have any questions or require further information, please call Kalia Savage at (503) 464-7432. Please direct all formal correspondence or requests to the following e-mail address pge.opuc.filings@pgn.com.

Sincerely,

/s/ Robert Macfarlane
Manager, Pricing & Tariffs

Enclosures

cc: UM 1827 Service List and Nick Sayen, OPUC

Memorandum

To: Rebecca Brisson, John Boroski (PGE)

From: Kathleen Ward, Jane Hummer (Navigant)

Date: January 14, 2020

Re: Connected Water Heaters Program: Summer 2019 DR Season Impacts

Introduction and Methodology

This memo summarizes the findings from Navigant's impact evaluation of the PGE Connected Water Heater summer 2019 DR season. The impact analysis relied on the following data elements:

- Hourly AMI data for all enrolled units through September 30, 2019 (PGE)
- Event log containing event start and end times for each test group (A or B) as well as program-calculated impacts (Enbala)
- Program tracking data (CLEAResult)
- Water heater switch activity data (Aquanta)

To estimate event impacts, Navigant employed a fixed effects regression analysis on an event-by-event basis using hourly AMI data for all enrolled assets. For each event, either group A or group B was targeted for the event dispatch. The non-targeted group served as the control group for each event. The impact estimation relied on the control group to form the event baseline.[1]

Key Findings

Table 1 summarizes the key metrics for the summer 2019 DR events. Each of these metrics is then discussed in more depth in the remainder of the memo.

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[1] Four events overlapped with events called as part of PGE's FLEX program, a program in which Connected Water Heater participants can also enroll. Despite the overlap, the control group design of the Connected Water Heater means that FLEX participants should be randomly distributed between the A and B groups. As such, the control group baseline should include any effects of the FLEX events.

Table 1. Summer 2019 Impacts per Event

Metric	Season Average (per Event)	Minimum	Maximum
Total Demand Reduction (kW)	106.95	-7.36	224.27
Percent of Devices Controlled	46%	7%	61%
Impact per Controlled Device (kW)	0.15	-0.04	0.80
Snapback per Controlled Device (kW)	-0.48	-0.76	0.35

Source: Navigant analysis.

The **total demand reduction per event** averaged 106.9 kW. As shown in the grey bars in Figure 1, impacts varied from event to event, with a range of -7.4 kW to 224.3 kW. Some of the variation in impacts is due to the variation in percent of devices that were successfully controlled (shown as the light green line in Figure 1), as well as an increase in the overall number of devices participating as installations were completed through the season. The **percent of devices controlled** ranged from 7% to 61%, and the total number of enrolled devices increased 40% from 2,995 at the beginning of the season to 4,192 at the end of the season.[2]

