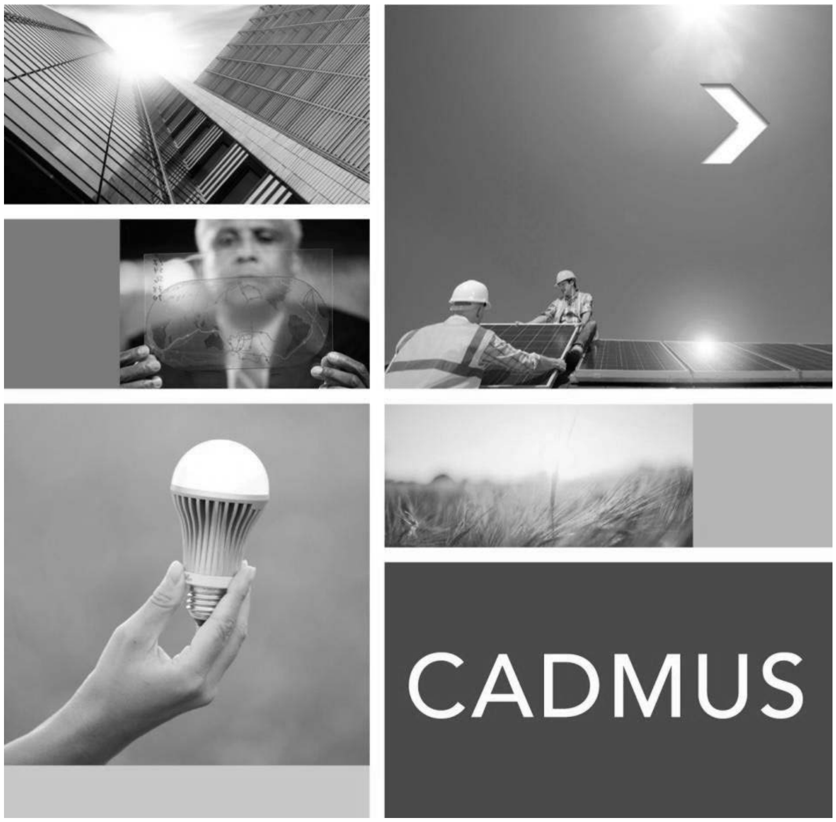
BEFORE THE PUBLIC UTILITIES COMMISSION OF NEVADA

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 7 OF 18

TECHNICAL APPENDIX
DEMAND SIDE PLAN

DSM-1



DSM PORTFOLIO PRO: ELECTRIC MODEL USER MANUAL

May 2017

The Cadmus Group, Inc.

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CADMUS

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Overview of Cost-Effectiveness Analysis

Strategies that improve energy efficiency prove beneficial, at least from a societal viewpoint, as long as their costs can be justified by their economic worth. However, benefits from energy-efficiency improvements may accrue in varying ways for different stakeholders.

Utilities sponsoring energy efficiency programs pose significant questions concerning equity, since, under most circumstances, such actions lead to rate increases.[1] Analysts have struggled to determine how conservation affects utilities, participants, ratepayers, and society. The energy sector widely uses avoided cost analysis to assess the cost-effectiveness (or net benefits) of demand-side management (DSM) relative to conventional supply alternatives.

When calculating DSM benefits, analysts begin by adjusting avoided costs for administrative or programmatic costs as well as other expenses associated with participating in DSM programs. Depending on the analysis perspective taken, competing views can emerge regarding benefits. Generally, the following five basic tests provide comparisons of demand and supply management alternatives, with each representing a measure of cost-effectiveness from various unique perspectives:

- Total Resource Costs (TRC)
- Rate Impact Measure (RIM)
- Utility Cost Test (UCT)
- Participant Cost Test (PCT)
- Societal Cost Test (SCT)

Table 1 summarizes potential DSM benefits, relevant costs, and the allocations of these from the five perspectives. Each assessment begins using the gross DSM benefits, measured by the utility's avoided cost, and subtracts the costs associated with the program (such as equipment, labor, and overhead).

From a TRC perspective, a conservation measure or practice fails if it produces negative net benefits, meaning the costs of achieving savings outweigh the savings' value. Some conservation methods pass one test while failing others. The TRC test can be used to evaluate DSM's effect on total outlays for utility services (for both participants and nonparticipants), and has been defined not as a test of "least cost" but of "most value."[2]

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[1] An exception occurs when the average per-unit cost of conservation falls below the difference between the utility's rate and its avoided resource costs.

[2] Beecher, Janice A. *Avoided Cost: An Essential Concept for Integrated Resource Planning*. Center for Urban Policy and the Environment, Indiana University-Purdue University, Indianapolis. 1998.

Table 1. Alternative Measures of Program Performance

Elements	TRC	RIM	UCT	PCT	SCT
Benefits					
Avoided Power Supply Costs	√	√	√		√
Avoided T&D Costs	√	√	√		√
Bill Reductions				√	
Rebates				√	
Environmental Adder					√
Indirect Fuel Benefits	√				√
Indirect Other Benefits					√
Costs					
Direct Utility DSM Costs	√	√	√		√
Direct Customer DSM Costs	√			√	√
Utility Program Administration	√	√	√		√
Lost Revenues		√			

Conservation programs' effects on utility rates can be measured by the RIM test, also known as the nonparticipant or no-loser test because it recognizes the potential for lost revenues and the need for nonparticipants to subsidize participants through higher utility rates. The test emphasizes DSM's distributional (equity) effects. Per this test, demand-side options should be implemented only when the end result increases utility revenue requirements by an amount less than the increase in revenue requirements associated with various supply-side options. Determining actual rate impacts also can be used to more directly measure equity in conservation investment decisions.

The UCT emphasizes the use of utility resources to test cost-effectiveness. Per this test, demand-side options should be implemented when the value of acquired conservation resources justifies the utility's portion of conservation costs. This test does not account for sales lost due to conservation.

The PCT evaluates whether the net benefits provided by DSM programs sufficiently motivate customers' participation.

Finally, the SCT measures DSM's complete societal benefits, including indirect benefits (mainly arising from avoided environmental externalities, such as emissions).

Though such cost-effectiveness tests reflect different vantage points, they cannot be considered entirely independent.[3] A demand-side measure passing the RIM test can be presumed to pass the UCT. The TRC test essentially represents the sum of the RIM test and the PCT. The TRC test and PCT formulas can be modified to include indirect costs, such as participants' investments in time, and the RIM test and PCT

3 Berman, J.S. and D.M. Logan. *A Comprehensive Cost-Effectiveness Methodology for Integrated Least-Cost Planning*. Presented at a conference of the Electric Power Research Institute, Milwaukee, Wisconsin. May 2-4, 1990.

formulas can be modified to reflect effects from shared costs and savings (accruing to utilities and participants).

Many utilities currently use a two-step approach to evaluating conservation and DSM. First, they use the TRC test, reflecting direct utility and participant costs and shared savings, for integrated resource planning. Second, they use the RIM test and PCT to design successful programs, which motivate customer participation and fairly distribute conservation's benefits and costs. This approach offers a consistency of criteria and clarity of method, both of which aid decision making and implementation.

Overview of Portfolio Analysis

Historically, energy-efficiency procurement investment decisions have been made on a measure-by-measure basis. Detailed, engineering-based assessments of technologies and their associated costs and energy savings have formed the basis for defining DSM resource acquisition programs. Cost-effectiveness analyses have been conducted for individual measures, with programs then developed using bundles of cost-effective measures.

Increasingly, DSM professionals recognize the importance of developing a portfolio strategy, not only for designing individual programs, but for evaluating a mix of DSM programs. Mirroring the financial industry's portfolio theory, the energy-efficiency industry recognizes the value in assessing programs' diversification benefits. This portfolio approach to energy-efficiency program design and assessment includes defining and estimating risks at each DSM level: measures, programs, and bundles of programmatic initiatives. Using a portfolio approach for decision making and analysis offers several advantages.

First, this approach improves resource procurement decisions. Most energy-efficiency programs combine multiple measures to form a program. If each measure included in the program must be deemed cost-effective on its own, this ignores the diversification benefits and economies of joint delivery from bundled programs. A portfolio approach analyzes combinations of measures to determine the most cost-effective program design.

This may lead to the procurement of greater energy-efficiency resources than otherwise would have occurred. An additional (and perhaps more important) advantage offered by the portfolio approach arises from its help in quantifying and managing the potential risks of DSM resources. Such risks can be categorized into supply-side and demand-side risks. The supply-side includes: technical (e.g., measure quality and reliability); behavioral (e.g., persistence of savings); and market risks (e.g., market penetration). The demand-side risks principally result from uncertainty concerning future avoided costs.

Energy-efficiency projects, especially those with projected savings linked to the utility's resource planning requirements, carry substantial uncertainty risks regarding the determination of actual savings, and the persistence of the savings over the expected life of the conservation measure. These risks constitute a significant barrier to large-scale investments in such projects. Performance risks from energy-efficiency measures may originate from multiple sources, including measure failures, malfunctions, removals by customers, and degradations in quality.

Laboratory analyses of technological performance rely on assumptions of maximum useful life for conservation measures. Generally, physical life in the field differs from performance in a laboratory. Unfortunately, measure life estimates, based on laboratory results or optimum field conditions, do not account for real-life variables such as: installations, operations, and maintenance practices employed at sites where the conservation measures have been installed. Similarly, estimates not factoring in the effects that remodeling, renovation, and business turnover can have on a conservation measure's life expectancy may prove inaccurate.[4] Although enhanced measurement and verification procedures have significantly improved program designers' ability to determine energy savings of various conservation measures more accurately, evaluations of conservation programs have shown actual conservation measures' impacts sometimes fell short of design expectations. Technology assessments can help identify DSM program candidates by determining the technologies in appropriate applications that will enhance customer value. Such assessments can be research or applications oriented.[5]

In evaluating conservation risks, calculations must also account for supply-side uncertainties, as these relate to calculations of avoided costs, especially when using future price curves to evaluate conservation.[6] Clearly, fluctuations in avoided costs directly affect the expected future value of conservation resources. However, the direction of these impacts depends on expectations of future market price movements. When market prices rise above forecast levels, the value of conservation resources increases. Conversely, lower future market prices diminish the value of conservation investments.

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4 Skumatz, L. and C. Hickman. "Measure Life Study: The Effect of Commercial Building Changes on Energy Using Equipment." Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings, Vol. 3:3.281-3.292. 1992.

5 Several useful recommendations have been offered for improving measure performance in conservation programs. For example, see: "Practical Integrated Resource Planning with Demand-Side Planning and Management: A Good Cents Position Paper," Good Cents Solutions, Stone Mountain, GA, 2004.

6 On the supply side, many utilities consider some or most of at least six risk types: capital risks, production tax credit risks, fuel price exposure, CO_2 tax exposure, market exposure, and load uncertainty.

Overview of the Model

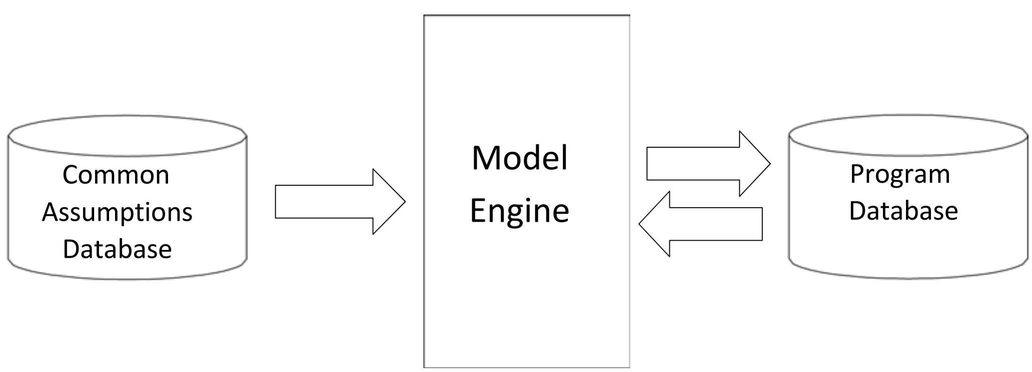
DSM Portfolio Pro uses Microsoft Excel as the basis for a DSM program analysis and scenario tool. Users begin analysis by entering measure information, such as measure costs, rebates, measure life, and annual energy savings. DSM Portfolio Pro allows users to combine measures into programs and programs into portfolios (such as residential or commercial), and to assess their outcomes under alternative assumptions. Cost-effectiveness results can be obtained for each measure, program, or portfolio of programs, and scenarios can be run using varying avoided cost and measure savings assumptions. To create the maximum resolution for DSM impacts, DSM Portfolio Pro's structure accepts data at the 8760 hourly level. Computer system requirements for DSM Portfolio Pro include Microsoft Excel 2007 or higher and Windows XP.

DSM Portfolio Pro's capabilities have been designed with a focus on:

- Creating a transparent and flexible tool for DSM planners and program designers.
- Providing standard calculations and algorithms for analyzing DSM results, including energy impacts, capacity impacts, and environmental benefits.
- Allowing users to analyze DSM outcomes easily under different scenarios.
- Providing a means for easy tracking and standard internal and external reporting of DSM performance.
- Allowing comprehensive assessment of DSM results and cost-effectiveness from multiple perspectives, following the California Standard Practice Manual protocols.

DSM Portfolio Pro consists of three workbooks: a model engine, containing all cost-effectiveness calculations; and two external workbooks. The common assumptions database (CAD) contains all utility-level details, such as the discount rate, avoided energy and capacity costs, energy savings curves, and retail rates. Figure 1 illustrates the relationship between the model engine and the external workbooks.

Figure 1. High-Level Model Overview



Major Functions of the Model

Build Program and View Results

Each program contains one or more measures that share common assumptions (e.g., inflation, discount rates, retail rates, line losses). When the user builds a program, they must specify the costs, customer sector, and the program start and end years (years in which measures will be installed).

Users must enter details for measures that define the program. For each measure, this includes: the number of measures installed each year; annual rebates and measure costs per installation; annual energy savings; and measure lifetime. Once the program has been built, users save the program inputs to the program database and can view the outputs.

Build Portfolio and View Results

A combination of programs makes up each portfolio. If users choose to develop a new portfolio, an input form appears, providing a list of available programs from the program database. Users then select programs to add to the portfolio. Finally, they select the primary sector for the portfolio, allowing use of the proper retail rates for the PCT and RIM tests. Portfolio costs and benefits are calculated at the measure level, by program. Users then save the portfolio to the program database and view the outputs.

Run and/or Save Scenario Analysis

When choosing to run a scenario, users must select which program or portfolio to use as the base, and then choose a multiplier on any (or all) five variables:

1. Avoided energy costs.
2. Avoided generation costs.
3. Measure life.
4. Electric energy savings.
5. Incremental measure costs.

Common Assumptions Database

The CAD stores utility and regional data in datasets common to all programs, including: energy savings curves, avoided costs, on/off peak and season definitions, inflation, retail rates, and discount rates. If the user does not populate the CAD, the model will not work correctly.

Program Database

The program database stores all inputs needed to run a cost-effectiveness analysis for a program, including: measure details, program costs, and economic assumptions. Each sheet in the file contains the inputs for a unique program or portfolio. When a user creates or edits a program and saves it, details are saved to this database so they can be recalled quickly at a later time. Users do not need to manually modify the program database; by clicking the save button, modifications occur through the model engine interface.

Setting Up the Common Assumptions Database

DSM Portfolio Pro's CAD stores utility and regional data that do not vary by program, such as: energy savings curves, avoided costs, on-peak, off-peak, and season definitions, inflation, and escalators. The CAD must be populated before any programs can be built and analyzed, and should be fully updated annually to record changes in avoided cost expectations and annual load expectations. The same CAD should be used across all program evaluations.

Basic Inputs

Table 2 outlines basic data required in the CAD on the *Basic_Data* sheet, and denotes how each variable will be used.

Table 2. Basic Utility Inputs

Variable	Cell Range	What	How Used	Input Terms
First Year	B4:C4	First year of analysis for the model. Once set for the utility, this should not be changed, as previous input databases will not be compatible.	Defines first available year for all other data input.	Numeric
Sectors	B18:B22	Defines the customer sectors.	Differentiates between program and measure types.	Text
Discount Rate	B5:C5	Company's cost of capital.	Deflates streams of future costs and benefits.	Annual Percent (%)
Rate Escalator	B6:C6	Allows future rates to be escalated linearly by a fixed annual percent.	Modifies future retail rates used to calculate customer bill savings and lost revenues.	Annual Percent (%)
Inflation Rate (T&D)	B7:C7	Estimate of annual expected inflation.	Used as default figure to inflate future T&D cost streams.	Annual Percent (%)
Electric Retail Rates	C18:C22	Customer retail rates, by sector, per KWh.	Used to calculate bills savings for PCT benefits and lost revenues for RIM costs.	$/kWh
Gas Retail Rates	D16:D22	Customer retail rates/gas avoided costs, by sector, per Therm.	Used to calculate TRC and SCT gas benefits.	$/Therm
Environmental Adder	B11:C11	Additional benefit (if any) placed by regulators on DSM projects.	Percent is applied to TRC benefits and added on to SCT benefits.	Annual Percent (%)
Line Loss	B8:C9	Estimate of average line losses from generation to building end use. Different line losses are specified for energy and demand.	This percentage is added to on-site energy savings to account for additional energy that must be generated to account for losses.	Annual Percent (%)
T&D Avoided Capacity Cost	B10:C10	Average cost of T&D capacity in dollars per MW.	Used to calculate T&D capacity benefits.	$/MW

Variable	Cell Range	What	How Used	Input Terms
Absolute System Peak	B29:C29	Hour of the year of system peak.	Used to calculate peak hour demand savings.	Numeric

Using daily and seasonal periods, the program calculates the average energy (kWh) and demand (kW) saved during the analysis period, as shown in Table 3.

Table 3. Daily and Seasonal Inputs

Time-of-Use Information	Range	Definition
Daily Periods	G4:K27	Define summer and winter on-peak and off-peak hours by hour and day type (weekend, weekday).
Seasonal Periods	L4:M15	Specify seasons (winter and summer) by month.

The next section defines the cost categories and names of cost types (these costs are in addition to the per-unit measure and installation costs input as measure-specific information). These relate to the ongoing costs of maintaining the program.

Table 4. Cost Types

Costs	Range	Definition
Cost Types	O4:O15	Define cost categories for non-measure program costs.

The energy savings curves allow a measure to be defined from within the program wizard. It populates a pull-down menu.

Table 5. Energy Savings Curves

Measure Options	Range	Definition
Available Energy Savings Curves	R4:R100	Defines the available energy savings curves for measures.

Energy Savings Curves

The *EnergySavingsCurves* sheet stores energy savings curves, starting in cell I15. Columns A to H provide the day type, season, and daily period for each hour of the year. New energy savings curves should be added in the first blank column found to the right of Column I. When adding an energy savings curve, the name should be specified in row 12 (which should match a name in the energy savings curves list on the *Basic_Data* sheet). Users then fill in annual hourly data for the new energy savings curve in rows 15 through 8,774. Energy savings curve values should be entered as a percentage of the annual load, summing to one (1) across the 8,760 hours.

Avoided Energy Costs

The model can accept multiple years of hourly avoided energy cost data, entered as dollars per MWh. Hourly avoided cost values are stored in rows 15 through 8,774, beginning in column E of the *AvoidedEnergyCosts* sheet. The first year for avoided costs will be the same as the first year entered on the *Basic_Data* sheet. Users should enter 30 years of hourly avoided costs; if they enter fewer than 30 years, the program will not estimate annual energy benefits for the missing years.

Avoided Capacity Costs

Avoided generation costs should be entered in row three of the *CapacityCosts* sheet, starting in Column B. Thirty years of costs should be entered; otherwise, annual capacity benefits will not be estimated for the missing years. Avoided T&D costs should be entered as a constant value, which does not escalate, on the *Basic_Data* sheet. To inflate future T&D costs with the inflation rate, enter a percent value in the *Inflation T&D* box of the *Assumptions* form. Failure to enter a percent value will result in avoided T&D costs remaining constant over time.

Avoided Energy Costs by Energy Savings Curve

The *AC_EndUses* sheet shows the average annual avoided cost, weighted by the energy savings curves. The rows in the sheet show each energy savings curve name from the *EnergySavingsCurves* sheet; columns show the years. The values represent the average avoided cost for the year, with the hourly avoided costs weighted by the hourly energy savings curves.

Column AG shows the percentage of load occurring in the system peak hour for each energy savings curve. Columns AH and AI show the average percentage load for all hours considered summer on-peak or winter on-peak, respectively. Columns AJ and AK show the total percentage of load occurring in the summer on-peak and winter on-peak hours, respectively.

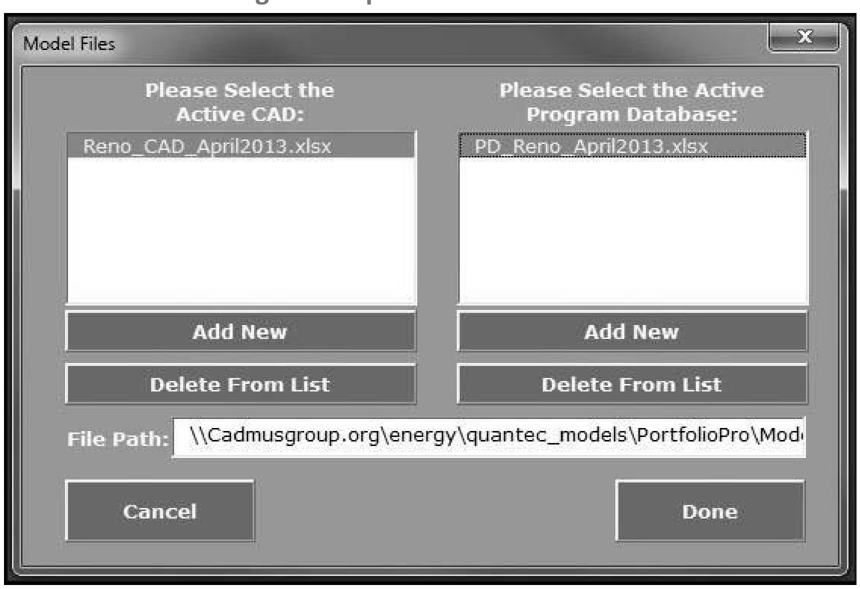
Opening Portfolio Pro

Upon opening the model, users must enable macros by clicking on the security options button appearing in the upper left corner of the Excel window, near the formula bar (Excel 2007). The user interface will not function without macros enabled.

The form in Figure 2 then appears. This allows the user to open the desired database files, add new files, or delete files from the list. CAD and program database files must be saved in the same directory, entered in the *File Path* box. The file path automatically defaults to the directory where the program saves the model. If users choose to save CAD and program database files in another directory, they must update the file path. If the desired CAD or program database files do not appear in the white boxes, users should click the *Add New* buttons under the white boxes. An additional dialog box opens, and the user enters the exact file name in that box. If a program database file does not exist, users should type a file name, and the model will create the file.

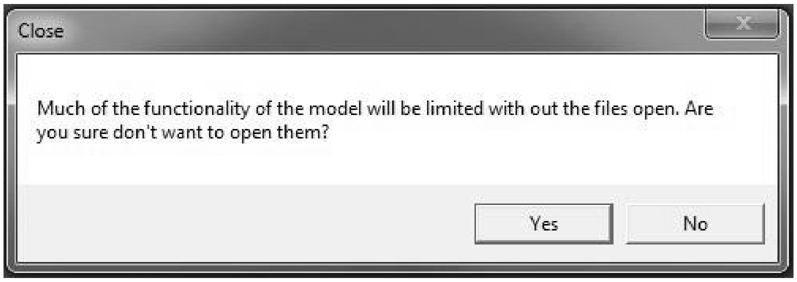
To open the database files, users select the desired CAD and program database files from the white boxes, and click the *Done* button. If the file names selected exist in the file path provided, the two supporting files open in the background, and the model's *Dashboard* sheet appears.

Figure 2. Open Model Files Form



If users click the *Cancel* button, the message shown in Figure 3 will appear.

Figure 3. Close Model Files Message



If users select *Yes*, the model opens, and the *Dashboard* page appears. However, since the supporting files do not open, users will only see spreadsheet cells, and will not be able to use the interface.

If users enter the file path or file names for the CAD and program database incorrectly, they receive an error dialog box, which explains the CAD could not be found. A program database file will be created with the given file path and name. At that point, users must click the *Open Database Files* button on the Dashboard to correct the file paths and file names.

Note that to ensure the model operates efficiently, the calculation settings default to manual. When running the model through the user interface, calculations refresh programmatically. However, if users conduct separate calculations within the spreadsheet, they will have to refresh calculations manually to receive accurate results.

Dashboard Layout

The Dashboard allows users to navigate to all other sheets in the model and operate the model's functions. This section outlines the layout and purpose of options shown on the Dashboard page.

A) **Open Database Files Button.** Pressing this button opens the form shown in Figure 4, which allows users to open the data files that support DSM Portfolio Pro (CAD, program database).

B) **Navigate Model Button**. Pressing this button opens a form that allows the user to navigate to other sheets in the model.

C) **Create Button**. Pressing this button opens a form that allows users to enter information for a new program or portfolio.

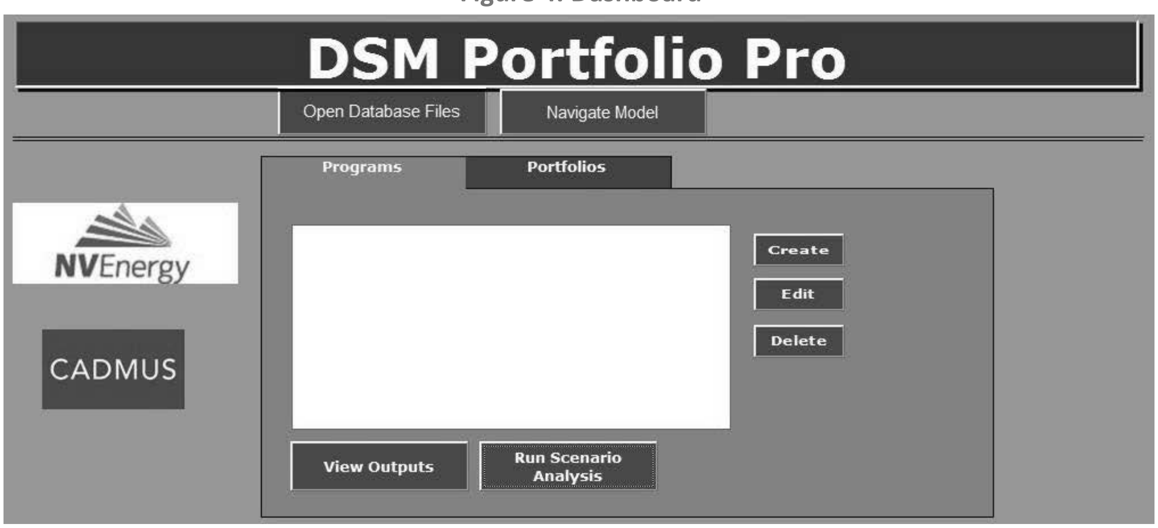
D) **Edit Button**. Pressing this button opens a form that allows users to edit information for an existing program or portfolio that previously has been set up in the model and is stored in the program database.

E) **Delete Button**. Pressing this button allows users to delete an existing program or portfolio, removing it from the program database.

F) **View Outputs Button**. Pressing this button allows users to view the cost-effectiveness results for an existing program or portfolio without having to tab through the input forms.

G) **Run Scenario Analysis Button**. Pressing this button allows users to run scenarios on a previously existing program or portfolio.

Figure 4. Dashboard



Building a Program

1. **Open Database Files**

   Press the *Open Database Files* button on the Dashboard, and select the desired CAD and program database files after updating the file path and file names, if necessary.

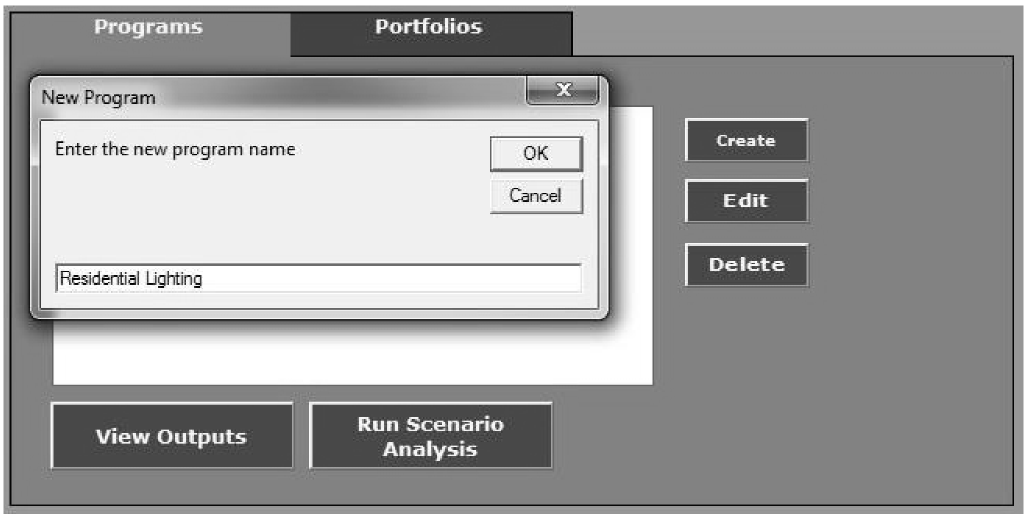
2. **Create New Program**

   Select the Programs tab on the Dashboard (see Figure 4) and click the *Create* button.

3. **Name the Program**

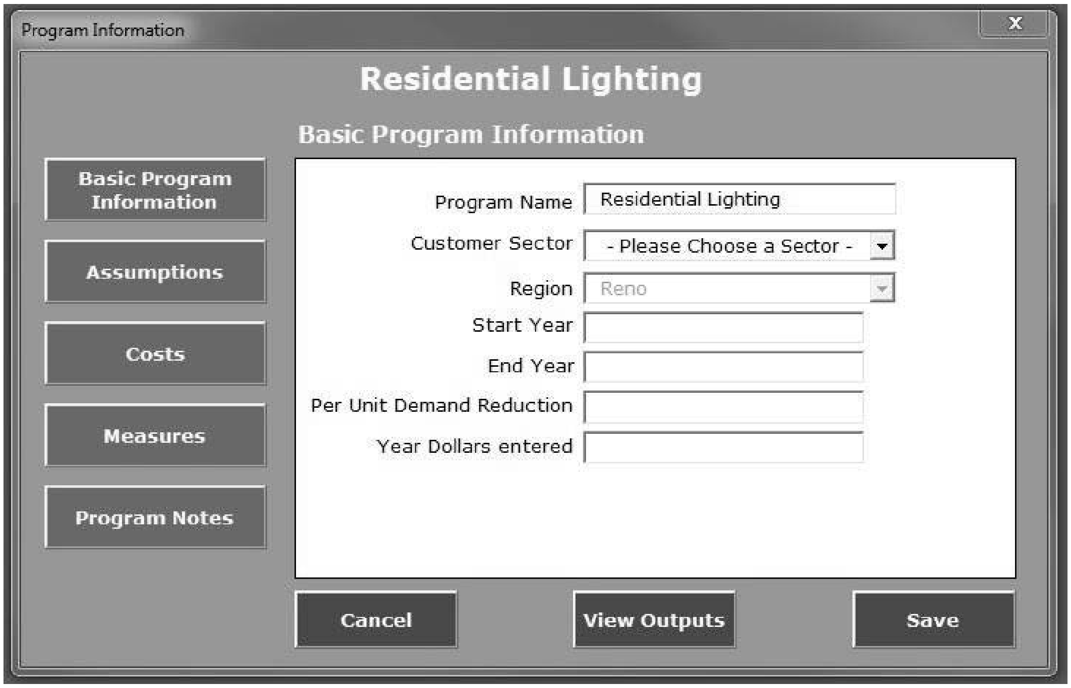
   In the form that appears (shown in Figure 5), provide a name for the new program and press *OK.* Note that program names must be less than 31 characters.

Figure 5. Create New Program



Form 1 of 5: Basic Program Information

Figure 6. Basic Program Information Form



4. **Choose Sector**

   Choose a customer sector for the program; this will define the retail rate used for the participant and RIM tests.

5. **Choose Start Year and End Year**

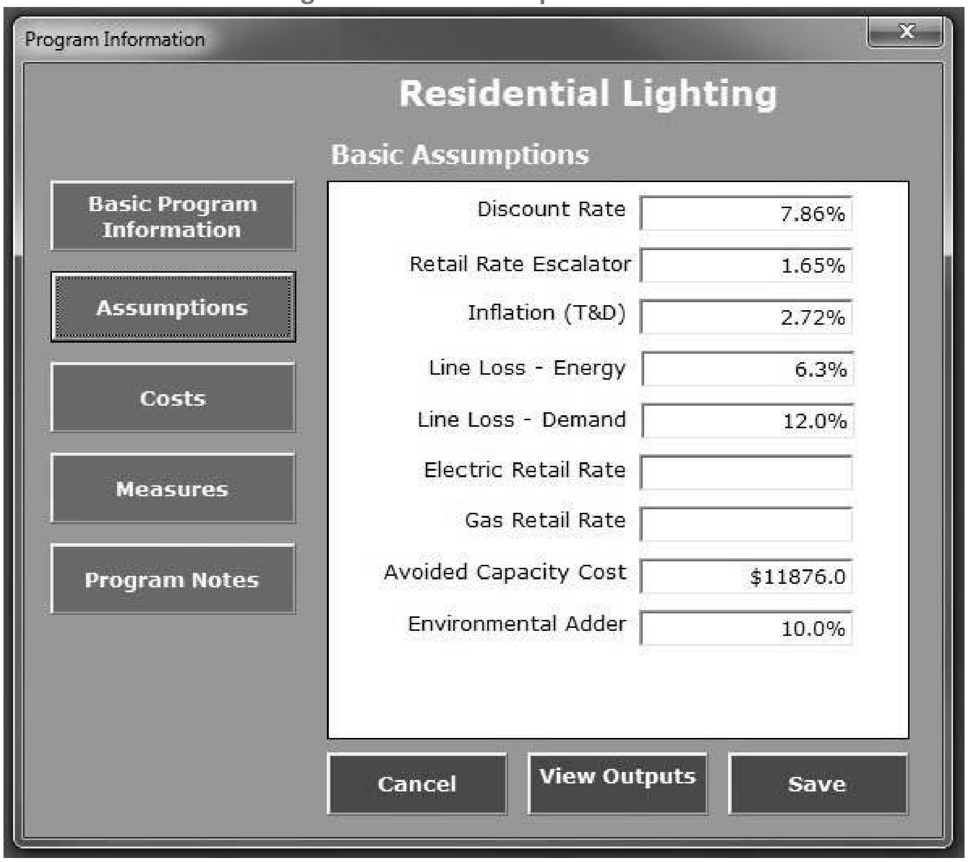
   Choose the start year and end year for the program (i.e., the years for which measures will be installed). The program uses measure life to calculate the full benefits of installed measures. By default, the *Year Dollars Entered* box will be populated with the start year. This field will be the year to which results are discounted. Although it defaults to the start year, users can manually override this with a different year.

6. **Input Demand Reduction**

   Users should input demand reduction (kW per unit installed) only if the model does not correctly estimate the demand savings, based on energy savings curves and kWh energy savings (e.g., a demand response program). Note: this only works for programs and not for portfolios.

Form 2 of 5: Assumptions

Figure 7. Basic Assumptions Form



7. **Edit Utility Assumptions from Basic Data**

   Any changes made to the basic data on this form will only be saved within the program, and will not overwrite the values in the CAD. Once the program has been developed, the basic data saved with a program will not update with changes made to the basic data in the CAD.

Form 3 of 5: Costs

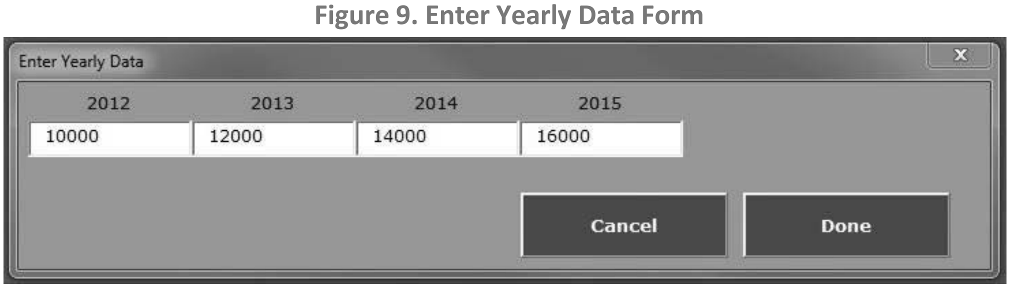
Figure 8. Program Cost Data Form

8. Enter Program Costs

All program cost inputs offer two data input options:

1. *Constant value*. The value entered in the annual cost box equals the value for all program years.
2. *Nominal values for all installation years*. After clicking the *Enter Yearly Data* button to the right of the *Annual Cost* box, users can enter annual monetary values in the new form that appears, shown in Figure 9.

Figure 9. Enter Yearly Data Form



Form 4 of 5: Measures

Figure 10. Program Measures Form

9. **Add Measure(s) to the Program**

   To add a measure to the program, click the *Add New Measure* button. A form will appear, allowing users to enter the name of the measure. After entering the measure name and clicking the *OK* button, the form shown in Figure 11 appears. Once measures have been added to the program, their names appear in the white box under the *Measures Used* header, shown in Figure 10.

Figure 11. Add New Measure Form

10. Enter Measure Details

Enter the measure lifetime, annual energy savings, annual degradation (how much savings have been lost each year), net-to-gross (NTG) ratio, and drop-out rate (the percentage of participants uninstalling the measure). Assign the measure an energy savings curve by picking from the provided drop-down list. Enter non-energy benefits by selecting *Other* from the *Secondary Benefits* drop-down list, and entering the value in dollars per unit installed. Then enter the annual number of units installed, the incremental measure cost per unit, and the rebate dollars per unit in the boxes provided. After all details have been entered, click the *Done* button.

11. Delete a Measure

To remove a measure from a program, highlight the measure name in the *Measures Used* box, and click the *Remove Measure* button. The measure name will no longer appear in the white box.

12. View or Edit Measure Details

To view or edit the details for a measure already saved to the program, highlight the measure name in the *Measures Used* box, and click the *Measure Details* button. The form shown in Figure 11 will appear, except it will be populated with the previously entered information.

Form 5 of 5: Program Notes

13. Add Notes for Reference

Notes regarding a program can be added for ease of reference, and will be reflected in the program database as well as in the *Results* sheet.

Program Form—Save and View Outputs

14. Save Program and View Outputs

Once the user has completed entering and reviewing the program and measure inputs, the program should be saved to the program database, and results can be viewed:

- *Save:* Saves the program inputs to the program database for future editing/scenarios.
- *View Outputs*: Runs cost-effectiveness analysis and displays the *Results* sheet.

Cost-Effectiveness Results

DSM Portfolio Pro provides three levels of results for all programs and portfolios. The *Results* sheet provides an aggregate summary of the present value of costs and benefits for each of the five primary cost-effectiveness tests, along with benefit-cost ratios. The *Program_Calculations* sheet provides the annual values for the individual components of the cost-effectiveness tests, aggregated at the program level. Finally, the *Measure_Calculations* sheet provides the annual values for the individual components of the cost-effectiveness tests at the measure level.

Results

The *Results* sheet provides the program's cost-effectiveness, based on the present value of program costs and benefits (see Figure 12). This shows the benefit-cost ratios for the five cost-effectiveness tests listed in the Standard Practice Manual (with two TRC versions provided: one including rebates paid to freeriders as a cost, and one that does not) as well as: the total present value of costs and benefits; the net benefits; and the cost of conserved energy. This information shows users the perspectives from which the program or portfolio can be considered cost-effective.

In addition, the *Results* sheet reports total utility savings and costs for the first three years of the program or portfolio as well as total project savings and costs. This includes the total utility investment, net energy benefits, and energy and demand savings.

