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BEFORE THE PUBLIC UTILITIES COMMISSION OF NEVADA

Application of NEVADA POWER COMPANY d/b/a NV Energy and SIERRA PACIFIC POWER COMPANY d/b/a NV Energy, seeking approval to add 1,001 MW of renewable power purchase agreements and 100 MW of energy storage capacity, among other items, as part of their joint 2019-2038 integrated resource plan, for the three year Action Plan period 2019-2021, and the Energy Supply Plan period 2019-2021

Docket No. 18-06___

VOLUME 10 OF 18

TECHNICAL APPENDIX
DEMAND SIDE PLAN

DSM-19

Commercial Demand Response
NV Energy – Southern Nevada (NPC)
Program Year 2017

Measurement and Verification Report
March 12, 2018

Prepared for:

NVEnergy

Prepared by:

ADM
ENERGY RESEARCH AND EVALUATION

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1 EXECUTIVE SUMMARY

This report provides results of the ADM Associates Inc. ("ADM") impact evaluation of the NV Energy ("NVE") 2017 Commercial Demand Response ("DR") program for its Southern Nevada service territory (NPC[1]). The Commercial Demand Response program is intended, through the remote control of a participating customer's HVAC[2], lighting and other systems, to quickly reduce demand from the electric grid, either for economic reasons, or in the event of a system emergency. By curtailing those loads and effectively shifting them to later, non-critical peak demand hours, NV Energy can achieve the following objectives.

- Improve the efficiency of its grid.
- Avoid certain energy costs that would otherwise be incurred during critical peak demand periods (when electricity cost is typically highest).
- Potentially defer the construction of new transmission and generation capacity.

The Measurement and Verification (M&V) effort for the Commercial Demand Response program is designed to quantify both peak kW impacts that are realized during called DR events as well as energy efficiency savings that occur as a result of the technologies controlling equipment throughout the year. It is important to note that the program technology offerings fall into specific budget categories outlined in the Demand Response Program Data Sheet which distinguishes budget categories between "Manage" and "Build" budgets. Support for all customers enrolled before 2017 are included in the Manage budget categories, while all customers newly enrolled in 2017 are included in the Build budget categories. For 2017, the customer offerings are related to budget categories as shown in Table 1. The DR event peak kW impacts are calculated in two ways:

- **Verified Demand Reduction (VDR)** – This is the largest coincidental demand reduction observed during the DR season for a given technology. The maximum VDR for a device population represents the maximum kW reduction capacity of that resource if all devices within a group were to be called for a curtailment event simultaneously. Because all devices within a technology group in the Commercial DR program are called for events simultaneously (i.e. the same start/end times), except for DP2 and DP8, the VDR is an observed reduction that is associated with a specific event hour. This is slightly different from the VDR reported in the Residential DR program report. DR events within the Residential Program, and within the DP2 and DP8 populations, use staggered, or phased, start times meaning that a complete device population does not respond to an event simultaneously and thus a VDR cannot be directly observed during a specific event hour[3].
- **Potential Demand Reduction (DR_p)** – For the Build populations, this is a theoretical demand reduction that takes into account the total number of installed devices at the end of the calendar

[1] NPC: Nevada Power Company or "Nevada Power"
[2] HVAC: Heating, Ventilation, and Air Conditioning
[3] The VDR reported for the Residential Program, and DP2/DP8, is calculated using verified kW factors (kW reduction per device), total device populations, and calculated %NRDs, but is not directly observed due to the phasing of events.

year (as opposed to the number of available devices during the DR season), and the maximum kW impact per device calculated for the DR season. For Manage populations, this value represents the maximum cumulative kW impact that could be expected if each facility hit its peak reduction during the same hour and is not associated with a specific event hour.

1.1 OVERVIEW OF THE COMMERCIAL DEMAND RESPONSE PORTFOLIO

The 2017 Commercial DR program included eleven different technology offerings that covered all sizes of commercial and industrial (C&I) customers, as well as specifically targeted equipment types. A list of technologies along with a target facility description, a count of 2017 devices and sites, vendor names, and savings types are shown in Table 1.