Figure 1. Total kW Reduction and Percent of Devices Controlled per Event
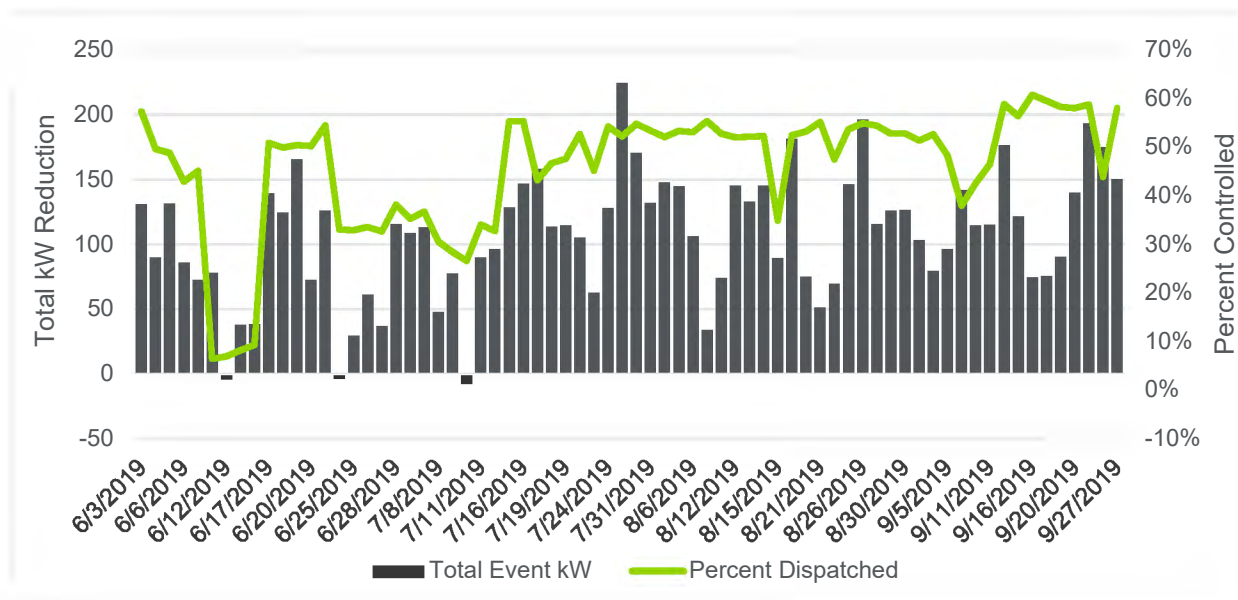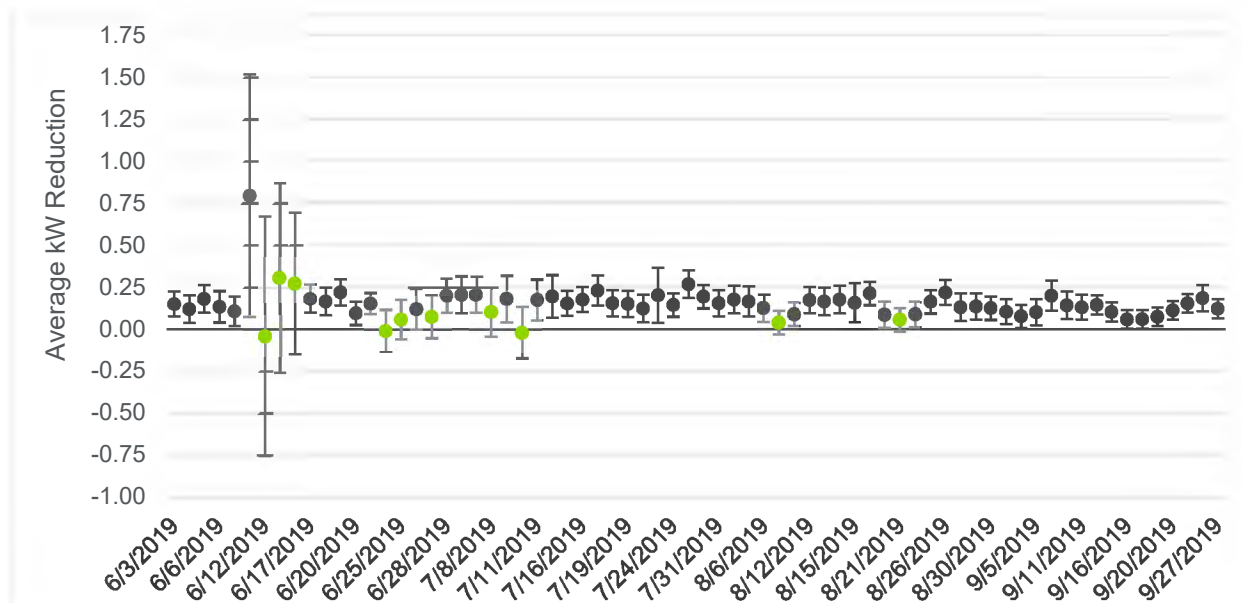

Source: Navigant analysis.

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[2] Note that due to the A/B design of the program, roughly half of all participating devices were eligible for each event. On weeks that the A group received events, the B group served as the control group, and vice versa.

Figure 2 presents the **average impact per controlled device** for each event. These averages are calculated by dividing the total event impact (shown in the previous graphic) by the number of controlled devices[3] for that event, which is a function of water heater connectivity, heating status, and tank level[4]. The average impact is 0.15 kW per controlled device, with a range of -0.04 to 0.80 kW. The impact estimates were statistically significant (i.e., statistically different from zero) for 60 out of the 70 events; statistically significant estimates are represented with grey dots in the graph, and the range around each dot represents the margin of error in the estimate.