Figure 12. Results Sheet

Name:	Residential Lighting	**Last Updated:**	5/9/2013 10:30
Customer Sector:	0	**Avg Measure Life:**	12.00
Region :	Reno	**Energy Savings Curve:**	Residential_Lighting
Start Year:	2012	**Model File Name:**	DSM_PortPro_April2013.xlsm
End Year:	2015	**CAD File Name:**	Reno_CAD_April2013.xlsx.xls
Notes:		**Program DB Name:**	PD_Reno_April2013.xlsx

Stakeholder Perspectives & Tests	Benefits (PV)	Costs (PV)	Net Benefits (PV)	B/C Ratio	Cost of Conserved Energy ($/kWh)
Total Resource Cost (TRC)	$324,785	$144,096	$180,690	2.25	$0.021
Total Resource Cost (TRC) - Adjusted*	$324,785	$144,096	$180,690	2.25	$0.021
Utility Cost Test (UCT)	$324,785	$139,126	$185,660	2.33	$0.020
Participant Cost Test (PCT)	$42,368	$7,918	$34,450	5.35	$0.001
Ratepayer Impact (RIM)	$324,785	$139,126	$185,660	2.33	$0.020
Societal Cost (SCT)	$354,348	$144,096	$210,253	2.46	$0.021

*Includes rebates paid to freeriders

Utility Savings & Costs*	2012	2013	2014	Total Project
Total Utility Investment ($)	$38,100	$39,100	$39,200	$155,400
Electric Benefits ($)	$1,986	$20,872	$22,055	$324,785
Gas Benefits ($)	$0	$0	$0	$0
Incremental Energy & Demand Savings:				
Electric Savings (kWh)	53,362	586,980	640,342	10,374,877
Critical Peak Hour Demand (kW)	5	54	59	141
Gas Savings (therms)	0	0	0	0
Total On Peak Hours (kWh)	1,644	18,082	19,726	2,360,963
Total On Peak Hours (%)				23%

*Savings in this section are adjusted for line loss and net-to-gross

Financial Data		Secondary Benefits	
Discount Rate:	7.86%	Other Savings	$0
Rate Escalator:	1.65%		
Inflation Rate (T&D):	2.72%	**Scenarios:**	
Line Loss (Energy):	6.30%	Measure Life	100%
Line Loss (Demand):	12.00%	Energy Savings	100%
Avoided T&D Capacity $/MW:	$11,876	Avoided Energy Cost	100%
Environmental Adder (SCT only)	10.00%	Avoided Capacity Cost	100%
Electric Retail Rate ($/KWh):	$0.00	Incremental Measure Cost	100%
Gas Retail Rate ($/therm)	$0.00		
Net-To-Gross Ratio	100.0%		

Program Calculations

This sheet shows the program or portfolio annual costs, benefits, and savings used to calculate benefit-cost ratios for each of the five perspectives. It includes how costs are incurred and benefits accrued over time, for up to 30 years from the program's inception.

The many series of annual data reported include:

- TRC costs and benefits.
- UCT costs and benefits.
- PCT costs and benefits.
- RIM costs and benefits.
- SCT costs and benefits.
- Utility administrative, measure rebate, and program incentive costs.
- Gross and net participant measure costs.
- Net annual savings in KWh and in dollars.
- Net capacity savings in KW and in dollars.

- Seasonal peak energy savings.
- Incremental energy and demand savings.

Measure Calculations

This sheet reports annual costs, benefits, and savings for each measure in the program or portfolio. It allows for comparisons of the costs and benefits of each measure over time, up to 30 years from the program's inception.

The many series of annual measure data reported include:

- Inputs such as: annual savings per unit, energy savings curve, measure life, NTG ratio, and other benefits savings per unit.
- Cumulative installations.
- Net annual energy savings in KWh and Therms.
- Net annual demand savings in KW.
- Annual energy and demand benefits in dollars.
- Seasonal peak energy and demand savings.
- Utility measure costs (incentives).
- Gross and net participant measure costs.
- Transfer incentive recapture quantity (proportion of incentives paid to freeriders, recaptured for TRC).
- Incremental energy and demand savings.

Building a Portfolio

A portfolio consists of a combination of programs to be analyzed together, per the following steps.

1. **Open Database Files**

   Press the *Open Database Files* button on the Dashboard, and select the desired CAD and program database after updating the file path and file names, if necessary.

2. **Add New Portfolio**

   Select the Portfolios tab on the Dashboard (shown in Figure 4), and click the *Create* button to the right of the white box.

3. **Name the Portfolio**

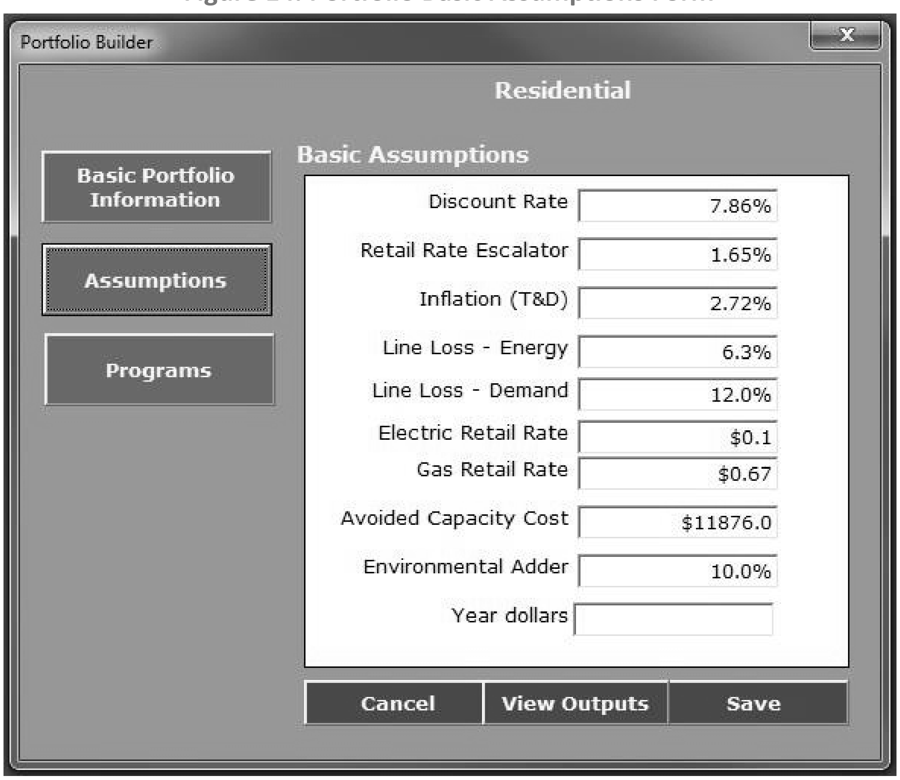
   In the form that appears, provide a name for the new portfolio and press *OK.* Portfolio names must be less than 31 characters.

Figure 13. Basic Portfolio Information Form

4. **Choose Portfolio Sector**

   Select a sector from the drop-down list. This establishes the retail rate used in determining the portfolio's participant benefits and RIM costs. Though programs from multiple sectors can be combined into a portfolio, only one sector can be assigned to the portfolio. Combining multiple sectors into one portfolio may result in incorrect retail rates being applied to some programs.

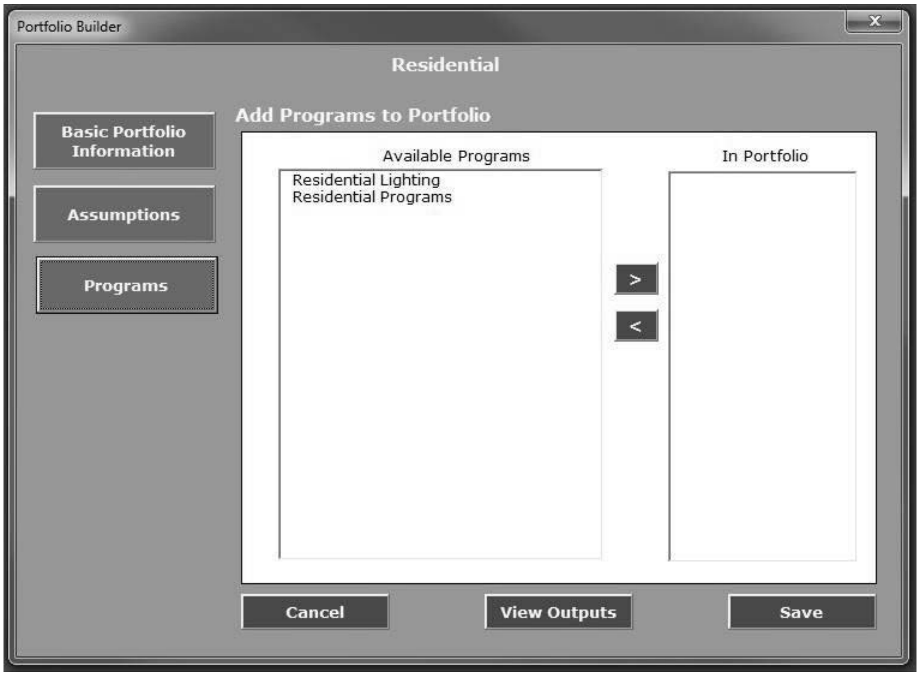
Figure 14. Portfolio Basic Assumptions Form



5. **Edit Assumptions**

   Utility assumptions can be changed for the overall portfolio. As with a program, changes made to basic data are saved only within the portfolio, and do not overwrite the values in the CAD, nor are portfolio assumptions updated when updating the CAD.

Figure 15. Add Programs to Portfolio Form



6. **Add Programs to the Portfolio**

   Programs can be added to the portfolio by highlighting the program in the *Available Programs* box, and clicking on the arrow (>) shown in Figure 15.

7. **Save Portfolio and View Outputs**

   The finished portfolio should be saved to the program database, and results can be viewed:

   - *Save:* Saves program inputs for each program added to the portfolio to the program database for future editing/scenarios.
   - *View Outputs:* Runs cost-effectiveness analysis and displays the output page.

Editing a Program or Portfolio

1. **Open Database Files**

   If database files have not been opened, or if file names or the file path have changed on the Dashboard, click the *Open Database Files* button, and open the appropriate CAD and program database files.

2. **Choose Program or Portfolio**

   Click the Program or Portfolio tab on the Dashboard.

3. **Edit Program or Portfolio**

   Click the program or portfolio name that requires editing, and click the *Edit* button.

4. **Make Changes**

   The forms used in previous sections of this user manual under “Building a Program” and “Building a Portfolio” will appear, with the previously entered program data populating the data entry boxes. Edit the program or portfolio as desired, then save it and view the outputs. If the user chooses to change the program and save it as a new program, this can be done by using the form shown in Figure 5, and typing a new name in the *Program Name* box.

Running a Scenario

1. **Open Database Files**

   If database files have not been opened or if the file names or file paths have changed on the Dashboard, click the *Open Database Files* button.

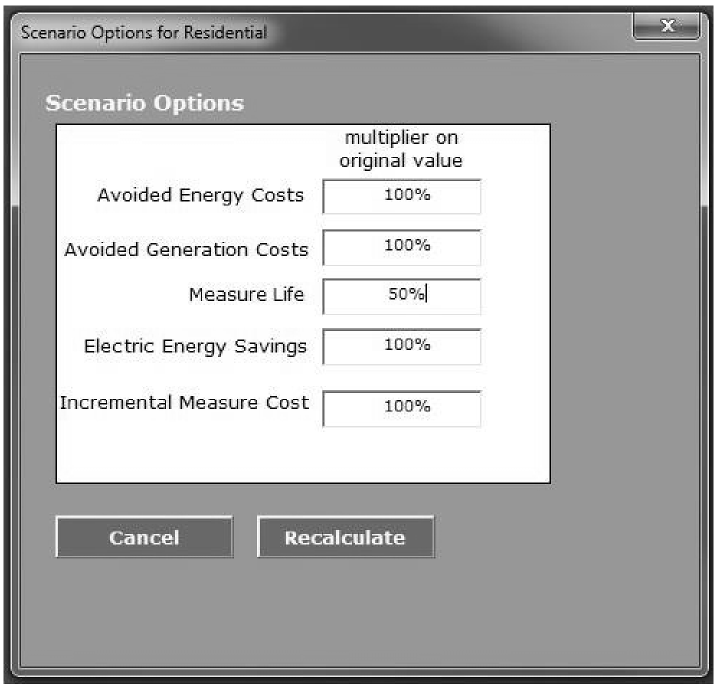
2. **Choose Program or Portfolio**

   Click the Program or Portfolio tab on the Dashboard.

3. **Choose Program or Portfolio for Scenarios**

   Choose a program or portfolio, and click the *Run Scenario Analysis* button under the white box. In the form that appears, shown in Figure 16, enter a name for the scenario to differentiate base case results from scenario results (scenario inputs appear on the *Results* sheet).

Figure 16. Scenario Options Form



4. **Choose and Change Variables for a Scenario**

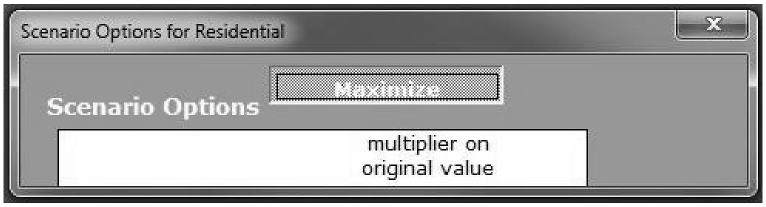
   The input values (multipliers) for avoided energy costs, avoided generation costs, measure life, electric energy savings, and incremental measure costs will be multiplied by the original assumptions. For example, to run a scenario assuming 50% of the measure life, input 0.5 in the *Measure Life* box.

5. **View Scenario Outputs**

   Viewing the outputs allows the user to see scenario results without saving the inputs. Clicking the *Recalculate* button updates the *Results* sheet to show the new cost-effectiveness results. However, the scenario builder will remain open in a minimized form (Figure 17). Clicking

Maximize again shows the entire form, and users can make changes to the scenario. Clicking *Cancel* returns users to the Dashboard.

Figure 17. Minimized Scenario Form



Calculations

DSM Portfolio Pro calculations have been based upon the 1987 California Standard Practice Manual. The TRC ratio reflects the revisions to TRC in the 2007 Clarification Memo from the California Public Utility Commission (CPUC).

Definitions

y = calculation year
h = hour
life = measure life
m = individual measures
M = total measures in program
p = program
t = total over calculation horizon (30 years)
SummerOn = summer on peak period
SummerOnHours = total hours during summer on-peak period
WinterOn = winter on peak period
WinterOnHours = total hours during winter on-peak period
C = customer class
Peak = peak system hour(s)
DR = demand reduction (kW) per unit of measure installed

Energy Benefits to Utility

- $CumlativeInstalls_{y} = NewInstalls_{y} + CumlativeInstalls_{y-1} * (1 - DropOut\% - Degradation\%) - NewInstalls_{y-life} * (1 - DropOut\% - Degradation\%)^{life}$
- $Gross\ Electric\ Energy\ Savings_{mh} = CumulativeInstalls_{y} * PerUnitkWhSavings * EnergySavingsCurve_{h} / (1 - LinelossEnergy\ \%)$
- $Net\ Electric\ Energy\ Savings_{mh} = Gross\ Electric\ Energy\ Savings_{mh} * NTG$
- $NetElectricEnergySavings_{h} = \sum_{m=1}^{M} NetElectricEnergySavings_{mh}$
- $NetElectricEnergySavings_{y} = \sum_{h=1}^{8760} NetElectricEnergySavings_{h}$
- $EnergyBenefit_{h} = NetElectricEnergySavings_{h} / 1000 * AvoidedEnergyCost_{h}$
- $EnergyBenefit_{y} = \sum_{h=1}^{8760} EnergyBenefit$
- $EnergyBenefit_{t} = EnergyBenefit_{y=1} + \sum_{y=2}^{30} \frac{EnergyBenefit_{y}}{(1 + DiscountRate)^{y}}$

Seasonal Energy Benefits to Utility

- $$SumKWh_{m,SummerOn} = \sum_{h=1}^{SummerOnHours} EnergySavingsCurve_{mh}$$
- $$SumKWh_{m,WinterOn} = \sum_{h=1}^{WinterOnHours} EnergySavingsCurve_{mh}$$
- $KWh_{m,SummerOn}$ = $NetElectricEnergySavings_y$ * $SumKWh_{m,SummerOn}$
- $KWh_{m,WinterOn}$ = $NetElectricEnergySavings_y$ * $SumKWh_{m,WinterOn}$

Capacity Benefits to Utility

- **Case 1: Use energy savings curve to determine peak hour savings**
  - *Net Peak Demand Savings$_y$ = CumulativeInstalls$_y$ * PerUnitkWhSavings * EnergySavingsCurve$_{Peak}$ / (1 - LinelossDemand %) * NTG*
- **Case 2: Use per unit demand reduction to determine peak hour savings**
  - *Net Peak Demand Savings$_y$ = CumulativeInstalls$_y$ * DR / (1 - LinelossDemand %) * NTG*
- $$GenerationCapacityBenefit_y = NetPeakDemandSavings_y / 1000 * AvoidedGenerationCapacityCost_y$$
  $$T\&DCapacityBenefit_y = NetPeakDemandSavings_y / 1000 * AvoidedT\&DCapacityCost_y$$
  $$CapacityBenefit_t = GenerationCapacityBenefit_{y=1} + T\&DCapacityBenefit_{y=1} + \sum_{y=2}^{30} \frac{GenerationCapacityBenefit_y + T\&DCapacityBenefit_y}{(1+DiscountRate)^y}$$

Seasonal Capacity Benefits to Utility

- $$AvgKW_{y,SummerOn} = \sum_{h=1}^{SummerOnHours} EnergySavingsCurve_h \div SummerOnHours$$
- $$AvgKW_{y,WinterOn} = \sum_{h=1}^{WinterOnHours} EnergySavingsCurve_h \div WinterOnHours$$
- $KW_{y,SummerOn}$ = $CumulativeInstalls_y$ * PerUnitkWhSavings / (1 - LinelossDemand %) * NTG * $AvgKW_{y,SummerOn}$
- $KW_{y,WinterOn}$ = $CumulativeInstalls_y$ * PerUnitkWhSavings / (1 - LinelossDemand %) * NTG * $AvgKW_{y,WinterOn}$

Bill Reductions and Lost Revenue

- $$BillReduction_y = GrossElectricEnergySavings_y * (1 - LineLossEnergy\%) * retailRate_c * \Psi_{i=1}^{y} (1 + RetailRateEscalator_y)$$

- $$Bill\ Reduction_t = Bill\ Reduction_{y=1} + \sum_{y=2}^{30} \frac{Bill\ Reduction_y}{(1 + DiscountRate)^y}$$
- $$Lost\ Revenue_y = NetElectricEnergySavings_y * (1 - LineLossEnergy\%) * retailRate_c * \Psi_{i=1}^{y} (1 + RetailRateEscalator_y)$$
- $$Lost\ Revenue_t = Lost\ Revenue_{y=1} + \sum_{y=2}^{30} \frac{Lost\ Revenue_y}{(1 + DiscountRate)^y}$$

Other Benefits

- $$NetGasSavings_m = CumulativeInstalls_{y^m} * \mathrm{PerUnitThermSavings} * NTG$$
- $$NetGasSavings_y = \sum_{m=1}^{M} NetGasSavings_m$$
- $$NetGasBenefits_y = NetGasSavings_y * \mathrm{Gas}Rate\$_y$$
- $$NetGasBenefit_t = GasBenefit_{y=1} + \sum_{y=2}^{30} \frac{GasBenefit_y}{(1 + DiscountRate)^y}$$
- $$OtherBenefit_y = CumulativeInstalls_y * OtherSavings\$_m * NTG$$
- $$OtherBenefit_t = OtherBenefit_{y=1} + \sum_{y=2}^{30} \frac{OtherBenefit_y}{(1 + DiscountRate)^y}$$

Environmental Impacts

- *$BenefitAvoidedEmissions_y = (EnergyBenefit_y + GasBenefit_y) * (EnvironmentalAdder\%)$*
- $$BenefitAvoidedEmissions_t = BenefitAvoidedEmissions_{y=1} + \sum_{y=2}^{30} \frac{BenefitAvoidedEmissions_y}{(1 + DiscountRate)^y}$$

Participant and Utility Costs

- $$ParticipantMeasureCost_y = \sum_{m=1}^{M} NewInstalls_{ym} * PerUnitMeasureCost_{ym}$$
- $$ParticipantMeasureCost_t = ParticipantMeasureCost_{y=1} + \sum_{y=2}^{30} \frac{ParticipantMeasureCost_y}{(1 + DiscountRate)^y}$$

M

- $TRCMeasureCost_y = \sum_{m=1} NewInstalls_{ym} * PerUnitMeasureCost_{ym} * NTG$

- $TRCMeasureCost_t = TRCMeasureCost_{y=1} + \sum_{y=2}^{30} \frac{TRCMeasureCost_y}{(1+DiscountRate)^y}$

- $UtilityMeasureIncentiveCost_y = \sum_{m=1}^{M} NewInstalls_{ym} * IncentiveAmount\$_{ym}$

- $UtilityMeasureIncentiveCost_t = UtilityMeasureIncentiveCost_{y=1} + \sum_{y=2}^{30} \frac{UtilityMeasureIncentiveCost_y}{(1+DiscountRate)^y}$

  $Utility\ ProgramIncentive_y = \text{ProgramIncentive1}_y + \text{ProgramIncentive2}_y + \ldots\ldots$
  $+ \text{ProgramIncentiveN}_y$

- $Utility\ ProgramIncentive_t = Utility\ ProgramIncentive_{y=1} + \sum_{y=2}^{30} \frac{Utility\ ProgramIncentive_y}{(1+DiscountRate)^y}$

- $UtilityAdministrativeCost_y = ProgramCost1_y + ProgramCost2_y + \ldots\ldots + ProgramCostN_y$

- $UtilityAdministrativeCost_t = UtilityAdministrativeCost_{y=1} + \sum_{y=2}^{30} \frac{UtilityAdministrativeCost_y}{(1+DiscountRate)^y}$

  $TransferIncentiveRecaptureQuantity_y = \sum_{m=1}^{M} (1-NTG) * NewInstalls_{ym} * IncentiveAmount\$_{ym}$

  $TransferIncentiveRecaptureQuantity_t = TransferIncentiveRecaptureQuantity_{y=1} + \sum_{y=2}^{30} \frac{TransferIncentiveRecaptureQuantity_y}{(1+DiscountRate)^y}$

Benefit/Cost Tests

- ***Total Resource Cost Test***
  - *$TotalResourceCost_t = TRCMeasureCost_t + UtilityAdministrativeCost_t + UtilityProgramIncentive_t + TransferIncentiveRecaptureQuantity_t$*
  - *$TotalResourceBenefit_t = EnergyBenefit_t + CapacityBenefit_t + GasBenefit_t$*
- ***Utility Cost Test***
  - *$UtilityCost_t = UtilityAdministrativeCost_t + UtilityMeasureIncentiveCost_t + UtilityProgramIncentive_t$*
  - *$UtilityBenefit_t = EnergyBenefit_t + CapacityBenefit_t$*
- ***Participant Cost Test***
  - *$ParticipantCost_t = ParticipantMeasureCost_t$*
  - *$ParticipantBenefit_t = BillReduction_t + UtilityMeasureIncentiveCost_t + UtilityProgramIncentive_t$*
- ***RIM Test***
  - *$RIMCost_t = LostRevenue_t + UtilityAdministrativeCost_t + UtilityMeasureIncentiveCost_{t+}$*

$UtilityProgramIncentive_t$

- $RIMBenefit_t = EnergyBenefit_t + CapacityBenefit_t$

- ***Societal Test***
  - *SocietalCost$_t$ = TRCMeasureCost$_t$ + UtilityAdministrativeCost$_t$ + UtilityProgramIncentive$_t$ + TransferIncentiveRecaptureQuantity$_t$*
  - *SocietalBenefit$_t$ = EnergyBenefit$_t$ + CapacityBenefit$_t$ + GasBenefit$_t$ + OtherBenefit$_t$ + BenefitAvoidedEmissions$_t$*

Other Calculations

The following calculations occur for each perspective: TRC, UCT, PCT, RIM, and SCT:

$$CostConservedEnergy_y = \frac{Costs_y}{Savings_y}$$

$$CostConservedEnergy_t = \sum_{y=1}^{30} \frac{Costs_y}{(1 + DiscountRate)^y} \div \sum_{y=1}^{30} \frac{ElectricEnergySavings_y}{(1 + DiscountRate)^y}$$

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Table DSM-15A Nevada Power Revenue Multiplier Methodology ("RAM")
Docket No. 17-06003

NPC Programs 2019-2021	2019 Plan Budget	2019 Multiplier Value	2020 Plan Budget	2020 Multiplier Value	2021 Plan Budget	2021 Multiplier Value
Energy Education	$500,000	$46,000	$500,000	$46,000	$500,000	$46,000
Energy Reports	$1,200,000	$110,400	$1,200,000	$110,400	$1,200,000	$110,400
Energy Assessments	$2,500,000	$230,000	$2,500,000	$230,000	$2,500,000	$230,000
Program Development	$200,000	$18,400	$300,000	$27,600	$300,000	$27,600
Subtotal - Outreach & Program Development	**$4,400,000**	**$404,800**	**$4,500,000**	**$414,000**	**$4,500,000**	**$414,000**
Residential Lighting	$2,000,000	$184,000	$1,600,000	$147,200	$1,000,000	$92,000
Pool Pumps	$1,000,000	$92,000	$1,200,000	$110,400	$1,200,000	$110,400
Low Income	$2,000,000	$184,000	$2,000,000	$184,000	$2,000,000	$184,000
Residential Air Conditioning	$7,000,000	$644,000	$7,000,000	$644,000	$7,000,000	$644,000
Direct Install	$500,000	$46,000	$500,000	$46,000	$500,000	$46,000
Residential Demand Response - Manage	$7,300,000	$671,600	$7,500,000	$690,000	$7,700,000	$708,400
Residential Demand Response - Build	$7,000,000	$644,000	$7,100,000	$653,200	$7,300,000	$671,600
Subtotal - Home Services	**$26,800,000**	**$2,465,600**	**$26,900,000**	**$2,474,800**	**$26,700,000**	**$2,456,400**
Schools Program	$1,600,000	$147,200	$1,700,000	$156,400	$1,700,000	$156,400
Commercial Services	$14,500,000	$1,334,000	$14,500,000	$1,334,000	$15,000,000	$1,380,000
Commercial Demand Response Program - Manage	$800,000	$73,600	$900,000	$82,800	$1,000,000	$92,000
Commercial Demand Response Program - Build	$1,700,000	$156,400	$1,700,000	$156,400	$1,700,000	$156,400
Subtotal - Business Services	**$18,600,000**	**$1,711,200**	**$18,800,000**	**$1,729,600**	**$19,400,000**	**$1,784,800**
Total Demand Side	**$49,800,000**	**$4,581,600**	**$50,200,000**	**$4,618,400**	**$50,600,000**	**$4,655,200**

Multiplier:
2017 GRC Dockets 17-06003 and 17-06004 - Order Issued December 29, 2017

	Percent	Cost	Return	WACC Grossed-up for Taxes	
Customer Deposits	1.44%	0.61%	0.01%	0.01%	
Long-Term Debt	48.58%	6.66%	3.24%	3.24%	
	50.02%	7.27%	3.25%	3.25%	
Common Equity	49.99%	9.40%	4.70%	5.95%	
Authorized WACC	100.00%		7.95%	**9.20%**	**Multiplier**

Table DSM-15B Sierra Pacific Lost Revenue Multiplier Methodology ("RAM")
Docket No. 16-06007

SPPC Programs 2019-2021	2019 Preferred Plan Budget	2019 Multiplier Value	2020 Preferred Plan Budget	2020 Multiplier Value	2021 Preferred Plan Budget	2021 Multiplier Value
Energy Education	$400,000	$31,533	$400,000	$31,533	$400,000	$31,533
Energy Reports	$575,000	$45,328	$675,000	$53,211	$775,000	$61,094
Energy Assessments	$1,125,000	$88,685	$1,375,000	$108,393	$1,375,000	$108,393
Program Development	$50,000	$3,942	$100,000	$7,883	$100,000	$7,883
Subtotal - Outreach & Program Development	**$2,150,000**	**$169,488**	**$2,550,000**	**$201,020**	**$2,650,000**	**$208,903**
Residential Lighting	$1,100,000	$86,715	$800,000	$63,065	$600,000	$47,299
Low Income	$600,000	$47,299	$700,000	$55,182	$700,000	$55,182
Residential Air Conditioning	$600,000	$47,299	$500,000	$39,416	$500,000	$39,416
Direct Install	$150,000	$11,825	$150,000	$11,825	$150,000	$11,825
Residential Demand Response - Manage	$800,000	$63,065	$900,000	$70,948	$1,100,000	$86,715
Residential Demand Response - Build	$2,500,000	$197,079	$2,600,000	$204,962	$2,700,000	$212,845
Subtotal - Home Services	**$5,750,000**	**$453,281**	**$5,650,000**	**$445,398**	**$5,750,000**	**$453,281**
Schools Program	$600,000	$47,299	$600,000	$47,299	$600,000	$47,299
Commercial Services	$5,000,000	$394,158	$5,300,000	$417,807	$5,600,000	$441,456
Commercial Demand Response Program - Manage	$400,000	$31,533	$500,000	$39,416	$600,000	$47,299
Commercial Demand Response Program - Build	$900,000	$70,948	$900,000	$70,948	$900,000	$70,948
Subtotal - Business Services	**$6,900,000**	**$543,937**	**$7,300,000**	**$575,470**	**$7,700,000**	**$607,003**
Total Demand Side	**$14,800,000**	**$1,166,706**	**$15,500,000**	**$1,221,888**	**$16,100,000**	**$1,269,187**

Multiplier:
2016 GRC Dockets 16-06006 and 16-06007 - Order Issued December 28, 2016
Stipulation at page 5, Authorized Rate of Return

	Percen	Cost	Return	WACC Grossed-up for Taxes	
Customer Deposits	0.75%	0.42%	0.00%	0.00%	
Long-Term Debt	51.22%	3.97%	2.04%	2.04%	
	51.97%	4.39%	2.04%	2.04%	
Common Equity	48.03%	9.60%	4.61%	5.84%	
Authorized WACC	100.00%		6.65%	**7.88%**	**Multiplier**

DSM-3

Demand Side Management

DSM COLLABORATIVE WORKSHOP SEPTEMBER 14, 2017

1

Agenda

Teleconference: 1-877-336-1828; Access Code: 4872326

- Welcome
- 2017 Program Updates
- Legislative Updates - Implementation of AB223 and SB150
- Regulatory Updates
- Market Potential Study
- 2018 Combined Integrated Resource Plan

Welcome and Collaborative Overview

- **Introductions**
- **Welcome new members**
- **What is the DSM Collaborative**
- **Structure moving forward**

Nevada Power Company
July 2017 Update

Budget	Budget($)	YTD Spend (as of 7/31)	Projected Year End Spend	Demand Savings (kW)	Annual Demand Savings (kW) YTD As of 7/31	Projected Year End Annual Demand Savings (kW)	Annual Energy Savings (kWh) Targets	Annual Energy Savings (kWh) YTD As of 7/31	Projected Year End Annual Energy Savings (kWh)
Energy Education Program	$400,000	$177,409	$400,000				N/A		
Energy Reports Program (including recapture)	$1,200,000	$403,405	$975,000				N/A		
Program Development	$400,000	$71,275	$400,000				N/A		
Outreach & Program Development	**$2,000,000**	**$652,089**	**$1,775,000**						
Energy Assessments Program (including recapture)	$3,500,000	$855,775	$3,235,000				N/A		
Residential AC Program	$7,000,000	$3,830,523	$6,850,000				13,300,000	8,935,771	13,342,649
Residential DR Program - Manage	$7,600,000	$2,898,519	$7,526,000	189,044	180,992	175,413	21,982,000	12,276,667	20,369,990
Residential DR Program - Build	$7,500,000	$3,656,571	$7,410,000	23,000	18,741	33,089	4,535,000	2,155,555	6,524,288
Residential Services Total	**$25,600,000**	**$11,241,388**	**$25,021,000**	**212,044**	**199,733**	**208,502**	**39,817,000**	**23,367,993**	**40,236,927**
Schools Program	$1,600,000	$513,862	$1,575,000				10,660,000	4,471,656	12,500,000
Commercial Program (including recapture)	$11,150,000	$4,516,977	$12,000,000				90,000,000	41,003,549	130,000,000
Commercial DR Program - Manage	$1,150,000	$568,963	$1,075,000	27,184	27,085	27,014	4,420,000	2,568,943	4,392,359
Commercial DR Program - Build	$1,500,000	$596,959	$1,450,000	5,000	4,170	6,000	2,700,000	1,313,550	2,700,000
Business Services Total	**$15,400,000**	**$6,196,761**	**$16,100,000**	**32,184**	**31,255**	**33,014**	**107,780,000**	**49,357,698**	**149,592,359**
DSM Portfolio Total	**$43,000,000**	**$18,090,238**	**$42,896,000**	**244,228**	**230,988**	**241,516**	**147,597,000**	**72,725,691**	**189,829,286**

Sierra Pacific Power Company
July 2017 Update

Budget	Budget($)	YTD Spend (as of 7/31)	Projected Year End Spend	Demand Savings (kW)	Annual Demand Savings (kW) YTD As of 7/31	Projected Year End Annual Demand Savings (kW)	Annual Energy Savings (kWh) Targets	Annual Energy Savings (kWh) YTD As of 7/31	Projected Year End Annual Energy Savings (kWh)
Energy Education Program	$300,000	$79,847	$270,000	[redacted]	[redacted]	[redacted]	N/A	[redacted]	[redacted]
Energy Reports Program	$700,000	$261,638	$580,000	[redacted]	[redacted]	[redacted]	N/A	[redacted]	[redacted]
Program Development	$100,000	$13,746	$100,000	[redacted]	[redacted]	[redacted]	N/A	[redacted]	[redacted]
Outreach & Program Development	**$1,100,000**	**$355,231**	**$950,000**	[redacted]	[redacted]	[redacted]	-	-	-
Energy Assessments Program	$1,700,000	$440,991	$1,389,000	[redacted]	[redacted]	[redacted]	N/A	[redacted]	[redacted]
Residential DR Program - Manage	$500,000	$210,974	$550,000	7,419	7,294	7,204	1,004,000	575,799	974,904
Residential DR Program - Build	$2,200,000	$1,196,730	$2,525,000	7,000	2,346	3,847	1,272,000	248,676	699,055
Residential Services Total	**$4,400,000**	**$1,848,695**	**$4,464,000**	**14,419**	**9,640**	**11,051**	**2,276,000**	**824,475**	**1,673,959**
Schools Program	$400,000	$83,638	$400,000	[redacted]	[redacted]	[redacted]	2,500,000	284,690	2,500,000
Commercial Program	$4,600,000	$1,171,474	$4,500,000	[redacted]	[redacted]	[redacted]	34,000,000	8,347,312	45,000,000
Commercial DR Program - Manage	$450,000	$152,130	$400,000	1,200	1,200	1,200	375,000	218,750	375,000
Commercial DR Program - Build	$750,000	$342,091	$675,000	2,000	1,299	2,000	450,000	366,318	700,000
Business Services Total	**$6,200,000**	**$1,749,333**	**$5,975,000**	**3,200**	**2,499**	**3,200**	**37,325,000**	**9,217,070**	**48,575,000**
DSM Portfolio Total	**$11,700,000**	**$3,953,259**	**$11,389,000**	**17,619**	**12,139**	**14,251**	**39,601,000**	**10,041,545**	**50,248,959**

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Legislative Updates

AB223- Allocation of 5% of DMS budget to low income customers

- Effective date: July 1, 2017
- NVE impacts:
  - NVE will need to adjust or modify how it evaluates energy efficiency programs based on a set of programs as opposed to individual programs. This change will now allow programs that historically were not cost effective to now be incorporated thus expanding the amount of energy efficiency programs and associated administration and implementation costs.