Table 1: 2017 Commercial DR Technology Offerings

Option No.	Option Name	Facility Criteria	No. of Devices	No. of Facilities	Vendors	EE	DR
1	HVAC Energy Optimization	• Facility must offer 500K+ Sq.Ft of conditioned space area under central plant cooling or large rooftop air conditioning units (60+ tons each). • Facility equipped with Building Energy Management System enabled with BACnet/IP networked communications.	Total: 4 Manage: 4	Total: 4 Manage: 4	Building IQ	X	X
2	Customer Owned Equipment	• Facility must have an existing Building Energy Management System, networked thermostats, lighting controls or other load controlling equipment that is already OpenADR2.0 certified.	Total:0 Manage: 0	Total: 0 Manage: 0	NA[4]	-	X
3	Demand Response Gateway	• Facility must have an existing Building Energy Management System, lighting controls or other load controlling equipment that can respond to two dry contact relay signals during a DR Event request. • Provide outbound Internet access to OpenADR2.0 gateway device over port 443.	Total: 0 Manage: 0	Total: 0 Manage: 0	Universal Devices	-	X
4	Networked Thermostats	• Facility must have dedicated thermostat-controlled HVAC equipment with an aggregate cooling load greater than 40 kW. • Provide outbound Internet access to OpenADR2.0 gateway device over port 443.	Total: 4,332 Manage: 2,468	Total: 647 Manage: 386	Pelican Wireless Systems	X	X

[4] Participation is not vendor specific.

Option No.	Option Name	Facility Criteria	No. of Devices	No. of Facilities	Vendors	EE	DR
5	Demand Limiting Controls	• Facility must have at least five (5) rooftop package HVAC units greater than 10-tons each with an overall facility average greater than 20-tons.	Total: 138 Manage: 109	Total: 9 Manage: 7	Encycle	X	X
6	Freezer Controls	• Walk-in Freezer with dedicated compressor system.	Total: 5 Manage: 5	Total: 4 Manage: 4	National Energy Conservers, Weiss Instruments	X	X[5]
7	Delta T AHU controls	• Large tonnage air handling units.	Total: 25 Manage: 25	Total: 3 Manage: 3	Belimo	X	X[6]
8	Fitness Test	• Facility must have central plant cooling equipment and multiple air handling units serving variable air volume systems	Total: 3 Manage: 3	Total: 3 Manage: 3	AOG	X	X[7]
9	MultiPro	• Must have central plant cooling equipment	Total: 0 Manage: 0	Total: 0 Manage: 0	Multistack	X	X[8]
10	DP2	• Facility must have dedicated thermostat-controlled HVAC equipment	Total: 2,991 Manage: 2,991	Total: 1,224 Manage: 1,224	Carrier	-	X
11	DP8	• Facility must have dedicated thermostat-controlled HVAC equipment	Total: 468 Manage: 468	Total: 202 Manage: 202	Honeywell	-	X

In 2017, NVE continued recruitment into the Commercial and Industrial program with the most significant growth being in the Networked Thermostats component. New customers were recruited into the Networked Thermostats and Demand Limiting Controls components. Therefore these two components include both "Manage" and "Build" populations, while all other offerings only include "Manage" populations.

1.2 ORGANIZATION OF THE STUDY

The purposes of this measurement and verification (M&V) study are to determine the achieved peak demand savings and energy efficiency savings due to the Commercial customer offerings which collectively are referred to as the Commercial Demand Response (DR) program. The study is organized according to

[5] DR impacts are accomplished through the installation of a gateway device (Option No. 3)
[6] Ibid.
[7] Ibid.
[8] Ibid.

the different groups of control Device Populations (DPs), comprising the program. Table 2 provides the formal organization of the Commercial DR program[9].

Table 2: Commercial Device Population Definitions

CS1 **Manage**	DP2	Carrier Commercial Two-Way PCTs
	DP8	Honeywell Commercial One-Way PCTs
C&I **Manage**	Energy Optimization (Building IQ)	BuildingIQ automated DR system
	Demand Limiting Controls	Encycle's Swarm Energy Management™
	Demand Response Gateway	Universal Devices Gateway
	Networked (Pelican) Thermostats	Pelican Networked Thermostats
	Freezer Controls	National Energy Conservers, Weiss Instruments
	Delta T AHU Controls	Belimo Pressure Independent Valves
	Fitness Test	AOG
	Multipro	Multistack Chiller Controls
C&I **Build**	Networked (Pelican) Thermostats	Pelican Networked Thermostats
	Demand Limiting Controls	Encycle's Swarm Energy Management

1.3 PROGRAM RESULTS

For the NVE Commercial Demand Response program, 2017 demand response events provided peak verified demand reductions (VDR) presented in Table 3 below. Only those sites that participated in full DR events and had sufficient data available to allow for proper M&V analysis are shown in Table 3.