*Figure 2. Average kW Reduction per Controlled Device by Event*

Source: Navigant analysis. Note: grey dots signify kW reduction estimates that are statistically different than zero. The narrower the error bands around each dot, the higher the confidence in accuracy of the point estimate.

Figure 3 presents a **comparison to impact estimates from Enbala**, the demand response management system vendor. Note that Navigant and Enbala use different methodologies: Navigant's analysis is conducted using regression analysis on hourly household electricity consumption and uses a control group for the baseline (i.e., the amount of energy that controlled devices would have been using if not controlled). Enbala's analysis uses 15-minute water heater telemetry data to estimate a customer-specific baseline from each household's past water heater usage. For 61 out of the 70 events, Navigant's estimates are higher than Enbala's estimates, suggesting that Enbala may be using conservative baseline assumptions in their analysis.

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[3] Navigant calculated controlled device counts using Aquanta's control records retrieved through the Aquanta API by CLEAResult.
[4] Water heaters are controllable only when heating and not in override mode due to low water levels

Figure 3. Total kW Reduction: Comparison between Navigant and Enbala Estimates
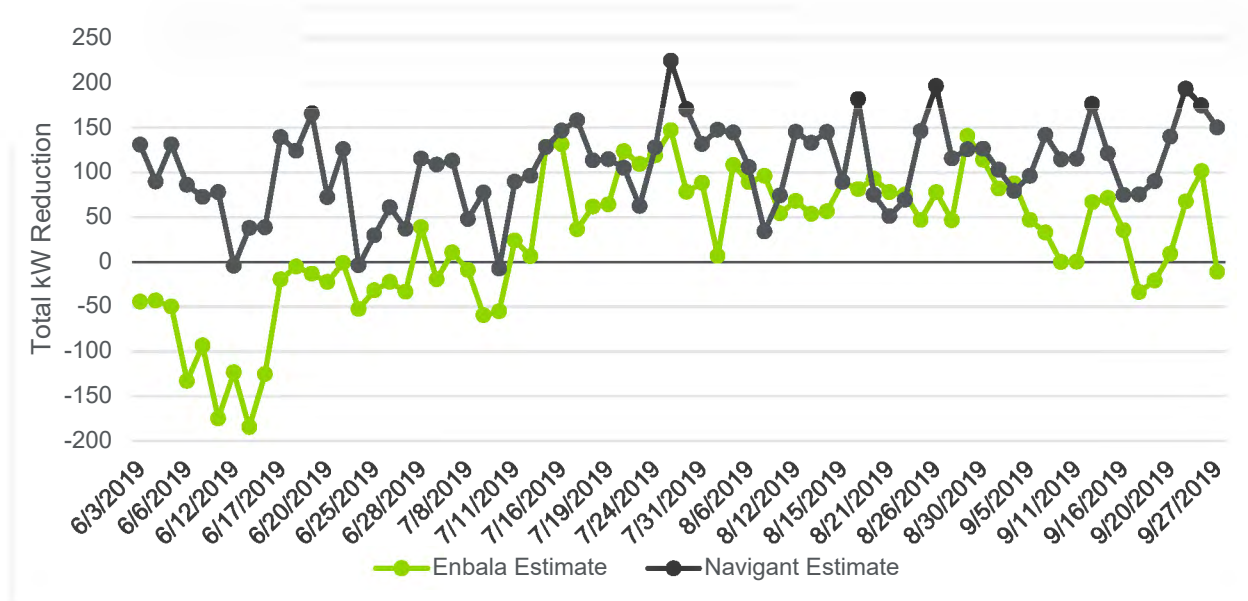
Source: Navigant analysis, Enbala Performance Summary from 10/24/2019

Figure 4 presents the average **snapback per controlled device**. Snapback is the increase in overall electricity demand that occurs in the one hour after a device has been controlled for a DR event; for this program, snapback occurs when the water heaters start heating again after the event. The average snapback per controlled device was -0.48 kW, meaning that on average the participating households were using 0.48 kW *more* than the control group households during the period after the events. Per-device snapback ranged from -0.76 kW to 0.35 kW.