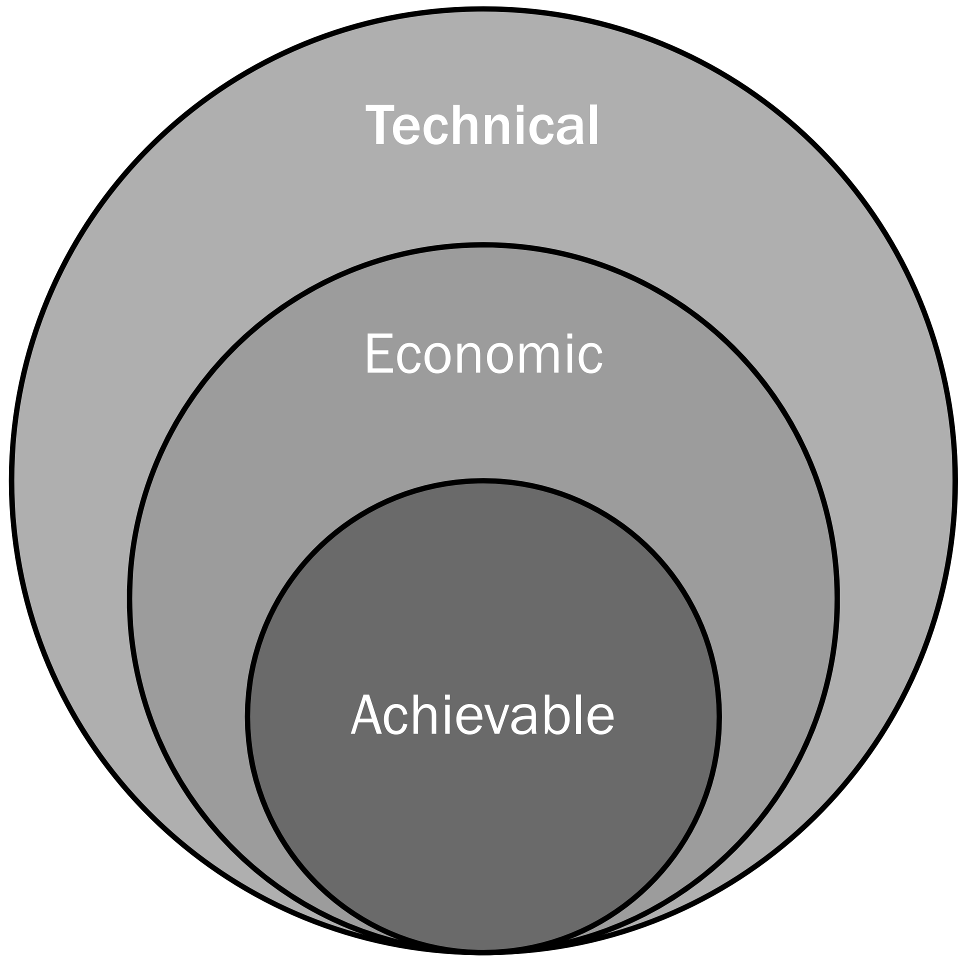
SB150 - Energy efficiency targets and cost effectives tests

- Effective date: July 1, 2017
- NVE impacts:
  - The Commission is required to establish by regulation goals for energy efficiency to be included in the company's integrated resource plan.
  - NVE required to submit in its' integrated resource plan an energy efficiency plan that meets the goals established by the Commission.
  - NVE agreed to conduct a study to evaluate all potential energy efficiency programs by end of 2018

Regulatory Updates

- **Residential Lighting – Docket No. 17-02011**
- **AB223 – Docket No. 17-07011**
- **SB150 – Docket 17-08023**
- **Consolidated electric DSM Annual Reports Docket Nos. 17-06043 and 17-06044**
- **Gas Conservation and Energy Efficiency Annual Report – Docket No. 17-06045 - Stipulated**
- **2018 IRP Filings**

Market Potential Study



8

NPC 2018 Plan

Programs	Budget($)	Demand Savings (kW)	Annual Energy Savings (kWh)
Energy Education Program	$400,000	N/A	N/A
Energy Reports Program	$1,200,000	3,427	9,040,000
Energy Assessments Program	$3,000,000	1,137	3,000,000
Program Development	$400,000	N/A	N/A
Educational Services Total	$5,000,000	**4,564**	**12,040,000**
Residential AC Program	$7,000,000	7,125	13,300,000
Residential DR Program - Manage*	$8,700,000	TBD	TBD
Residential DR Program - Build	$7,700,000	25,000	4,000,000
Residential Services Total	**$23,400,000**	**32,125**	**17,300,000**
Schools Program	$1,600,000	505	10,660,000
Commercial Program	$11,150,000	9,568	90,000,000
Commercial DR Program - Manage*	$1,850,000	TBD	TBD
Commercial DR Program - Build	$1,500,000	5,000	1,000,000
Business Services Total	**$16,100,000**	**15,073**	**101,660,000**
DSM Portfolio Total	**$44,500,000**	**51,762**	**131,000,000**

* Targets will be determined based on 2017 Build results and losses

SPPC 2018 Plan

Programs	Budget($)	Demand Savings (kW)	Annual Energy Savings (kWh)
Energy Education Program	$300,000	N/A	N/A
Energy Reports Program	$700,000	2,749	8,515,000
Energy Assessments Program	$1,700,000	646	2,000,000
Program Development	$100,000	N/A	N/A
Educational Services Total	$2,800,000	**3,395**	**10,515,000**
Residential DR Program - Manage*	$800,000	TBD	TBD
Residential DR Program - Build	$2,200,000	6,000	848,000
Residential Services Total	**$3,000,000**	**6,000**	**848,000**
Schools Program	$400,000	314	2,500,000
Commercial Program	$4,600,000	4,648	34,000,000
Commercial DR Program - Manage*	$600,000	TBD	TBD
Commercial DR Program - Build	$800,000	2,000	565,000
Business Services Total	**$6,400,000**	**6,962**	**37,065,000**
DSM Portfolio Total	**$12,200,000**	**16,357**	**48,428,000**

* Targets will be determined based on 2017 Build results and losses

Questions and Next Steps

- **Next meeting December 14, 2017**
- **Please sign in before you leave**

Demand Side Management

DSM COLLABORATIVE WORKSHOP DECEMBER 11, 2017

Agenda

Teleconference: 1-877-336-1828; Access Code: 4872326

- Welcome
- Market Potential Study Update
- 2017 Program Updates
- Collaborative Subcommittee Updates
  - Low Income
  - Non-Energy Benefits
- Regulatory Updates – Workshops on AB223 and SB150
- 2018 Combined Integrated Resource Plan

Market Potential Status

Project Schedule

Milestone	Date
Data assembly and market segmentation	Complete
Response to stakeholder comments on measure list	Week of December 12, 2017
Estimates of potentials	End of February 2018
Program design recommendations	Late March 2018
Stakeholder presentation	Week of March 26, 2018
Final Report	April 2018

Nevada Power Company
October 2017 Update

Budget	Budget($)	YTD Spend (as of 10/31)	Projected Year End Spend	Demand Savings (kW)	Annual Demand Savings (kW) YTD As of 10/31	Projected Year End Annual Demand Savings (kW)	Annual Energy Savings (kWh) Targets	Annual Energy Savings (kWh) YTD As of 10/31	Projected Year End Annual Energy Savings (kWh)
Energy Education Program	$400,000	$211,739	$400,000				N/A		
Energy Reports Program (including recapture)	$1,200,000	$579,558	$1,085,523				N/A		
Program Development	$400,000	$155,392	$400,000				N/A		
Outreach & Program Development	**$2,000,000**	**$946,689**	**$1,885,523**						
Energy Assessments Program (including recapture)	$3,500,000	$1,468,272	$2,283,757				N/A		
Residential AC Program	$7,000,000	$5,260,125	$6,650,000				13,300,000	11,892,048	13,342,649
Residential DR Program - Manage	$7,600,000	$4,636,077	$6,500,000	189,044	182,651	179,567	21,982,000	17,698,853	20,880,016
Residential DR Program - Build	$7,500,000	$5,241,321	$7,000,000	23,000	23,634	29,660	4,535,000	3,883,340	5,848,178
Residential Services Total	**$25,600,000**	**$16,605,795**	**$22,433,757**	**212,044**	**206,285**	**209,227**	**39,817,000**	**33,474,241**	**40,070,843**
Schools Program	$1,600,000	$719,176	$1,275,035				10,660,000	6,618,405	12,500,000
Commercial Program (including recapture)	$11,150,000	$8,256,385	$12,500,000				90,000,000	83,609,609	140,000,000
Commercial DR Program - Manage	$1,150,000	$720,633	$1,075,000	27,184	26,193	26,000	4,420,000	3,549,056	4,227,486
Commercial DR Program - Build	$1,500,000	$980,003	$1,450,000	5,000	5,970	6,200	2,700,000	2,686,500	3,348,000
Business Services Total	**$15,400,000**	**$10,676,197**	**$16,300,035**	**32,184**	**32,163**	**32,200**	**107,780,000**	**96,463,570**	**160,075,486**
DSM Portfolio Total	**$43,000,000**	**$28,228,681**	**$40,619,315**	**244,228**	**238,448**	**241,427**	**147,597,000**	**129,937,811**	**200,146,329**

Sierra Pacific Power Company
October 2017 Update

Budget	Budget($)	YTD Spend (as of 10/31)	Projected Year End Spend	Demand Savings (kW)	Annual Demand Savings (kW) YTD As of 10/31	Projected Year End Annual Demand Savings (kW)	Annual Energy Savings (kWh) Targets	Annual Energy Savings (kWh) YTD As of 10/31	Projected Year End Annual Energy Savings (kWh)
Energy Education Program	$300,000	$102,259	$280,313				N/A		
Energy Reports Program	$700,000	$384,048	$659,805				N/A		
Program Development	$100,000	$21,161	$100,000				N/A		
Outreach & Program Development	**$1,100,000**	**$507,468**	**$1,040,118**	-			-	-	-
Energy Assessments Program	$1,700,000	$772,436	$1,205,117				N/A		
Residential DR Program - Manage	$500,000	$308,188	$500,000	7,419	7,144	7,048	1,004,000	805,653.95	953,793.00
Residential DR Program - Build	$2,200,000	$1,667,954	$2,125,400	7,000	3,410	5,660	1,272,000	516,371	1,028,500.00
Residential Services Total	**$4,400,000**	**$2,748,578**	**$3,830,517**	**14,419**	**10,554**	**12,708**	**2,276,000**	**1,322,025**	**1,982,293**
Schools Program	$400,000	$166,136	$400,000				2,500,000	2,253,534	2,500,000
Commercial Program	$4,600,000	$2,123,936	$4,750,000				34,000,000	15,950,992	45,000,000
Commercial DR Program - Manage	$450,000	$221,523	$400,000	1,200	1,200	1,200	375,000	312,500	375,000
Commercial DR Program - Build	$750,000	$530,462	$675,000	2,000	2,160	2,300	450,000	405,000	517,000
Business Services Total	**$6,200,000**	**$3,042,057**	**$6,225,000**	**3,200**	**3,360**	**3,500**	**37,325,000**	**18,922,026**	**48,392,000**
DSM Portfolio Total	**$11,700,000**	**$6,298,103**	**$11,095,635**	**17,619**	**13,914**	**16,208**	**39,601,000**	**20,244,051**	**50,374,293**

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Collaborative Subcommittee Updates

Low Income

Working on definition.

Non-Energy Benefits

Doing research on defining non-energy benefits and what other states are doing. Looking to propose an adder to the cost benefit test.

Regulatory Updates

- **Residential Lighting – Docket No. 17-02011**
- **SB150/AB223 – Docket Nos. 17-08023 and 17-07011 – Next workshop scheduled for January 12, 2018.**
- **2018 Deferred Energy Accounting Adjustment Application filing date is March 1, 2018.**
- **2018 Integrated Resource Plan filing date May 9, 2018.**

NPC 2018 Plan

Programs	Budget($)	Demand Savings (kW)	Annual Energy Savings (kWh)
Energy Education Program	$400,000	N/A	N/A
Energy Reports Program	$1,200,000	3,427	9,040,000
Energy Assessments Program	$3,000,000	1,137	3,000,000
Program Development	$400,000	N/A	N/A
Educational Services Total	$5,000,000	**4,564**	**12,040,000**
Residential AC Program	$7,000,000	7,125	13,300,000
Residential DR Program - Manage*	$8,700,000	TBD	TBD
Residential DR Program - Build	$7,700,000	25,000	4,000,000
Residential Services Total	**$23,400,000**	**32,125**	**17,300,000**
Schools Program	$1,600,000	505	10,660,000
Commercial Program	$11,150,000	9,568	90,000,000
Commercial DR Program - Manage*	$1,850,000	TBD	TBD
Commercial DR Program - Build	$1,500,000	5,000	1,000,000
Business Services Total	**$16,100,000**	**15,073**	**101,660,000**
DSM Portfolio Total	**$44,500,000**	**51,762**	**131,000,000**

* Targets will be determined based on 2017 Build results and losses

SPPC 2018 Plan

Programs	Budget($)	Demand Savings (kW)	Annual Energy Savings (kWh)
Energy Education Program	$300,000	N/A	N/A
Energy Reports Program	$700,000	2,749	8,515,000
Energy Assessments Program	$1,700,000	646	2,000,000
Program Development	$100,000	N/A	N/A
Educational Services Total	$2,800,000	**3,395**	**10,515,000**
Residential DR Program - Manage*	$800,000	TBD	TBD
Residential DR Program - Build	$2,200,000	6,000	848,000
Residential Services Total	**$3,000,000**	**6,000**	**848,000**
Schools Program	$400,000	314	2,500,000
Commercial Program	$4,600,000	4,648	34,000,000
Commercial DR Program - Manage*	$600,000	TBD	TBD
Commercial DR Program - Build	$800,000	2,000	565,000
Business Services Total	**$6,400,000**	**6,962**	**37,065,000**
DSM Portfolio Total	**$12,200,000**	**16,357**	**48,428,000**

* Targets will be determined based on 2017 Build results and losses

Questions and Next Steps

- **Next meeting March 15, 2018**
- **Please sign in before you leave**

NVEnergy

Demand Side Management

DSM COLLABORATIVE WORKSHOP MARCH 12, 2018

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Agenda

Teleconference: 1-877-336-1828; Access Code: 4872326

- Welcome
- Market Potential Study Update
- 2017 Results
- Collaborative Subcommittee Updates
  - Low Income
  - Non-Energy Benefits
- Regulatory Updates
- 2018 Combined Integrated Resource Plan

Market Potential Status

Project Schedule

Milestone	Date
Data assembly and market segmentation	Complete
Response to stakeholder comments on measure list	Week of December 12, 2017
Preliminary potential estimates	Early March 2018
Stakeholder presentation	March 12, 2018
Finalized potential estimates	End of March, 2018
Final report	End of April, 2018

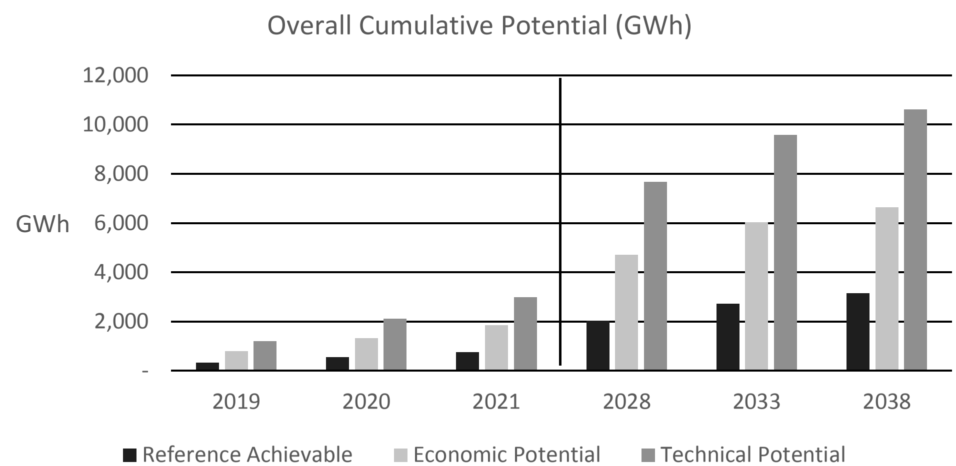
Preliminary Potential Estimates

Total NV Energy

Preliminary achievable savings are 1.1% in the first year and an average of 0.8% over three years

- Economic potential is more than half of technical potential
- Achievable potential represents net savings after accounting for appliance standards and naturally-occurring efficiency

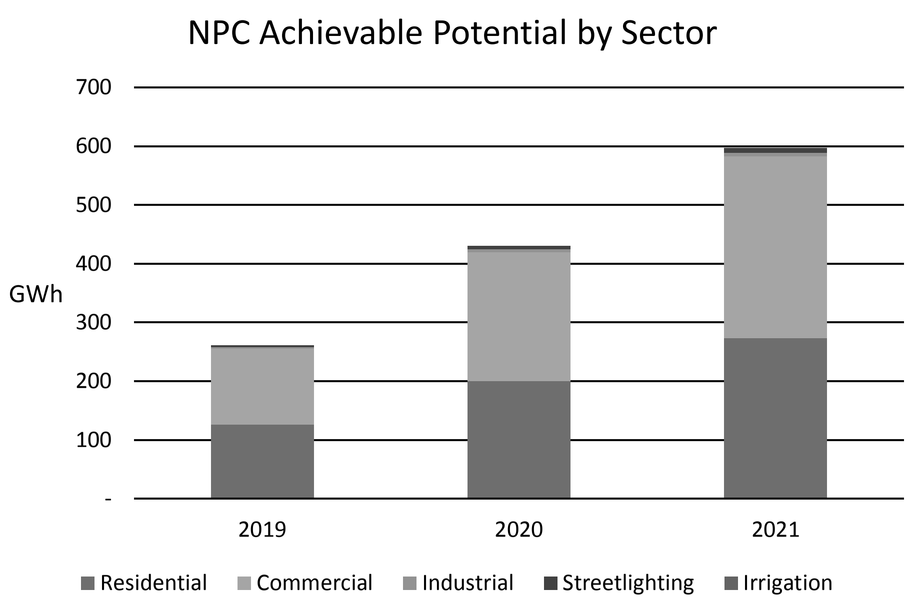
NVE Total, All Sectors	2019	2020	2021	2028	2033	2038
Baseline Forecast (GWh)	29,607	30,047	30,316	29,544	29,673	29,887
Cumulative Savings (GWh)						
Reference Achievable	329	542	751	2,034	2,720	3,134
Economic Potential	788	1,328	1,845	4,714	6,034	6,636
Technical Potential	1,195	2,119	2,990	7,662	9,587	10,607
Energy Savings (% of Baseline)						
Reference Achievable	1.1%	1.8%	2.5%	6.9%	9.2%	10.5%
Economic Potential	2.7%	4.4%	6.1%	16.0%	20.3%	22.2%
Technical Potential	4.0%	7.1%	9.9%	25.9%	32.3%	35.5%

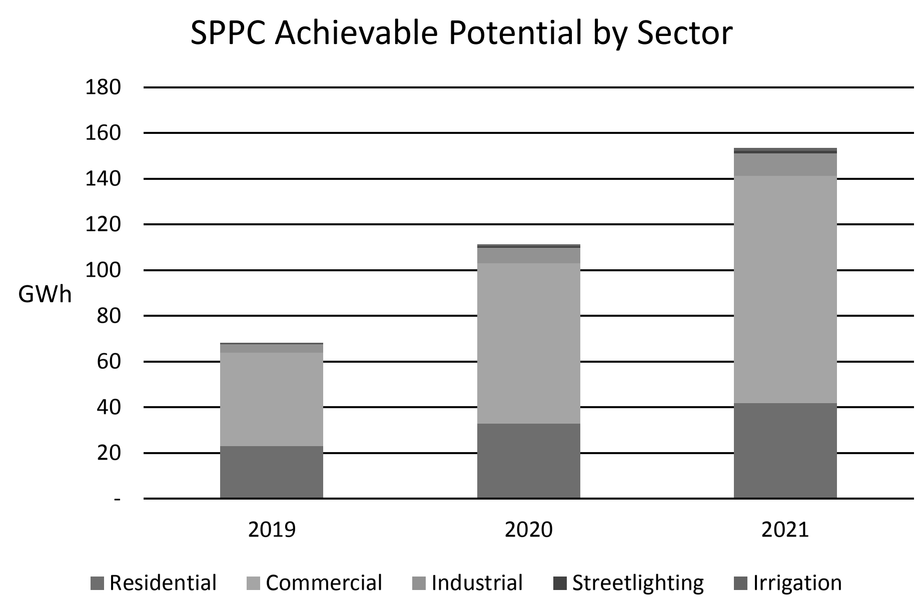


Summary of Preliminary Achievable Potential by Sector

This slide focuses on the first three program years

- The commercial sector accounts for the largest share of savings in both regions
- Residential is second, also in both regions
- Industrial has a significant portion in SPPC
- Streetlighting and Irrigation are both small sectors and account for minimal savings



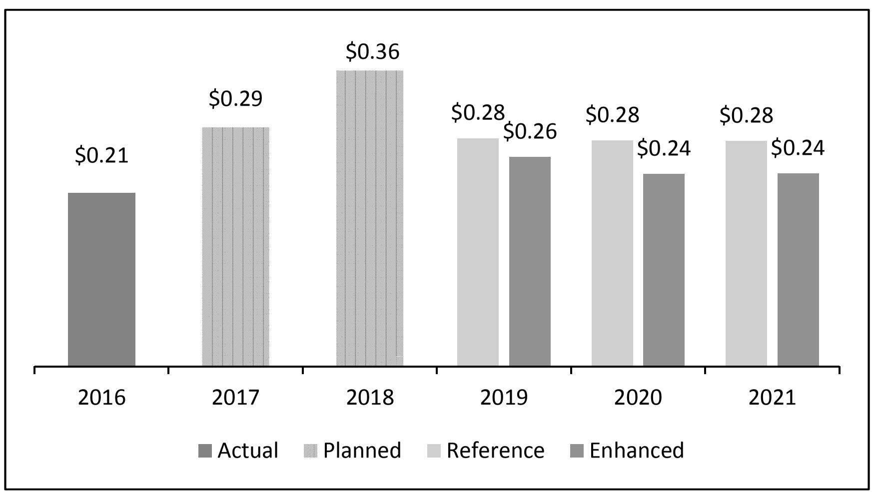


Preliminary Savings
Residential and C&I Sectors, All NVE

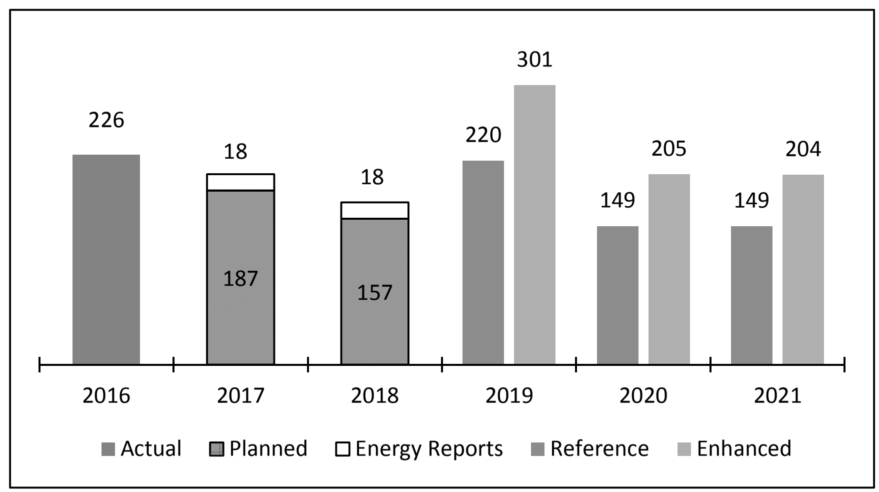
This slides shows preliminary savings and cost estimates for two scenarios and compares with actual and planned program results for 2016-2018:

- Reference case – continuation of 2016 programs
- Enhanced case – 2016 programs plus new ones, most notably lighting for two years

Annual $/kWh



Annual Savings (GWh)



Nevada Power Company
2017 Results

Budget	Budget($)	Final Spend	Demand Savings (kW)	Annual Demand Savings (kW)	Annual Energy Savings (kWh) Targets	Estimated Energy Savings (kWh)
Energy Education Program	$400,000	$400,567			N/A	
Energy Reports Program (including recapture)	$1,200,000	$943,606			N/A	
Program Development	$400,000	$334,268			N/A	
Outreach & Program Development	**$2,000,000**	**$1,678,441**				
Energy Assessments Program (including recapture)	$3,500,000	$2,222,104			N/A	
Residential AC Program	$7,000,000	$6,237,363			13,300,000	11,941,836
Residential DR Program - Manage	$7,600,000	$5,852,210	189,044	168,100	21,982,000	19,546,636
Residential DR Program - Build	$7,500,000	$7,016,381	23,000	26,955	4,535,000	5,314,823
Residential Services Total	**$25,600,000**	**$21,328,058**	**212,044**	**195,055**	**39,817,000**	**36,803,295**
Schools Program	$1,600,000	$1,402,427			10,660,000	12,406,224
Commercial Program (including recapture)	$11,150,000	$12,439,622			90,000,000	136,638,282
Commercial DR Program - Manage	$1,150,000	$895,044	27,184	22,429	4,420,000	3,646,858
Commercial DR Program - Build	$1,500,000	$1,470,947	5,000	6,720	2,700,000	2,341,340
Business Services Total	**$15,400,000**	**$16,208,040**	**32,184**	**29,149**	**107,780,000**	**155,032,704**
Market Potential Study	$0	$175,758				
Other Total	**$0**	**$175,758**				
DSM Portfolio Total	**$43,000,000**	**$39,390,297**	**244,228**	**224,204**	**147,597,000**	**191,835,998**

Sierra Pacific Power Company
2017 Results

Budget	Budget($)	Final Spend		Demand Savings (kW)	Annual Demand Savings (kW)		Annual Energy Savings (kWh) Targets	Estimated Energy Savings (kWh)
Energy Education Program	$300,000	$282,156		[redacted]	[redacted]		N/A	[redacted]
Energy Reports Program	$700,000	$597,572		[redacted]	[redacted]		N/A	[redacted]
Program Development	$100,000	$54,055		[redacted]	[redacted]		N/A	[redacted]
Outreach & Program Development	**$1,100,000**	**$933,783**		[redacted]	[redacted]		-	[redacted]
Energy Assessments Program	$1,700,000	$1,224,157		[redacted]	[redacted]		N/A	[redacted]
Residential DR Program - Manage	$500,000	$448,643		7,419	6,681		1,004,000	904,128
Residential DR Program - Build	$2,200,000	$2,428,553		7,000	5,658		1,272,000	1,028,139
Residential Services Total	**$4,400,000**	**$4,101,353**		**14,419**	**12,339**		**2,276,000**	**1,932,267**
Schools Program	$400,000	$361,400		[redacted]	[redacted]		2,500,000	2,876,298
Commercial Program	$4,600,000	$4,425,553		[redacted]	[redacted]		34,000,000	50,487,489
Commercial DR Program - Manage	$450,000	$261,775		1,200	2,624		375,000	820,000
Commercial DR Program - Build	$750,000	$801,004		2,000	3,049		450,000	1,385,860
Business Services Total	**$6,200,000**	**$5,849,732**		**3,200**	**5,673**		**37,325,000**	**55,569,647**
Market Potential Study	$0	$75,309		[redacted]	[redacted]		[redacted]	[redacted]
Other Total	**$0**	**$75,309**		[redacted]	[redacted]		[redacted]	[redacted]
DSM Portfolio Total	**$11,700,000**	**$10,960,177**		**17,619**	**18,012**		**39,601,000**	**57,501,914**

Collaborative Subcommittee Updates

Low Income

Definition:

A utility shall include in its demand side plan a proposal of programs or measures with a budget of not less than 5 percent of the total expenditures related to energy efficiency and conservation programs directed to low-income customers. Low-income customers targeted for these programs and measures are:

a. Households that do not exceed 200 percent of the federal poverty level; and

b. Individuals, areas or households identified by the utility as low-income on a program or measure basis deemed in the public interest.

Non-Energy Benefits

Benefits currently captured by NV Energy can be found in the Annual Update Reports. A carbon value is NOT included in the avoided cost. Subcommittee recommended as part of the discussion, that an adder of 10% should be applied for regular programs and an adder of 15% should be applied for low income.

Regulatory Updates

- **Residential Lighting – Docket No. 17-02011 – Still Open – Still pending**
- **SB150/AB223 – Docket Nos. 17-08023 and 17-07011 – With Commission - pending**
- **2018 Deferred Energy Accounting Adjustment Application filed on March 1, 2018.**
- **2018 Integrated Resource Plan filing date on or before June 1, 2018.**

NPC 2018 Plan

Programs	Budget($)	Demand Savings (kW)	Annual Energy Savings (kWh)
Energy Education Program	$350,000	N/A	N/A
Energy Reports Program	$970,000	3,427	9,040,000
Energy Assessments Program	$2,200,000	1,137	3,000,000
Program Development	$330,000	N/A	N/A
Educational Services Total	**$3,850,000**	**4,564**	**12,040,000**
Residential AC Program	$6,400,000	7,125	13,300,000
Residential DR Program - Manage*	$6,300,000	TBD	TBD
Residential DR Program - Build	$7,000,000	25,000	4,000,000
Residential Services Total	**$19,700,000**	**32,125**	**17,300,000**
Schools Program	$1,400,000	505	10,660,000
Commercial Program	$11,150,000	9,568	90,000,000
Commercial DR Program - Manage*	$900,000	TBD	TBD
Commercial DR Program - Build	$1,500,000	5,000	1,000,000
Business Services Total	**$14,950,000**	**15,073**	**101,660,000**
DSM Portfolio Total	**$38,500,000**	**51,762**	**131,000,000**

* Targets will be determined based on 2017 Build results and losses

SPPC 2018 Plan

Programs	Budget($)	Demand Savings (kW)	Annual Energy Savings (kWh)
Energy Education Program	$300,000	N/A	N/A
Energy Reports Program	$700,000	2,749	8,515,000
Energy Assessments Program	$1,700,000	646	2,000,000
Program Development	$100,000	N/A	N/A
Educational Services Total	$2,800,000	**3,395**	**10,515,000**
Residential DR Program - Manage*	$800,000	TBD	TBD
Residential DR Program - Build	$2,200,000	6,000	848,000
Residential Services Total	**$3,000,000**	**6,000**	**848,000**
Schools Program	$400,000	314	2,500,000
Commercial Program	$4,600,000	4,648	34,000,000
Commercial DR Program - Manage*	$600,000	TBD	TBD
Commercial DR Program - Build	$800,000	2,000	565,000
Business Services Total	**$6,400,000**	**6,962**	**37,065,000**
DSM Portfolio Total	**$12,200,000**	**16,357**	**48,428,000**

* Targets will be determined based on 2017 Build results and losses

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Questions and Next Steps

- **Next meeting June 11, 2018**
- **Please sign in before you leave**

Demand Side Management

DSM COLLABORATIVE WORKSHOP MAY 11, 2018

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Agenda

Teleconference: 1-888-636-3807; Access Code: 7178104

- Welcome
- 2017 Results
- 2019-2021 Gas Portfolio
- 2019-2021 Electric Portfolio
- Collaborative Subcommittee Updates
  - Non-Energy Benefits
- Next Steps

Nevada Power 2017 Results

Nevada Power Programs	2017 Approved Budget	2017 Actual Expenditures	Demand kW		Energy kWh			
			Target	Verified Demand Savings	Target	Verified Energy Savings	EUL	Lifetime savings
Energy Education	$400,000	$400,567	N/A	N/A	N/A	N/A	N/A	N/A
Energy Reports	$1,200,000	$943,606	N/A	2,266	N/A	6,125,445	3.5	34,391,733
Energy Assessments	$3,500,000	$2,222,104	N/A	824	N/A	2,216,280	2.0	4,432,560
Program Development	$400,000	$334,268	N/A	N/A	N/A	N/A	N/A	N/A
Education Services Total	**$5,500,000**	**$3,900,544**	**N/A**	**3,090**	**N/A**	**8,341,725**		**38,824,293**
Residential Air Conditioning	$7,000,000	$6,237,363	N/A	5,267	13,300,000	10,937,357	13.0	142,185,641
Residential Demand Response - Manage	$7,600,000	$5,852,210	189,044	180,890	21,982,000	19,753,922	4.0	79,015,688
Residential Demand Response - Build	$7,500,000	$7,016,381	23,000	23,590	4,535,000	3,659,813	10.0	36,598,130
Residential Services Total	**$22,100,000**	**$19,105,955**	**212,044**	**209,747**	**39,817,000**	**34,351,092**		**257,799,459**
Schools	$1,600,000	$1,402,427		2,749	10,660,000	12,542,061	12.5	156,148,659
Commercial Services	$11,150,000	$12,439,622		15,798	90,000,000	135,176,397	11.7	1,581,563,845
Commercial Demand Response - Manage	$1,150,000	$895,044	27,184	16,529	4,420,000	7,677,895	5.0	38,389,475
Commercial Demand Response - Build	$1,500,000	$1,470,947	5,000	2,897	2,700,000	1,310,511	10.0	13,105,110
Commercial Services Total	**$15,400,000**	**$16,208,040**	**32,184**	**37,973**	**107,780,000**	**156,706,864**		**1,789,207,089**
Market Potential Study		**$175,758**						
Total DSM Programs	**$43,000,000**	**$39,390,297**	**244,228**	**250,809**	**147,597,000**	**199,399,681**		**2,085,830,841**

Note: Includes recapture funds

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Sierra 2017 Results

Sierra Programs	2017 Approved Budget	2017 Actual Expenditures	Demand kW		Energy kWh			
			Target	Verified Demand Savings	Target	Verified Energy Savings	EUL	Lifetime savings
Energy Education	$300,000	$282,156	N/A	N/A	N/A	N/A	N/A	N/A
Energy Reports	$700,000	$597,572	N/A	3,014	N/A	8,865,320	3.5	31,028,620
Energy Assessments	$1,700,000	$1,224,157	N/A	293	N/A	906,596	2.0	1,813,192
Program Development	$100,000	$54,055	N/A	N/A	N/A	N/A	N/A	N/A
Educational Services Total	**$2,800,000**	**$2,157,940**	-	**3,307**	**N/A**	**9,771,916**		**32,841,812**
Residential Demand Response - Manage	$500,000	$448,643	7,419	7,373	1,004,000	1,188,915	8.0	9,511,320
Residential Demand Response - Build	$2,200,000	$2,428,553	7,000	6,503	1,272,000	761,727	10.0	7,617,270
Residential Services Total	**$2,700,000**	**$2,877,196**	**14,419**	**13,876**	**2,276,000**	**1,950,642**		**17,128,590**
Schools	$400,000	$361,400		471	2,500,000	3,253,549	15.0	48,803,235
Commercial Services	$4,600,000	$4,425,553		7,000	34,000,000	50,803,353	12.7	645,202,583
Commercial Demand Response - Manage	$450,000	$261,775	1,200	2,405	375,000	130,440	9.0	1,173,960
Commercial Demand Response - Build	$750,000	$801,004	2,000	1,573	450,000	228,553	10.0	2,285,530
Commercial Service Total	**$6,200,000**	**$5,849,732**	**3,200**	**11,449**	**37,325,000**	**54,415,895**		**697,465,308**
Market Potential Study		$75,309						
Total DSM	**$11,700,000**	**$10,960,177**	**17,619**	**28,632**	**39,601,000**	**66,138,453**		**747,435,710**

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2019 – 2021 Gas Portfolio

Program	2019	2020	2021
Energy Education	$ 100,000	$ 100,000	$ 100,000
Energy Reports	$ 125,000	$ 125,000	$ 125,000
Energy Assessments	$ 325,000	$ 325,000	$ 325,000
Direct Install	$ 50,000	$ 50,000	$ 50,000
Gas DSM Portfolio Total	$ 600,000	$ 600,000	$ 600,000

2019 – 2021 Nevada Power Portfolio

DRAFT FOR DISCUSSION ONLY

	Budget ($)			Energy Savings (kWh)		
Nevada Power Company	**2019**	**2020**	**2021**	**2019**	**2020**	**2021**
Energy Education	$500,000	$500,000	$500,000	1,000,000	1,000,000	1,000,000
Energy Reports	$1,200,000	$1,200,000	$1,200,000	12,000,000	13,300,000	14,100,000
Energy Assessments	$2,500,000	$2,500,000	$2,500,000	2,700,000	2,700,000	2,700,000
Program Development	$200,000	$300,000	$300,000	n/a	n/a	n/a
Subtotal - Education	$4,400,000	$4,500,000	$4,500,000	15,700,000	17,000,000	17,800,000
Residential Lighting	$2,000,000	$1,600,000	$1,000,000	10,500,000	8,000,000	5,000,000
Pool Pumps	$1,000,000	$1,200,000	$1,200,000	5,300,000	6,300,000	6,300,000
Low Income	$2,000,000	$2,000,000	$2,000,000	1,000,000	1,100,000	1,300,000
Residential AC Program	$7,000,000	$7,000,000	$7,000,000	12,700,000	12,700,000	12,700,000
Direct Install	$500,000	$500,000	$500,000	1,000,000	1,000,000	1,000,000
Residential Demand Response - Manage	$7,300,000	$7,500,000	$7,700,000	23,200,000	23,800,000	24,500,000
Residential Demand Response - Build	$7,000,000	$7,100,000	$7,300,000	3,400,000	3,500,000	3,600,000
Subtotal - Residential	$26,800,000	$26,900,000	$26,700,000	57,100,000	56,400,000	54,400,000
Schools Program	$1,600,000	$1,700,000	$1,700,000	14,500,000	15,500,000	15,500,000
Commercial Services	$14,500,000	$14,500,000	$15,000,000	161,100,000	152,600,000	157,900,000
Commercial Demand Response Program - Mana	$800,000	$900,000	$1,000,000	1,300,000	1,800,000	2,000,000
Commercial Demand Response Program - Build	$1,700,000	$1,700,000	$1,700,000	1,000,000	1,000,000	1,000,000
Subtotal - Commercial	**$18,600,000**	**$18,800,000**	**$19,400,000**	**177,900,000**	**170,900,000**	**176,400,000**
Total DSM Programs	**$49,800,000**	**$50,200,000**	**$50,600,000**	**250,700,000**	**244,300,000**	**248,600,000**
Retail Sales Forecast (MWh)				20,272,610	20,487,236	20,780,182
% of Retail Sales				1.24%	1.19%	1.20%

2019 – 2021 Sierra Portfolio

DRAFT FOR DISCUSSION ONLY

	Budget ($)			Energy Savings (kWh)		
Sierra Pacific Power Company	**2019**	**2020**	**2021**	**2019**	**2020**	**2021**
Energy Education	$400,000	$400,000	$400,000	800,000	800,000	800,000
Energy Reports	$575,000	$675,000	$775,000	7,800,000	8,900,000	11,300,000
Energy Assessments	$1,125,000	$1,375,000	$1,375,000	1,100,000	1,300,000	1,300,000
Program Development	$50,000	$100,000	$100,000	n/a	n/a	n/a
Subtotal - Education	$2,150,000	$2,550,000	$2,650,000	9,700,000	11,000,000	13,400,000
Residential Lighting	$1,100,000	$800,000	$600,000	5,500,000	3,800,000	2,900,000
Low Income	$600,000	$700,000	$700,000	300,000	400,000	400,000
Residential AC Program	$600,000	$500,000	$500,000	700,000	700,000	800,000
Direct Install	$150,000	$150,000	$150,000	400,000	400,000	400,000
Residential Demand Response - Manage	$800,000	$900,000	$1,100,000	1,700,000	1,900,000	2,300,000
Residential Demand Response - Build	$2,500,000	$2,600,000	$2,700,000	800,000	850,000	900,000
Subtotal - Residential	$5,750,000	$5,650,000	$5,750,000	9,400,000	8,050,000	7,700,000
Schools Program	$600,000	$600,000	$600,000	4,600,000	4,300,000	4,300,000
Commercial Services	$5,000,000	$5,300,000	$5,600,000	52,600,000	55,800,000	58,900,000
Commercial Demand Response Program - Mana	$400,000	$500,000	$600,000	200,000	300,000	400,000
Commercial Demand Response Program - Build	$900,000	$900,000	$900,000	500,000	500,000	500,000
Subtotal - Commercial	**$6,900,000**	**$7,300,000**	**$7,700,000**	**57,900,000**	**60,900,000**	**64,100,000**
Total DSM Programs	**$14,800,000**	**$15,500,000**	**$16,100,000**	**77,000,000**	**79,950,000**	**85,200,000**
Retail Sales Forecast (MWh)				9,071,001	9,338,156	9,613,733
% of Retail Sales				0.85%	0.86%	0.89%

2019 – 2021 Joint Portfolio

DRAFT FOR DISCUSSION ONLY

	Budget ($)			Energy Savings (kWh)		
NV Energy (Statewide)	**2019**	**2020**	**2021**	**2019**	**2020**	**2021**
Energy Education	$900,000	$900,000	$900,000	1,800,000	1,800,000	1,800,000
Energy Reports	$1,775,000	$1,875,000	$1,975,000	19,800,000	22,200,000	25,400,000
Energy Assessments	$3,625,000	$3,875,000	$3,875,000	3,800,000	4,000,000	4,000,000
Program Development	$250,000	$400,000	$400,000			
Subtotal - Education	$6,550,000	$7,050,000	$7,150,000	25,400,000	28,000,000	31,200,000
Residential Lighting	$3,100,000	$2,400,000	$1,600,000	16,000,000	11,800,000	7,900,000
Pool Pumps	$1,000,000	$1,200,000	$1,200,000	5,300,000	6,300,000	6,300,000
Low Income	$2,600,000	$2,700,000	$2,700,000	1,300,000	1,500,000	1,700,000
Residential AC Program	$7,600,000	$7,500,000	$7,500,000	13,400,000	13,400,000	13,500,000
Direct Install	$650,000	$650,000	$650,000	1,400,000	1,400,000	1,400,000
Residential Demand Response - Manage	$8,100,000	$8,400,000	$8,800,000	24,900,000	25,700,000	26,800,000
Residential Demand Response - Build	$9,500,000	$9,700,000	$10,000,000	4,200,000	4,350,000	4,500,000
Subtotal - Residential	$32,550,000	$32,550,000	$32,450,000	66,500,000	64,450,000	62,100,000
Schools Program	$2,200,000	$2,300,000	$2,300,000	19,100,000	19,800,000	19,800,000
Commercial Services	$19,500,000	$19,800,000	$20,600,000	213,700,000	208,400,000	216,800,000
Commercial Demand Response Program - Mana	$1,200,000	$1,400,000	$1,600,000	1,500,000	2,100,000	2,400,000
Commercial Demand Response Program - Build	$2,600,000	$2,600,000	$2,600,000	1,500,000	1,500,000	1,500,000
Subtotal - Commercial	**$25,500,000**	**$26,100,000**	**$27,100,000**	**235,800,000**	**231,800,000**	**240,500,000**
Total DSM Programs	**$64,600,000**	**$65,700,000**	**$66,700,000**	**327,700,000**	**324,250,000**	**333,800,000**

	2019	2020	2021
Retail Sales Forecast (MWh)	29,343,611	29,825,392	30,393,915
% of Retail Sales	1.12%	1.09%	1.10%

Collaborative Subcommittee Updates

Non-Energy Benefits

NV Energy is recommending percentages based on type of program and if there is a low income measure or component.

The percentages are as follows:

- **10% - Programs without low income measures or components**
- **15% - Programs which have low income measures or components**
- **25% - Low Income Program**

Questions and Next Steps

- **2018 Joint IRP Filing date June 1, 2018**
- **Next meeting June 11, 2018**

powershift by NVEnergy

DSM-4

Evaluation, Measurement and Verification

Introduction

Evaluation, measurement, and verification ("EM&V") is a systematic approach for auditing program performance by using quantitative and qualitative data, measurements, and industry-accepted analytical methods to accurately determine the energy and peak demand savings achieved by the Companies' energy efficiency and demand response programs.

The M&V component of the EM&V effort involves data collection, monitoring and analysis that are directed at reliably calculating the energy and peak demand savings resulting from energy efficiency and demand response measures implemented at customers' sites that participate in the Companies' demand side management (DSM) programs. The M&V process ensures that the DSM programs report savings that are measurable, repeatable, and defensible to the regulators, ratepayers and shareholders.

Evaluation – which may also be referred to as "process evaluation" – pertains to those activities that are aimed at determining what the effects of a DSM program were, why those effects occurred, and what can be done to improve existing programs and select future ones. The evaluation effort provides feedback enabling the Companies to continually improve the effectiveness and delivery of their DSM programs.

Specific objectives for the Companies' EM&V efforts include:

- Documenting the programs' energy savings, load reductions, and cost-effectiveness;
- Providing insight into how programs could be structured to increase market penetration, raise energy savings, and/or reduce costs;
- Identifying opportunities for program improvement or the identification of potential new programs;
- Providing data to improve load forecasting and resource planning efforts; and
- Providing a systematic reliability/performance evaluation of technology options.

To ensure that their EM&V objectives are met, the Companies use a process that is based on generally accepted industry standards and procedures. This work is performed by an independent, third-party EM&V contractor that has vast experience applying industry standards and procedures. The Companies have committed to using best practice EM&V for several reasons.

- M&V provides systematic measurement of the performance of energy efficiency and demand response programs and technologies.
- Evaluation provides objective data for assessing program performance rather than relying on anecdotal evidence and personal impressions.