[9] CS1 consists of device populations for both commercial and residential customers. DP2 and DP8 consist of commercial communicating thermostats and thus, results are presented in this report. For DP1, and DP3 through DP7 results, please see the 2017 NPC Residential DR program report.

Table 3: Demand Response Events Verified Demand Reduction

Technology Offering	***Device Population***	***%NRD***	***Device Count[10]***	***kW Factor***	***Max VDR (kW)***
CS1 **Manage**	DP2	9.1%	2,991	3.1	8,498.8
	DP8	11.6%	468	1.3	491.9
C&I **Manage**	Building IQ	6.5%	4	N/A	396.1
	Demand Limiting Controls	8.7%	109	N/A	374.1
	Demand Response Gateway	N/A	0	N/A	N/A
	Pelican Thermostats	39.0%	2,468	3.2	4,790.2
	Freezer Controls	40.1%	5	N/A	79.2
	Delta T AHU Controls	70.4%	25	N/A	702.0
	Fitness Test	16.7%	3	N/A	1,196.2
	Multipro	N/A	0	N/A	0
C&I **Build**	Pelican Thermostats	50.0%	1,864	5.4	2,897.20
	Demand Limiting Controls	N/A	29	N/A	0
Total			***7,966***		***19,425.6***

The relative contribution to kW savings by device population is shown in Figure 1 below. DP2 continues to be a significant contributor to the overall program impacts, accounting for 35% of overall maximum VDR. The Pelican population is also a significant contributor, with the Build and Manage sub-populations providing 17% and 28% of the overall program impacts, respectively.

[10] Device counts in this table include all devices installed at the end of PY2017. Not all these devices were available during the PY2017 DR season.

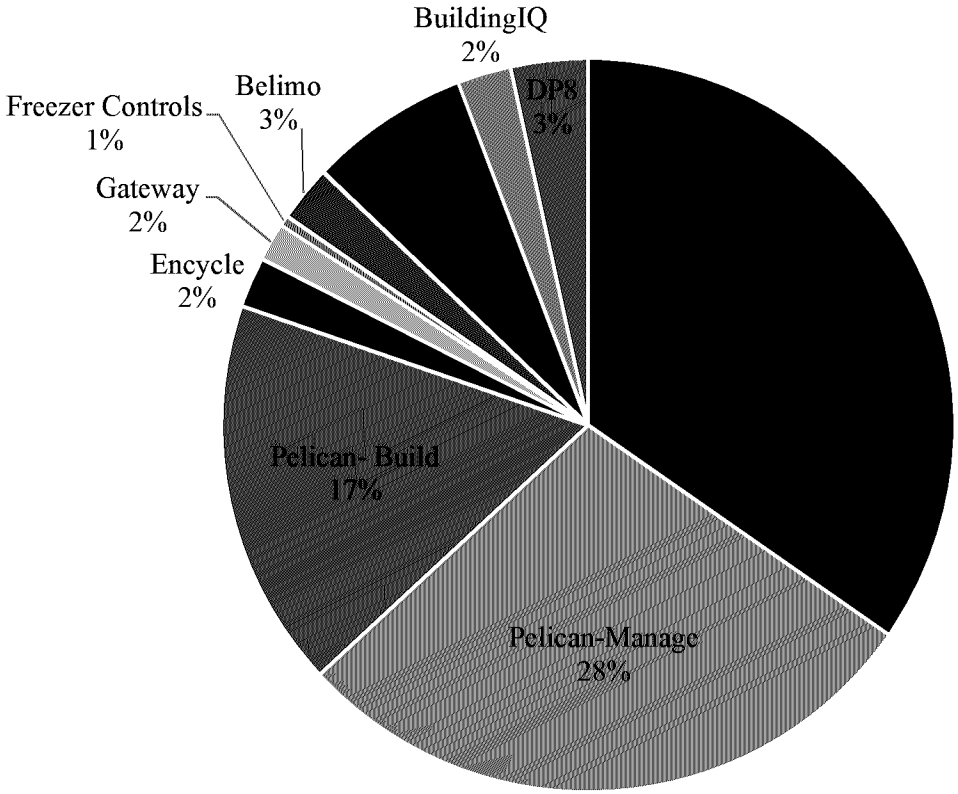

Figure 1: Contribution to Commercial DR kW Savings by Device Population

In addition to peak kW demand reductions, DR events can also result in energy (kWh) savings. Additionally, many of the technologies offered through the program provide energy optimization that has an impact on energy usage throughout the year. Table 4 shows the 2017 DR event and optimization energy savings for each technology offering.