Figure 4. Average Snapback per Controlled Device by Event
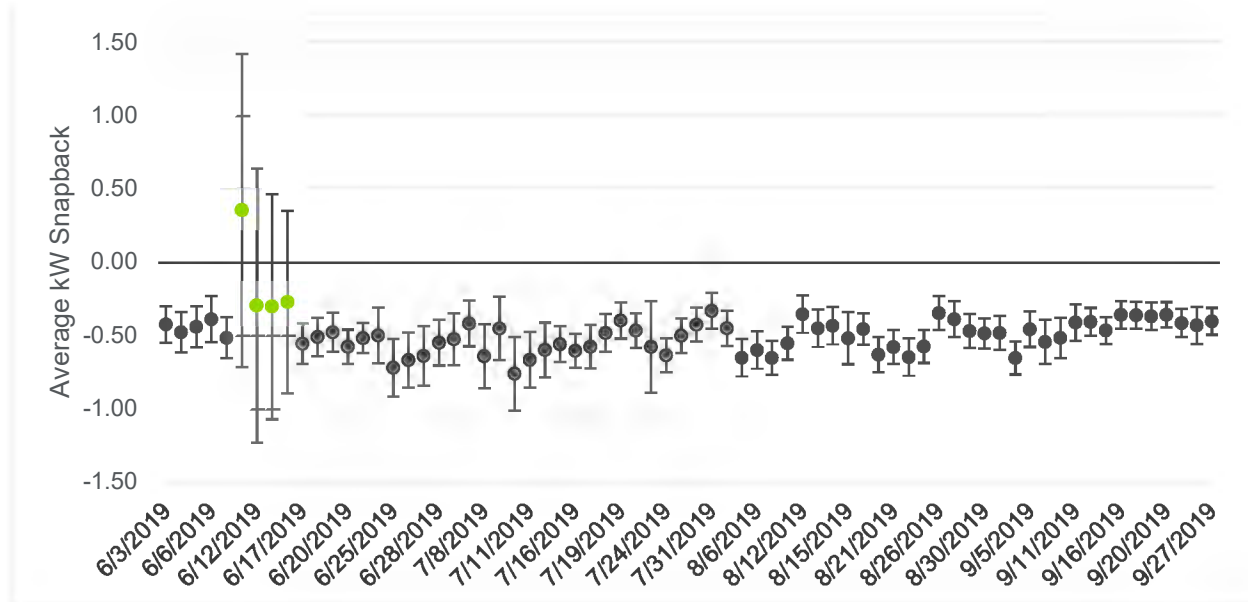
Source: Navigant analysis. Note: grey dots signify kW snapback estimates that are statistically different than zero. The narrower the error bands around each dot, the higher the confidence in accuracy of the point estimate.

Figure 5 shows the breakdown of device dispatch status by event across the summer season. Device participation is broken down into one of six categories:

- **No Connectivity:** a device that was not actively connected to Wi-Fi and could not receive a dispatch signal

- **Not Heating:** a device that was not actively heating and thus had no load to curtail

- **Heating, Not Dispatched[5]:** a device that was actively heating, but was not dispatched

- **Override, Not Dispatched:** a device in override mode[6] that was not dispatched for any part of the event

- **Override, Partial Dispatch:** a device that was actively heating and was dispatched for the event, but was in override mode for part of the event

- **Dispatched:** a device that was actively heating and was dispatched for the entire event

During Summer 2019, connectivity rates were higher than the previous winter, at 70% or higher for all events throughout the season. As noted previously, the percent of devices controlled (dispatched) varied from event to event, averaging 46% (an increase over the Winter 2018-2019 season's 36%).