- Engineering methods and technical data provide valid, reliable results that provide a basis for benchmarking and comparing the Companies' energy efficiency programs against those of other utilities.

Overall Approach for M&V Activities

The purpose of M&V activities is to collect and analyze data to calculate reliable estimates of the energy and demand savings resulting from the Companies' DSM program activities, which range from behavioral measures to demand response strategies to energy efficiency measures installed at participating customers' homes, schools, or commercial or industrial sites.

Planning M&V Activities

The Companies use a team approach for planning and designing M&V activities. The team includes M&V staff and the Companies' program managers, as well as staff from the various program implementation contractors. For each energy efficiency program, a program-specific team is formed that defines the M&V objectives for the program, including the identification of program milestones and target goals. Drawing on the results of these program-specific planning activities, the Companies' M&V contractor prepares program-specific M&V plans with protocols and procedures that are based on industry standards.

In preparing the program-specific M&V plans, the M&V contractor takes account of differences among the energy efficiency programs with respect to factors such as types of customers targeted, expected number of participants, types of measures being installed, expected demand (kW) reductions and energy (kWh) savings associated with those measures, and variability of savings among participants. Because of the differences across programs and with a given overall budget, it is important to prepare plans that allocate resources efficiently and cost-effectively while maintaining a balance in M&V effort among the programs.

Choosing Approach to Estimate Savings

Conceptually, determining energy savings involves comparing baseline energy consumption (i.e., energy usage before the program caused a given measure to be installed or implemented) to post-implementation[1] energy consumption. However, estimating savings by simply subtracting post-implementation energy use from baseline energy use does not account for the impacts of other factors such as differences in weather or occupancy. Adjustments must be made for factors such as weather and other usage factors. In general terms then:

Savings = (Baseline energy use) - (Post-installation energy use) + Adjustments

The "adjustments" term brings energy use in the two time periods to the same set of conditions; adjustments are generally made to restate baseline consumption under post-retrofit conditions.

[1] "Post-implementation may" also be referred to as "post-installation."

Choosing an approach for calculating estimates of energy savings and demand reductions for program efforts is an important consideration in planning the M&V activities for a program. Following the taxonomy presented in the *Energy Efficiency Program Impact Evaluation Guide*, there are three major approaches for calculating estimates of energy savings and demand reductions.

- A site-specific M&V approach involves (1) selecting a representative sample of customers or sites that participated in a program; (2) determining the savings for each customer or site in the sample, usually by using one or more of M&V Options defined in the International Performance Measurement and Verification Protocol ("IPMVP"); and (3) applying the results of estimating the savings for the sample to the entire population in the program. The IPMVP Options that can be used are summarized in Table DS-60. Full descriptions of these Options are provided in *IPMVP Volume 1, Concepts and Options for Determining Energy and Water Savings*.

- A deemed savings approach involves using stipulated savings for energy conservation measures for which savings values are well-known and documented. For example, this approach may be acceptable for lighting retrofits for customers' spaces (e.g., offices) where there is general agreement on the hours of use for such spaces.

- A large-scale data analysis approach involves estimating energy savings and demand reductions by applying one or more statistical methods to measured energy consumption – which is typically utility billing data or interval meter data for participating customers – and independent variable data. This approach usually (a) involves analysis of a census of program sites (rather than a sample) and (b) does not involve onsite data collection for model calibration. However, a sample of customers or sites may be selected and visited to confirm that the energy conservation measures were properly installed and are still operating.

Table DS-60:
IPMVP M&V Options

IPMVP Option	How Savings Are Calculated
Option A: Retrofit Isolation – Key Parameter Measurement Based on measured equipment performance, measured or stipulated operational factors, and annual verification of potential to perform	Engineering calculations using short-term measured data and stipulations
Option B: Retrofit Isolation – All Parameter Measurement Based on periodic or continuous measurements taken at the device or system level	Engineering calculations using measured data
Option C: Whole Facility Based on whole-building or facility level utility meter or sub-metered data adjusted for weather and / or other factors	Analysis of utility meter data
Option D: Calibrated Simulation Based on computer simulation of building or process	Compare pre and post simulation models with calibrated measured data

In choosing which approach to specify for estimating savings for a given program, the Companies' M&V contractor takes account of several factors:

- There are differences between residential and commercial/industrial energy efficiency programs in the numbers and characteristics of participants. Programs for residential customers usually have larger numbers of participants, who can be expected to show a fair degree of homogeneity. For such programs, the large-scale data analysis approach is often feasible and appropriate. Conversely, programs for commercial/industrial customers usually have smaller numbers of participants, and some of the customers who do participate can be relatively large with unique operations, making it difficult to perform meaningful statistical comparisons across participating customers. The site-specific M&V approach is therefore often more appropriate for commercial/industrial programs, with more reliance placed on using site-specific engineering analysis and end-use metering as methods to estimate savings.

- The magnitude of expected savings from a measure affect the choice of savings estimation approach, in that analysis of participating customers' energy consumption data may not be sufficient to detect savings of small magnitude.

- The number and complexity of the measures and technologies being promoted through a program is a factor in determining the savings estimation approach. For example, if multiple measures can be installed at a single customer site, there may be overlapping and/or interactive effects among the measures. Identifying the effects of individual measures therefore requires using a savings estimation approach that can account for the impact of interrelated measures.

- Costs associated with the different approaches are different and therefore are also considered in choosing the savings estimation approach.

More than one method of estimating savings may be used for a program. For example, suppose large-scale data analysis may be chosen as the primary approach for estimating savings for a given program. However, it may also be appropriate to select a sample of customers from the program to perform site-specific M&V. Employing more than one method can potentially improve the accuracy of the savings estimation.

Choosing Participant Samples for M&V Activities

The M&V work to assess the savings impacts of the energy efficiency programs is performed under a budget constraint that creates the need for a trade-off between measurement accuracy and statistical precision. That is, within a given budget collecting more data, or more detailed data, to provide greater accuracy of measurement for individual sites may mean collecting data for fewer sites, thus decreasing the statistical precision of the results. Accordingly, in considering the sampling requirements for each program, the M&V contractor considers sampling approaches that balance these measurement and statistical considerations.

It is normal in conducting M&V of energy efficiency programs to use statistical sampling techniques to limit data collection and analysis to a sample (i.e., a relatively small subset) of the program population. Examples of statistical sampling approaches include the following methods:

- Census

- Simple Random Sampling

- Stratified Random Sampling

The choice of a statistical sampling approach depends on the characteristics of the energy savings for customers participating in the program, the uncertainty about these savings, and the variability of energy savings estimates. To illustrate the role of these factors, consider the simple random sampling approach. For this approach, the following equations are used to determine the sample size:

$$n_0 = \frac{z^2 cv(y)^2}{p^2}$$

$$n = n_0 \left(\frac{1}{1 + \frac{n_0}{N}} \right)$$

where:

n is the required sample size;

z is the abscissa of the standard normal curve for a specified level of confidence (e.g., 1.645 for 90 percent confidence level);

p is the required precision level (e.g., 10 percent);

cv(y) is the coefficient of variation for the variable to be estimated (e.g., hours of use); and

N is the total population size.

The second equation applies a finite population correction factor to determine final sample size when n_0/N is greater than 10 percent.

For some types of programs, particularly those that are targeted at commercial and industrial customers and facilities, it is often found that a small number of sites account for a large percentage of total program savings. In such cases, stratified random sampling can be more appropriate. For example, one effective sampling plan is to select sites with large savings with certainty and to take a probability (e.g., simple random) sample of the other sites that participated in the program.

The sampling approach also needs to take into consideration that the M&V effort will be occurring in real time while programs are being implemented. Sites participating in a program will be accumulating over time as a program is implemented. The sampling plan is therefore designed to have a predetermined sample size requirement for achieving certain analytical goals, but with the expectation that adjustments to the sampling plan will occur over time as data for additional participants become available.

Sample selection is thus spread over the entire implementation period. A near real-time process is used whereby a portion of the sample is selected each quarter (or more frequently for a DSM program with a large population of participants) as participants accumulate in the program. The information used for making this selection is developed from tracking system data that the Companies and their implementation contractors maintain for the programs. Participants are sampled as they become available. The progress of this sample selection process is monitored by looking at the additions to the participant population, then comparing cumulative population totals and cumulative sample totals to the corresponding values that were predicted by the initial sampling analysis. If appropriate, the sampling rates are adjusted to accommodate major changes in the size or characteristics of a program population.

M&V sampling protocols are designed to achieve program-level statistical precision of ±10 percent at the 90 percent confidence level (also called “90/10 confidence”).

The M&V contractor may achieve better than 90/10 confidence by oversampling, which is not an unusual occurrence for a stratified random sampling approach in which real-time M&V efforts cause sampling to be concurrent with program implementation. In other words, given that program participation accumulates concurrent with ongoing M&V sampling, the final sampling frame will inevitably differ from the original M&V sampling plan. Knowing in advance that the final sampling frame will differ from the original sampling plan, it is prudent for the M&V contractor to oversample to minimize the possibility that final statistical precision could fall short of the 90/10 confidence requirement.

The M&V contractor can also achieve better than 90/10 confidence by analyzing program data for a census of participants. The census (in lieu of sampling) is applicable only for programs for which the large-scale data analysis approach is the most efficient and cost-effective M&V approach. When a census is appropriate, it provides significantly better statistical precision than ±10 percent at the 90 percent confidence level. That is, to evaluate a census of participants is to evaluate the whole population of participants, whereas sampling is a statistical construct through which the M&V contractor selects and analyzes program results for a subset of participants that are determined to be representative of the whole population of participants.

Preparing Program-Specific M&V Plans

For each energy efficiency program, the M&V contractor prepares an M&V Plan that contains details on the following:

- What will be done and when it will be done (schedule);
- How performance of energy conservation measures, behavioral measures, demand response measures, and other measures implemented through program activities will be measured and verified, and who will conduct these M&V activities;
- Specifications for statistically valid and cost-effective sample sizes;
- How the energy savings and load impacts will be calculated; and
- How M&V will be adjusted to account for variables.

Performing M&V Activities

The activities that are involved in performing the M&V work for a program will depend on which approach to estimating savings is chosen, be it the Site-Specific M&V Approach or the Large-Scale Data Analysis Approach.

M&V Activities with Site-Specific M&V Approach

For programs where the site-specific M&V approach is used, the following activities are performed at each customer site that is in the sample selected for the program.

- *Determine the IPMVP Option specific to the site*. This determination may be made through a site inspection; stipulations by the evaluator; program value of the Energy Conservation Measure (ECM); the expectations of desired confidence and accuracy; and site-specific factors such as ECM complexity, type of ECM technologies involved, and ECM interrelated or interactive effects.

- *Perform a Pre-Installation Site Survey*. When feasible, a pre-installation site survey is performed to establish the baseline and to identify and document physical and operating characteristics that will affect M&V. This step may include pre-installation monitoring to establish the baseline.

- *Develop a Site-Specific M&V Plan*. The information collected during the pre-installation site survey is used to develop a site-specific M&V plan. The M&V plan addresses the site-specific nature of the following elements:

    - Overview of chosen IPMVP Option;
    - Specification of approach to calculating savings;
    - Identification of corresponding variables and specification of assumptions;
    - Identification of data sources or collection techniques or both,
    - Specification of data collection (i.e., sampling, site inspection, and monitoring plan), if required; and
    - Identification and resolution of any other M&V issues.

- *Conduct Pre-Installation M&V Activities.* If required, metering activities are conducted in accordance with the site-specific M&V plan. Baseline metering or a pre-installation survey is conducted for the time interval needed to acquire data on the operating conditions of affected systems.

- *Conduct Post-Installation M&V Activities.* Upon completion of the program installation, a post-installation survey is conducted along with any required post-installation metering. As identified in the M&V Plan for the site, post-installation metering may be conducted for the time interval needed to acquire data on the operating conditions of affected systems.

- *Prepare Post-Installation Report.* A post-installation report is prepared that includes the following:

  - Pre-installation survey information;
  - Post-installation survey information;
  - Metering data; and
  - Estimates of actual energy savings achieved, both on an annual basis and on a first-year or partial-year basis for energy savings that occurs during the calendar year in which the subject ECMs were installed.

After the M&V work has been accomplished for all sites in the sample for a program, a Gross Realization Rate ("GRR") is calculated to determine the energy savings (kWh) and peak demand reduction (kW) for the entire population of sites participating in the program for the given year. The GRR is defined as the ratio of the sum of the savings from the M&V sample to the sum of the ex-ante expected savings that were recorded in the program tracking database for the same sample.

Essentially, the GRR is used in an application of ratio estimation to calculate an estimate of total program savings.[2] The following formula is used to make the calculation:

$$\text{Estimated Project Savings} = \left(\frac{\sum_{\text{sample}} \text{Achieved Savings}_i}{\sum_{\text{sample}} \text{Expected Savings}_i} \right) \sum_{\text{Population}} \text{Expected Savings}_i$$

where:

Achieved Savings_i is an estimate calculated for each site in the M&V sample;

Expected Savings_i is the ex-ante expected savings for each site as recorded in the tracking database for the program; and

GRR is given by the term in brackets.

M&V Activities with Large-Scale Data Analysis Approach

A Large-Scale Data Analysis approach may be used for some programs. With this approach, regression analysis is applied to energy consumption data for participants in the program. The energy consumption data may be monthly billing data or interval meter data obtained from the

[2] For a discussion of the ratio estimation approach, see Cochran, W.G. *Sampling Techniques, 3rd Ed.*, John Wiley & Sons, 1977, Chapter 6.

Companies' customer account records. The monthly billing data or interval meter data are pre-processed to ensure that all needed data are identified and included in the analysis. Data for each participant are screened to identify anomalous observations that may incorrectly bias the estimates of average behavior.

After the monthly billing data or interval meter data for each participant in a program have been cleaned and verified, a regression analysis is used that will allow normalizing the meter data for the effects of weather and other conditions that may differ between the baseline period and the participation period. The following equation illustrates the general formulation for the regression analysis.

$$AEC_t = \beta_0 + \beta_1 HDD_t + \beta_2 CDD_t + \beta_3 EP_t + \beta_4 POST + \beta_5 POSTHDD_t + \beta_6 POSTCDD_t + E_t$$

where:

AEC_t is average daily (or hourly) electricity use for billing period t for the site (determined by dividing billing period electricity usage by number of days in billing period);

HDD_t is the average daily heating degree days for billing period t for the site (heating degree hours may be used in place of HDD);

CDD_t is the average daily cooling degree days for billing period t for the site (cooling degree hours may be used in place of CDD);

EP_t is the price of electricity for billing period t;

POST is a binary (0-1) variable with a value of 1 for post-participation months;

$POSTHDD_t$ is an interaction term between POST and HDD;

$POSTCDD_t$ is an interaction term between POST and CDD;

β_0 is the intercept term;

β_1 is a coefficient showing the change in electricity use that occurs for a change in the HDD variable;

β_2 is a coefficient showing the change in electricity use that occurs for a change in the CDD variable;

β_3 is a coefficient showing the change in electricity use that occurs with a change in the price of electricity;

β_4 is a coefficient showing the change in electricity use after participation in the program;

β_5 is a coefficient showing the change in electricity use that occurs for a change in the heating degree day variable after participation in the program;

β_6 is a coefficient showing the change in electricity use that occurs for a change in the cooling degree day variable after participation in the program; and

E_t is an error term.

Time-series regression techniques are applied to the electricity usage data for each participant to estimate the coefficient values. For the baseline period, up to 24 months of data will be used. All available monthly data for the post-participation period will be used for up to 36 months. Two types of regression analysis are applied for each site.

- First, the data for each site are used individually in single equation regression estimation. Because of the time dimension in the billing data for each site, there may be autocorrelation in such data, and techniques for correcting for such autocorrelation are incorporated into the regression analysis.

- Second, the data for all sites are used in combination in a "Seemingly Unrelated Regression" analysis.[3] This technique allows account to be taken of possible correlations among the regression error terms across sites, thereby improving the efficiency with which coefficients are estimated for the individual sites.

The billing data for the participants in a program are also analyzed using a least square dummy variable ("LSDV") regression analysis applied to a "pooled" data set.[4] In this approach, a binary dummy variable is created for participants in the analysis sample, and the full set of these dummy variables is included in the regression analysis. This covariance approach has the advantage of bringing all sample information together in a consistent manner for estimation purposes.

For all estimation procedures, standard statistical tests and regression diagnostics are used to evaluate the performance of the models and to screen regression models for implausible results. The statistical tests and diagnostics include evaluating the t-statistics for estimated coefficients and the R^2 for equation fit and examining residuals from the fitted models.

Once the best model and data set for a site is determined, that model and data are used to calculate "weather normalized" baseline and post-participation electricity use for program participants. This weather normalization is performed so that the effects of changes in weather conditions are not

[3] See Kmenta, J., *Elements of Econometrics*, 2nd Edition, Macmillan Publishing Company, 1986, pp. 635-648.

[4] For a discussion of this approach, *see* Kmenta, J., *Elements of Econometrics*, 2nd Edition, Macmillan Publishing Company, 1986, pp. 630-635.

included in the estimates of savings. To calculate baseline and post-participation electricity usage that are normalized for possible differences in weather conditions, long-run averages of the climatological variables (HDD, CDD) and the appropriate values for the binary variable are inserted into the chosen model. The long-run weather data will be for the area in which the participants are located and may be taken from data supplied by the National Oceanic and Atmospheric Administration ("NOAA"). Electricity savings for program participants are calculated as the difference between the baseline and post-participation weather-normalized estimates of electricity use.

Documenting M&V Activities

For each energy efficiency program, the Companies' M&V contractor prepares an annual M&V report. Each report includes the following:

- Executive summary
- Background or introduction
- Discussion of approaches and methods used for sampling and calculating estimates of energy savings and demand reductions
- Presentation and discussion of impact evaluation findings
- Recommendations
- Appendices (which may include a bibliography and reference list, supporting documentation and data source references and documentation of any electronic databases).

Overall Approach for Evaluation Activities

For some programs, the Companies' M&V contractor will conduct evaluations that are aimed at determining what the effects of a program were, why those effects occurred, and what can be done to improve existing programs and select future ones. The evaluation effort for a program has three main aspects.

- To evaluate the energy savings algorithms and criteria that the Companies used in developing the program and deciding what measures to include.
- To assess how effective the program has been and what changes can be made to improve its effectiveness.
- To assess and evaluate the procedures for administering and managing the program.

Evaluate Energy Savings Algorithms and Criteria

As a first aspect of the evaluation of a program, the M&V contractor will evaluate the energy savings algorithms and criteria that the Companies' used in developing the program and deciding what measures to include. This aspect of the program evaluation includes the following:

- Making recommendations on how to improve the methods used to estimate electric demand and electric consumption savings;
- Recommending modifications or updates to the energy-savings assumptions;
- Evaluating the validity of the energy efficiency measures and technologies for which the Companies offer incentives through the program; and
- Using findings from the M&V work on the program to identify and present training opportunities for the Companies' program staff.

The M&V contractor reviews the analyses and calculations that were used to develop the deemed or stipulated savings values for the measures that are being promoted through the program and evaluates the analysis for each type of measure according to the degree to which the savings calculations are supported and defensible and documentation is adequate. This review considers (1) whether the methodology used for the calculation was appropriate, (2) whether assumptions used were reasonable and appropriate, and (3) whether savings calculations were performed correctly. The M&V contractor identifies any deficiencies pertaining to the reasonableness of the given assumptions, the adequacy of the given documentation, and the appropriateness of the given methodology and prepares recommendations to the Companies regarding changes to the savings calculations or values.

Assessing Program Effectiveness

As a second aspect of evaluating a program, the M&V contractor will assess how effective the program has been and what changes can be made to improve the effectiveness. The work related to this aspect of the evaluation includes:

- Investigating participation levels for the program and making recommendations on how to improve participation levels;
- Evaluating the overall effectiveness of the program in terms of reducing electric demand and electric savings; and
- Comparing the program to similar programs offered by other utilities in terms of validity of electric energy savings and program management.

To investigate participation levels for the program, the M&V contractor conducts a quantitative analysis using data that the implementation contractor collects and uploads to the Companies' DSM Central database. These data will be used to develop various types of quantitative indicators of how participation in the program varies according to different factors. The M&V contractor also conducts interviews with trade allies, both those who are participating in the program and those who are not. These interviews are used to identify factors that are important in affecting the decisions of trade allies to participate in the program and to promote the energy efficiency measures and technologies being offered through the program.

Information obtained from the analysis of tracking data and from the interviews with trade allies is used to assess the effectiveness of marketing strategies and messaging for the program and of the communication efforts among the various parties involved (i.e., the Companies' program staff, implementation contractor staff, and trade allies). The goal is to identify areas in which communication and outreach efforts can be enhanced and more properly targeted to improve levels of participation in the program. The assessment determines the extent to which marketing, outreach, and communication efforts are reaching the desired audience and desired sectors. In addition, the information is used to assess the structure and effectiveness of allocating responsibilities between the Companies and the implementation contractor. This analysis provides information on where future opportunities may exist and whether the program is effectively targeting appropriate decision-makers. The workings of the program are also assessed by comparing the program to similar programs offered by other entities.

Assess and Evaluate Procedures for Administering and Managing Programs

A third aspect of the evaluation effort is to assess and evaluate administrative procedures and management for a program. The work effort for this aspect includes the following:

- Evaluating the administrative process for the program and making recommendations on how to improve the administration and management of the program;

- Evaluating the administrative costs incurred to manage the program and making recommendations on how to improve the costs of implementing and managing the program;

- Investigating whether the program as offered was successful by evaluating the reactions and expectations of the marketplace and Commission.

The M&V contractor obtains information for assessing the management of the program by (1) reviewing program documentation and (2) interviewing the Companies' staff and their implementation contractor. The interviews with trade allies also provide information for this aspect of the evaluation.

- The document and database reviews are used to evaluate how well data collection and storage procedures are serving the information needs of staff and other involved parties. This effort includes gathering and analyzing tracking system data and conducting interviews concerning the operation of the tracking system.

- The Companies' program staff and implementation contractor staff are interviewed, and the information gathered through these interviews is used to compare actual program implementation and delivery to the program plan, and to identify areas in which the program is working well and areas where changes could be made to improve the program's efficiency and efficacy. The information is also used to assess the effectiveness of internal program communications and communications between program staff and trade allies. This assessment will include reviewing the quality control (QC) and quality assurance (QA) processes that are currently in place and make recommendations for improvements.

The M&V contractor uses the information gathered through the document review and the interviews to describe the "program logic" for the program. The program logic model is used to accomplish the following:

- Summarizing the key elements of the program process;
- Explaining the rationale behind process activities;
- Clarifying the difference between the activities and the intended outcomes of the processes; and
- Showing the cause-and-effect relationships between activities and outcomes (i.e., which activities are expected to lead to which outcomes).

The logic model for the program is used to identify gaps in the program, to develop measures for assessing progress, to identify critical issues that need attention, and to communicate with stakeholders about the program and their outcomes. Developing the logic model and using it to evaluate program processes allows important issues pertaining to the administration and success of the program to be identified systematically. Essentially, the logic model allows structuring the evaluation work to show what the process is supposed to achieve, with whom and why.

The M&V contractor also uses the logic model for a program to address how its procedures and processes compare in structure and effectiveness to those used in other programs. The program logic model is used to determine where the processes for the program differ from those of other programs, and where resources or activities employed by other programs can be utilized to improve the subject program's processes. The bottom line for evaluating the process is to determine what important outcomes the process has produced (i.e., what results/changes have occurred because of the processes utilized by the subject program).

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California Public Utilities Commission. *The California Evaluation Framework.* June 2004.[10]

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[6] IPMVP Volume 1 is available at www.eeperformance.org/uploads/8/6/5/0/8650231/ipmvp_volume_i__2012.pdf or available through a subscription at evo-world.com.

[7] The Energy Efficiency Program Impact Evaluation Guide is available at the following location: www4.eere.energy.gov/seeaction/system/files/documents/emv_ee_program_impact_guide_0.pdf

[8] The protocols are available at www.energy.gov/eere/about-us/ump-protocols.

[9] This NSPM document is available at nationalefficiencyscreening.org/wp-content/uploads/2017/05/NSPM_May-2017_final.pdf.

[10] This document is available at www.calmac.org/publications/California_Evaluation_Framework_June_2004.pdf.

DSM-5

Energy Education Program
NV Energy – Southern Nevada (NPC)
Program Year 2017

Measurement and Verification Report
March 30, 2018

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TABLE OF CONTENTS

1 EXECUTIVE SUMMARY

This measurement and verification ("M&V") report addresses the evaluation of NV Energy's 2017 Energy Education Program in the southern Nevada service territory ("Nevada Power Company" or "NPC"). The focus of the evaluation is to depict the implementation and outcomes associated with the 2017 Energy Education program's three main components, which are:

- Residential Customer Education
- Building Industry Support
- Commercial Customer Education

The major conclusions and recommendations for each component of the 2017 Energy Education program are presented in this chapter. Table 1-1 provides a summary of program goals and results.

Table 1-1. Summary Results, Energy Education Program

Energy Education Program Components	*Program Goal (Count of Customers)*	*Count of Customers Educated*	*Percentage of Program Activity*	*Percentage of Goal per Component*
Residential Customer Education	30,000	69,740	89%	232%
Building Industry Support	2,250	3,967	5%	176%
Commercial Customer Education	350	4,816	6%	1376%
Total	**32,600**	**78,523**	**100%**	**241%**

1.1 Residential Customer Education Conclusions and Recommendations

Residential Customer Education engaged in education activities with 69,740 customers, achieving 232 percent of the goal of educating 30,000 customers. Table 1-2 shows the count of customers educated by each type of Residential Customer Education activity.

Table 1-2. Summary Results, Residential Customer Education

Residential Customer Education Activities	*Count of Customers Educated*
Energy Efficiency Booth Visitors, Presentations	28,788
Senior 100 Project	174
National Theatre for Children Live Performance Program – students educated	29,997
National Theatre for Children Live Performance Program – teachers educated	1,395
EnergySmart Educator – teachers educated	28
EnergySmart Educator – students educated	9,358
Total	**69,740**

ADM Associates, Inc. (“ADM”), NV Energy’s independent third-party M&V contractor, found that the teachers who participated in the EnergySmart Educator Program (“ESE”) training reported a positive perception of the ESE training content and the ESE training program overall. Teachers who utilized the Green Boxes and ESE curriculum reported high levels of engagement from students.

Going forward, with respect to 2018 Residential Customer Education, ADM recommends:

- NVE should continue monthly DSM Central updates for Residential Customer Education.
- NVE should share monthly updates for Residential Customer Education event calendars
- For the EnergySmart Educator activity, NV Energy should consider increasing the supply of Green Boxes.

1.2 Building Industry Support Conclusions and Recommendations

The Building Industry Support component resulted in education for 3,967 industry professionals, achieving 176 percent of the program goal of educating 2,250 industry professionals. Table 1-3 shows the count of industry professionals educated by each type of Building Industry Support activity; the majority of industry professionals received education through the Building Science e-Book Download.

Table 1-3. Summary Results, Building Industry Support

Building Industry Support Activities	***Count of Customers Educated***
In-person Training	130
Booth Event	348
Webinar	1,158
Building Science e-Book Download	2,274
The Homeowners’ Guide e-Book Download	57
Total	**3,967**

Survey data collected from the participants indicated that building industry professionals were satisfied with the Webinar Training provided by Green Builder Media in support of Nevada Power Company.

Going forward, with respect to 2018 Building Industry Support, ADM recommends:

- NV Energy and Green Building Media should consider reaching out to additional customers who may benefit from the Webinar training activity.

1.3 Commercial Customer Education Conclusions and Recommendations

The Commercial Customer Education component resulted in education for 4,816 commercial customers, achieving 1376 percent of the program goal of educating 350 commercial customers. Table 1-4 depicts customer counts per activity for Commercial Customer Education.

Table 1-4. Summary Results, Commercial Customer Education

Commercial Customer Education Activities	*Count of Events*	*Count of Customers Educated*
Commercial Energy Efficiency Presentations and Booth Events	29	3,155
AEE Lunch-and-Learn Events	6	202
Energy Savings Kits	1	1,459
Total	**36**	**4,816**

Customers provided generally positive ratings and comments regarding the 2017 Commercial Customer Education activities.

Going forward, with respect to 2018 Commercial Customer Education, ADM recommends:

- NV Energy should augment the Association of Energy Engineers ("AEE") Lunch-and-Learn activity by distributing the presentation slides to attendees.

1.4 Process-Related Recommendations

Timely and frequent feedback from the independent third-party M&V contractor may help NV Energy implement real-time improvements or course corrections related to Energy Education. During 2018, ADM plans to provide real-time feedback via quarterly M&V update memos which will be provided to NV Energy within two weeks after the end of each of the first three calendar quarters. Quarterly M&V update memos will provide quantitative and qualitative documentation of Energy Education activities occurring throughout 2018.

2 PROGRAM BACKGROUND

The Energy Education Program is designed to educate customers regarding various strategies, technologies and opportunities for significantly increasing the efficiency of customers' electric loads[1]. The overall goal of the program is to empower NV Energy's customers to better manage their energy use and reduce their energy bills in their homes and businesses.

This chapter provides a brief description of the program design and activity during 2017 for each component of the 2017 Energy Education Program.

2.1 Residential Customer Education

In 2017, Residential Customer Education focused on providing energy efficiency education through four efforts:

- Presentations at community events and media, as well as distributing literature packets at community events
- The EnergySmart Educator Program
- The National Theatre for Children Live Performance Program
- The Senior 100 Project

The community presentations and events effort focused on delivering conservation literature and concepts to NV Energy's customers through personal interaction.

The EnergySmart Educator Program focused on training teachers to supplement their teaching efforts with materials focused on energy and related topics. Participating teachers were provided access to Green Boxes that contained all of the necessary lessons and materials to implement the EnergySmart Educator training in their classrooms.

2.2 Building Industry Support

In 2017, Building Industry Support was designed to present the value of energy efficiency concepts in new construction and remodels to realtors, lenders, contractors, and builders in southern Nevada. Building Industry Support provided building industry professionals energy efficiency education through five activities:

- In-person Training
- Booth Event

[1] Lighting and air conditioning are examples of significant electric loads that can become more efficient.

- Webinar
- Building Science e-Book Download
- The Homeowners' Guide e-Book Download

NV Energy representatives leveraged these activities to provide building industry professionals valuable information regarding the benefits of incorporating energy efficiency measures in new construction as well as existing homes and commercial properties. While interacting with building industry professionals, NVE representatives also informed and reminded them regarding NVE's demand side management programs and resources.

2.3 Commercial Customer Education

In 2017, Commercial Customer Education provided technical training and energy efficiency training to small and medium business owners and facility operators through three activities:

- Energy efficiency presentations and booth events for commercial customers
- AEE Lunch-and-Learn events
- Energy Savings Kits

NV Energy representatives presented energy efficiency information and introduced NV Energy's demand side management programs at presentations to groups of commercial customers. The goal of the presentations was to help customers identify energy efficiency opportunities in their businesses and to highlight NV Energy's energy efficiency resources available to business owners.

The Association of Energy Engineers (AEE) Lunch-and-Learn events featured expert speakers who presented to commercial customers on topics for improving building energy management and equipment upgrades to achieve energy efficiency. The goal of the AEE Lunch-and-Learn events was to provide commercial customers the basic information to be able to identify potential energy efficiency opportunities in their processes and buildings.

Energy Savings Kits are an additional measure that NV Energy utilized in 2017 to engage with and educate 1,459 commercial customers – specifically, small and medium-sized businesses. The Energy Savings Kits, which featured the PowerShift brand, included four 15W Energy Star LEDs, one Energy Star flood LED, one eight-outlet advanced power strip, one low-flow faucet aerator, one section of water pipe insulation, and one occupancy sensor.

3 RESIDENTIAL CUSTOMER EDUCATION

NV Energy promoted electric energy conservation awareness through Residential Customer Education. NVE accomplished this by providing information at community events such as Earth Day celebrations, community fairs, and events sponsored by community organizations including hotels and schools. At Residential Customer Education events, NVE representatives distributed brochures at table displays, while also providing information during personal interactions and through presentations on energy conservation topics. NVE also engaged in media interviews

In addition, NV Energy sponsored and supported the EnergySmart Educator Program that provided southern Nevada teaching professionals with training on how to present energy efficiency in the classroom. Curriculum and supporting materials were provided in Green Boxes that were loaned to teachers for use in the classrooms.

In 2017, Residential Customer Education aimed to deliver energy-efficiency education to 30,000 customers. The actual count of customers educated was 69,740 customers, 232 percent of goal. Table 3-1 shows Residential Customer Education activities and the counts of customers educated through these activities.

Table 3-1. Summary Results, Residential Customer Education

Residential Customer Education Activities	***Count of Customers Educated***
Energy Efficiency Booth Visitors, Presentations	28,788
Senior 100 Project	174
National Theatre for Children Live Performance Program – students educated	29,997
National Theatre for Children Live Performance Program – teachers educated	1,395
EnergySmart Educator – teachers educated	28
EnergySmart Educator – students educated	9,358
Total	**69,740**

3.1 Residential Customer Education Events and Presentations

NV Energy activities at residential customer education events included:

- Providing table displays and interacting with customers;
- Distributing bags containing literature on energy conservation (e.g., conservation tips and information about energy conservation programs); and
- Delivering presentations on energy conservation topics.

3.1.1 Community Outreach Events and Presentations

In 2017, NV Energy representatives participated in 78 community outreach events in southern Nevada. As shown in Table 3-2, these community outreach events included booth events (55 percent of event activities), presentations, trainings Senior 100 Project and National Theatre for Children (45 percent of event activities). National Theatre for Children performed in 51 schools in southern Nevada and educated 1,395 teachers and 29,997 students.

Table 3-2. Residential Customer Education Activities in 2017

Indicator	***Booth Event***	***Presentation, Training, Senior 100 Project and National Theatre for Children***	***Total Activities***
Count of Events	43	35	78
Percent of Total Activities	55%	45%	100%

Table 3-3 provides details on NV Energy's dissemination of energy efficiency information through Residential Customer Education activities in 2017. Information was disseminated to 69,740 customers through event activities.

Table 3-3. Customers Educated through 2017 Residential Customer Education Activities

Indicator	***Booth Event***	***Presentation, Training, Senior 100 Project and National Theater for Children***	***Total Count of Customers Educated***
Count of Customers Educated	19,339	50,401	69,740
Percent of Total Activities	25%	75%	100%

The Energy Education Program tracked key customer segments targeted by Residential Customer Education events in 2017. Table 3-4 summarizes the data from NV Energy's outreach tracking system by identifying the number and percentage of outreach events that focused on particular customer segments and by illustrating the typical kinds of outreach events conducted for a particular customer segment.[2]

[2] The outreach tracking system codes the primary customer segment targeted by a given outreach event; the system codes up to two customer segments per event. The tracking system does not include counts of participants.

Table 3-4. Community Outreach Events by Customer Segment in 2017 (n = 78[3])

Customer Segment	***Number of Events***	***Percent of Events***	***Illustrative Outreach Event***
General Population	55	71%	Zappos Earth Day Event
Latino	4	5%	Copa Latina
African Americans	0	0%	-
Asian	0	0%	Asian Community Resource Center Health Fair
Green	12	15%	Green Fest
Senior	9	12%	TLC Care Center
Teachers/Students	17	22%	NTC- Spring Tour
Low Income	2	3%	East Valley Family Services
Onsite Assessment	1	1%	Senior 100 Project

3.1.2 Residential Customer Education Survey Results

ADM collected survey responses from 70 customers that visited NV Energy's exhibits at eight selected community events.

The top three reasons that customers visited NV Energy exhibits at community outreach events:

1. To learn ways to save energy
2. The NV Energy exhibit looked interesting
3. To see what NV Energy was giving away at the exhibit

Highlighted below are the major survey findings:

- Southern Nevada survey respondents reported that the NV Energy programs or services that they would be most interested in participating in would be High Efficiency Air Conditioning Program (33.3 percent).
- Other programs that respondents would like to participate in were Smart Thermostat Program (31.7 percent), Home Energy Assessments (22.2 percent), Energy Education Opportunities (17.5 percent), Equal Payment Plan Program (14.3 percent), My Account Online Tools (9.5 percent).
- 21.3 percent of the southern Nevada survey participants indicated that they would like to be contacted by NV Energy with additional information on how to participate in their energy saving and demand response programs.
- When asked, "What can NV Energy do to provide better service to you," the only significant response was, "more solar options and incentives"?

[3] Some events are associated with multiple customer segments.

Table 3-5 presents agreement with the two satisfaction questions included in the Residential Customer Education survey. Customer satisfaction was evaluated using the 11-point Likert scale, which measures on a continuum from strong dissatisfaction (0) to strong satisfaction (10).

Table 3-5. Residential Customer Education Participant Survey Summary Statistics

Survey Questions	***Mean***	***90% Confidence Interval***	***N***
How satisfied were you with the way that your needs were addressed by visiting NV Energy's exhibit?	8.3	7.8-8.7	65
How satisfied were you that you left today's exhibit knowing more about NV Energy's incentives for energy efficiency and other customer programs and services?	8.4	7.9-8.9	61

Note: Scale anchor points were as follows: strong dissatisfaction (0) to strong satisfaction (10) with a Neutral midpoint of 5 on the 11-point scale.

Responses to the satisfaction questions show that customers were highly satisfied that their needs were being addressed when visiting NV Energy's exhibits as indicated by a mean score of 8.3. Additionally, customers were highly satisfied that they left NV Energy's exhibits knowing more about NV Energy's incentives for energy efficiency and other customer programs and services as indicated by a mean score of 8.4.

3.2 EnergySmart Educator Program

In 2017, NV Energy, working with the Desert Research Institute and GreenPower, provided financial support to the EnergySmart Educator ("ESE") program that supplied energy efficiency training and curriculum to 28 southern Nevada science teachers and 9,358 students.

ADM delivered a survey to teachers who participated in the ESE training.[4] The participant survey was designed to capture teachers' energy efficiency actions and curriculum prior to participating in the ESE training and teachers' views on the implementation of the Green Box curriculum. To present meaningful results, the aggregated survey data for 11 north and south ESE survey respondents is presented here.

3.2.1 Teacher Impacts

Table 3-6 presents the distribution of ways that teachers found out about the ESE training. The top channel for teachers becoming aware of the ESE training was "recommended to me by a colleague."

[4] The survey is provided in Appendix A.

Table 3-6. Program Awareness (n=11)

Program Awareness Channels	***Teacher %***
ESE training was recommended to me by a colleague	45.5
ESE training was recommended to me by a friend	36.4
I attended the EnergyWise Educator training last year	9.1
Desert Research Institute website	9.1

Table 3-7 presents the distribution of grade level taught by teachers who completed the survey.

Table 3-7. Grade Taught (n=11)

Grade Taught	***Teacher %***
High School: 9th through 12th grade	9.1
Middle School: 6th through 8th grade	18.2
Elementary: 3rd through 5th grade	27.3
Elementary: kindergarten through 2nd grade	27.3
Other	18.2

Table 3-8 shows how teachers ranked the benefits of the ESE training. The highest-ranked benefit for the participating teachers related to providing 'ideas about other ways to teach about the environment.' Comments by teachers also indicated that the ESE training afforded them an opportunity to network with their peers and to enhance materials and lessons.

Table 3-8. Ranking of the Benefits to Teachers of the ESE Training (n=11)

Benefits	***Ranking***
Provided me ideas about other ways to teach about the environment	1
Helped my professional development	2
Improved my environmental education offerings to my classes	3
Easy to implement	4
My students have become more environmentally conscious	5
I have become more environmentally conscious	6

Of the teachers who responded to the participant survey, 27.3 percent reported instituting energy efficiency into their curriculum prior to their ESE participation. Table 3-9 depicts teachers' attitudes ***pre-ESE*** regarding the inclusion of energy efficiency into their curriculum.

Table 3-9. Prior to ESE Participation: Incorporation of Energy Efficiency Curriculum (n=11)

Pre-ESE Incorporation of Energy Efficiency	***Teacher %***
I actively incorporated energy efficiency topics into my curriculum and tried to find ways to save energy at home	27.3
I was aware of energy efficiency and related topics but it was not a point of emphasis for me	72.7

Table 3-10 shows how teachers responded to the ESE training. Of the 11 teachers that reported their response to the ESE training, the most popular response (81.8 percent) to the ESE training was to find ways to include energy efficiency and related topics in their curriculum.