Table 4: Verified Energy Savings[11]

Technology Offering	***Device Population***	***2017 DR Energy Savings (Events), kWh***	***2017 EE Energy Savings (Optimization), kWh***	***2017 Total Energy Savings, kWh***
CS1 **Manage**	DP2-DP8	382,543	N/A	382,543
C&I **Manage**	Building IQ	8,218	163,870	172,088
	Demand Limiting Controls	9,955	124,092	134,047
	Demand Response Gateway	N/A		
	Pelican Thermostats	83,531	982,814	1,066,345
	Freezer Controls	477	109,102	109,579
	Delta T AHU Controls	10,720	274,608	285,328
	Fitness Test	27,085	5,499,137	5,526,222
	Multipro	N/A		
C&I **Build**	Pelican Thermostats	33,310	662,557	695,867
	Demand Limiting Controls	0	0	0
Total		***555,840***	***7,816,180***	***8,372,020***

The results in Table 3 and Table 4 are the verified savings from DR impacts and EE savings that occurred during PY2017. EE savings for the Build population are calculated starting on either the "installation" or "active" date provided in the program data, depending on the device. For those devices that are installed and immediately commissioned (Networked Thermostats), the energy savings are assumed to begin the day after installation. For devices that require more detailed commissioning (Demand Limiting Controls), the "active" date is used as the beginning day for EE savings.

Installation of equipment in the Build population continued throughout the year, and not all devices were able to contribute to demand and energy savings. This occurred when devices were installed during or after the DR season, or were not fully commissioned prior to the end of PY2017, which did not allow for sufficient data collection for verification of EE savings. Table 5 presents *potential* EE and DR impacts that could be expected if all equipment had been installed at the beginning of the program year, had been fully commissioned, and operated optimally throughout the year. Results presented in Table 5 are not verified savings and did not necessarily occur during PY2017 and are provided for informational purposes only.

[11] This table presents verified energy savings for only those sites that had sufficient data to allow for M&V.

Table 5: Demand Response Potential Annual Energy Savings[12]

Technology Offering	*Device Population*	*Available Devices*	*Potential kWh Savings DR*	*Potential kWh Savings EE*	*Potential kWh Savings Total*	*Potential Demand Reduction (kW)*
CS1 **Manage**	DP2-DP8	3,459	384,209	N/A	384,209	8,966.2
C&I **Manage**	Building IQ	4	8,218	163,870	172,088	482.7
	Demand Limiting Controls	109	9,955	124,092	134,047	449.1
	Demand Response Gateway	N/A				
	Pelican Thermostats	2,468	83,531	982,814	1,066,345	4,790.2
	Freezer Controls	5	477	109,102	109,579	87.1
	Delta T AHU Controls	25	10,720	274,608	285,328	784.7
	Fitness Test	3	27,085	5,499,137	5,526,222	1,715
	Multipro	N/A				
C&I **Build**	Pelican Thermostats	1,864	63,088	1,215,096	1,278,184	5,032.8
	Demand Limiting Controls	29	2,573	29,754	32,327	119.5
Total		***7,966***	***589,933***	***8,398,473***	***8,988,406***	***22,427.3***

In addition to conducting DR and EE analyses, ADM also reviewed the impacts of snapback periods on the small to medium size customers that have participated in the program. Due to the devices being installed in these small to medium sized commercial facilities, the impacts of recovering from a DR event could be significant if multiple HVAC units had temperature setpoints reset simultaneously. During the M&V effort, the number of participants that had peak monthly kW usages that occur during the snapback period following a DR event were analyzed, with results presented in the findings section of this report. The purpose of this analysis was to determine if recovering from a DR event (through resetting thermostat setpoints) was causing customers to experience higher peak demand levels. The implications of setting a new monthly peak demand during a snapback period could result in customers experiencing higher billing for that month, or potentially for the next twelve months if the customers' Facilities Charge was impacted. The analysis showed that a small number of customers are experiencing their monthly peak demand during a snapback period. It is recommended that strategies be put in place to avoid increasing customer bills due to snapback effects.