Figure 5. Device Dispatch Status by Event
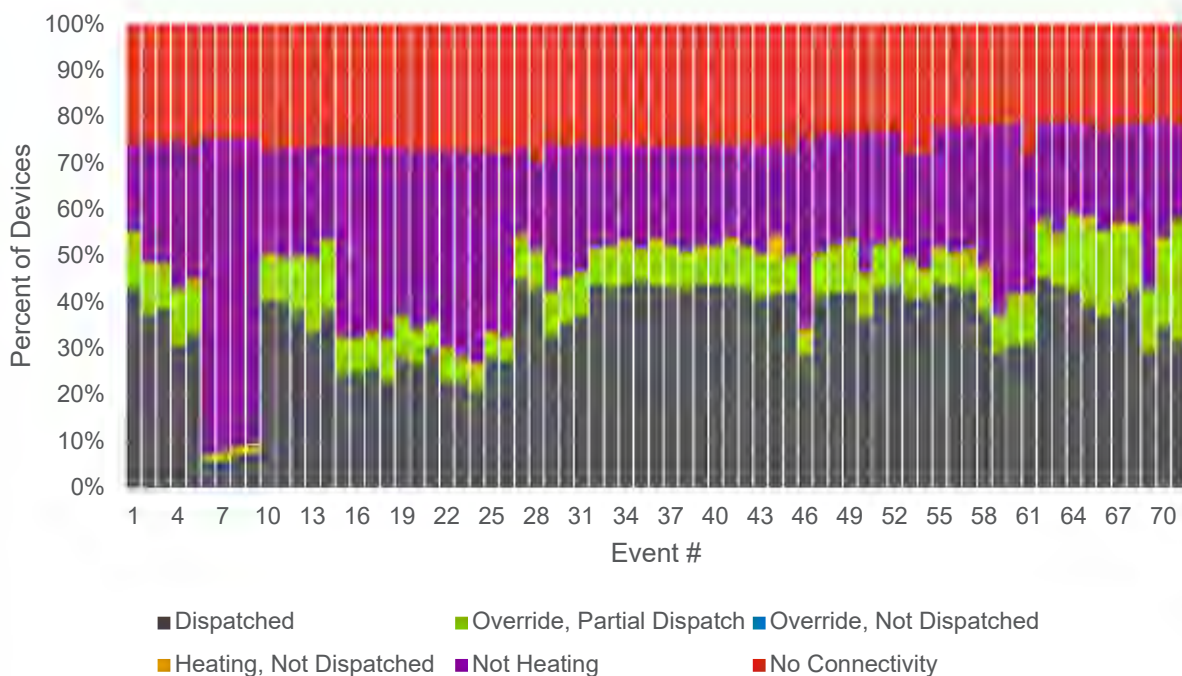
Source: Navigant analysis of CLEAResult data.

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[5] These are a small number of cases, but this status should not occur.
[6] A device enters override mode when its tank drains more than 50 percent and cannot be curtailed until the tank refills.

Table 2 shows a comparison between the Summer 2019 season impacts and the Winter 2018-2019 season impacts (the first program season). The average total event impact is noticeably higher for the Summer season, stemming from the higher impact per controlled device. Few events produced statistically significant impacts in Winter 2018-2019, in contrast with Summer 2019 where the majority of events had statistically significant impacts. A few factors contribute to the increase in demand impacts. Events in Summer 2019 started and ended on the hour instead of staggering the event end across portions of the dispatched group, allowing the hourly data to more easily reflect reduced demand as a result of the event. Summer 2019 also saw the average percent of devices controlled increase and a doubling of enrolled devices compared to Winter 2018-2019[7]. The increased control rate increases the average impact per enrolled device (the base effect estimated in the regression analysis) and a larger effect is easier to detect. The increase in enrollment increases the sample size used in the regression – larger samples improve the precision of the estimates, meaning event impacts are more likely to be statistically significant if they are greater than zero.

Table 2. Winter 2018-2019 Impact Comparison

Metric	Winter 2018-2019 Season Average (per Event)	Summer 2019 Season Average (per Event)
Total Demand Reduction (kW)	-0.003	106.95
Percent of Devices Connected	64%	75%
Percent of Devices Controlled	36%	46%
Impact per Controlled Device (kW)	-0.037	0.15
Per Controlled Device Full Hour Impact (kW)	0.135	0.15

Source: Navigant analysis.

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[7] The Winter 2018-2019 dispatch rates average 36% and ranged from 1% to 65%.