Table 3-10. Teacher Response to ESE Training (n=11)

Teacher Responses to ESE Training	***Teacher %***
Now, I find ways to include energy efficiency and related topics in my curriculum	81.8
I made changes to my behavior to save energy	54.5
I shared the information that I learned on NV Energy's residential and commercial energy saving programs with my family, friends, colleagues, and students	45.5
I made structural and/or equipment changes to my home such as installing more insulation or energy efficient lighting	9.1

More than half of the teachers reported finding ways to include energy efficiency and related topics in their curriculum in the ways shown in Table 3-11.

Table 3-11. Energy Efficiency Curriculum (n=11)

Energy Efficient Curriculum	***Teacher %***
Hands on activities	77.8
Behavioral reinforcement, e.g., designating a student to turn out lights	66.7
Lecture	44.4
Video presentation on energy efficiency	22.2
Energy efficiency project or homework	11.1
Other activity: will cover it next semester	11.1

Teachers reported participating in NV Energy DSM programs that they learned about during the ESE training e.g. LED Lighting Program, My Account Online tools, and the Smart Thermostat Program. Additionally, teachers reported sharing what they learned with family (80 percent), friends (80 percent), colleagues (80 percent), and students (80 percent).

3.2.2 GREEN BOX IMPLEMENTATION

Following are Participant Survey findings regarding teachers' utilization of Green Boxes:

- 36.4 percent of the teachers that responded to the participant survey checked out a Green Box during 2017.
- 57.1 percent of teachers who did not check out a Green Box during 2017 plan on checking out a Green Box during the next two years.
- 80 percent Teachers checked out Green Boxes that easily integrated into their curriculum and were most relevant to their students for practical application.
- 20 percent of the teachers that checked out a Green Box reported that the Green Box that they chose was the most appropriate for the grade that they teach.

3.2.3 STUDENT IMPACTS

Student impacts reported by teachers showed that:

- Students had a high level (75 percent) of engagement with the Green Box lessons.
- Students increased energy saving behavior such as turning off lights and conserving water.
- Students asked for more projects and lessons related to the environment and increased their discussion of energy efficiency and environmental changes.
- Students reported changes that they have made at home after going through the Green Box curriculum. (Changes included conserving water, turning off lights and appliances when not in use, recycling old appliances, and telling others about the Green Box curriculum as well as ways to reduce impacts on the environment.)

3.2.4 ENERGYSMART EDUCATOR PARTICIPANT SATISFACTION RESULTS

The teachers' responses to the satisfaction questions included in the ESE Participant Survey are shown in Table 3-12. Teacher responses were evaluated to measure attitudes following the ESE training using the 11-point Likert scale, which measures on a continuum from heavily negative (0) to heavily positive (10).

Table 3-12. EnergySmart Educators Summary Statistics: Teacher Satisfaction

Survey Questions	*Mean*	*90% Confidence Interval*	*N*
Please rate your overall satisfaction with the EnergySmart Educator training?	9.2	8.8-9.6	11
Please rate your satisfaction with the content of the EnergySmart Educator training?	9.5	9.1-9.9	11

Note: Scale anchor points were as follows: heavily negative attitudes (0) to heavily positive attitudes (10) with a Neutral midpoint of 5 on the 11-point scale.

Responses to the two questions on the survey that addressed satisfaction were all positive; thus, none of the teachers had a negative attitude towards NV Energy, the ESE training program, or the ESE content following the ESE training sessions. As can be seen in Table 3-12, Satisfaction with the ESE training and the presented content was heavily clustered on a rating of 10 with a slight leftward skew.

4 BUILDING INDUSTRY SUPPORT

In 2017, Building Industry Support activities focused on energy efficiency and Green Building practices education for builders in southern Nevada. Building Industry Support in southern Nevada delivered education through five types of educational activities:

- In-person Training
- Booth Event
- Webinar
- Building Science e-Book Download
- The Homeowners' Guidebook e-book Download

Table 4-1 shows the types of educational activities and respective counts of indusrty professionals who were educated through NVE's program activities. The goal of Building Industry Support was to educate 2,250 industry professionals. In 2017, Building Industry Support actually educated 3,967 industry professionals, achieving approximately 176 percent of goal.

Table 4-1. Summary Results, Building Industry Support

Building Industry Support Activities	***Count of Customers Educated***
In-person Training	130
Booth Event	348
Webinar	1,158
Building Science e-Book Download	2,274
The Homeowners' Guide e-Book Download	57
Total	**3,967**

4.1 Building Industry Support Survey Results

During 2017, NV Energy sponsored 19 educational events and provided educational activities to 3,967 home builders, home energy raters, and local building department officials as shown in Table 4-2.

Table 4-2. Summary Results, Building Industry Support Events

Training Event	***Professionals Educated***
Real Estate Expo	300
Webinar: Smart Home Evolution	428
Webinar: Beyond Net Zero	313
GBM Homeowner's Guide Distribution	57
Webinar: Code Update	110
IECC Las Vegas Training (Commercial)	53
IECC Las Vegas Training (Residential)	27
Building Science June/July E-book Download (South)	1,317
Financing Options for Commercial Energy Efficiency Projects	14
2015 IECC Code Workshop	11
Green Alliance Green Home Symposium	48
Home Energy Connection-Building Science Principals	12
Webinar: HERS Rating	135
Home Energy Connection-ITC Infrared Training Level 1 Certification	13
Webinar: Green Financing	101
Building Science November e-book (South)	957
Webinar: Energy Management Strategies	71
Total	**3,967**

Green Building Media cooperated with ADM and sent a survey questionnaire to a sample of customers who participated in Building Industry Support Events. ADM analyzed 98 surveys returned by NV Energy customers. The results of this analysis of the survey data are discussed in this section.

Highlighted below are the major survey findings:

- Respondents reported that the NV Energy programs or services that they would be most interested in participating in would be LED Lighting Program (68 percent) and High-Efficiency Air Conditioning Programs (53 percent).
- Respondents reported the energy efficiency topics that would like to learn about were Building Science (88 percent), Insulation (68 percent), Building above code (65 percent), Air Heating and Coding (65 percent), Windows and Doors (62 percent), Water Heating (59 percent), Roofing (46 percent), Appliances (37 percent), etc.
- 74 percent of respondents participated in Webinar training in 2017, 38 percent of them participated in Homeowners' Guidebook programs, 6 percent of them participated in In-person Training and 6 percent of them participated in Building Science Guidebook.

Table 4-3 presents agreement with the satisfaction question included in the Building Industry Support Survey. Customer satisfaction was evaluated using the 11-point Likert scale, which measures on a continuum from strong dissatisfaction (0) to strong satisfaction (10).

Table 4-3. Building Industry Support Summary Statistics: Customer Satisfaction

Survey Questions	***Mean***	***90% Confidence Interval***	***N***
Please rate your overall satisfaction with the In-person Training?	8.3	6.2-10.5	6
Please rate your satisfaction with the Webinar Training?	8.4	7.9-8.8	73
Please rate your satisfaction with the Homeowners' Guidebook?	8.3	7.6-8.9	38
Please rate your satisfaction with the Building Science Guidebook?	10	10-10	6

The table above shows that responses to the four satisfaction questions are all positive.

5 COMMERCIAL CUSTOMER EDUCATION

In 2017, Commercial Customer Education consisted of the following activities:

- Energy efficiency presentations and booth events
- AEE Lunch-and-Learn events
- Energy Savings Kits

In 2017, the goal of Commercial Customer Education was to educate 350 commercial customers. Commercial Customer Education actually educated 4,816 commercial customers directly through educational events, achieving 1376 percent of goal, as shown in Table 5-1.

Table 5-1. Summary Results, Commercial Customer Education

Commercial Customer Education Program Activity Components	*Count of Events*	*Count of Customers Educated*
Commercial Energy Efficiency Presentations and Booth Events	29	3,155
AEE Lunch-and-Learn Events	6	202
Energy Savings Kits	1	1,459
Total	**36**	**4,816**

5.1 Energy Efficiency Presentations and Booth Events to Commercial Customers Survey Results

During 2017, NV Energy sponsored 29 business community events that delivered energy efficiency training to 3,155 industry professionals. Thirty-five surveys were gathered from Energy Code Training events. The results of this analysis of the survey data are discussed in this section. Most of the participants received the Energy Code Training information through email.

Participant feedback regarding the Energy Code Training events was evaluated in Table 5-2 using the 11-point Likert scale, which measures on a continuum from 0, strong disagreement to 10, strong agreement.

Table 5-2. Energy Code Training Events Summary Statistics

Survey Questions	*Mean*	*90% Confidence Interval*	*N*
I gained valuable information today.	9.3	9.0-9.6	35
The trainer was knowledgeable.	9.7	9.5-9.9	35
The trainer communicated effectively.	9.7	9.5-9.9	35
I would recommend this training to a colleague.	9.5	9.3-9.7	35
I am likely to attend a future seminar.	9.6	9.4-9.8	35

Note: Scale anchor points were as follows: strong disagreement (0) to strong agreement (10) with a Neutral midpoint of 5 on the 11-point scale.

Responses to the satisfaction questions show that participants learned valuable and useful information and were satisfied with the trainer. Participants indicated that they would recommend this training to a colleague and that they are highly likely to attend future events.

5.2 Association of Energy Engineers Lunch-and-Learn Events

During 2017, NV Energy sponsored six Association of Energy Engineers ("AEE") Lunch-and-Learn events that delivered energy efficiency training to 202 commercial customers on the topics shown in Table 5-3.

Table 5-3. Summary Results, AEE Lunch-and-Learn Events

Lunch-and-Learn Topics	***Count of Customers Educated***
AEE Lunch and Learn	49
Commercial/AEE Lunch and Learn February (South)	16
Commercial/AEE Lunch and Learn March (South)	53
Commercial/AEE Lunch and Learn April (South)	13
AEE Lunch and Learn May (South)	29
AEE Lunch and Learn October (South)	42
Total	**202**

ADM sampled and analyzed 278 surveys collected from the AEE events and January Commercial Services Lunch and Learn (South) implemented by DNV-GL. All participants were invited to complete an event evaluation form, which yielded the following data. (The survey is included in this report as Appendix C.)

Participants learned about the AEE Lunch-and-Learn events training primarily through AEE email invitation. The top three reasons that participants attended the AEE events were in the order of overall rank:

1. The topic was relevant to the attendee or their firm
2. Professional development and networking
3. The event was sponsored (free)

Table 5-4 provides a description of participants' degree of agreement with the six satisfaction statements included in the AEE Lunch-and-Learn Participant Survey. Participant feedback was evaluated using the 11-point Likert scale, which measures on a continuum from strong disagreement (0) to strong agreement (10).

Table 5-4. AEE Lunch-and-Learn Participant Survey Summary Statistics

Survey Questions	***Mean***	***90% Confidence Interval***	***N***
I gained valuable information today.	8.7	8.5-8.9	277
I will use the information today to improve my business operations.	8.7	8.5-8.9	273
The trainer was knowledgeable.	9.3	9.2-9.4	274
The trainer communicated effectively.	9.2	9.0-9.3	275
I would recommend this training to a colleague.	9.0	8.8-9.2	274
I am likely to attend a future event.	9.2	9.1-9.3	273

Note: Scale anchor points were as follows: strong disagreement (0) to strong agreement (10) with a Neutral midpoint of 5 on the 11-point scale.

Responses to the satisfaction questions show that participants learned new energy efficiency information and were satisfied with the workshop, the speakers, and the content. Participants indicated that they would recommend AEE events to a colleague and that they are highly likely to attend future AEE events as indicated by a mean score of 9.2.

Participants indicated that the topics that would most likely motivate them to attend a future workshop are presentations on lighting, energy management systems, energy audits and heating, ventilation and air conditioning (HVAC). Additionally, participants indicated that distribution of the slides that were presented would improve the workshops.

6 CONCLUSIONS AND RECOMMENDATIONS

This report addresses the evaluation of NV Energy's 2017 Energy Education Program in the southern Nevada service territory. The focus of the evaluation is to depict the implementation and outcomes associated with the various programs of the overall program. These programs are:

- Residential Customer Education
- Building Industry Support
- Commercial Customer Education

The major conclusions and recommendations for each Energy Education program component are presented in this chapter. Table 6-1 presents the annual goals and activity for each program.

Table 6-1. Summary Results, Energy Education Program

Energy Education Program Components	***Program Goal***	***Count of Customers Educated***	***Percentage of Program-Level Activity***	***Percentage of Goal per Component***
Residential Customer Education	30,000	69,740	89%	232%
Building Industry Support	2,250	3,967	5%	176%
Commercial Customer Education	350	4,816	6%	1376%
Total	**32,600**	**78,523**	**100%**	**241%**

6.1 Residential Customer Education Conclusions and Recommendations

Residential Customer Education engaged in education activities with 69,740 customers, achieving 232 percent of the program goal of educating 30,000 customers. Table 6-2 shows the count of customers educated by each Residential Customer Education activity. The majority of residential customers were educated through interaction at event tables at community outreach events.

Table 6-2. Summary Results, Residential Customer Education

Residential Customer Education Components	***Count of Customers Educated***
Energy Efficiency Booth Visitors, Presentations	28,788
Senior 100 Project	174
National Theatre for Children Live Performance Program – students educated	29,997
National Theatre for Children Live Performance Program – teachers educated	1,395
EnergySmart Educator – teachers educated	28
EnergySmart Educator – students educated	9,358
Total	**69,740**

ADM found that the teachers who participated in the ESE training reported an increased positive attitude towards NV Energy, the ESE training program overall, and the ESE program content.

Teachers who utilized the Green Boxes and ESE curriculum reported high levels of engagement from students.

Going forward, with respect to 2018 Residential Customer Education, ADM recommends:

- NVE should continue monthly DSM Central updates for Residential Customer Education.
- NVE should share monthly updates for Residential Customer Education event calendars
- For the EnergySmart Educator activity, NV Energy should consider increasing the supply of Green Boxes.

6.2 Building Industry Support Conclusions and Recommendations

Building Industry Support educated 3,967 industry professionals, achieving 176 percent of the program goal to educate 2,250 industry professionals. Table 6-3 shows the count of industry professionals educated by each Building Industry Support activity. The majority of industry professionals were educated through Building Science e-Book Download.

Table 6-3. Summary Results, Building Industry Support

Building Industry Support Program Activity Components	***Count of Customers Educated***
In-person Training	130
Booth Event	348
Webinar	1,158
Building Science e-Book Download	2,274
The Homeowners' Guide e-Book Download	57
Total	**3,967**

Survey data collected from the participants indicated that building industry professionals were satisfied with the trainings provided by NV Energy in support of the Green Building Media.

Going forward, with respect to 2018 Building Industry Support, ADM recommends:

- NV Energy and Green Building Media should consider reaching out to additional customers who may benefit from the Webinar training activity.

6.3 Commercial Customer Education Conclusions and Recommendations

The Commercial Customer Education Program interacted with 4,816 commercial customers, achieving 1376 percent of the program goal of educating 350 commercial customers. Table 6-4 shows the count of commercial customers educated by each type of Commercial Customer Education activity.

Table 6-4. Summary Results, Commercial Customer Education

Commercial Customer Education Program Activity Components	***Count of Events***	***Count of Customers Educated***
Commercial Energy Efficiency Presentations and Booth Events	29	3,155
AEE Lunch-and-Learn Events	6	202
Energy Savings Kits	1	1,459
Total	**36**	**4,816**

Customers provided generally positive ratings and comments regarding the 2017 Commercial Customer Education activities.

Going forward, with respect to 2018 Commercial Customer Education, ADM recommends:

- NV Energy should augment the Association of Energy Engineers ("AEE") Lunch-and-Learn activity by distributing the presentation slides to attendees.

6.4 Process-Related Recommendations

Timely, frequent feedback from the independent third-party M&V contractor may help NV Energy implement real-time improvements or course corrections related to Energy Education. During 2018, ADM will provide real-time feedback via quarterly M&V update memos which will be provided to NV Energy within two weeks after the end of each of the first three calendar quarters. Quarterly M&V update memos will provide quantitative and qualitative documentation of Energy Education activities occurring throughout 2018.

APPENDIX A: RESIDENTIAL CUSTOMER EDUCATION SURVEYS

A.1 Residential Customer Education – 'Public Outreach' – Survey

NVEnergy 2017 Public Outreach Survey

We value your opinion because customer satisfaction is important to us at NV Energy. Please take a few minutes to fill out this short survey.

1. **After visiting NV Energy's exhibit, which of the following energy savings program that you learned about would you like to participate in (program descriptions provided on back):**

- ☐ High-efficiency Air Conditioning Program (southern Nevada only)
- ☐ LED Lighting Program
- ☐ Equal Payment Plan
- ☐ Energy Education Opportunities
- ☐ My Account Online Tools
- ☐ Refrigerator Recycling
- ☐ Energy Efficient Pool Pumps (southern Nevada only)
- ☐ Time of Use Rates
- ☐ Solar Generation Rebates
- ☐ Solar Thermal Water Heating
- ☐ mPowered Thermostat Program
- ☐ Home Energy Assessments
- ☐ None of These Programs

2. **Would you like to be contacted by NV Energy with additional information on how to participate in their energy saving and demand response programs:**

   Yes ☐ No ☐

3. **Please rank the top 3 reasons why you visited the NV Energy exhibit today:**

   Had questions about renewable programs: ____
   Had questions about my bill: ______
   Learn ways to save energy: _____
   The display(s) looked interesting to me: ____
   I am new to the area and don't know much about NV Energy: ____
   Someone recommended that I stop by NV Energy's exhibit: ___
   To see what NV Energy was giving away at the exhibit: ____
   Other: ____________________ Rank: ____

Using a zero-to-ten scale, where a zero means that you were extremely dissatisfied and ten means you are extremely satisfied.

Extremely Dissatisfied				Neutral						Extremely Satisfied
0	1	2	3	4	5	6	7	8	9	10

4. **How satisfied were you with the way that your needs were addressed by visiting NV Energy's exhibit?**
5. **How satisfied were you that you left today's exhibit knowing more about NV Energy's incentives for energy efficiency and other customer programs and services?**
6. **How could NV Energy improve the exhibit to provide a better experience for you:**

   ____

7. **What can NV Energy do to provide better service to you:**

   ____

8. **Is there anything that you would like NV Energy to follow up on for you:**

   ____

Thank you for your feedback!
To receive additional information, please fill out the optional contact fields below.

Name: ______________________________ **Address:** __________________________

Email Address: ______________________ **Phone #:** __________________________

High Efficiency Air Conditioning Program: Provides instant rebates for upgrading AC systems and equipment through participating contractors.
LED Lighting Program: Program subsidizes LED light bulbs at participating retailers and contractors.
Equal Payment Plan: Averages your energy costs over the year so your monthly bill is easier to manage.
My Account Online Tools: NV Energy's online personal account management tools.
Refrigerator Recycling: Provides a financial incentive for recycling old refrigerators and freezers.
Energy Efficient Pool Pump Rebates: Provides an instant rebate through participating retailers for installing energy efficient pool pumps.
Time of Use Rates: Program that provides rates structured to increase off-peak use for NV Energy customers.
Solar Generation Rebates: Program for customers who want to install photovoltaic cells on their homes.
Solar Thermal Water Heating: Program provides rebates for residential customers who install solar thermal water heaters.
mPowered Thermostat Program: Program where customers earn money back on their energy costs for allowing their thermostat setpoints to be adjusted during summer peak usage times. Program includes installation of a free smart thermostat.
Home Energy Assessments: NV Energy service whereby a home energy consultant visits residences and provides tips on how the homeowner may reduce their energy usage.

A.2 EnergySmart Educator Participant Survey

1. Hi, [insert teacher first name], you were sent this survey by ADM an independent research firm contracted by NV Energy.

   According to Green Power's records, you participated in the annual EnergySmart Educator training at Springs Preserve in Las Vegas, an event sponsored by NV Energy. Is this correct?
   1. Yes
   2. No [Terminate Interview]

2. Prior to receiving this survey, were you aware that NV Energy sponsored the annual EnergySmart Educator training that you attended?
   1. Yes
   2. No

3. How did you first learn about the EnergySmart Educator training?
   1. The EnergySmart Educator training was recommended to me by a colleague e.g. teacher or principal
   2. I attended the EnergySmart Educator training last year
   3. Industry newsletter
   4. Desert Research Institute website
   5. One of my student's parents suggested the EnergySmart program to me
   6. At a previous continuing education event [Please specify event]
   7. NV Energy representative

   97. Other [Please specify]
   98. Don't know

4. What grade do you teach?
   1. Elementary: kindergarten through 2nd grade
   2. Elementary: 3rd through 5th grade
   3. Middle School: 6th through 8th grade
   4. High School: 9th through 12th grade

   97. Other [Please specify]

5. Which of the following do you perceive as benefits of the EnergySmart Educator program and training? [Check all that apply]
   1. Improved my environmental education offerings to my classes
   2. Helped my professional development
   3. I have become more environmentally conscious
   4. My students have become more environmental conscious
   5. Provided me ideas about other ways to teach about the environment
   6. Easy to implement
   7. Reduced my personal teaching expenses

   97. Other [Please specify]
   98. Don't know
   99. I do not perceive any benefits of the program

[DISPLAY Q6 IF Q5 ≠ 98,99]

6. Please rank the benefits of the EnergySmart Educator program and training. [Rank the most significant benefit as number 1 and so forth]

EnergySmart Educator Impact on Energy Efficiency Beliefs and Behaviors

7. Prior to the EnergySmart Educator training, which of the following statements best describes your level of emphasis on energy efficiency? [Select the option that most describes you]
    1. I actively incorporated energy efficiency topics into my curriculum and tried to find ways to save energy at home
    2. I was aware of energy efficiency and related topics but it was not a point of emphasis for me
    3. I was not familiar with energy efficiency and related topics prior to the EnergySmart Educator training
    97. Other [Please specify]

8. Since participating in the EnergySmart Educator training, have you taken any of the following actions? [Check all that apply]
    1. Now, I find ways to include energy efficiency and related topics in my curriculum
    2. I made structural and/or equipment changes to my home such as installing more insulation or energy efficient lighting
    3. I participated in one or more of NV Energy's residential and commercial programs that I learned about at the EnergySmart Educator training
    4. I made changes to my behavior to save energy
    5. I shared the information that I learned on NV Energy's residential and commercial energy saving programs with my family, friends, colleagues, neighbors, or students
    97. Other [Please specify]
    98. Don't know
    99. No, I have not taken any action

[DISPLAY Q9 IF Q8 = 1]

9. How have you included energy efficiency and related topics in your curriculum since the EnergySmart Educator training? [Check all that apply]
    1. Lecture
    2. Hands on activities
    3. Behavioral based reinforcement e.g. designating a student to turn the lights off
    4. Video presentation on energy efficiency
    5. Energy efficiency project or homework
    97. Other activity [Please specify]
    98. Don't know
    99. None of the above

[DISPLAY Q10 IF Q8 = 2]

10. What structural or equipment changes did you make to your home? [Check all that apply]
    1. Installed building upgrades such as insulation or windows
    2. Purchased a more efficient air conditioner or furnace
    3. Sealed the ducts in my home
    4. Purchased a new pool pump
    5. Recycled an old refrigerator or freezer
    6. Installed more efficient lighting fixtures or lamps
    7. Purchased more energy efficient appliance(s)
    8. Installed solar energy related equipment
    9. Installed a new thermostat
    98. Other upgrades [Please specify]
    99. Don't recall

[DISPLAY Q11 IF Q8 = 2]

11. Did you off-set the cost of some or all the recent structural and/or equipment changes by participating in any of NV Energy's programs that you learned about during the EnergySmart Educator training?
    1. Yes
    2. No

98. Don't know

[DISPLAY Q12 IF Q8 = 3 OR IF Q11 = 1]

12. Which of the following NV Energy programs did you participate in following the EnergySmart Educator training? [Check all that apply]
    1. High Efficiency Air Conditioning Program (Southern Nevada only)
    2. LED Lighting Program [Purchased NV Energy subsidized light bulbs at participating retailers]
    3. My Account Online Tools
    4. Refrigerator Recycling
    5. Energy Efficient Pool Pumps (southern Nevada only)
    6. Solar Generation Rebates
    7. mPowered Thermostat Program
    8. Energy Smart Schools
    97. Other program(s) [Please specify]
    98. Don't know
    99. I did not participate in any of NV Energy's programs

[DISPLAY Q13 IF Q8 = 4]

13. What energy efficient behavior have you engaged in since the EnergySmart Educator training? [Check all that apply]
    1. Turned off lights and/or appliances when you leave a room
    2. Adjusted the thermostat when you leave your home
    3. Used machines like washers, dryers, and dishwashers early in the morning or later at night
    4. Washed clothes with cold water
    5. Saved hot water by taking shorter showers
    6. Opened your blinds or curtains on sunny days to let the sun light your home
    97. Other energy saving behavior [Please specify]
    98. Don't know

[DISPLAY Q14 IF Q8 = 5]

14. With whom did you share the information that you learned about NV Energy's residential and commercial energy saving programs? (Check all that apply)
    1. Family
    2. Friends
    3. Colleagues (other teachers)
    4. Students
    5. Neighbors
    97. Other [Please specify]
    99. None of the above

[DISPLAY Q15 IF Q14 ≠ 99]

15. Are you aware if any of the [Insert answer's to Q14] participated in NV Energy's residential or commercial energy savings programs as a result of your recommendation?
    1. Yes
    2. No
    98. Don't know

[DISPLAY Q16 IF Q15 = 1]

16. How many of the [Insert answer's to Q11] participated in NV Energy's residential or commercial energy savings programs as a result of your recommendation?

Green Box Implementation

17. Did you check out a Green Box during 2017?

1. Yes [Skip to Q20]
2. No [Skip to Q31 after Q18 and Q19]

[DISPLAY Q18 IF Q17 = 2]

18. Do you plan on checking out a Green Box within the next two years?
    1. Yes
    2. No

[DISPLAY Q19 IF Q17 = 2]

19. Please rank the following reasons why you will not check out a Green Box in the next two years. [Rank the most influential reason as number 1 and so forth]
    1. There are no Green Boxes that I can integrate into my existing curriculum
    2. The Green Boxes are not for the grade that I teach
    3. The Green Boxes currently available are not interesting to my students
    4. The Green Boxes currently available are not interesting to me
    5. The Green Boxes are not relevant to my students for practical application
    97. Other [Please specify]

[IF Q17 = 2, NOW SKIP TO Q31]

20. What subject did you teach using the Green Box curriculum? (Check all that apply)
    1. General science
    2. Biology
    3. Chemistry
    4. Mathematics
    5. Geology
    6. Statistics
    7. English
    97. Other [Please specify]

Pro-Environmental Curriculum

21. Which titles from the Green Box curriculum did you use in your classroom? (Please check all that apply)
    1. Electrical Systems
    2. Thermal Systems
    3. Natural Gas
    4. Energy Efficiency
    5. Solar Energy
    6. Climate Change
    7. Water Basics
    8. Water in the Natural and Build Environment
    9. Intro to Hydrologic Cycle
    10. Water Resources and Conservation
    11. Properties of Water
    97. Other [Please specify]

22. What are the reasons you chose the Green Box that you checked out?
    1. The Green Box that I chose integrated easily into my existing curriculum.
    2. The Green Box that I chose was the most appropriate for the grade that I teach
    3. The Green Box that I chose seemed to be the most interesting to my students
    4. The Green Box that I chose seemed to be the most interesting to me
    5. The Green Box that I chose was the most relevant to my students for practical application
    97. Other [Please specify]

23. Please rank the reasons you chose the Green Box that you checked out. [Rank the most significant reason as number 1 and so forth]

24. Based upon your experience with the curriculum thus far, which of the following titles would you use in your classroom if you repeated the program? (Please check all that apply)
    1. Electrical Systems
    2. Thermal Systems
    3. Natural Gas
    4. Energy Efficiency
    5. Solar Energy
    6. Climate Change
    7. Water Basics
    8. Water in the Natural and Build Environment
    9. Intro to Hydrologic Cycle
    10. Water Resources and Conservation
    11. Properties of Water
    97. Other [Please specify]
    98. Don't know
    99. None

[Display Q25 if Q24 ≠ 99]

25. Why would you include these titles/subjects?

26. Are there other titles or subjects that should be included in future Green Boxes that you think would increase your students' pro-environmental behavior and energy awareness?

Student Behavior Change

27. In general, what was the overall level of student interest in the Green Box lessons?
    1. Very interested
    2. Somewhat interested
    3. Neither interested or disinterested
    4. Somewhat disinterested
    5. Very disinterested
    98. Don't know

28. How frequently did you notice the following changes as a result of the Green Box curriculum while in the classroom?
    (Frequency rating: 1-significantly more than before curriculum, 2-more than before the curriculum, 3-equal to before the curriculum, 4-less than before the curriculum, 5-significantly less than before the curriculum)
    1. Students discussed energy efficiency and environmental changes
    2. Students engaged in more pro-environmental behaviors such as turning off lights when leaving the room, recycling, conserving water
    3. Students asking for more projects and/or lessons about the environment
    4. Opening blinds or curtains on sunny days to let the sun light the room
    5. Develop ideas for ways to make the classroom/school more environmentally friendly
    97. Other [Please specify]
    98. Don't know

29. Have your students reported making any of the following behavioral changes at home as a result of the Green Box curriculum? [Select all that apply]
    1. Buying local produce
    2. Recycling
    3. Turning off lights and appliances when not in use

4. Conserving water
5. Telling others (i.e., family members, peers) about the curriculum and/or ways to reduce the impact on the environment
6. Composting
7. Adjusting the thermostat when leaving the home
8. Used machines like washers, dryers, and dishwashers early in the morning or later at night
9. Saving hot water by taking shorter showers
10. Opening blinds or curtains on sunny days to let the sun light your home
11. Participating in energy efficiency programs (i.e., home audits, NV Energy rebate programs)
97. Other [Please specify]
98. Don't know
99. None of the above

30. To your knowledge, have your students influenced family members to make any of the following structural changes at home as a result of the Green Box curriculum?
    1. Installing building upgrades such as insulation or windows
    2. Purchasing a more efficient air conditioner or furnace
    3. Installing more efficient lighting fixtures or lamps
    4. Purchasing more energy efficient appliance(s)
    5. Recycling old appliances e.g. second freezers or refrigerators
    97. Other [Please specify]
    98. Don't know
    99. No

Program Satisfaction

31. On a scale of 0-10 where 0 is Very Dissatisfied and 10 is Very Satisfied, please rate your overall satisfaction with the EnergySmart Educator training:

0	1	2	3	4	5	6	7	8	9	10

32. On a scale of 0-5 where 0 is Very Dissatisfied and 10 is Very Satisfied, please rate your satisfaction with the content of the EnergySmart Educator training:

0	1	2	3	4	5	6	7	8	9	10

33. Knowing that the EnergySmart Educator program was supported by NV Energy, does that:
    1. Increase your satisfaction with NV Energy as your electrical service provider
    2. Somewhat increase your satisfaction with NV Energy as your electrical service provider
    3. Neither increase or decrease your satisfaction with NV Energy as your electrical service provider
    4. Somewhat decrease your satisfaction with NV Energy as your electrical service provider
    5. Decrease your satisfaction with NV Energy as your electrical service provider
    98. Don't know

[DISPLAY Q34 IF Q33 = 4 or 5]

34. Why did your participation in the Energy Smart Educator Program decrease your satisfaction with NV Energy?

Valediction

[Display Q35 if Q1=2]

35. You received a survey invitation in error. Have a great day!

[Display Q36 if Q1=1]

36. Thank you for taking our survey. Your response is very important to us and your comments help to improve the program for future participants!

APPENDIX B: BUILDING INDUSTRY SUPPORT SURVEY FORMS

1. **After visiting NV Energy's exhibit, which of the following energy savings program that you learned about would you like to participate in (program descriptions provided on back):**

- ☐ LED Lighting Program
- ☐ Equal Payment Plan
- ☐ Energy Education Opportunities
- ☐ My Account Online Tools
- ☐ Refrigerator Recycling
- ☐ Time of Use Rates
- ☐ Solar Generation Rebates
- ☐ mPowered Thermostat Program
- ☐ Home Energy Assessments
- ☐ None of These Programs

2. **Would you like to be contacted by NV Energy with additional information on how to participate in their energy saving and demand response programs:**

Yes ☐ No ☐

3. **Please rank the top 3 energy efficiency topics that you would like to learn more about:**

Air conditioning: ____
Water heating: ______
Windows: _____
Insulation: ____
Roofing: ____
Large Appliances (Refrigerators & Dishwashers): ___
Building Above Code: ____
Other: ____________________ Rank: __

4. **How satisfied were you with the way that your needs were addressed by visiting NV Energy's exhibit?**

Extremely Dissatisfied				Neutral					Extremely Satisfied
1	2	3	4	5	6	7	8	9	10

5. **How satisfied were you that you left today's exhibit knowing more about NV Energy's incentives for energy efficiency and other customer programs and services?**
6. **How could NV Energy improve the exhibit to provide a better experience for you:**
7. **What can NV Energy do to provide better service to you:**
8. **Is there anything that you would like NV Energy to follow up on for you:**

APPENDIX C: COMMERCIAL CUSTOMER EDUCATION SURVEY FORMS

C.1 AEE Lunch-and-Learn Survey Form

NVEnergy

How Did We Do Today?

We value your feedback. Please tell us if today's training met your expectations.

	0 (Strongly Disagree)	1	2	3	4	5 (Neutral)	6	7	8	9	10 (Strongly Agree)
I gained valuable information today.											
I will use the information today to improve my business operations.											
The trainer was knowledgeable.											
The trainer communicated effectively.											
I would recommend this training to a colleague.											
I am likely to attend a future training seminar.											

What improvement(s) could we implement to better your experience? ______

Are you interested in additional trainings? Please indicate the topics that interest you:

- ❑ Compressed Air
- ❑ Lighting
- ❑ Motors
- ❑ HVAC
- ❑ Energy Management Systems
- ❑ Refrigeration
- ❑ New construction
- ❑ Energy audits
- ❑ Other: ______________

How did you learn about today's training?

- ❑ NV Energy Sure Bet E-mail Invitation
- ❑ Referred by a colleague
- ❑ NV Energy Website
- ❑ NV Energy Representative
- ❑ Social Media (e.g. Facebook or LinkedIn)
- ❑ Other: __________

Please rank the top 3 reasons why you attended today's event?

- ❑ The topic was relevant to me or my firm
- ❑ Professional development and networking
- ❑ Continuing education credit(s)
- ❑ The event was sponsored (free)
- ❑ Other

Can we provide you with additional resources or assistance?

- ❑ I would like to receive the quarterly e-newsletter from NV Energy Sure Bet
- ❑ I would like to receive AEE's invites and e-newsletters
- ❑ I would like to join the Contractor Network
- ❑ I plan to submit an incentive application

My name: ____________________ Company: ____________________

Email: ____________________ Phone: ____________________

Thank you for attending today's training and for sharing your comments. Please contact a member of our team if you would like any additional information.

C.2 Commercial Customer Education Survey

NV Energy

Event Topic
Event Date - Site

	Strongly Disagree 0	1	2	3	4	Neutral 5	6	7	8	9	Strongly Agree 10
Today's presentation provided new information that improved your knowledge on the topic that was presented.											
Based on the topic and promotion, today's event met your expectations.											
You are satisfied with the content of today's presentation.											
The trainer communicated effectively.											
You would recommend this training to a colleague.											
You are likely to attend a future event.											

1. How did you find out about today's event? Please check one box
   - ❑ AEE Email
   - ❑ AEE Website
   - ❑ Colleague or friend
   - ❑ From an NV Energy, Southwest Gas or DNV-GL staff member
   - ❑ Through my firm or company
   - ❑ Other: _______________

2. Please rank the top 3 reasons why you attended today's event?

   The topic was relevant to me or my firm: _____

   Professional development and networking: _____

   Continuing education credit(s): _____

   The event was sponsored (free): _____

   Other: ________________

3. Which topics or aspects of today's workshop are you most likely to implement or share with a colleague or friend?

   ____

4. What suggestions do you have to improve this workshop?

   ____

5. What other topics would motivate your participation in future workshops?

   ____

6. What can NV Energy or Southwest Gas do to improve service for you?

   ____

7. Would you like to be contacted by NV Energy or Southwest Gas with additional information on their energy efficiency and demand response programs?

   Yes ☐ No ☐

To receive additional energy saving information, please fill out the optional contact fields below.

Name: ______________________________

Company Name: ____________________

Position/Title: ________________________

Best Contact Method: ☐ Phone ☐ E-Mail

Phone #: _________________________

C.3 2017 Energy Code Education Training Survey

2017 Energy Code Education Training Survey

How Did We Do Today?

Please tell us if today's training met your expectations, we value your feedback.

Based on your overall experience, how satisfied are you with the training? Using the zero-to-ten scale below, please rank each statement where a zero means you strongly disagree and a ten means you strongly agree with the question.

	Strongly Disagree					Neutral					Strongly Agree
	0	1	2	3	4	5	6	7	8	9	10
I gained valuable information today.											
The trainer was knowledgeable.											
The trainer communicated effectively.											
I would recommend this training to a colleague.											
I am likely to attend a future training seminar.											

What improvement (s) can we implement in the future to better your experience?

Are there any new code provisions that you see having a difficult time implementing?

How did you find out about today's training session? What improvement (s) can we implement to better your experience?

Your profession or occupation:

Name: ______________________________ Company: ________________________________

Email: ______________________________ Phone: __________________________________

Thank you for attending today's training and for sharing your comments.

DSM-6

Energy Education Program
NV Energy – Northern Nevada (SPPC)
Program Year 2017

Measurement and Verification Report
March 30, 2018

Prepared for:

NV Energy

Prepared by:

ADM
ENERGY RESEARCH AND EVALUATION

3239 Ramos Circle
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TABLE OF CONTENTS

1 EXECUTIVE SUMMARY

This measurement and verification ("M&V") report addresses the evaluation of NV Energy's 2017 Energy Education Program in the northern Nevada service territory ("Sierra Pacific Power" or "SPPC"). The focus of the evaluation is to depict the implementation and outcomes associated with the 2017 Energy Education program's two components, which are:

- Residential Customer Education
- Commercial Customer Education

The major conclusions and recommendations for each Energy Education Program component are presented in this chapter. Table 1-1 depicts annual goals as well as actual achieved in 2017.

Table 1-1. Summary Results, Energy Education Program

Energy Education Program Components	***Program Goal (Count of Customers)***	***Count of Customers Educated***	***Percentage of Program Activity***	***Percentage of Goal per Component***
Residential Customer Education	23,000	36,668	95%	159%
Commercial Customer Education	300	3,301	5%	1100%
Total	**23,300**	**39,969**	**100%**	**172%**

1.1 Residential Customer Education Conclusions and Recommendations

Residential Customer Education engaged in education activities with 36,668 customers, achieving 159 percent of the goal of educating 23,000 customers. Table 1-2 shows the count of customers educated by each type of Residential Customer Education activity.

Table 1-2. Summary Results, Residential Customer Education

Residential Customer Education Activities	***Count of Customers Educated***
Booth Table Visitors	20,371
Energy Efficiency Presentations	5,932
EnergySmart Educator – teachers educated	74
EnergySmart Educator – students educated	1,268
National Theatre for Children Live Performance Program – teachers educated	341
National Theatre for Children Live Performance Program – students educated	8,682
Total	**36,668**

ADM Associates, Inc. ("ADM"), NV Energy's independent third-party M&V contractor, found that the teachers who participated in the EnergySmart Educator ("ESE") training reported an increased positive attitude towards NV Energy, the ESE training, and the ESE content. Teachers who utilized Green Boxes and ESE curriculum reported high levels of engagement from students. Going forward, with respect to 2018 Residential Customer Education, ADM recommends:

- NVE should continue monthly DSM Central updates for Residential Customer Education.
- NVE should share monthly updates for Residential Customer Education event calendars.
- For EnergySmart Educator, NVE should consider increasing the supply of Green Boxes.
- NV Energy and GreenPower should provide an EnergyWise Educator Summer Training Seminar in northern Nevada.

1.2 Commercial Customer Education Conclusions and Recommendations

Commercial Customer Education activities included Energy Efficiency Presentations and Booth Events, Energy Savings Kits, and Association of Energy Engineers ("AEE") Lunch-and-Learn Events. The Building Industry Support component included the Building Science e-Book Download as well as Webinar training. A summary of 2017 Commercial Customer Education activities and results is provided in Table 1-3.

Table 1-3. Summary Results, Commercial Customer Education

Commercial Customer Education Activities	***Count of Customers Educated***
Commercial Energy Efficiency Presentations and Booth Events	1,321
Energy Savings Kits	745
AEE Lunch-and-Learn Events	156
Building Science e-Book Download (Building Industry Support)	627
Webinar (Building Industry Support)	452
Total	**3,301**

Survey data collected from the participants indicated that commercial customer ratings and comments were generally positive and building industry professionals were satisfied with the Webinar training provided by NV Energy in support of the Green Building Media. Going forward, with respect to 2018 Commercial Customer Education, ADM recommends:

- NV Energy should augment the Association of Energy Engineers ("AEE") Lunch-and-Learn activity by distributing the presentation slides to attendees.
- NV Energy and Green Building Media should consider reaching out to additional customers who may benefit from the Webinar training activity.