1.4 PY2017 DATA REVIEW

Obtaining sufficient, accurate data for the DR program continues to be a concern for M&V purposes. ADM relies on NV Energy's Demand Response Management System (DRMS) database for device populations, install/active/inactive dates, meter numbers, premise numbers, etc. The data provided through the DRMS is critical for determining actual program device counts as well as determining the proper meter data that should be used in both DR and EE analyses. In PY2017, several data management and quality control issues continued from prior program years which impacted both the cost of conducting M&V for this program

[12] This table represents potential annual energy savings from the program if all the devices were installed at the beginning of the program year, no devices leave the program and all devices function optimally. This is not to be confused with future savings values as the same population is evaluated each year.

and potentially reduced the total verified savings. These data issues are summarized below, with more detailed discussions included throughout this report.

- Inconsistencies in Pelican device counts between DRMS and Pelican's network inventory
- Incomplete or insufficient data entered into either DRMS or the Pelican portal by the installation contractors
- Incomplete interval meter data – both missing site data and incomplete date ranges

2 PROGRAM OVERVIEW

In this introductory chapter, we provide a high-level summary of the Commercial DR program and the participating technologies, and the basic structure of the remainder of this report.

Throughout, important terms will appear in **boldface** when introduced for the first time.

2.1 NV ENERGY'S COMMERCIAL DEMAND RESPONSE PROGRAM

Demand Response, as the name suggests, encompasses a range of interventions and techniques that utilities can use to respond to and control demand for electricity, either for economic reasons or in the event of an electric system emergency. The type of intervention used in the Commercial DR program include technology-based measures.

NVE has been deploying DR technologies addressed in this report in its Southern Nevada service territory since 2001, beginning with smaller scale technology demonstrations, eventually scaling up to a system of over 117,000 control devices in over 78,000 homes and businesses in 2017.

Currently, NVE's entire DR portfolio includes three primary customer offerings:

1. **CS1**, or **Cool Share**, is comprised of those customers who enrolled in NVE's DR effort prior to 2012 with non-EcoFactor devices.
2. **CS2**, or **mPowered**, is comprised of residential enrollees in the DR program after 2012 with Home Energy Management systems leveraging cloud-based software from EcoFactor.
3. **Commercial and Industrial (C&I)** is comprised of a portfolio of technologies designed for small, medium, and large commercial customers.

This report provides the M&V results from the Commercial and Industrial portion of NVE's DR portfolio. The results from the evaluation of the residential portion of the portfolio are presented in a separate report.

2.1.1 History of the Commercial DR Program

In October of 2012, NVE expanded the demand response program offered through a traditional residential program to the commercial sector with customer trials of an advanced commercial offering, now referred to as the Commercial Energy Optimization (or BuildingIQ) program. This offering was deployed as an integrated energy efficiency and demand response technology. In 2014, the Company expanded the commercial offerings with pilot installations at several sites using multiple technologies. These pilot installs grew in 2015 and have been incorporated into the Commercial and Industrial program (sometimes referred to as the "Commercial mPowered", "C&I", or simply "Commercial" program), serving all sizes of commercial customers.

In late 2014, the Company added three new offerings that were targeted at medium sized commercial customers. All three new offerings were designated part of the C&I program that primarily reduce demand by controlling HVAC loads utilizing several different technologies. The three Commercial and Industrial offerings first offered in 2014 were: Smart Networked Thermostats, using technology from vendor Pelican

Wireless; Demand Limiting Controls, using technology from vendor Encycle™; and Demand Response Gateways, using technology vendor Universal Devices.

In the 2016 program year, four new pilot technologies were introduced. These technologies expanded the Commercial DR offerings to include specific targeted equipment, including; commercial freezers, large air handler units with chilled water control valves, central chilled water plants, and variable air volume HVAC systems. The offerings are labeled in this report as: Freezer Controls, which utilize controls from technology vendors National Energy Conservers and Weiss Instruments; Delta T AHU controls, which utilize pressure independent control valves from Belimo; Fitness Test, which utilizes software from AOG; and, Multipro, which utilizes software and hardware from vendor Multistack. While these four pilot technologies were offered and installed during PY2016, no new installations of these technologies were completed during PY2017.

The PY2017 Commercial DR program in the southern territory includes 11 different technology offerings that are designed and marketed for a wide range of customer facility size as well as devices designed for specific types of equipment. During PY2017, three technology offerings, Certified Customer Equipment, Demand Response Gateways, and Multipro did not have any active participants.

A description of each technology offering available to customers during the 2017 program is included in the following sections.

2.1.2 Commercial Energy Optimization

The Commercial Energy Optimization offering uses hardware and software from technology vendor BuildingIQ (BIQ). The hardware interfaces with a customer's building management system (BMS), receiving input from BMS sensors and provides output to control equipment operation. The software technology platform is a Cloud based system which pulls data in real time from the BMS and weather data sources. BIQ reduces energy use on a continual real time basis for year-round energy savings and can also provide demand reduction during DR events.

The DR capacity of each building is dependent on the size and type of systems being controlled by BIQ and varies among buildings. The DR capacity for each building is determined by performing three DR events; one at 10% of expected capacity, the second at 50% and the third at 100% of expected capacity. These test events allow BIQ to determine the total DR capacity of each facility.

The energy savings and demand reductions are achieved through proprietary model-based continuous reset strategies that target the zone temperature, the supply air temperature, and the duct static pressure in the HVAC systems. Thermal comfort of the client spaces is determined by the building operators in conjunction with BIQ. Allowable ranges of temperatures are maintained in accordance with ASHRAE thermal comfort standards and are determined and adjusted on an on-going basis. BIQ collects baseline data from the BMS which it uses to develop optimization of HVAC systems beyond what the BMS can provide. Baseline development occurs when BIQ is initially implemented and periodically as seasons change or other building operations change. No savings occur during the periods of BIQ baseline development.

For their participation in the C&I DR program, customers receive the energy optimization services of the BIQ system. Customers sign agreements regarding the responsibilities of each side toward achieving DR and energy savings.

PY2017 Participation: During the 2017 program year, four large commercial facilities in southern NV were enrolled in the BIQ component of the DR program. All buildings were enrolled in the program during previous program years and thus are all included in the Manage population. No new buildings were recruited or enrolled in the BIQ component during 2017.

2.1.3 Customer Owned Equipment

This program component is a generic offering to allow customers with OpenADR 2.0 compliant equipment to participate in the DR program. This component requires the customer to own a Building Management System, or other OpenADR 2.0 compliant system, and to implement custom demand response algorithms to ensure kW reductions are observed during called events. This program offering allows customers to customize how they respond to DR events in their facilities.

PY2017 Participation: No customers participated in the PY2017 program through this offering.

2.1.4 Demand Response Gateways

Demand response gateways, provided by vendor Universal Devices, are implemented in two ways; as standalone units installed in conjuction with customer owned equipment, or as a communication gateway between NVE's DRMS and another vendor's technology installed under the Commercial DR Program.

For those sites where the gateway device is used with customer owned equipment, the gateway device is integrated into the customer's existing Building Management System (BMS). The gateway is used as a communication device between the NVE **Demand Response Management System (DRMS)** and the customer's BMS. The BMS is programmed to accept OpenADR signals from the gateway. Facility managers then decide ahead of an event what system they will turn off or reduce when a DR call arrives. They will program their strategy into the BMS so when an OpenADR signal is received, the BMS will implement the demand reduction strategy. Generally, it is expected these systems will reduce load by controlling air conditioning and lighting loads.

The gateway devices implemented in conjuction with another vendor's technology work in a similar fashion, functioning as a communication portal between NVE's DRMS and the device installed in the customer's facility. The gateway provides a digital (ON/OFF) signal to indicate whether a DR event is being called. The signal from the gateway device allows technologies that are primarily focused on EE savings to be used in the DR program to provide peak kW reductions during called events. Peak reduction results are reported under the vendor's technology that implemended the DR event and not within the Demand Response Gateway section.

PY2017 Participation: No gateway devices were installed as stand alone units during PY2017. However, the gateway devices were used in conjuction with the Pilot technologies implemented during 2016 and are included in technology Options 6 through 9 as shown in Table 1 above. Additionally, the use of the gateway devices uses an OpenADR signal to respond only to DR events called by NV Energy and therefore only provides energy efficiency savings when used in conjunction with another technology.