1.3 Process-Related Recommendations

Timely and frequent feedback from the independent third-party M&V contractor may help NV Energy implement real-time improvements or course corrections related to Energy Education. During 2018, ADM plans to provide real-time feedback via quarterly M&V update memos which will be provided to NV Energy within two weeks after the end of each of the first three calendar quarters. Quarterly M&V update memos will provide quantitative and qualitative documentation of Energy Education activities occurring throughout 2018.

2 PROGRAM BACKGROUND

The Energy Education Program is designed to educate customers regarding various strategies, technologies and opportunities for significantly increasing the efficiency of customers' electric loads[1]. The overall goal of the program is to empower NV Energy's customers to better manage their energy use and reduce energy bills in homes and businesses.

This chapter provides a brief description of the program design and activity during 2017 for each component of the 2017 Energy Education Program.

2.1 Residential Customer Education

in 2017, Residential Customer Education provided energy efficiency education through the following initiatives:

- Community outreach events, including presentations at community events and media, as well as distributing literature packets at community events
- The EnergySmart Educator Program
- The National Theatre for Children Live Performance Program

The community presentations and events effort focused on delivering conservation literature and concepts to NV Energy's customers through personal interaction.

The EnergySmart Educator Program focused on training teachers to supplement their teaching efforts with materials focused on energy and related topics. Participating teachers were provided access to Green Boxes that contained all the necessary lessons and materials to implement the EnergySmart Educator training in their classrooms.

2.2 Commercial Customer Education

In 2017, Commercial Customer Education provided technical and energy efficiency training to small and medium business owners and facility operators through webinars, presentations, booth events and workshops.

NV Energy representatives presented energy efficiency information and introduced NV Energy's demand side management programs at industry events and presentations to commercial customers. The goal of the presentations and booth events was to help customers identify energy efficiency

[1] Lighting and air conditioning are examples of significant electric loads that can become more efficient.

opportunities in their businesses and to highlight NV Energy's energy efficiency resources available to business owners.

Association of Energy Engineers ("AEE") Lunch-and-Learn events featured expert speakers who presented to commercial customers on topics for improving building energy management and equipment upgrades to achieve energy efficiency. The goal of the AEE Lunch-and-Learn events was to provide commercial customers the basic information to be able to identify potential energy efficiency opportunities in their processes and buildings.

Energy Savings Kits are an additional measure that NV Energy utilized in 2017 to engage with and educate 745 commercial customers – specifically, small and medium-sized businesses. The Energy Savings Kits, which featured the PowerShift brand, included four 15W Energy Star LEDs, one Energy Star flood LED, one eight-outlet advanced power strip, one low-flow faucet aerator, one section of water pipe insulation, and one occupancy sensor.

In 2017, NV Energy also provided building industry support to northern Nevada builders, realtors, architects, and contractors. The goal was to present valuable education related to energy efficiency concepts in new construction and remodeling; specific energy education activities included in-person training, webinars and the Building Science e-book download.

3 RESIDENTIAL CUSTOMER EDUCATION

NV Energy promoted electric energy conservation awareness through Residential Customer Education. NVE accomplished this by providing information at community events such as Earth Day celebrations, community fairs, and events sponsored by community organizations including hotels and schools. At Residential Customer Education events, NVE representatives distributed brochures at table displays, while also providing information during personal interactions and through presentations on energy conservation topics. NVE also engaged in media interviews.

In 2017, NVE also sponsored and supported the EnergySmart Educator Program that provided northern Nevada teaching professionals with training on how to present energy efficiency in the classroom. Curriculum and supporting materials were provided in Green Boxes that were loaned to teachers for use in the classrooms.

In 2017, Residential Customer Education aimed to deliver energy-efficiency education to 23,000 customers. The actual count of customers educated was 36,668 customers, 159 percent of goal.

Table 3-1. Summary Results, Residential Customer Education

Residential Customer Education Activities	***Count of Customers Educated***
Booth Table Visitors	20,371
Energy Efficiency Presentations	5,932
EnergySmart Educator – teachers educated	74
EnergySmart Educator – students educated	1,268
National Theatre for Children Live Performance Program – teachers educated	341
National Theatre for Children Live Performance Program – students educated	8,682
Total	**36,668**

3.1 Residential Customer Education Events and Presentations

NV Energy activities at residential customer education events included:

- Providing table displays and interacting with customers;
- Distributing bags containing literature on energy conservation (e.g., conservation tips and information about energy conservation programs);
- Delivering presentations on energy conservation topics; and
- Sponsorship of the National Theatre for Children Live Performance Program.

3.1.1 Community Outreach Events and Presentations

In 2017, NV Energy representatives participated in 31 community outreach events in northern Nevada. As shown in Table 3-2, these community outreach events included booth events (78 percent of event activities), presentations, trainings and National Theatre for Children (22 percent of event activities). National Theatre for Children performed in 21 different schools in northern Nevada and educated 341 teachers and 8,682 students.

Table 3-2. Residential Customer Education Activities in 2017

Indicator	Booth Event	Presentation, Training and National Theatre for Children	Total Activities
Count of Events	25	7	32
Percent of Total Activities	78%	22%	100%

Table 3-3 provides details regarding the energy efficiency information that NVE provided through Public Outreach Education activities in 2017 – in total, 36,668 customers were educated.

Table 3-3. Customers Educated through 2017 Residential Customer Education Activities

Indicator	Booth Event	Presentation, Training and National Theatre for Children	Total Count of Customers Educated
Customers Educated	20,371	16,297	36,668
Percent of Total Activities	56%	44%	100%

The Energy Education Program tracked key customer segments targeted by Residential Customer Education events in 2017. Table 3-4 provides summary data from NVE's outreach tracking system, including the number and percent of outreach events focused on specific customer segments. For each customer segment, a representative example of an outreach event is indicated.[2]

Table 3-4. Community Outreach Education Events by Customer Segment in 2017 (n = 32[3])

Customer Segment	Number of Events	Percent of Events	Illustrative Outreach Event
General Population	25	74%	Reno Earth Day Event
Latino	1	3%	Cinco de Mayo Festival
African Americans	0	0%	-
Asians	0	0%	-
Green	6	18%	IGT Employee Earth Day
Senior	2	6%	Senior Fest
Teachers/Students	3	9%	DRI EnergySmart Education
Low Income	0	0%	-

[2] The outreach tracking system codes the primary customer segment targeted by a given outreach event; the system codes up to two customer segments per event. The tracking system does not include counts of participants.

[3] Some events are associated with multiple customer segments.

3.1.2 Residential Customer Education Survey Results

ADM collected survey responses from 81 customers that visited NV Energy's exhibits at four selected community events.

The top three reasons that customers visited NV Energy exhibits at community outreach events:

1. The NV Energy exhibit looked interesting
2. To learn ways to save energy
3. To see what NV Energy was giving away at the exhibit

Highlighted below are the major survey findings:

- Northern Nevada survey respondents reported that the NV Energy program or service that they would be most interested in participating in would be the Smart Thermostat Program (42.9 percent).

  Other programs that respondents would like to participate in were Home Energy Assessments (24.7 percent), Time of Use Rate (13.0 percent), Equal Payment Plan (7.8 percent), My Account Online Tools (6.5 percent), Energy Education Opportunities (6.5 percent).
- 28.8 percent of the northern Nevada survey participants indicated that they were interested in participating in NV Energy's energy conservation programs.
- When asked, "what can NV Energy do to provide better service to you," the only significant response was, "more solar options and incentives".

Table 3-5 presents the results for the two satisfaction questions included in the Residential Customer Education Survey. Customers' satisfaction was evaluated using the 11-point Likert scale, which measures on a continuum from strong dissatisfaction (0) to strong satisfaction (10).

Table 3-5. Residential Customer Education Participant Survey Summary Statistics

Survey Questions	Mean	90% Confidence Interval	N
How satisfied were you with the way that your needs were addressed by visiting NV Energy's exhibit?	8.1	7.7-8.5	76
How satisfied were you that you left today's exhibit knowing more about NV Energy's incentives for energy efficiency and other customer programs and services?	8.3	7.9-8.7	69

Note: Scale anchor points were as follows: strong dissatisfaction (0) to strong satisfaction (10) with a Neutral midpoint of 5 on the 11-point scale.

Responses to the satisfaction questions show that customers were satisfied that their needs were being addressed when visiting NV Energy's exhibits as indicated by a mean score of 8.1. Additionally, customers were satisfied that they left NV Energy's exhibits knowing more about NV Energy's incentives for energy efficiency and other customer programs and services as indicated by a mean score of 8.3.

3.2 EnergySmart Educator Program

In 2017, NV Energy, working with the Desert Research Institute and GreenPower, provided financial support to the EnergySmart Educator Program (“ESE”) that supplied energy efficiency training and curriculum to 74 northern Nevada science teachers and 1,268 students.

ADM delivered a survey to teachers who participated in the ESE training. The participant survey was designed to capture teachers’ energy efficiency actions and curriculum prior to participating in the ESE training and teachers’ views on the implementation of the Green Box curriculum. To present meaningful results, aggregated survey data from 11 northern and southern ESE survey respondents is presented here. (The survey is included in this report as Appendix A.)

3.2.1 Teacher Impacts

Table 3-6 presents the distribution of ways that teachers found out about the ESE training. The top channel for teacher awareness of the ESE training was “recommended to me by a colleague.”

Table 3-6. Program Awareness (n=11)

Program Awareness Channels	***Teacher %***
The ESE training was recommended to me by a colleague	45.5
ESE training was recommended to me by a friend	36.4
I attended the EnergyWise Educator training last year	9.1
Desert Research Institute website	9.1

Table 3-7 presents the distribution of grade level taught by teachers who completed the survey.

Table 3-7. Grade Taught (n=11)

Grade Taught	***Teacher %***
High School: 9th through 12th grade	9.1
Middle School: 6th through 8th grade	18.2
Elementary: 3rd through 5th grade	27.3
Elementary: kindergarten through 2nd grade	27.3
Other	18.2

Table 3-8 shows how teachers ranked the benefits of the ESE training. The greatest benefit for the participating teachers was providing teachers ideas about other ways to teach about the environment. Comments by teachers indicated that the ESE training afforded them an opportunity to network with their peers and to enhance materials and lessons.

Table 3-8. Ranking of the Benefits to Teachers of the ESE Training (n=11)

Benefits	***Ranking***
Provided me ideas about other ways to teach about the environment	1
Helped my professional development	2
Improved my environmental education offerings to my classes	3
Easy to implement	4
My students have become more environmentally conscious	5
I have become more environmentally conscious	6

Of the teachers who responded to the participant survey, 27.3 percent reported instituting energy efficiency into their curriculum prior to their ESE participation. Table 3-9 depicts teachers' attitudes ***pre-ESE*** regarding the inclusion of energy efficiency into their curriculum.

Table 3-9. Prior to ESE Participation: Incorporation of Energy Efficiency Curriculum (n=11)

Pre-ESE Incorporation of Energy Efficiency	***Teacher %***
I actively incorporated energy efficiency topics into my curriculum and tried to find ways to save energy at home.	27.3
I was aware of energy efficiency and related topics, but it was not a point of emphasis for me.	72.7

Table 3-10 shows how teachers responded to the ESE training. Of the 11 teachers that reported their response to the ESE training, the most popular response (81.8 percent) to the ESE training was to find ways to include energy efficiency and related topics in their curriculum.

Table 3-10. Teacher Response to ESE Training (n=11)

Teacher Responses to ESE Training	***Teacher %***
Now, I find ways to include energy efficiency and related topics in my curriculum	81.8
I made changes to my behavior to save energy	54.5
I shared the information that I learned on NV Energy's residential and commercial energy saving programs with my family, friends, colleagues, and students	45.5
I made structural and/or equipment changes to my home such as installing more insulation or energy efficient lighting	9.1

More than half of the teachers reported finding ways to include energy efficiency and related topics in their curriculum in the ways shown in Table 3-11.

Table 3-11. Energy Efficiency Curriculum (n=11)

Energy Efficient Curriculum	***Teacher %***
Hands on activities	77.8
Behavioral reinforcement, e.g., designating a student to turn out lights	66.7
Lecture	44.4
Video presentation on energy efficiency	22.2
Energy efficiency project or homework	11.1
Other activity: will cover it next semester	11.1

Teachers reported participating in NV Energy DSM programs that they learned about during the ESE training e.g. LED Lighting Program, My Account Online tools, and the Smart Thermostat Program. Additionally, teachers reported sharing what they learned with family (80 percent), friends (80 percent), colleagues (80 percent), and students (80 percent).

3.2.2 Green Box Implementation

Following are Participant Survey findings regarding teachers' utilization of Green Boxes:

- 36.4 percent of the teachers that responded to the participant survey checked out a Green Box during 2017.
- 57.1 percent of teachers who did not check out a Green Box during 2017 plan on checking out a Green Box during the next two years.
- 80 percent of teachers checked out Green Boxes that easily integrated into their curriculum and were most relevant to their students for practical application.
- 20 percent of the teachers that checked out a Green Box reported that the Green Box that they chose was the most appropriate for the grade that they teach.

3.2.3 Student Impacts

Student impacts reported by teachers indicated that:

- Students had a high level (75 percent) of engagement with the Green Box lessons.
- Students increased energy saving behavior such as turning off lights and conserving water.
- Students asked for more projects and lessons related to the environment and increased their discussion of energy efficiency and environmental changes.
- Students reported changes that they have made at home after going through the Green Box curriculum. (Changes included conserving water, turning off lights and appliances when not in use, recycling old appliances, and telling others about the Green Box curriculum as well as ways to reduce impacts on the environment.)

3.2.4 EnergySmart Educator Participant Satisfaction Results

The teachers' responses to the satisfaction questions included in the ESE Participant Survey are shown in Table 3-12. Teachers' responses were evaluated to measure attitudes following the ESE training using the 11-point Likert scale, which measures on a continuum from heavily negative (0) to heavily positive (10).

Table 3-12. EnergySmart Educators Summary Statistics: Teacher Satisfaction

Survey Questions	***Mean***	***90% Confidence Interval***	***N***
Please rate your overall satisfaction with the EnergySmart Educator training?	9.2	8.8-9.6	11
Please rate your satisfaction with the content of the EnergySmart Educator training?	9.5	9.1-9.9	11

Note: Scale anchor points were as follows: heavily negative attitudes (0) to heavily positive attitudes (10) with a Neutral midpoint of 5 on the 11-point scale.

Responses to the two questions on the survey that addressed satisfaction were all positive; thus, none of the teachers had a negative attitude towards NV Energy, the ESE training, or the ESE content following the ESE training sessions. As can be seen in Table 3-12, satisfaction with the ESE training and the presented content was heavily clustered on a rating of 10 with a slight leftward skew.

4 COMMERCIAL CUSTOMER EDUCATION

Commercial Customer Education activities included Energy Efficiency Presentations and Booth Events, Energy Savings Kits, Association of Energy Engineers ("AEE") Lunch-and-Learn Events, and Energy Code Training. The Building Industry Support component included the Building Science e-Book Download as well as Webinar training. A summary of 2017 Commercial Customer Education activities and results is provided in Table 4-1.

Table 4-1. Summary Results, Commercial Customer Education

Commercial Customer Education Activities	*Count of Customers Educated*
Energy Efficiency Presentations, Code Training and Booth Events	1,321
Energy Savings Kits	745
AEE Lunch-and-Learn Events	156
Building Science e-Book Download (Building Industry Support)	627
Webinar (Building Industry Support)	452
Total	**3,301**

Survey data collected from the participants indicated that commercial customer ratings and comments were generally positive and building industry professionals were satisfied with the Webinar training provided by NV Energy in support of the Green Building Media.

Commercial Customer Education activities in 2017 included the following components:

- Energy Efficiency Presentations (including Energy Code Training)
- Booth Events
- AEE Lunch-and-Learn Events
- Energy Efficiency Kits

4.1 Survey Results for Energy Efficiency Presentations

During 2017, 80 surveys were gathered from participants in NVE's Energy Code Training initiative. Survey results are characterized in Table 4-2 using the 11-point Likert scale, which measures on a continuum from strong disagreement (0) to strong agreement (10).

Table 4-2. Energy Code Training Events Summary Statistics

Survey Questions	*Mean*	*90% Confidence Interval*	*N*
I gained valuable information today.	9.1	8.9-9.3	80
The trainer was knowledgeable.	9.5	9.3-9.7	80
The trainer communicated effectively.	9.5	9.3-9.7	80
I would recommend this training to a colleague.	9.3	9.1-9.5	80
I am likely to attend a future seminar.	9.2	9.0-9.4	80

Note: Scale anchor points were as follows: strong disagreement (0) to strong agreement (10) with a Neutral midpoint of 5 on the 11-point scale.

Responses to the satisfaction questions show that participants learned valuable and useful information and were satisfied with the trainer. Participants indicated that they would recommend this training to a colleague and that they are highly likely to attend the future event.

In 2017, ADM also sampled and analyzed 16 surveys from other energy efficiency presentations. Results from those 16 surveys are characterized below. (The survey is included in this report as Appendix C.) Major survey findings are:

- The top three reasons participants attended the event were "the topic was relevant to me and firm", "professional development and networking" and "the event was sponsored (free)".
- 81.3 percent learned of the event information from AEE email, 12.5 percent received the information from a utility (NV Energy or Southwest Gas) staff member.
- 62.5 percent of respondents would like to be contacted by NV Energy or Southwest Gas with additional information on their energy efficiency and demand response programs.

Participant responses are characterized Table 4-3 using the 11-point Likert scale, which measures on a continuum from strong disagreement (0) to strong agreement (10).

Table 4-3. Energy Efficiency Presentations to Commercial Customers Summary Statistics

Survey Questions	***Mean***	***90% Confidence Interval***	***N***
I gained valuable information today.	8.1	7.7-8.9	16
Based on the topic and promotion, today's event met my expectations.	8.1	7.5-9.1	16
I am satisfied with the content of today's presentation.	8.3	7.5-9.1	16
The trainer communicated effectively.	8.6	8.1-9.1	15
I would recommend this training to a colleague.	8.4	7.5-9.3	16
I am likely to attend a future event.	9.3	8.8-9.8	16

Note: Scale anchor points were as follows: strong disagreement (0) to strong agreement (10) with a Neutral midpoint of 5 on the 11-point scale.

Responses to the satisfaction questions show that participants learned valuable and useful information and were satisfied with the trainer. Participants indicated that they would recommend this training to a colleague and that they are highly likely to attend the future event.

4.2 Association of Energy Engineers Lunch-and-Learn Events

During 2017, NV Energy sponsored six Association of Energy Engineers ("AEE") Lunch-and-Learn events that delivered energy efficiency training to 156 commercial customers on the topics shown in Table 4-4.

Table 4-4. Summary Results, AEE Lunch-and-Learn Events

Lunch-and-Learn Topics	***Commercial Customers Educated***
AEE Lunch-and-Learn	30
Commercial/AEE Lunch-and-Learn February (North)	20
Commercial/AEE Lunch-and-Learn March (North)	37
Commercial/AEE Lunch-and-Learn April (North)	13
AEE Lunch-and-Learn May (North)	29
AEE Lunch-and-Learn October (North)	27
Total	**156**

ADM sampled and analyzed 136 surveys collected from the AEE events and January Commercial Services Lunch and Learn (North) implemented by DNV-GL. All participants were invited to complete an event evaluation form, which yielded the following data. (The survey is included in this report as Appendix C.)

Participants learned about the AEE Lunch-and-Learn events training primarily through AEE email invitation. The top three reasons participants attended the AEE events were the following:

1. The topic was relevant to the attendee or their firm
2. Professional development and networking
3. The event was sponsored (free)

As shown in Table 4-5, participants generally agreed with the six satisfaction statements included in the AEE Lunch-and-Learn survey. Participant feedback was evaluated using the 11-point Likert scale, which measures on a continuum from strong disagreement (0) to strong agreement (10).

Table 4-5. AEE Lunch-and-Learn Participant Survey Summary Statistics

Survey Questions	***Mean***	***90% Confidence Interval***	***N***
I gained valuable information today.	8.6	8.4-8.8	136
I will use the information today to improve my business operations.	8.4	8.1-8.7	134
The trainer was knowledgeable.	9.1	8.9-9.3	136
The trainer communicated effectively.	9.1	8.9-9.3	136
I would recommend this training to a colleague.	9.0	8.8-9.2	136
I am likely to attend a future event.	9.3	9.1-9.5	134

Note: Scale anchor points were as follows: strong disagreement (0) to strong agreement (10) with a Neutral midpoint of 5 on the 11-point scale.

Responses to the satisfaction questions show that participants learned new energy efficiency information and were satisfied with the workshop, the speakers, and the content. Participants indicated that they would recommend AEE events to a colleague and that they are highly likely to attend future AEE events as indicated by a mean score of 9.3.

Respondents indicated that the topic that would most likely motivate them to attend a future workshop is a presentation on lighting, HVAC, energy management systems and energy audits. Additionally, respondents indicated that distribution of the slides that were presented would improve the workshops.

4.3 Building Industry Support and Survey Results

Building Industry Support activities in 2017 continued NVE's focus on educating northern Nevada builders regarding energy efficiency opportunities and Green Building practices. Building Industry Support included in-person training, webinars, and the Building Science e-Book Download.

ADM, in collaboration with Green Building Media, surveyed a sample of customers who attended building industry support events. ADM analyzed 98 surveys returned by NVE customers. Results of our analysis of the survey data are discussed in this section. The significant findings are:

- Respondents reported that the NV Energy programs or services that they would be most interested in participating in would be LED Lighting (68 percent) and High-Efficiency Air Conditioning programs (53 percent).
- Respondents reported the energy efficiency topics that they would like to learn about were Building Science (88 percent), Insulation (68 percent), Building above code (65 percent), Air Heating and Cooling (65 percent), Windows and Doors (62 percent), Water Heating (59 percent), Roofing (46 percent), Appliances (37 percent).
- 74 percent of respondents participated in Webinar training, 38 percent participated in Homeowners' e-Guidebook, 6 percent participated in In-person Training and 6 percent participated in Building Science e-Guidebook.

As described in Table 4-6, customers provided relatively high scores in response to satisfaction questions in the Building Industry Support survey. Customer satisfaction was evaluated using the 11-point Likert scale which measures on a continuum from strong dissatisfaction (0) to strong satisfaction (10). Customers responded affirmatively to the following satisfaction questions.

Table 4-6. Building Industry Support Summary Statistics: Customer Satisfaction

Survey Questions	***Mean***	***90% Confidence Interval***	***N***
Please rate your overall satisfaction with the In-person Training?	8.3	6.2-10.5	6
Please rate your satisfaction with the Webinar Training?	8.4	7.9-8.8	73
Please rate your satisfaction with the Homeowners' Guidebook?	8.3	7.6-8.9	38
Please rate your satisfaction with the Building Science Guidebook?	10	10-10	6

5 CONCLUSIONS AND RECOMMENDATIONS

This M&V report addresses the evaluation of NV Energy's 2017 Energy Education Program in the northern Nevada service territory. The focus of the evaluation is to depict the implementation and outcomes associated with the Energy Education Program's two components, which are:

- Residential Customer Education
- Commercial Customer Education

The major conclusions and recommendations for each Energy Education Program component are presented in this chapter. Table 5-1 presents the annual goals and activity for each program.

Table 5-1. Summary Results, Energy Education Program

Energy Education Program Components	*Program Goal (Count of Customers)*	*Count of Customers Educated*	*Percentage of Program Activity*	*Percentage of Goal per Component*
Residential Customer Education	23,000	36,668	95%	159%
Commercial Customer Education	300	3,301	5%	1100%
Total	**23,300**	**39,969**	**100%**	**172%**

5.1 Residential Customer Education Conclusions and Recommendations

Residential Customer Education engaged in education activities with 36,668 customers, achieving 159 percent of the goal of educating 23,000 customers. Table 5-2 shows the count of customers educated by each type of Residential Customer Education activity. The majority of residential customers were educated through interaction at event tables at community outreach events.

Table 5-2. Summary Results, Residential Customer Education

Residential Customer Education Activities	*Customers Educated*
Booth Table Visitors	20,371
Energy Efficiency Presentations	5,932
EnergySmart Educator – teachers educated	74
EnergySmart Educator – students educated	1,268
National Theatre for Children Live Performance Program – teachers educated	341
National Theatre for Children Live Performance Program – students educated	8,682
Total	**36,668**

ADM found that teachers who participated in the EnergySmart Educator (ESE) training reported an increased positive attitude towards NV Energy, the ESE training, and the ESE content. Teachers who utilized the Green Boxes and ESE curriculum reported high levels of engagement from students. Going-forward recommendations for 2018 Residential Customer Education are:

- NVE should continue monthly DSM Central updates for Residential Customer Education.

- NVE should share monthly updates for Residential Customer Education event calendars.
- For EnergySmart Educator, NVE should consider increasing the supply of Green Boxes.
- NV Energy and GreenPower should provide an EnergyWise Educator Summer Training Seminar in northern Nevada.

5.2 Commercial Customer Education Conclusions and Recommendations

Commercial Customer Education activities included Energy Efficiency Presentations and Booth Events, Energy Savings Kits, and Association of Energy Engineers ("AEE") Lunch-and-Learn Events. The Building Industry Support component included the Building Science e-Book Download as well as Webinar training. A summary of 2017 Commercial Customer Education activities and results is provided in Table 5-3.

Table 5-3. Summary Results, Commercial Customer Education

Commercial Customer Education Activities	***Customers Educated***
Commercial Energy Efficiency Presentations and Booth Events	1,321
Energy Savings Kits	745
AEE Lunch-and-Learn Events	156
Building Science e-Book Download (Building Industry Support)	627
Webinar (Building Industry Support)	452
Total	**3,301**

Survey data collected from the participants indicated that commercial customer ratings and comments were generally positive and building industry professionals were satisfied with the Webinar training provided by NV Energy in support of the Green Building Media. Going-forward recommendations for 2018 Commercial Customer Education are:

- NV Energy should augment the Association of Energy Engineers ("AEE") Lunch-and-Learn activity by distributing the presentation slides to attendees.
- NV Energy and Green Building Media should consider reaching out to additional customers who may benefit from the Webinar training activity.

5.3 M&V Process Recommendations

Timely, frequent feedback from the independent third-party M&V contractor may help NV Energy implement real-time improvements or course corrections related to Energy Education. During 2018, ADM will continue to provide real-time feedback via quarterly M&V update memos which will be provided to NV Energy within two weeks after the end of each of the first three calendar quarters. Quarterly M&V update memos will provide quantitative and qualitative documentation of Energy Education activities occurring throughout 2018.

6 GAS EDUCATION AND CONSULTATION

NV Energy promoted gas energy conservation awareness through the Gas Education and Consultation Program. NV Energy accomplished this by providing information at community events such as Earth Day celebrations, community fairs, and events sponsored by community organizations including hotels and schools. At Gas Education and Consultation events, NV Energy representatives provided information by distributing brochures at table displays, as well as personal interactions and presentations on gas energy conservation topics.

For 2017, the Gas Education and Consultation Program provided education to 26,386 customers, achieving approximately 113 percent of the program goal to educate 23,300 customers. Table 6-1 depicts the gas education and consultation program components and the counts of NV Energy customers educated through program activities. This chapter presents the details on each of these activities.

Table 6-1. Summary Results, Gas Education

Gas Customer Education Components	***Count of Customers Educated***
Booth Table Visitors	14,715
Presentation, Training and National Theatre for Children Live Performance Program	11,671
Total	**26,386**

NV Energy activities at gas education and consultation events included:

- Providing table displays and interacting with customers;
- Distributing bags containing literature on energy conservation (e.g., conservation tips and information about energy conservation programs); and
- Delivering presentations on energy conservation topics.

In 2017, NV Energy representatives participated in 24 community outreach events in northern Nevada. As shown in Table 6-2, these community outreach events included booth events (79 percent of event activities), presentations and trainings (21 percent of event activities).

Table 6-2. Gas Education and Consultation Activities in 2017

Indicator	***Booth Event***	***Presentation, Training and National Theatre for Children***	***Total Activities***
Count	19	5	24
Percent of Total Activities	79%	21%	100%

Table 6-3 provides details regarding the energy efficiency information that NVE provided through Gas Education and Consultation activities in 2017 – in total, 26,386 customers were educated.

Table 6-3. Customer Impacts from Gas Education and Consultation Activities in 2017

Indicator	Booth Event	Presentation, Training and National Theatre for Children	Total Count of Customers Educated
Customers Educated	14,715	11,671	26,386
Percent of Total Activities	56%	44%	100%

ADM collected surveys responses from 81 customers that visited NV Energy's exhibits who are both electric and gas customers at four selected community events. survey details were described in this M&V report in section 3.1.2 above.

For the 2018 Gas Education and Consultation program, ADM recommends:

- NV Energy should continue to update Gas Education and Consultation data monthly in DSM Central.
- NV Energy should send ADM an updated Gas Education and Consultation event calendar on a monthly basis.

APPENDIX A: RESIDENTIAL CUSTOMER EDUCATION SURVEYS

A.1 Residential Customer Education – 'Public Outreach' – Survey

NVEnergy

2017 Public Outreach Survey

We value your opinion because customer satisfaction is important to us at NV Energy. Please take a few minutes to fill out this short survey.

1. **After visiting NV Energy's exhibit, which of the following energy savings program that you learned about would you like to participate in (program descriptions provided on back):**

- ☐ High-Efficiency Air Conditioning Program (southern Nevada only)
- ☐ LED Lighting Program
- ☐ Equal Payment Plan
- ☐ Energy Education Opportunities
- ☐ My Account Online Tools
- ☐ Refrigerator Recycling
- ☐ Energy Efficient Pool Pumps (southern Nevada only)
- ☐ Time of Use Rates
- ☐ Solar Generation Rebates
- ☐ Solar Thermal Water Heating
- ☐ mPowered Thermostat Program
- ☐ Home Energy Assessments
- ☐ None of These Programs

2. **Would you like to be contacted by NV Energy with additional information on how to participate in their energy saving and demand response programs:**

   Yes ☐ No ☐

3. **Please rank the top 3 reasons why you visited the NV Energy exhibit today:**

   Had questions about renewable programs: _____
   Had questions about my bill: _____
   Learn ways to save energy: _____
   The display(s) looked interesting to me: ___
   I am new to the area and don't know much about NV Energy: _____
   Someone recommended that I stop by NV Energy's exhibit: _____
   To see what NV Energy was giving away at the exhibit: _____
   Other: ____________________ Rank: ____

Using a zero-to-ten scale, where a zero means that you were extremely dissatisfied and ten means you are extremely satisfied.

	Extremely Dissatisfied				Neutral					Extremely Satisfied
	0	1	2	3	4	5	6	7	8	9	10
4. How satisfied were you with the way that your needs were addressed by visiting NV Energy's exhibit?											
5. How satisfied were you that you left today's exhibit knowing more about NV Energy's incentives for energy efficiency and other customer programs and services?											

6. **How could NV Energy improve the exhibit to provide a better experience for you:**

   ____

7. **What can NV Energy do to provide better service to you:**

   ____

8. **Is there anything that you would like NV Energy to follow up on for you:**

Thank you for your feedback!
To receive additional information, please fill out the optional contact fields below.

Name: ______________________________ **Address:** ____________________________

Email Address: _____________________ **Phone #:** ____________________________

High Efficiency Air Conditioning Program: Provides instant rebates for upgrading AC systems and equipment through participating contractors.
LED Lighting Program: Program subsidizes LED light bulbs at participating retailers and contractors.
Equal Payment Plan: Averages your energy costs over the year so your monthly bill is easier to manage.
My Account Online Tools: NV Energy's online personal account management tools.
Refrigerator Recycling: Provides a financial incentive for recycling old refrigerators and freezers.
Energy Efficient Pool Pump Rebates: Provides an instant rebate through participating retailers for installing energy efficient pool pumps.
Time of Use Rates: Program that provides rates structured to increase off-peak use for NV Energy customers.
Solar Generation Rebates: Program for customers who want to install photovoltaic cells on their homes.
Solar Thermal Water Heating: Program provides rebates for residential customers who install solar thermal water heaters.
mPowered Thermostat Program: Program where customers earn money back on their energy costs for allowing their thermostat setpoints to be adjusted during summer peak usage times. Program includes installation of a free smart thermostat.
Home Energy Assessments: NV Energy service whereby a home energy auditor visits residences and provides tips on how the homeowner may reduce their energy usage.

A.2 EnergySmart Educator Participant Survey

1. Hi, [insert teacher first name], you were sent this survey by ADM an independent research firm contracted by NV Energy.

   According to Green Power's records, you participated in the annual EnergySmart Educator training at Springs Preserve in Las Vegas, an event sponsored by NV Energy. Is this correct?
   1. Yes
   2. No [Terminate Interview]

2. Prior to receiving this survey, were you aware that NV Energy sponsored the annual EnergySmart Educator training that you attended?
   1. Yes
   2. No

3. How did you first learn about the EnergySmart Educator training?
   1. The EnergySmart Educator training was recommended to me by a colleague e.g. teacher or principal
   2. I attended the EnergySmart Educator training last year
   3. Industry newsletter
   4. Desert Research Institute website
   5. One of my student's parents suggested the EnergySmart program to me
   6. At a previous continuing education event [Please specify event]
   7. NV Energy representative

   97. Other [Please specify]
   98. Don't know

4. What grade do you teach?
   1. Elementary: kindergarten through 2nd grade
   2. Elementary: 3rd through 5th grade
   3. Middle School: 6th through 8th grade
   4. High School: 9th through 12th grade

   97. Other [Please specify]

5. Which of the following do you perceive as benefits of the EnergySmart Educator program and training? [Check all that apply]
   1. Improved my environmental education offerings to my classes
   2. Helped my professional development
   3. I have become more environmentally conscious
   4. My students have become more environmental conscious
   5. Provided me ideas about other ways to teach about the environment
   6. Easy to implement
   7. Reduced my personal teaching expenses

   97. Other [Please specify]

98. Don't know
99. I do not perceive any benefits of the program

[DISPLAY Q6 IF Q5 ≠ 98,99]

6. Please rank the benefits of the EnergySmart Educator program and training. [Rank the most significant benefit as number 1 and so forth]

EnergySmart Educator Impact on Energy Efficiency Beliefs and Behaviors

7. Prior to the EnergySmart Educator training, which of the following statements best describes your level of emphasis on energy efficiency? [Select the option that most describes you]
   1. I actively incorporated energy efficiency topics into my curriculum and tried to find ways to save energy at home
   2. I was aware of energy efficiency and related topics, but it was not a point of emphasis for me
   3. I was not familiar with energy efficiency and related topics prior to the EnergySmart Educator training
   97. Other [Please specify]

8. Since participating in the EnergySmart Educator training, have you taken any of the following actions? [Check all that apply]
   1. Now, I find ways to include energy efficiency and related topics in my curriculum
   2. I made structural and/or equipment changes to my home such as installing more insulation or energy efficient lighting
   3. I participated in one or more of NV Energy's residential and commercial programs that I learned about at the EnergySmart Educator training
   4. I made changes to my behavior to save energy
   5. I shared the information that I learned on NV Energy's residential and commercial energy saving programs with my family, friends, colleagues, neighbors, or students
   97. Other [Please specify]
   98. Don't know
   99. No, I have not taken any action

[DISPLAY Q9 IF Q8 = 1]

9. How have you included energy efficiency and related topics in your curriculum since the EnergySmart Educator training? [Check all that apply]
   1. Lecture
   2. Hands on activities
   3. Behavioral based reinforcement e.g. designating a student to turn the lights off
   4. Video presentation on energy efficiency
   5. Energy efficiency project or homework
   97. Other activity [Please specify]
   98. Don't know
   99. None of the above

[DISPLAY Q10 IF Q8 = 2]

10. What structural or equipment changes did you make to your home? [Check all that apply]
    1. Installed building upgrades such as insulation or windows
    2. Purchased a more efficient air conditioner or furnace
    3. Sealed the ducts in my home
    4. Purchased a new pool pump
    5. Recycled an old refrigerator or freezer
    6. Installed more efficient lighting fixtures or lamps
    7. Purchased more energy efficient appliance(s)
    8. Installed solar energy related equipment
    9. Installed a new thermostat
    98. Other upgrades [Please specify]
    99. Don't recall

[DISPLAY Q11 IF Q8 = 2]

11. Did you off-set the cost of some or all the recent structural and/or equipment changes by participating in any of NV Energy's programs that you learned about during the EnergySmart Educator training?
    1. Yes
    2. No
    98. Don't know

[DISPLAY Q12 IF Q8 = 3 OR IF Q11 = 1]

12. Which of the following NV Energy programs did you participate in following the EnergySmart Educator training? [Check all that apply]
    1. High Efficiency Air Conditioning Program (southern Nevada only)
    2. LED Lighting Program [Purchased NV Energy subsidized light bulbs at participating retailers]
    3. My Account Online Tools
    4. Refrigerator Recycling
    5. Energy Efficient Pool Pumps (southern Nevada only)
    6. Solar Generation Rebates
    7. mPowered Thermostat Program
    8. Energy Smart Schools
    97. Other program(s) [Please specify]
    98. Don't know
    99. I did not participate in any of NV Energy's programs

[DISPLAY Q13 IF Q8 = 4]

13. What energy efficient behavior have you engaged in since the EnergySmart Educator training? [Check all that apply]
    1. Turned off lights and/or appliances when you leave a room
    2. Adjusted the thermostat when you leave your home
    3. Used machines like washers, dryers, and dishwashers early in the morning or later at night
    4. Washed clothes with cold water
    5. Saved hot water by taking shorter showers
    6. Opened your blinds or curtains on sunny days to let the sun light your home
    97. Other energy saving behavior [Please specify]
    98. Don't know

[DISPLAY Q14 IF Q8 = 5]

14. With whom did you share the information that you learned about NV Energy's residential and commercial energy saving programs? (Check all that apply)
    1. Family
    2. Friends
    3. Colleagues (other teachers)
    4. Students
    5. Neighbors
    97. Other [Please specify]
    99. None of the above

[DISPLAY Q15 IF Q14 ≠ 99]

15. Are you aware if any of the [Insert answer's to Q14] participated in NV Energy's residential or commercial energy savings programs as a result of your recommendation?
    1. Yes
    2. No
    98. Don't know

[DISPLAY Q16 IF Q15 = 1]

16. How many of the [Insert answer's to Q11] participated in NV Energy's residential or commercial energy savings programs as a result of your recommendation?

Green Box Implementation

17. Did you check out a Green Box during 2017?
    1. Yes [Skip to Q20]
    2. No [Skip to Q31 after Q18 and Q19]

[DISPLAY Q18 IF Q17 = 2]

18. Do you plan on checking out a Green Box within the next two years?
    1. Yes
    2. No

[DISPLAY Q19 IF Q17 = 2]

19. Please rank the following reasons why you will not check out a Green Box in the next two years. [Rank the most influential reason as number 1 and so forth]
    1. There are no Green Boxes that I can integrate into my existing curriculum
    2. The Green Boxes are not for the grade that I teach
    3. The Green Boxes currently available are not interesting to my students
    4. The Green Boxes currently available are not interesting to me
    5. The Green Boxes are not relevant to my students for practical application
    97. Other [Please specify]

[IF Q17 = 2, NOW SKIP TO Q31]

20. What subject did you teach using the Green Box curriculum? (Check all that apply)
    1. General science
    2. Biology
    3. Chemistry
    4. Mathematics
    5. Geology
    6. Statistics
    7. English
    97. Other [Please specify]

Pro-Environmental Curriculum

21. Which titles from the Green Box curriculum did you use in your classroom? (Please check all that apply)
    1. Electrical Systems
    2. Thermal Systems
    3. Natural Gas
    4. Energy Efficiency
    5. Solar Energy
    6. Climate Change
    7. Water Basics
    8. Water in the Natural and Build Environment
    9. Intro to Hydrologic Cycle
    10. Water Resources and Conservation
    11. Properties of Water
    97. Other [Please specify]

22. What are the reasons you chose the Green Box that you checked out?
    1. The Green Box that I chose integrated easily into my existing curriculum.
    2. The Green Box that I chose was the most appropriate for the grade that I teach
    3. The Green Box that I chose seemed to be the most interesting to my students
    4. The Green Box that I chose seemed to be the most interesting to me
    5. The Green Box that I chose was the most relevant to my students for practical application
    97. Other [Please specify]

23. Please rank the reasons you chose the Green Box that you checked out. [Rank the most significant reason as number 1 and so forth]

24. Based upon your experience with the curriculum thus far, which of the following titles would you use in your classroom if you repeated the program? (Please check all that apply)
    1. Electrical Systems
    2. Thermal Systems
    3. Natural Gas
    4. Energy Efficiency
    5. Solar Energy
    6. Climate Change
    7. Water Basics
    8. Water in the Natural and Build Environment
    9. Intro to Hydrologic Cycle
    10. Water Resources and Conservation
    11. Properties of Water
    97. Other [Please specify]
    98. Don't know
    99. None

[Display Q25 if Q24 ≠ 99]
25. Why would you include these titles/subjects?

26. Are there other titles or subjects that should be included in future Green Boxes that you think would increase your students' pro-environmental behavior and energy awareness?

Student Behavior Change

27. In general, what was the overall level of student interest in the Green Box lessons?
    1. Very interested
    2. Somewhat interested
    3. Neither interested or disinterested
    4. Somewhat disinterested
    5. Very disinterested
    98. Don't know

28. How frequently did you notice the following changes as a result of the Green Box curriculum while in the classroom?
    (Frequency rating: 1-significantly more than before curriculum, 2-more than before the curriculum, 3-equal to before the curriculum, 4-less than before the curriculum, 5-significantly less than before the curriculum)
    1. Students discussed energy efficiency and environmental changes
    2. Students engaged in more pro-environmental behaviors such as turning off lights when leaving the room, recycling, conserving water
    3. Students asking for more projects and/or lessons about the environment

4. Opening blinds or curtains on sunny days to let the sun light the room
5. Develop ideas for ways to make the classroom/school more environmentally friendly
97. Other [Please specify]
98. Don't know

29. Have your students reported making any of the following behavioral changes at home as a result of the Green Box curriculum? [Select all that apply]
    1. Buying local produce
    2. Recycling
    3. Turning off lights and appliances when not in use
    4. Conserving water
    5. Telling others (i.e., family members, peers) about the curriculum and/or ways to reduce the impact on the environment
    6. Composting
    7. Adjusting the thermostat when leaving the home
    8. Used machines like washers, dryers, and dishwashers early in the morning or later at night
    9. Saving hot water by taking shorter showers
    10. Opening blinds or curtains on sunny days to let the sun light your home
    11. Participating in energy efficiency programs (i.e., home audits, NV Energy rebate programs)
    97. Other [Please specify]
    98. Don't know
    99. None of the above

30. To your knowledge, have your students influenced family members to make any of the following structural changes at home as a result of the Green Box curriculum?
    1. Installing building upgrades such as insulation or windows
    2. Purchasing a more efficient air conditioner or furnace
    3. Installing more efficient lighting fixtures or lamps
    4. Purchasing more energy efficient appliance(s)
    5. Recycling old appliances e.g. second freezers or refrigerators
    97. Other [Please specify]
    98. Don't know
    99. No

Program Satisfaction

31. On a scale of 0-10 where 0 is Very Dissatisfied and 10 is Very Satisfied, please rate your overall satisfaction with the EnergySmart Educator training:

0 1 2 3 4 5 6 7 8 9 10

32. On a scale of 0-5 where 0 is Very Dissatisfied and 10 is Very Satisfied, please rate your satisfaction with the content of the EnergySmart Educator training:

0 1 2 3 4 5 6 7 8 9 10

33. Knowing that the EnergySmart Educator program was supported by NV Energy, does that:
    1. Increase your satisfaction with NV Energy as your electrical service provider
    2. Somewhat increase your satisfaction with NV Energy as your electrical service provider
    3. Neither increase or decrease your satisfaction with NV Energy as your electrical service provider
    4. Somewhat decrease your satisfaction with NV Energy as your electrical service provider
    5. Decrease your satisfaction with NV Energy as your electrical service provider
    98. Don't know

[DISPLAY Q34 IF Q33 = 4 or 5]

34. Why did your participation in the Energy Smart Educator Program decrease your satisfaction with NV Energy?

Valediction

[Display Q35 if Q1=2]

35. You received a survey invitation in error. Have a great day!

[Display Q36 if Q1=1]

36. Thank you for taking our survey. Your response is very important to us and your comments help to improve the program for future participants!

APPENDIX B: BUILDING INDUSTRY SUPPORT SURVEY FORMS

1. After visiting NV Energy's exhibit, which of the following energy savings program that you learned about would you like to participate in (program descriptions provided on back):

- ☐ LED Lighting Program
- ☐ Equal Payment Plan
- ☐ Energy Education Opportunities
- ☐ My Account Online Tools
- ☐ Refrigerator Recycling
- ☐ Time of Use Rates
- ☐ Solar Generation Rebates
- ☐ mPowered Thermostat Program
- ☐ Home Energy Assessments
- ☐ None of These Programs

2. Would you like to be contacted by NV Energy with additional information on how to participate in their energy saving and demand response programs:

Yes ☐ No ☐

3. Please rank the top 3 energy efficiency topics that you would like to learn more about:

Air conditioning: ____
Water heating: ______
Windows: _____
Insulation: ____
Roofing: ____
Large Appliances (Refrigerators & Dishwashers): ___
Building Above Code: ____
Other: ____________________ Rank: __

4. How satisfied were you with the way that your needs were addressed by visiting NV Energy's exhibit?

Extremely Dissatisfied				Neutral					Extremely Satisfied
1	2	3	4	5	6	7	8	9	10

5. How satisfied were you that you left today's exhibit knowing more about NV Energy's incentives for energy efficiency and other customer programs and services?

6. How could NV Energy improve the exhibit to provide a better experience for you:

7. What can NV Energy do to provide better service to you:

8. Is there anything that you would like NV Energy to follow up on for you:

Valediction

Thank you for taking our survey. Your feedback is very important to us and will help us enhance future workshops.

C.1 AEE Lunch-and-Learn Surveys

NVEnergy

How Did We Do Today?

We value your feedback. Please tell us if today's training met your expectations.

	0 Strongly Disagree	1	2	3	4	5 Neutral	6	7	8	9	10 Strongly Agree
I gained valuable information today.											
I will use the information today to improve my business operations.											
The trainer was knowledgeable.											
The trainer communicated effectively.											
I would recommend this training to a colleague.											
I am likely to attend a future training seminar.											

What improvement(s) could we implement to better your experience? ______

Are you interested in additional trainings? Please indicate the topics that interest you:

- ❑ Compressed Air
- ❑ Lighting
- ❑ Motors
- ❑ HVAC
- ❑ Energy Management Systems
- ❑ Refrigeration
- ❑ New construction
- ❑ Energy audits
- ❑ Other: _______________

How did you learn about today's training?

- ❑ NV Energy Sure Bet E-mail Invitation
- ❑ Referred by a colleague
- ❑ NV Energy Website
- ❑ NV Energy Representative
- ❑ Social Media (e.g. Facebook or LinkedIn)
- ❑ Other: _______

Please rank the top 3 reasons why you attended today's event?

- ❑ The topic was relevant to me or my firm
- ❑ Professional development and networking
- ❑ Continuing education credit(s)
- ❑ The event was sponsored (free)
- ❑ Other

Can we provide you with additional resources or assistance?

- ❑ I would like to receive the quarterly e-newsletter from NV Energy Sure Bet
- ❑ I would like to receive AEE's invites and e-newsletters
- ❑ I would like to join the Contractor Network
- ❑ I plan to submit an incentive application

My name: ______________________ Company: ______________________

Email: ______________________ Phone: ______________________

Thank you for attending today's training and for sharing your comments. Please contact a member of our team if you would like any additional information.

C.2 Commercial Customer Education Survey

Event Topic
Event Date - Site

	Strongly Disagree 0	1	2	3	4	Neutral 5	6	7	8	9	Strongly Agree 10
Today's presentation provided new information that improved your knowledge on the topic that was presented.											
Based on the topic and promotion, today's event met your expectations.											
You are satisfied with the content of today's presentation.											
The trainer communicated effectively.											
You would recommend this training to a colleague.											
You are likely to attend a future event.											

1. How did you find out about today's event? Please check one box
   - ❑ AEE Email
   - ❑ AEE Website
   - ❑ Colleague or friend
   - ❑ From an NV Energy, Southwest Gas or DNV-GL staff member
   - ❑ Through my firm or company
   - ❑ Other: ______________
2. Please rank the top 3 reasons why you attended today's event?
   - The topic was relevant to me or my firm: _____
   - Professional development and networking: _____
   - Other: _______________
   - Continuing education credit(s): _____
   - The event was sponsored (free): _____

3. Which topics or aspects of today's workshop are you most likely to implement or share with a colleague or friend?

   ____

4. What suggestions do you have to improve this workshop?

   ____

5. What other topics would motivate your participation in future workshops?

   ____

6. What can NV Energy or Southwest Gas do to improve service for you?

   ____

7. Would you like to be contacted by NV Energy or Southwest Gas with additional information on their energy efficiency and demand response programs?

   Yes ❑ No ❑

To receive additional energy saving information, please fill out the optional contact fields below.

Name: ______________________________

Company Name: ____________________

Position/Title: _______________________

Best Contact Method: ☐Phone ☐E-Mail

Phone #: ____________________________

Email Address: _____________________

Thank you for participating, we appreciate your feedback.

C.3 2017 Energy Code Education Training Survey

2017 Energy Code Education Training Survey

Please tell us if today's training met your expectations, we value your feedback.

Based on your overall experience, how satisfied are you with the training? Using the zero-to-ten scale below, please rank each statement where a zero means you strongly disagree and a ten means you strongly agree with the question.	Strongly Disagree				Neutral						Strongly Agree
	0	1	2	3	4	5	6	7	8	9	10
I gained valuable information today.											
The trainer was knowledgeable.											
The trainer communicated effectively.											
I would recommend this training to a colleague.											
I am likely to attend a future training seminar.											

What improvement (s) can we implement in the future to better your experience?

Are there any new code provisions that you see having a difficult time implementing?

How did you find out about today's training session? What improvement (s) can we implement to better your experience?

Your profession or occupation:

Name: ________________________________ Company: ________________________________

Email: ________________________________ Phone: ________________________________

Thank you for attending today's training and for sharing your comments.

DSM-7

Home Energy Reports
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

3239 Ramos Circle
Sacramento, CA 95827
916-363-8383

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

This measurement and verification ("M&V") report provides the energy impacts evaluation of NV Energy's 2017 *Home Energy Reports component of the Energy Education Program* for the southern Nevada service territory ("Nevada Power").

The main features of the approach used for the impact evaluation of this program included:

- Using a control and treatment group design, a difference in differences econometric panel data model was utilized to determine energy savings.

The calendar year 2017 was the fourth year that NV Energy implemented the *Home Energy Reports Program*. This behavioral program was introduced to NV Energy's customers starting in August 2014. The 2017 *Home Energy Reports Program* is unlike typical Demand Side Management ("DSM") programs in that many participants in the 2014 *Home Energy Reports Program* continued their participation during the 2017 *Home Energy Reports Program*. In 2017, *Home Energy Reports Program* became an educational program, and thus no energy savings will be claimed for the savings documented in this report.

M&V analyses utilized two groups of treatment and corresponding control group members which were characterized as high consumption participants and low-income participants as described below.

On June 13, 2017 NV Energy's independent third-party M&V contractor, ADM Associates, Inc. ("ADM") provided the final M&V report for the 2016 *Home Energy Reports Program*. In it, the following was reported:

- There were 192,919 high consumption treatment group participants in the 2016 *Home Energy Reports Program*.
- Those 192,919 treatment group participants achieved 2016 "third-year" *ex-post* verified energy savings of 9,079,593 kWh, and it was projected that their 2017 "full-year" energy savings would amount to 6,255,175 kWh.

Of the 192,919 high- consumption treatment group participants in the 2016 *Home Energy Reports Program,* 176,499 continued to participate in the 2017 *Home Energy Reports program*. These high consumption participants in the 2017 *Home Energy* Reports Program are characterized in different groups as "wave 1", "wave2", "wave3", "wave 4", "wave 5", and "wave 6" in this M&V report for as the participants received the first Home Energy Reports in six different timeframes.

Measure life is expected to be 3.5 years from the beginning of the treatment period.[1]

In this M&V report for the 2017 *Home Energy Reports Program*, ADM is reporting the following *ex-post* verified high consumption participants energy savings:

[1] Measure life is discussed in section 3.2.5 in this report.

- 2,104,244 kWh for 2014 (same as indicated in the April 8, 2015 M&V report for the 2014 Home Energy Reports program)
- 12,874,537 kWh for 2015 (same as indicated in the May 12, 2015 M&V report for the 2015 Home Energy Reports program)
- 9,079,593 kWh for 2016 (same as indicated in the June 13, 2017 M&V report for the 2016 Home Energy Reports program)
- 6,125,445 kWh for 2017 (as verified in this M&V report)
- 4,207,914 kWh for 2018 (projected kWh savings)
- 34,391,733 kWh estimated total lifetime savings

High Consumption Participants

Table 1-1 indicates *ex-post* verified high consumption participants energy (kWh) savings for the *Home Energy Reports Program* in southern Nevada for the period of January 1 through December 31, 2017. The calendar-year 2017 energy savings of 6,125,445 kWh represents a realization rate of 99% for the program in southern Nevada.[2]

Table 1-1. Summary of Calendar Year 2017 kWh Savings, High Consumption

Calendar Year 2017 Ex-ante kWh Savings[3]	***Gross Verified Calendar Year 2017 Ex-post kWh Savings***	***Realization Rate***
6,218,536	6,125,445	99%

The difference between *ex-post* verified 2017 energy savings of 6,125,445 kWh and previously projected energy savings for 2017 is -129,730 kWh, as shown in Table 1-2. *Ex-post* verified critical peak demand savings are 2,266 kW.

Table 1-2. Reconciliation of Ex-Post Verified High Consumption Energy Savings for 2017

Ex-post verified calendar-year 2017 energy savings:	6,125,445 kWh
Previously projected calendar-year 2017 energy savings:	6,255,175 kWh
The difference, i.e., additional 2017 savings compared to previous M&V report:	-129,730 kWh

[2] The realization rate is the ratio of *ex-post* verified energy (kWh) savings to *ex-ante* expected energy (kWh) savings, i.e., at the program level: 6,125,445 kWh *ex-post* ÷ 6,218,536 kWh *ex-ante* = .99 or 99%.

[3] *Ex-ante* savings were provided in the final Tendril weekly status report, dated 11/7/2017.

Low-Income Participants

Table 1-3 indicates *ex-post* verified low-income participants energy (kWh) savings for the *Home Energy Reports Program* in southern Nevada for the period of January 1 through December 31, 2017. The calendar-year 2017, ADM found no statistically significant savings for the low-income participants.

Table 1-3. Summary of Calendar Year 2017 kWh Savings, Low-Income

Calendar Year 2017 Ex-ante kWh Savings	*Gross Verified Calendar Year 2017 Ex-post kWh Savings*	*Realization Rate*
908,853	0	0%

Table 1-4 shows the summary of program level 2017 energy kWh savings.

Table 1-4. Summary of Program Level 2017 Energy kWh Savings

Participant Group	*Ex-ante kWh Savings*	*Ex-post kWh Savings*	*Variance*	*Realization Rate*
High Consumption Participants	6,218,536	6,125,445	-93,091	99%
Low Income Participants	908,853	0	-908,853	0%
HERs Program Total	7,127,389	6,125,445	-1,001,944	86%

2. PROGRAM BACKGROUND

NV Energy contracted with implementation contractor Tendril to deliver a behavioral-based program targeted at residential customers. The program is designed to generate greater awareness of energy use and ways to manage energy use through energy efficiency education in the form of home energy reports (HERs).[4] The program provides customers with information about their home's energy use, compares that energy use to that of a group of similar households (both average and most efficient neighbors), and educates them on low-cost measures, practices or behaviors to reduce their energy use. It was expected that through this education, customers would be encouraged to implement measures or adopt practices that lead to more efficient energy use in their homes. The HERs were designed to also encourage residential customers to participate in other NV Energy demand side management programs. To increase participants' active engagement with their HERs, the implementer also sent participants eight email challenges.[5] An email challenge contained three components, the challenge activity, instructions to carry out the challenge, and a short description on how the challenge saves energy.

In 2014, the inception of the *Home Energy Reports Program*, Tendril chose a program population that targeted NV Energy's high-energy use, residential customers. After the initial target population was selected, Tendril randomly allocated each household into either the treatment (household receives HER) or the control group (household receives no communication related to Home Energy Reports). This method created two statistically similar groups (treatment and control) which were compared to accurately determine the program's energy savings. During the calendar year 2017, treatment group members from the 2014 *Home Energy Reports Program* continued to receive HERs. Since 2014, Tendril repeated the participant selection process to create more waves of treatment and control groups.

2.1 HIGH CONSUMPTION PARTICIPANTS

In 2014, when the initial treatment and control groups were constructed for the *Home Energy Reports Program*, Tendril reserved participants to be used as backfill for participants that exited the program. On 6/1/2015, Tendril added participants from the backfill group to both the treatment and control groups.

In September 2015, Tendril revised the design of the control and treatment groups to increase the savings achieved by the *Home Energy Reports Program*. To revise the program, Tendril estimated energy savings for each individual household. From the distribution of individual household energy savings, Tendril identified "low savers" as the lowest 20 percent of energy savers. Similarly, Tendril identified the "high savers" as the top 10 percent of energy savers. In the revised

[4] Example shown in Appendix B.

[5] Example shown in Appendix C.

design, "low savers" began to receive only email HERs or were removed from the program if Tendril did not have an email address for the household.

To determine backfill treatment group and corresponding control group members, Tendril utilized look-alike modeling based on demographic characteristics of the "high savers" in the program to identify among NV Energy's residential single-family customers those most likely to save energy.[6] In 2016, Tendril added two more treatment and control groups that began receiving HERs And in 2017, Tendril added one more treatment and control group.

During 2017, on NV Energy's behalf, Tendril delivered HERs to six treatment groups of high consumption customers as outlined below:[7]

Table 2-1: Treatment Group by Wave, High Consumption

Participant Group	***Number of Participants***	***Start Date***
Wave 1	77,561	August – December 2014
Wave 2	11,377	6/1/2015
Wave 3	12,404	11/1/2015, 12/1/2015
Wave 4	39,583	1/1/2016, 3/28/2016
Wave 5	51,994	10/15/2016
Wave 6	19,979	6/5/2017

The goals for the 2017 Home Energy Reports Program's high consumption participants were:

- Deliver a large-scale, cost-effective, and verifiable measure which reduces energy consumption by at least 1.5%
- Generate measurable demand (kW) savings that can be calculated and verified
- Motivate increased awareness and adoption of NVE's energy conservation programs
- Strengthen NV Energy's relationship with its customers

2.2 LOW-INCOME PARTICIPANTS

In 2015 Tendril began delivering home energy reports to select NV Energy low-income customers[8] and in 2016, Tendril added two more treatment groups.

[6] Outlined in the Tendril white paper entitled, *Optimizing Home Energy Reports Programs: Data Analytics to Maximize Program Impacts and Cost Effectiveness.*
[7] Distribution maps for each treatment group are provided in Appendix D.
[8] Distribution maps for each treatment group are provided in Appendix D.

Table 2-2: Treatment Group by Wave, Low-Income

Participant Group	Number of Participants	Start Date
Wave 1	10,993	August – December 2014
Wave 2	13,886	3/28/2016
Wave 3	9,997	10/15/2016

Tendril utilized the following criteria to assemble the pool of participants that were randomly selected into the Low-Income treatment and control groups:

- 150% or greater of the federal poverty level based on number of people in the house;
- Customers with a ratio greater than 13.8% of electricity bill to income; and
- Customers living in targeted zip codes[9].

The goals for the 2017 Home Energy Reports Program's Low-Income component were:

- Deliver a large-scale, cost-effective, and verifiable measure which reduces energy consumption by at least 1%;
- Generate measurable demand (kW) savings that can be calculated and verified; and
- Offer low and no cost solutions for participating low-income customers.

In November 2017, Tendril ended their operation of the program. NV Energy will operate the high consumption and low-income portions of the *Home Energy Reports Program* as an educational program in 2018.

[9] A zip code was targeted if 30% or greater of households had an annual income of $24,999 or less.

3. M&V METHODOLOGY

This chapter provides descriptions of the methodology applied by ADM Associates in performing the M&V work for the 2017 *Home Energy Reports Program*.

3.1 TREATMENT AND CONTROL GROUPS

M&V for the 2017 *Home Energy Reports Program* utilized a randomized control and test group experimental design to determine energy savings. M&V analyses utilized two groups of treatment and corresponding control group members which were characterized as high consumption participants and low-income participants as described in Chapter 2. Only participants with valid data for both their pre-treatment and post-treatment periods were counted as participants. The high consumption group of participants deployed in six waves as described below and shown in Table 3-1.

The counts of participants in the 2017 *Home Energy Reports Program* are provided in Table 3-1. ADM verified delivery of HERs to treatment group participants by comparing the list of participants to the HERs distribution dataset provided by Tendril. The description of each wave is provided in Section 2.1.

Table 3-1. Home Energy Reports Program Participant Counts and Pre-Program Consumption

High Consumption Participants				
Participant Group	***Treatment Group***		***Control Group***	
	Count	***Pre-Program Average Daily kWh***	***Count***	***Pre-Program Average Daily kWh***
wave 1	52,138	49.9	33,279	50.1
wave 2	8,330	57.8	4,653	58.3
wave 3	8,497	71.9	5,240	71.2
wave 4	23,882	52.1	15,857	51.6
wave 5 (low-savers)	43,428	27.5	20,797	27.6
wave 6	16,026	42.0	7,994	42.1
Total	**152,301**	**44.7**	**87,820**	**46.0**
Low-Income Participants				
Participant Group	***Treatment Group***		***Control Group***	
	Count	***Pre-Program Average Daily kWh***	***Count***	***Pre-Program Average Daily kWh***
wave 1	7,151	33.5	2,868	33.5
wave 2	9,409	29.1	3,736	29.1
wave 3	7,638	31.6	3,058	31.6
Total	**24,198**	**31.2**	**9,662**	**31.2**
HERs Program Total	**176,499**	**42.8**	**97,482**	**44.5**

3.2 CALCULATION OF ANNUAL KWH SAVINGS

To determine annual kWh savings, ADM utilized panel regression modeling to analyze program participants' monthly billing data. The data cleaning steps and methodology for the panel regression approach are presented in this following section. The analysis methodology was the same for each of the treatment and control groups described in Section 3.1.

3.2.1 PREPARATION OF DATA

ADM incorporated several types of data into the preparation of the dataset that was utilized in the regression analysis outlined in this section:

1. NV Energy provided raw monthly billing data for all treatment and control group participants for the period January 1, 2013, through December 31, 2017.
2. Regional weather data.
3. Participant information:
4. Home energy reports delivery data:
   - Date each treatment group member received their first HER
   - 2017 HERs distribution data
5. A dual enrollment dataset compiled by ADM of participants in NV Energy's other residential DSM programs.

ADM performed the following steps to prepare the dataset that was utilized to determine the verified energy savings for the 2017 Home Energy Reports Program.

1. Verified that participants were sent HERs during 2017.
2. Merged this dataset with the raw billing data provided by NV Energy.
3. Cleaned the data for duplicate bills and string characters in the monthly consumption column.
4. Removed customers with less than 10 bills during the pre-program year.
5. Removed customers with less than 10 bills during program year.
6. Removed customers that did not have both pre-program and program year data.
7. Removed bills where consumption was denoted with an estimate flag.
8. Removed outliers for observations that have the following characteristics: average daily usage greater than an order of magnitude from the median usage; or low average daily usage indicating lack of occupancy.
9. Parsed the data into the treatment groups along with their respective control groups.

3.2.2 CROSS PARTICIPATION VERIFICATION

ADM removed from the regression analysis any participants that also participated in NV Energy's other residential demand side management programs. The percentage of treatment group members in NV Energy's other DSM programs for the high consumption participants was around 15% as shown in Table 3-2. The percentage of low-income treatment group members in NV Energy's other DSM programs was similar at 13%.

Table 3-2. Treatment Group Members in NV Energy's Other DSM Programs

High Consumption Participants			
Participant Group	***Treatment Group Count***	***Count of Treatment Group in Other DSM Programs***	***Percent of Treatment Group in Other DSM Programs***
wave 1	52,138	8,314	16%
wave 2	8,330	1,362	16%
wave 3	8,497	1,352	16%
wave 4	23,882	3,675	15%
wave 5	43,428	6,435	15%
Eave 6	16,026	2,310	14%
Total	**152,301**	**23,448**	15%
Low-Income Participants			
Participant Group	***Treatment Group Count***	***Count of Treatment Group in Other DSM Programs***	***Percent of Treatment Group in Other DSM Programs***
wave 1	7,151	907	13%
wave 2	9,409	1,230	13%
wave 3	7,638	1,020	13%
Total	**24,198**	**3,157**	13%
HERs Program Total	**176,499**	**26,605**	**15%**

3.2.3 METHODOLOGY FOR REGRESSION APPROACH

ADM utilized the mixed effects panel regression model specified in Equation 3-1 to determine daily average electricity savings for treatment group members.

$$AEC_{i,t} = \beta_1 CDD_{i,t} + \beta_2 HDD_{i,t} + \beta_3 Post_{i,t} + \beta_4 Treat_{i,t} + \beta_5 Post_{i,t} * Treat_{i,t} + \alpha_i \mathrm{Customer_i} + E_{i,t}$$

Equation 3-1

Where the subscript i denotes individual customers and $t = 1, \ldots, T(i)$ serves as a time index, where $T(i)$ is the number of bills available for customer i. The model is defined as "mixed effects" because the model decomposes its parameters into fixed-effects (i.e. HDD, CDD, Post, Treat, and its various interactions) and random effects (i.e. the individual customer's base usage). A fixed effect is assumed to be constant and independent of the sample, while random effects are assumed to be sources of variation (other than natural measurement error) that are uncorrelated with the fixed effects. The variables included in the regression model are specified in Table 3-3.

The program implementer provided ADM with a dataset that included the participation start date for each treatment group member and their corresponding control group. In the model, the first billing period after the beginning of treatment is considered the "deadband period". Observations that occur in the deadband period are not included in the mixed effects panel regression. For the treatment and control group members, the post period begins in the first billing period following the deadband period. The post variable is defined as a 0 in the billing periods prior to the beginning of treatment and a 1 for billing periods following the beginning of treatment.

Heating degree day (HDD) and cooling degree day (CDD) were the metrics used in the model to control for energy demand based on outside temperature. HDD is derived from the difference between 65 degrees, the outside temperature above which a building needs no heating, and the actual outside air temperature. CDD is derived from the difference between the actual outside air temperature and 75 degrees, the outside temperature below which a building needs no cooling.

Table 3-3. Description of the Coefficients Estimated by the Regression Model

Variable	***Variable Description***
Average Electricity Consumption ($AEC_{i,t}$)	Average daily use of electricity for period t for a customer (determined by dividing total usage over a billing period by number of days in that period)
Customer	A panel of dummy variables that is a 1 if customer i is the i in $AEC_{i,t}$ or a 0 otherwise.
Cooling Degree Days (CDD)	The mean cooling degree days per day during the billing period.
Heating Degree Days (CDD)	The mean heating degree days per day during the billing period.
Post	Post is a dummy variable that is 0 if the monthly period is before the customer received their first HER and 1 if the monthly period is after the customer received their first HER. Similarly, for the control group, the post variable is defined as a 0 if the corresponding treatment group was 0 during that month and a 1 if the corresponding treatment group was a 1 during that month.
Treat	Treat is a dummy variable that is 0 if the customer is a member of the control group and a 1 if the customer is a member of the treatment group.
E_t	E_t is an error term

3.2.4 ESTIMATING COEFFICIENTS OF THE REGRESSION MODEL

With the panel approach, the regression model was applied to monthly billing data for each participant in the sample before and after participation in the program. The pre (2013,2014, 2015, or 2016) and post (2017) periods included data for January 1, 2013, through the end of December 2017. Table 3-4 describes the coefficients that were determined by using the mixed effects panel model shown in Equation 3-1.

Table 3-4. Description of Variables Used in the Regression Model

Coefficient	Coefficient Description
α_1	α_1 is a coefficient that represents the grand mean (mean of the the unique customer specific intercepts). The customer specific intercepts control for any customer specific differences.
β_1	β_1 is a coefficient that adjusts for the customer's cooling season weather-sensitive usage.
β_2	β_2 is a coefficient that adjusts for the customer's heating season weather-sensitive usage.
β_3	β_3 is a coefficient that adjusts for whether customer i's monthly billing data in period t is in the pre or post period.
β_4	β_4 is a coefficient that adjusts for whether customer i is in the treatment group or the control group.
β_5	β_5 is a coefficient that adjusts for the interactive effect between whether customer i's monthly billing data in period t is in the pre or post period and whether customer i was in the treatment or control group during period t. The value of β_5 is the kWh savings per customer per day if it is significant.

3.2.5 DETERMINATION OF EFFECTIVE USEFUL LIFE ("EUL")

The effective useful life for a behavioral program may be bifurcated into two periods:

1. Treatment period in which treatment group receives the treatment and the control group does not receive the treatment. For the Home Energy Reports Program, the treatment consists of receiving a combination of paper HERs, email HERs, and challenge emails.
2. Persistence period in which the treatment effect decays over time due to discontinued treatment.

NV Energy in their planning of the *Home Energy Reports Program* utilized a measure life based on the Integral Analytics Impact and Persistence Evaluation Report of the Sacramento Municipal Utility District (SMUD) Home Energy Report Program.[10] The SMUD report found that savings persistence was projected to dissipate approximately 24 months after report delivery ceased; specifically, the report found annual savings during the final year of HERs reports were 2.3 percent and that persisted savings in the following year (with no HERs reports) were 1.58 percent of energy use.

For the purpose of projecting program savings beyond 2017, ADM utilized several elements of the SMUD report referenced in the previous paragraph. For treatment group members that will continue to receive treatment during the calendar year 2017, ADM bifurcated future savings into the continued treatment period and the persistence period. For the continued treatment period, ADM conservatively projected that savings would continue at a rate of 69% of the savings determined during 2017. This is the same rate of decline found during the first year of the

[10] Wu, May, Osterhus, Tom, "Impact & Persistence Evaluation Report' November 2012, "Sacramento Municipal Utility District, Home Energy Reports Program," Integral Analytics, Inc.

persistence period in the SMUD study.[11] The measure life is expected to be 3.5 years from the beginning of the treatment period.

3.2.6 DETERMINING THE ENERGY SAVINGS CURVE

An energy savings curve for 2017 was intentionally not included in this report because they are typically used for NV Energy's process for reporting savings in their filings. It is ADM's understanding that savings will not be reported for 2017.

3.2.7 CALCULATION OF FIRST YEAR kWh SAVINGS

The *Home Energy Reports Program* is different from other standard DSM programs in that first-year savings for the treatment group members that continued to receive treatment during 2017 were reported in the 2014 *Home Energy Reports Program* M&V Report.

3.2.8 CALCULATION OF CRITICAL PEAK DEMAND (kW) SAVINGS

The ratio between kWh savings to kW savings in the previous three program years was used to determine the critical peak demand (kW) savings for 2017. For the last three program years, the ratio between kWh and kW savings has been between 0.00036 and 0.00038. For 2017, 0.00037 was multiplied by kWh savings to determine the critical peak demand kW savings.

Table 3-5. Relationship between kWh and kW Savings by Program Year

Program Year	Reported kWh savings	Reported kW savings	Ratio
2014	8,182,437	2,969	0.00036
2015	12,874,537	4,672	0.00036
2016	9,079,593	3,427	0.00038

3.2.9 SURVEY SAMPLING METHODOLOGY

Per agreement with NV Energy, no surveys were conducted for program year 2017.

3.2.10 CHALLENGE EMAIL DATA REVIEW

The program implementer sent randomly selected test group participants eight email challenges in addition to the HERs delivered to participants through the mail. ADM received the delivery schedule and challenge email "click through rate" data from the implementer for the email challenges. "Click-through rate" refers to the percentage of challenge email recipients that opened and accepted the email challenge. ADM examined the challenge email delivery data to determine the rate at which participants committed to each email challenge.

[11] Rate of decline = (0.023 - 0.0158) ÷ 0.023 = 0.31 or 31%

4. FINDINGS FROM M&V DATA COLLECTION AND ANALYSIS

This chapter presents results and findings from the data collection and energy savings analysis.

4.1. FINDINGS FROM ENERGY AND DEMAND IMPACT ANALYSIS

This section reports the findings from the M&V analysis of energy and demand impacts for the 2017 *Home Energy Reports Program.*

During 2017, Home Energy Reports were distributed to two distinct treatment groups – i.e., high consumption participants and low-income participants – as described previously in Chapter 2.

High Consumption Participants

Tendril reported 168,736 high consumption participants for 2017[12]. Based on ADM's analysis, we were able to verify 152, 301 high consumption participants.

ADM performed a mixed effects panel regression on the six waves of the high consumption participants group. ADM found statistically significant savings for the first three waves. No savings were found for waves 4 and 5. Wave 6 group members typically had six months or less of post billing data which was not enough post data on which to make statistically valid inferences.[13]

Low-Income Participants

Tendril reported 26,410 low-income participants for 2017[14]. Based on ADM's analysis, we were able to verify 24,198 low-income participants.

ADM found no statistically significant savings for the low-income participants.

4.1.1 CALCULATED kWh SAVINGS

Table 4-1 provides the results of the mixed-effects panel regression modeling that was performed on the data for all waves of participants.

As discussed previously in this section, ADM found statistically significant energy savings only for waves 1, 2 and 3 of the high-consumption participant group.

There were no statistically significant energy savings for high-consumption waves 4, 5, or 6 or low-income waves 1, 2, or 3. Notably, our previous M&V report (for program year 2016) also

[12] In the Tendril report entitled, *NV Energy's MyHome Report Program,* November 9, 2017.

[13] An industry standard white paper prepared by the Brattle Group recommends 12 months of treatment period billing data for treatment and control group members. The citation for the Brattle Group white paper is provided below.

Faruqui, Ahmad, Sanem, Sergici, "Measurement and Verification Principles for Behavior Based Efficiency Programs" May 2011, The Brattle Group.

[14] In the Tendril report entitled, *NV Energy's MyHome Report Program,* November 9, 2017.

reported no statistically significant energy savings for low-income waves 1, 2, 3 or high-consumption waves 4 and 5.

High consumption wave 6 was deployed starting in June 2017. Given that the savings opportunity for wave 6 was approximately half a year, and there is typically a ramp-up period before a new cohort starts responding to treatment, it's likely that there wasn't enough time during 2017 for wave 6 participants to accrue statistically significant energy savings. *Table 4-1.*

Results of Mixed Effects Panel Regression Modeling

High Consumption Participants						
Coefficient	**Wave 1**	**Wave 2**	**Wave 3**	**Wave 4**	**Wave5**	**Wave 6**
Intercept t-value	28.68 184.37	34.41 79.54	41.80 97.02	26.86 112.40	11.52 142.16	22.63 166.79
HDD65 t-value	0.66 234.68	0.73 90.10	0.77 83.60	0.59 154.98	0.38 235.31	0.49 108.78
CDD75 t-value	3.34 1,668.28	3.66 679.58	4.16 691.70	3.51 1,231.31	2.25 1957.56	2.87 933.75
Post t-value	-1.75 -43.24	-1.60 -13.96	-1.54 -11.85	-0.71 -11.5	.66 24.84	1.14 15.15
Treat t-value	-0.13 -0.69	-0.51 -1.02	0.73 1.46	-.41 -1.46	-0.09 -0.95	.07 0.42
Post x Treat t-value	-0.18 --3.77	-0.48 -3.62	-0.40 -2.64	0.04 0.54	-0.06 -1.80	0.08 0.1.00
R-squared	0.84	0.84	0.83	0.85	0.86	0.82

Low-Income Participants			
Coefficient	**Wave 1**	**Wave 2**	**Wave 3**
Intercept t-value	15.70 44.16	13.00 67.65	13.69 40.70
HDD65 t-value	0.63 90.31	0.48 117.62	0.41 83.85
CDD75 t-value	2.54 564.31	2.22 721.03	2.49 704.80
Post t-value	-0.02 -0.18	1.01 14.89	0.65 8.04
Treat t-value	0.06 0.15	-0.09 -0.43	0.04 0.10
Post x Treat t-value	-0.12 -1.11	-0.09 -1.18	-0.01 -0.07
R-squared	.82	.80	.86

Table 4-2 provides average annual kWh savings per participant; participant count; and program-level annual kWh savings for the 2017 Home Energy Reports Program.

Table 4-2 Summary of 2017 kWh Savings

High Consumption Participants				
Participant Group	***Daily kWh Savings***	***Ex-post kWh Savings per Participant***	***Count of Participants***	***Ex-post kWh Savings***
wave 1	0.18	65.70	52,138	3,425,467
wave 2	0.48	175.20	8,330	1,459,416
wave 3	0.40	146.00	8,497	1,240,562
wave 4	0	0	23,882	0
wave 5	0	0	43,428	0
wave 6	0	0	16,026	0
Total		386.90	152,301	6,125,445
Low-Income Participants				
Participant Group	***Daily kWh Savings***	***Ex-post kWh Savings per Participant***	***Count of Participants***	***Ex-post kWh Savings***
wave 1	0.00	0.00	7,151	0
wave 2	0.00	0.00	9,409	0
wave 3	0.00	0.00	7,638	0
Total		0.00	24,198	0

Ex-post verified kWh savings for the treatment groups were determined by applying the daily average per household energy savings value calculated from the regression model to the treatment group population. Program-level, program year 2017 *ex-post* verified kWh savings and *ex-ante* estimated kWh savings – and the realization rate for the program, i.e., the quotient of *ex-post* kWh and *ex-ante* kWh – are provided in Table 4-3.

At the program level, *ex-post* verified energy (kWh) savings are less than implementation contractor claimed *ex-ante* energy (kWh) savings. Differences in data cleaning steps, as well as a variety of factors related to modeling details will contribute to the variance between *ex-ante* estimates and *ex-post* verified savings. Below is a summary of a data cleaning steps employed by ADM in preparing the model dataset utilized by ADM to determine *ex-post* kWh savings:

- Initial data sets – The billing data that was provided directly by NV Energy covered the time range of mid-2014 through 2017. ADM combined this with the “historical” billing data that had previously been provided via Tendril covering the time range prior to mid-2014.
- Filtering – ADM employed consumption and billing duration filters for outliers. Also, ADM dropped the small fraction of bills with E (estimated) or NA values for the estimated flag.

- CDD Base - ADM used a CDD base of 75°F instead of 65°F based on previous analysis of the best fitting CDD base for single family homes in NPC that was conducted as part of ADM's evaluation of NV Energy's *Residential High-Efficiency AC Program*.
- Pre and Post Period Definitions – For each account with treatment starting in 2014, ADM defined the "pre" period as one year prior to treatment start and the "post" period as 2017. For wave 6 of high consumption participants and low income 2017 participants, the pre-period was defined as one year prior to treatment start and the post period as the remainder of 2017.

Table 4-3. Summary of Program-Level 2017 Energy kWh Savings

Participant Group	Ex-ante kWh Savings	Ex-post kWh Savings	Difference	Realization Rate
High Consumption Participants	6,218,536	6,125,445	-93,091	99%
Low Income Participants	908,853	0	-908,853	0%
HERs Program Total	7,127,389	6,125,445	-1,001,944	86%

The 176,499 participants in the 2017 Home Energy Reports program achieved 2017 full-year energy savings of 6,125,445 kWh. This is 129,730 kWh savings less than what ADM projected in the June 13, 2017 M&V report for the 2016 *Home Energy Reports Program* as shown in Table 4-4.

Table 4-4. Reconciliation of Ex-Post Verified Savings for 2017

Ex-post verified calendar-year 2017 energy savings:	6,125,445 kWh
Previously projected calendar-year 2017 energy savings:	6,255,175 kWh
The difference, i.e., additional 2017 savings compared to previous M&V report:	-129,730 kWh

Measure life is expected to be 3.5 years from the beginning of the treatment period.[15] Table 4-5 presents the program level *ex-post* verified energy savings for the 2017 *Home Energy Reports Program*.

Table 4-5. Summary of Program Level Ex-Post Verified kWh Savings

Year	Ex-post kWh Savings
2014	2,104,244
2015	12,874,537
2017	9,079,593
2017	6,125,445
2018	4,207,914
Total (Lifetime) Savings	34,391,733

[15] Measure life is discussed in section 3.2.5 in this report.

4.1.2 CALCULATED CRITICAL PEAK DEMAND (kW) SAVINGS

Critical peak demand (kW) savings were determined using the ratio between previous year's reported kWh and kW savings as described in Section 3.2.9. The annual critical peak demand savings for this program in 2017 was 2,266 kW.

4.1.3 CALCULATION OF *EX-POST* PRECISION

After completing the analysis of energy savings resulting from the program, we achieved an *ex-post* precision of better than ±10% at the 90% confidence level. Statistical analysis of participants' monthly billing data yields the most accurate and precise determination of actual energy savings that were achieved through the distribution of HERs.

Analyzing participants' billing data across the whole program achieves optimal precision, given that 1) sampling error is minimized when analyzing billing data for a census of control and treatment group participants and 2) measurement error is null or near zero given that NV Energy billing data is correct.[16]

4.2. PARTICIPANT SURVEYS

No participant surveys were completed for program year 2017.

4.2. CHALLENGE EMAILS

Seven email challenges were sent periodically to a random selection of HERs recipients. ADM determined the rate at which email challenge recipients committed to completing the challenge. Email challenge 30 had the highest click-through rate (13%).

Table 4-6: Challenge Email Commitment Rate

Challenge Number	Challenge	Number of Click-Throughs	No. Sent Challenge Email	Click Through Rate
28	When was the last time you changed your furnace filter?	6,355	79,441	8%
29	This Valentine's Day – Keep energy efficiency close to your heart	2,915	72,883	4%
30	Save energy and money when you wash your clothes	9,419	72,451	13%
31	Shift into savings for FREE	2,182	71,725	3%
32	Summer starts with Memorial Day	4,293	71,525	6%
33	4th of July means summer has arrived!	6,680	95,425	7%
34	HEROS for Nevada's Seniors	6,999	99,981	7%
35	the new NV Energy Website Is Here	3,008	100,281	3%

[16] ADM confirms this by inspecting and testing NV Energy billing data prior to actual analysis of the billing data.

5. CONCLUSIONS AND RECOMMENDATIONS

This chapter presents conclusions and recommendations.

5.1 CONCLUSIONS

The 2017 *Home Energy Report Program* specifically targeted two treatment groups which were characterized as high consumption participants and low-income participants. The high consumption group of participants were deployed in six waves. ADM only found statistically significant savings for the first three waves of the high consumption group.

At the program level, *ex-post* verified energy (kWh) savings were 6,125,445 kWh with a realization rate of 86%. The program level savings were attributable solely to the first three waves of the high consumption participants. ADM found no statistically significant savings for the remainder of the participant groups.

The program implementation team (i.e., Tendril and NV Energy program management) continued to work collaboratively and effectively to achieve a clear understanding of M&V approaches and algorithms utilized to measure energy savings achieved by the program.

5.2 RECOMMENDATIONS

For 2018, NV Energy is redesigning the Home Energy Reports program. ADM will collaborate with NVE Energy to determine the updated M&V plan for the 2018 program year.

APPENDIX A: SAVINGS PER MONTH BY RATE CLASS

ADM has intentionally not provided in 2017 the typical content reported in previous years for Appendix A because savings by month by rate class are used for NV Energy's process for reporting savings in their filings. It is ADM's understanding that savings will not be reported for 2017 and thus kWh savings by rate class and month were not needed.

APPENDIX B: EXAMPLE HOME ENERGY REPORT

▸ Report for:

▸ Report Period:

▸ Account:

MyHome Energy Report

NVEnergy

We're putting all of our energy into your energy

▸ Purpose of this report

- Help you better understand your electric usage
- Compare your energy use with similar homes
- Share energy saving tips and ideas
- **Help you save money**

▸ Questions?

We're here to help

▸ **Visit : nvenergy.com/MyHomeEnergyReport**

▸ **Email : MyHomeEnergyReport@nvenergy.com**

▸ **Call : 1-844-806-8660 | Mon-Sat 8 a.m. to 6 p.m.**

Compare your energy usage

Usage profile for

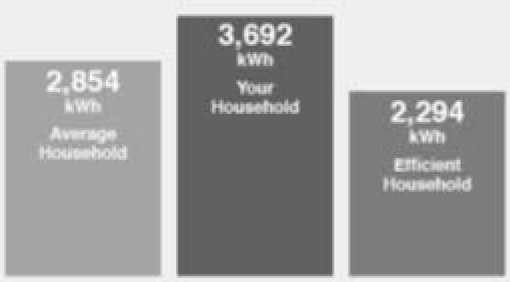
JOE SMITH

June 03, 2014 - July 02, 2014

Compare your electricity usage:

Whose electricity usage is being compared to mine?

- 3295 nearby households
- Single family homes
- Non-electric heating
- 3800 - 3900 sq. ft.
- Built in 1992 - 2003
- Based on public records
- Your information is not shared with other customers



▸ **You spent $95 more than the average home. We'd like to help you be more efficient, use the tips on this report to lower your next bill.**

Take action

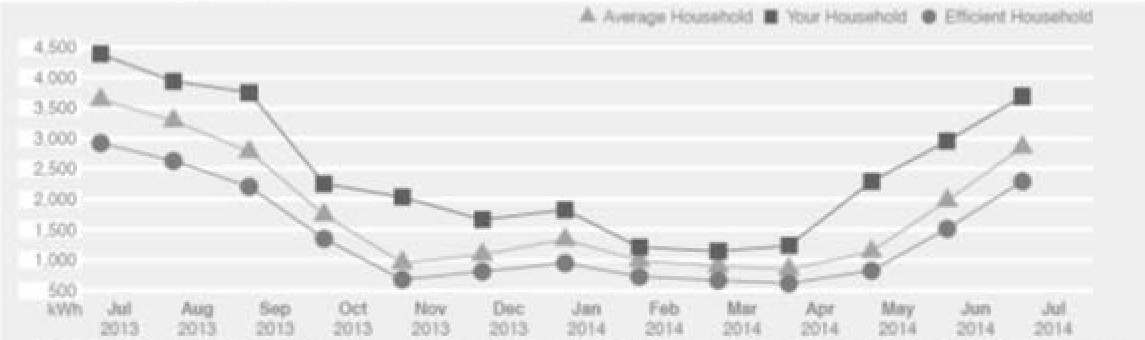
Recycle your second refrigerator or freezer — Save up to **$100** per year

Most backup refrigerators are at least 10 years old and use a lot of energy. Many families keep a second refrigerator to hold extra drinks or to use in the basement or garage during parties. If you're one of them, retire that second fridge and you'll be surprised how much energy you save. To learn more, visit: nvenergy.com/refrigerator–myher

Keep your shades closed in the summer — Save up to **$55** per year

Sunny windows can account for 40 percent of unwanted heat and can make your air conditioner work two to three times harder. You can minimize this heat by closing your blinds or curtains on sunny days. Focus on south and west facing windows as these allow the most amount of heat into your home. To learn more, visit: nvenergy.com/savemyway–myher

Your energy usage



Your electricity usage is decreasing compared to a year ago. However, you are spending about $2238 more per year on electricity than similar homes. Start saving energy and money now by using the tips on this report.

More ways to save

Be mPowered. Save Energy

Just in time for the hot summer months, mPowered features innovative technology that can lower the cooling costs for an average home by up to 15 percent.

- We provide you with a smart thermostat
- Control your thermostat with a smart phone or computer
- NV Energy calls "energy events" which adjust the thermostat up a few degrees
- Earn credits on your bill by the end of the year by participating in "energy events"

See if you are eligible at:
nvenergy.com/mpowered-myher

New MyAccount Tools

NV Energy is bringing a whole new meaning to the term power tools. New tools on our website:

- Tell you how much energy you're using each week
- Provide detailed information on power outages
- Send Weekly Billing Summaries and reminders on when your bill reaches a designated dollar or usage amount

You no longer have to be in the dark about power outages either. Our new online Outage Center will notify you as a MyAccount user via email or text when an outage occurs at your home. You may also report an outage and get updates.

See the tutorial videos explaining these new tools at:
nvenergy.com/videos-myher Visit MyAccount today.

Printed on recycled content paper

NVEnergy **NV Energy**
P.O. Box 800
Las Vegas, NV 89151
We're putting all of our energy into your energy

APPENDIX C: EXAMPLE CHALLENGE EMAIL

NVEnergy

MyHome Energy Report

We're putting all of our energy into your energy

NV Energy is here to help you save energy and money. Here's this month's challenge:

Replace one string of old incandescent holiday lights with LEDs.

What to do:

You can connect as many as 25 strings of LEDs together compared to 3-10 lengths of outdated incandescent holiday lights.

Why it matters:

Since LEDs use up to 90% less electricity, you'll have one less expense to worry about during the holidays!

Happy Holidays and please visit us at nvenergy.com/savemyway-myher for more tips on how to save.

I'll do this

I've done this

Figure F-1: Challenge Email Example

APPENDIX D: HOME ENERGY REPORTS DISTRIBUTION MAPS

This appendix provides maps that show the distribution of HERs in southern Nevada during 2017. The markers on the maps are in units of percent of total distribution. Percentages are not displayed for areas that received less than one percent of the total HERs distributed to each specific treatment group.

G.1. HIGH CONSUMPTION TREATMENT GROUPS

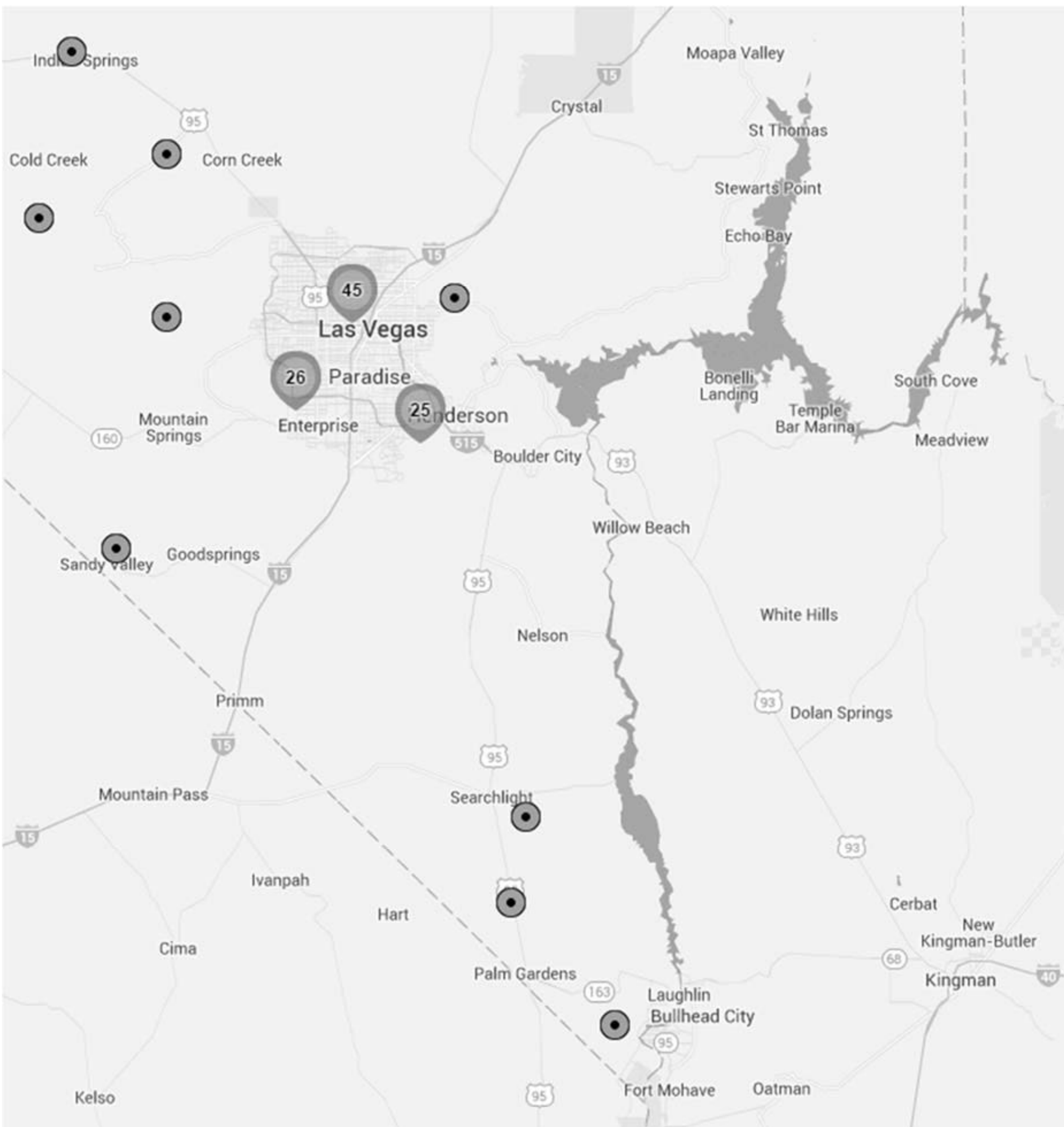


Figure G-1: HERs Distribution Map for the first three waves in 2017

Figure G-2: HERs Distribution Map for wave 4 Participants in 2017

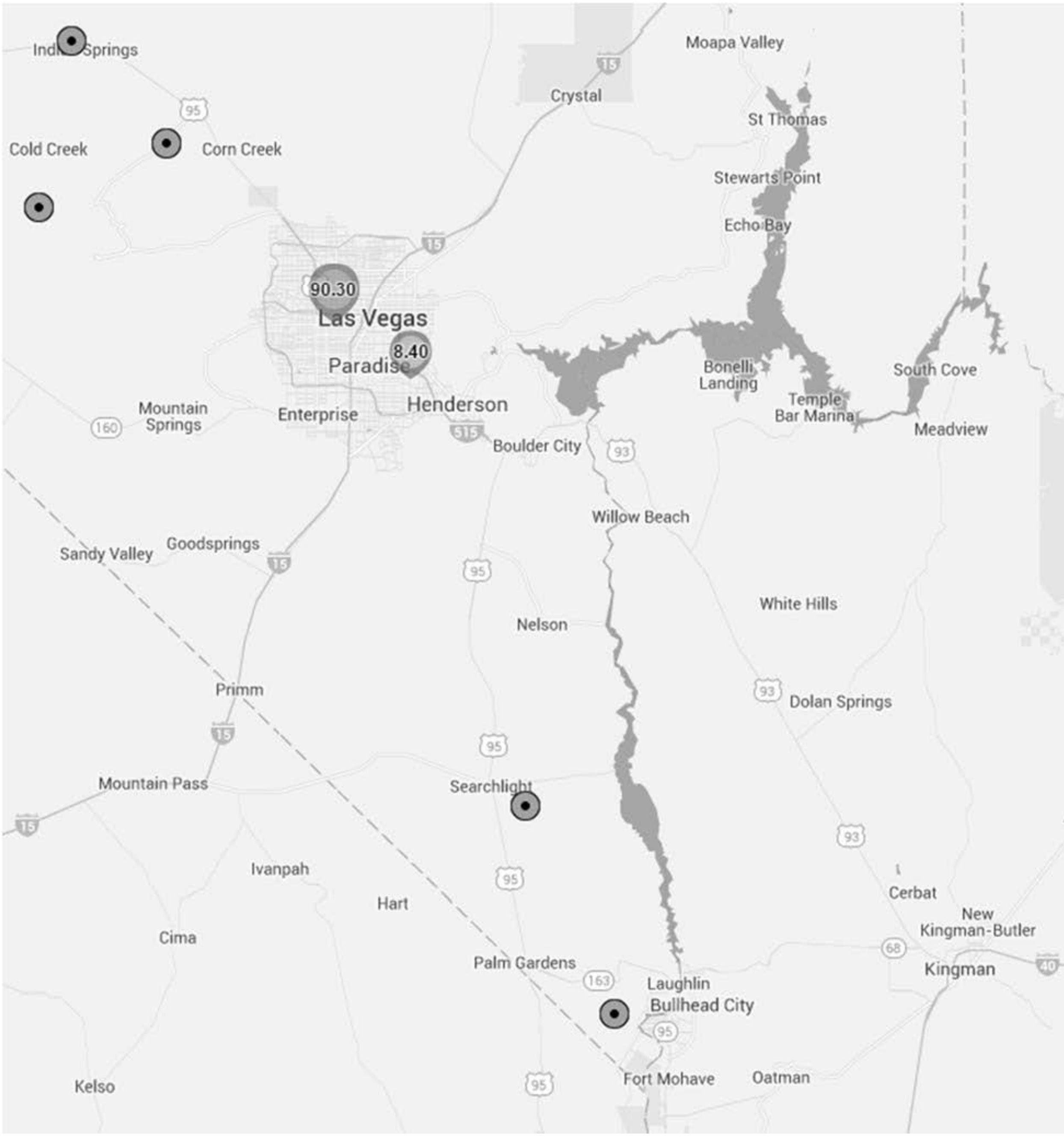


Figure G-3: HERs Distribution Map for wave 5 Participants in 2017

G.2 LOW INCOME TREATMENT GROUP

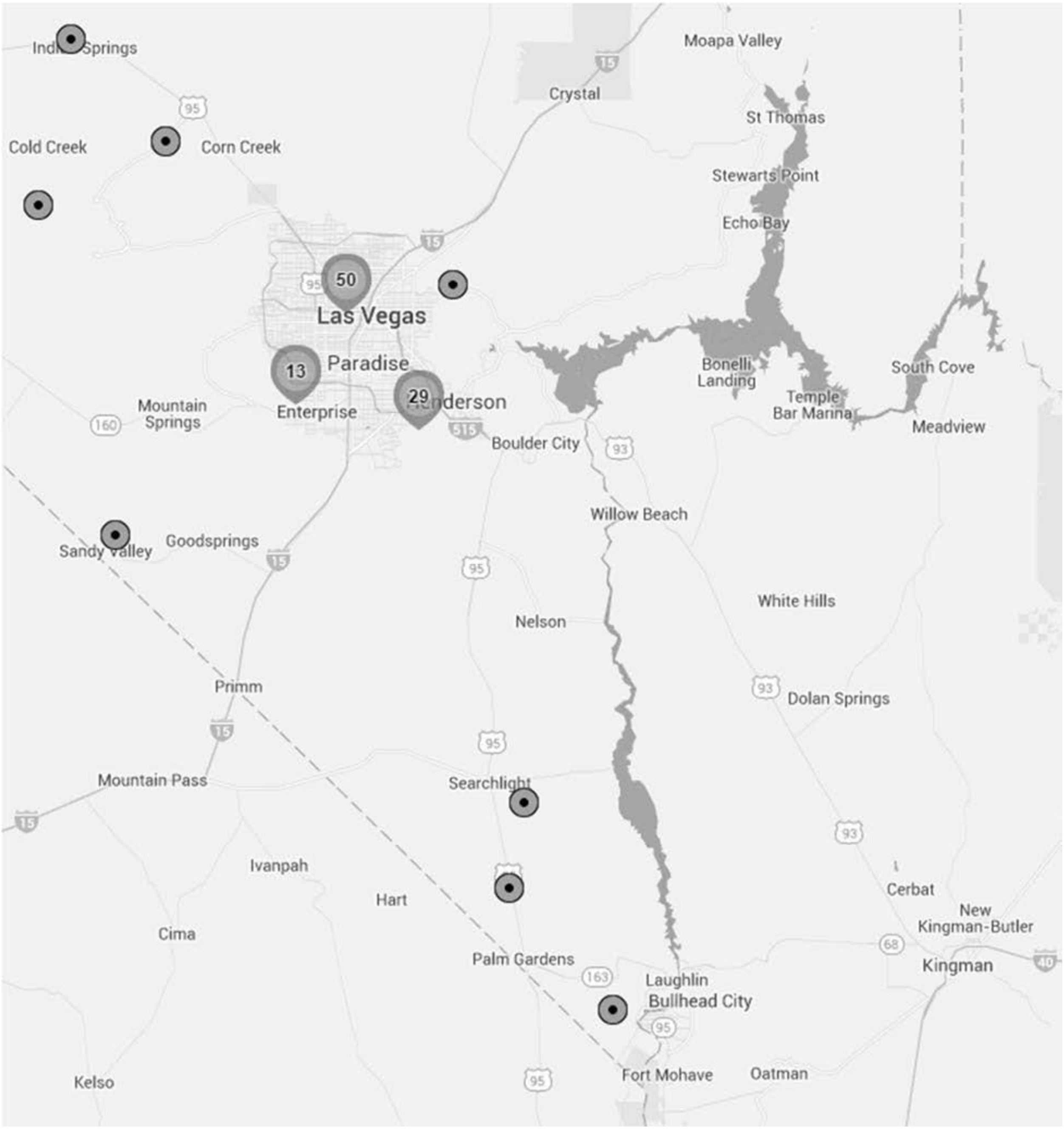


Figure G-2: HERs Distribution Map for 2017 Low Income Participants

DSM-8

Home Energy Reports Program
NV Energy – Northern Nevada (SPPC)
Program Year 2017

Measurement and Verification Report
March 12, 2018

Prepared for:

NV Energy

Prepared by:

ADM
ENERGY RESEARCH AND EVALUATION

3239 Ramos Circle
Sacramento, CA 95827
916-363-8383

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

This measurement and verification ("M&V") report provide the energy impacts evaluation of NV Energy's 2017 *Home Energy Reports Program* for the northern Nevada service territory ("Sierra Pacific Power").

The main features of the approach used for the impact evaluation of this program included:

- Using a control and treatment group design, a difference in differences econometric panel data model was utilized to determine energy savings.

The calendar year 2017 was the fourth year that NV Energy implemented the *Home Energy Reports Program*. This behavioral program was introduced to NV Energy's customers starting in August 2014. The 2017 *Home Energy Reports Program* is unlike typical Demand Side Management ("DSM") programs in that many participants in the 2014 *Home Energy Reports Program* continued their participation during the 2017 *Home Energy Reports Program*.

On June 13, 2017, NV Energy's independent third-party M&V contractor, ADM Associates, Inc. ("ADM") provided the final M&V report for the 2016 *Home Energy Reports Program*. In it, we reported the following:

- There were 114,212 treatment group participants in the 2016 *Home Energy Reports Program*.
- Those 114,212 treatment group participants achieved 2016 "third-year" *ex-post* verified energy savings of 8,515,557 kWh; and we projected that their 2017 "full-year" energy savings would amount to 5,861,614 kWh.

Of the 114,212 treatment group participants in the 2016 Home Energy Reports program, 93,989 continued to participate in the 2017 Home Energy Reports program. Those 93,989 participants in the 2017 program are called "wave 1", "wave2", "wave3", "wave 4", "wave 5", and "wave 6" in this M&V report for the 2017 *Home Energy* Reports Program as the participants received the first Home Energy Reports in six different timeframes.

Measure life is expected to be 3.5 years from the beginning of the treatment period.[1]

[1] Measure life is discussed in section 3.2.5 in this report.

In this M&V report for the 2017 *Home Energy Reports Program*, ADM is reporting the following *ex-post* verified energy savings:

- 2,103,998 kWh for 2014 (same as indicated in the April 8, 2015 M&V report for the 2014 *Home Energy Reports Program*)
- 7,726,917 kWh for 2015 (same as indicated in the May 12, 2016 M&V report for the 2015 *Home Energy Reports Program*)
- 8,515,557 kWh for 2016 (same as indicated in the June 13, 2017 M&V report for the 2016 *Home Energy Reports Program*)
- 8,865,320 kWh for 2017 (as verified in this M&V report
- 6,090,089 kWh for 2018 (projected kWh savings)
- Lifetime savings totaling 33,301,881 kWh

Table 1-1 indicates *ex-post* verified energy (kWh) savings for the *Home Energy Reports Program* in northern Nevada for the period of January 1 through December 31, 2017. The calendar-year 2017 energy savings of 8,865,320 kWh represents a realization rate of 105% for the program in northern Nevada.[2]

Table 1-1. Summary of Calendar Year 2017 kWh Savings, SPPC HERs Program

Calendar Year 2017 Ex Ante kWh Savings[3]	***Gross Verified Calendar Year 2017 Ex-post kWh Savings***	***Realization Rate***
8,424,471	8,865,320	105%

The difference between *ex-post* verified 2017 energy savings of 8,865,320 kWh and previously projected energy savings for 2017 is 5,861,614 kWh, as shown in Table 1-2.[4] *Ex-post* verified critical peak demand savings are 3,014 kW.

Table 1-2. Reconciliation of Ex-Post Verified Energy Savings for 2017

Ex-post verified calendar-year 2017 energy savings:	8,865,320
Previously projected calendar-year 2017 energy savings:	5,861,614
The difference, i.e., additional 2017 savings compared to previous M&V report:	3,003,706

[2] The realization rate is the ratio of *ex-post* verified energy (kWh) savings to *ex ante* expected energy (kWh) savings, i.e., at the program level: 8,865,320 kWh *ex-post*÷ 8,424,471 kWh *ex ante* = 1.05 or 105%.

[3] *Ex-ante* savings were provided in the final Tendril weekly status report, dated 11/7/2017.

[4] The previously projected energy savings for 2016 is 5,861,614 kWh, which ADM projected in the June 13, 2017 M&V report for the 2016 Home Energy Reports Programs as shown in page 2 of that M&V report.

2. PROGRAM BACKGROUND

NV Energy contracted with implementation contractor Tendril to deliver a behavioral-based program targeted at residential customers. The program is designed to generate greater awareness of energy use and ways to manage energy use through energy efficiency education in the form of home energy reports (HERs).[5] The program provides customers with information about their home's energy use, compares that energy use to that of a group of similar households (both average and most efficient neighbors), and educates them on low-cost measures, practices or behaviors to reduce their energy use. It was expected that through this education, customers would be encouraged to implement measures or adopt practices that lead to more efficient energy use in their homes. The HERs were designed to also encourage residential customers to participate in other NV Energy demand side management programs. To increase participants' active engagement with their HERs, the implementer also sent participants eight email challenges.[6] An email challenge contained three components, the challenged activity, instructions to carry out the challenge, and a short description on how the challenge saves energy.

In 2014, at the inception of the *Home Energy Reports Program*, Tendril chose a program population that targeted NV Energy's high-energy use residential customers. After the initial target population was selected, Tendril randomly allocated each household into either the treatment (household receives HER) or the control group (household receives no communication related to Home Energy Reports). This method created two statistically similar groups (treatment and control) which were compared to accurately determine the program's energy savings. During the calendar year 2017, treatment group members from the 2014 *Home Energy Reports Program* continued to receive HERs.

In 2014, when the initial treatment and control groups were constructed for the *Home Energy Reports Program*, Tendril reserved participants to be used as backfill for participants that exited the program. On 6/1/2015, Tendril added participants from the backfill group to both the treatment and control groups.

In September 2015, Tendril revised the design of the control and treatment groups to increase the savings achieved by the *Home Energy Reports Program*. To revise the program, Tendril estimated energy savings for each individual household. From the distribution of individual household energy savings, Tendril identified "low savers" as the lowest 20 percent of energy savers. Similarly, Tendril identified the "high savers" as the top 10 percent of energy savers. In the revised design, "low savers" began to receive only email HERs or were removed from the program if Tendril did not have an email address for the household.

[5] Example shown in Appendix B.

[6] Example shown in Appendix C.

To determine backfill treatment group and corresponding control group members, Tendril utilized look-alike modeling based on demographic characteristics of the "high savers" in the program to identify among NV Energy's residential single-family customers those most likely to save energy.[7] In 2016, Tendril added two more treatment and control groups that began receiving HERs and in 2017, Tendril added one more treatment and control group.

During 2017, on NV Energy's behalf, Tendril delivered HERs to six treatment groups of high consumption customers as outlined below:[8]

Table 2-1: Treatment Group by Wave, High Consumption

Participant Group	***Number of Participants***	***Start Date***
Wave 1	67,595	August – December 2014
Wave 2	3,475	6/1/2015
Wave 3	14,910	11/1/2015, 12/1/2015
Wave 4	18,498	1/1/2016, 3/28/2016
Wave 5	9,734	10/15/2016
Wave 6	14,997	6/5/2017

The goals for the 2017 Home Energy Reports Program's high consumption participants were:

- Deliver a large-scale, cost-effective, and verifiable measure which reduces energy consumption by at least 1.5%
- Generate measurable demand (kW) savings that can be calculated and verified
- Motivate increased awareness and adoption of NVE's energy conservation programs
- Strengthen NV Energy's relationship with its customers

In November 2017, Tendril ended their operation of the program. NV Energy will operate the high consumption and low-income portions of the *Home Energy Reports Program* as an educational program in 2018.

[7] Outlined in the Tendril white paper entitled, *Optimizing Home Energy Reports Programs: Data Analytics to Maximize Program Impacts and Cost Effectiveness.*
[8] Distribution maps for each treatment group are provided in Appendix D.

3. M&V METHODOLOGY

This chapter provides descriptions of the methodology applied by ADM Associates in performing the M&V work for the 2017 *Home Energy Reports Program*.

3.1 CONSTRUCTION OF CONTROL AND TREATMENT GROUPS

M&V for the 2017 *Home Energy Reports Program* utilized a randomized control and test group experimental design to determine energy savings. The M&V analyses utilized one group of high consumption participants as described in Chapter 2. The high consumption group of participants was further deployed in six waves as described below and shown in Table 3-1.

To the counts of participants in the 2017, *Home Energy Reports Program* are provided in Table 3-1. ADM verified delivery of HERs to treatment group participants by comparing the list of participants to the HERs distribution dataset provided by Tendril.

Table 3-1. Home Energy Reports Program Participant Counts

High Consumption Participants				
Participant Group Subset	***Treatment Group***		***Control Group***	
	Count	***Average Daily Pre-Treatment kWh***	***Count***	***Average Daily Pre-Treatment kWh***
wave 1	47,901	25.5	19,288	25.4
wave 2	2,640	24.8	648	24.4
wave 3	10,022	40.7	4,338	39.7
wave 4	13,100	23.2	5,234	23.4
wave 5	8,122	19.2	3,255	19.3
wave 6	12,204	27.0	4,881	27.1
Total	**93,989**	**26.4**	**37,644**	**26.4**

3.2 CALCULATION OF ANNUAL KWH SAVINGS

To determine annual kWh savings, ADM performed an analysis of the billing data for participants in the program utilizing panel regression modeling. The data cleaning steps and methodology for the panel regression approach are presented in this following section.

3.2.1 PREPARATION OF DATA

ADM incorporated several types of data into the preparation of the dataset that was utilized in the regression analysis outlined in this section:

1. NV Energy provided raw monthly billing data for all treatment and control group participants for the period January 1, 2013, through December 31, 2017.

2. Regional weather data.
3. Participant information:
4. Home energy reports delivery data:
   - Date each treatment group member received their first HER
   - 2017 HERs distribution data
5. A dual enrollment dataset compiled by ADM of participants in NV Energy's other residential DSM programs.

ADM performed the following steps to prepare the dataset that was utilized to determine the verified energy savings for the 2017 Home Energy Reports Program.

1. Verified that participants were sent HERs during 2017.
2. Merged this dataset with the raw billing data provided by NV Energy.
3. Cleaned the data for duplicate bills, outliers, and string characters in the monthly consumption column.
4. Removed bills where consumption was denoted with an estimate flag.
5. Removed customers with less than 10 bills during the pre-program year.
6. Removed customers with less than 10 bills during program year.
7. Removed customers that did not have both pre-program and program year data.
8. Parsed the data into the treatment groups along with their respective control groups.

3.2.2 CROSS PARTICIPATION VERIFICATION

ADM removed from the regression analysis any participants that also participated in NV Energy's other residential demand side management programs. The percentage of treatment group members in NV Energy's other DSM programs for the high consumption participants was in the 4-9% range for each wave as shown in Table 3-2.

Table 3-2. Treatment Group Members in NV Energy's Other DSM Programs

Treatment Group	***Treatment Group Count***	***Count of Treatment Group in Other DSM Programs***	***Percent of Treatment Group in Other DSM Programs***
wave 1	47,901	2,959	6%
wave 2	2,640	156	6%
wave 3	10,022	771	8%
wave 4	13,100	1,119	9%
wave 5	8,122	407	5%
wave 6	12,204	485	4%
Total	**93,989**	**5,653**	**6%**

3.2.3 METHODOLOGY FOR REGRESSION APPROACH

ADM utilized the mixed effects panel regression model specified in Equation 3-1 to determine daily average electricity savings for treatment group members.

$$AEC_{i,t} = \beta_1 CDD_{i,t} + \beta_2 HDD_{i,t} + \beta_3 Post_{i,t} + \beta_4 Treat_{i,t} + \beta_5 Post_{i,t} * Treat_{i,t} + \alpha_i \mathrm{Customer_i} + E_{i,t}$$

Equation 3-1

Where the subscript i denotes individual customers and $t = 1, \ldots, T(i)$ serves as a time index, where $T(i)$ is the number of bills available for customer i. The model is defined as "mixed effects" because the model decomposes its parameters into fixed-effects (i.e. HDD, CDD, Post, Treat, and its various interactions) and random effects (i.e. the individual customer's base usage). A fixed effect is assumed to be constant and independent of the sample, while random effects are assumed to be sources of variation (other than natural measurement error) that are uncorrelated with the fixed effects. The variables included in the regression model are specified in Table 3-3.

The program implementer provided ADM with a dataset that included the participation start date for each treatment group member and their corresponding control group. In the model, the first billing period after the beginning of treatment is considered the "deadband period". Observations that occur in the deadband period are not included in the mixed effects panel regression. For the treatment and control group members, the post period begins in the first billing period following the deadband period. The post variable is defined as a 0 in the billing periods prior to the beginning of treatment and a 1 for billing periods following the beginning of treatment.

Heating degree day (HDD) and cooling degree day (CDD) were the metrics used in the model to control for energy demand based on outside temperature. HDD is derived from the difference between 65 degrees, the outside temperature above which a building needs no heating, and the actual outside air temperature. CDD is derived from the difference between the actual outside air temperature and 75 degrees, the outside temperature below which a building needs no cooling.

Table 3-3. Description of Variables Used in the Regression Model

Variable	***Variable Description***
Average Electricity Consumption ($AEC_{i,t}$)	Average daily use of electricity for period t for a customer (determined by dividing total usage over a billing period by number of days in that period)
Customer	A panel of dummy variables that is a 1 if customer i is the i in $AEC_{i,t}$ or a 0 otherwise.
Cooling Degree Days (CDD)	The mean cooling degree days per day during the billing period.
Heating Degree Days (CDD)	The mean heating degree days per day during the billing period.
Post	Post is a dummy variable that is 0 if the monthly period is before the customer received their first HER and 1 if the monthly period is after the customer received their first HER.
Treat	Treat is a dummy variable that is 0 if the customer is a member of the control group and a 1 if the customer is a member of the treatment group.
E_t	E_t is an error term

3.2.4 ESTIMATING COEFFICIENTS OF THE REGRESSION MODEL

With the panel approach, the regression model was applied to monthly billing data for each participant in the sample before and after participation in the program. The pre (2013, 2014, 2015, or 2016) and post (2017) periods included data for January 1, 2013 through the end of December 2017. Table 3-4 describes the coefficients that were determined by using the mixed effects panel model shown in Equation 3-1.

Table 3-4. Description of the Coefficients Estimated by the Regression Model

Coefficient	*Coefficient Description*
α_1	α_1 is a coefficient that represents the grand mean (mean of the unique customer specific intercepts). The customer specific intercepts control for any customer specific differences.
β_1	β_1 is a coefficient that adjusts for the customer's cooling season weather-sensitive usage.
β_2	β_2 is a coefficient that adjusts for the customer's heating season weather-sensitive usage.
β_3	β_3 is a coefficient that adjusts for whether customer i's monthly billing data in period t is in the pre or post period
β_4	β_4 is a coefficient that adjusts for whether customer i is in the treatment group or the control group.
β_5	β_5 is a coefficient that adjusts for the interactive effect between whether customer i's monthly billing data in period t is in the pre or post period and whether customer i was in the treatment or control group during period t. The value of β_5 is the kWh savings per customer per day if it is significant.

3.2.5 DETERMINATION OF EFFECTIVE USEFUL LIFE ("EUL")

The effective useful life for a behavioral program may be bifurcated into two periods:

1. Treatment period in which treatment group receives the treatment and the control group does not receive the treatment. For the Home Energy Reports Program, the treatment consists of receiving a combination of paper HERs, email HERs, and challenge emails.
2. Persistence period in which the treatment effect decays over time due to discontinued treatment.

NV Energy in their planning of the *Home Energy Reports Program* utilized a measure life based on the Integral Analytics Impact and Persistence Evaluation Report of the Sacramento Municipal Utility District (SMUD) Home Energy Report Program.[9] The SMUD report found that savings persistence was projected to dissipate approximately 24 months after report delivery ceased; specifically, the report found annual savings during the final year of HERs reports were 2.3 percent

[9] Wu, May, Osterhus, Tom, "Impact & Persistence Evaluation Report' November 2012, "Sacramento Municipal Utility District, Home Energy Reports Program," Integral Analytics, Inc.

and that persisted savings in the following year (with no HERs reports) were 1.58 percent of energy use.

For the purpose of projecting program savings beyond 2017, ADM utilized several elements of the SMUD report referenced in the previous paragraph. For treatment group members that will continue to receive treatment during the calendar year 2017, ADM bifurcated future savings into the continued treatment period and the persistence period. For the continued treatment period, ADM conservatively projected that savings would continue at a rate of 69% of the savings determined during 2017. This is the same rate of decline found during the first year of the persistence period in the SMUD study.[10]

The measure life is expected to be 3.5 years from the beginning of the treatment period.

3.2.6 DETERMINING THE ENERGY SAVINGS CURVE

An energy savings curve for 2017 was intentionally not included in this report because they are typically used for NV Energy's process for reporting savings in their filings. It is ADM's understanding that savings will not be reported for 2017.

3.2.7 CALCULATION OF FIRST YEAR kWh SAVINGS

The *Home Energy Reports Program* is different from other standard DSM programs in that first-year savings for the treatment group members that continued to receive treatment during 2017 were reported in the 2014 *Home Energy Reports Program* M&V Report.

3.2.8 CALCULATION OF CRITICAL PEAK DEMAND (kW) SAVINGS

The ratio between kWh savings to kW savings in the previous three program years was used to determine the critical peak demand (kW) savings for 2017. For the last three program years, the ratio between kWh and kW savings has been between 0.00025 and 0.00079. The weighted average by kWh savings is 0.00034. For 2017, the weighted average (0.00034) was multiplied by kWh savings to determine the critical peak demand kW savings.

Table 3-3. Relationship between kWh and kW Savings by Program Year

Program Year	Reported kWh savings	Reported kW savings	Ratio
2014	2,103,998	1,659	0.00079
2015	7,726,917	1,939	0.00025
2016	8,515,557	2,749	0.00032
Weighted average			0.00034

[10] Rate of decline = (0.023 - 0.0158) ÷ 0.023 = 0.31 or 31%

3.2.9 SURVEY SAMPLING METHODOLOGY

Per agreement with NV Energy, no surveys were conducted for program year 2017.

3.2.10 CHALLENGE EMAIL DATA REVIEW

The program implementer sent randomly selected test group participants eight email challenges in addition to the HERs delivered to participants through the mail. ADM received the delivery schedule and challenge email "click through rate" data from the implementer for the email challenges. "Click-through rate" refers to the percentage of challenge email recipients that opened and accepted the email challenge. ADM examined the challenge email delivery data to determine the rate at which participants committed to each email challenge.

4. FINDINGS FROM M&V DATA COLLECTION AND ANALYSIS

This chapter presents results and findings from the data collection and energy savings analysis.

4.1. FINDINGS FROM ENERGY AND DEMAND IMPACT ANALYSIS

This section reports the findings from the M&V analysis of energy and demand impacts for the 2017 *Home Energy Reports Program.* During 2017, Home Energy Reports were distributed to one distinct treatment group – i.e., high consumption participants– as described previously in Chapter 2. Tendril reported 95,254 high consumption participants for 2017[11]. Based on ADM's analysis, we were able to verify 93,989 high consumption participants.

ADM performed a mixed effects panel regression on the six waves of the high consumption participants group. ADM found statistically significant savings for waves 1, 3 and 5. No savings were found for waves 2 and 4. Wave 6 group members typically had six months or less of post billing data which was not enough post data on which to make statistically valid inferences.[12]

4.1.1 CALCULATED kWh SAVINGS

As discussed previously in this section, ADM only found statistically significant savings for the waves 1, 3, and 5. Table 4-1 provides the results of the mixed-effects panel regression modeling that were performed on the data for all waves.

Table 4-1. Results of Mixed Effects Panel Regression Modeling

Coefficient	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6
Intercept t-value	15.55 135.51	15.07 25.03	24.33 93.28	13.11 58.99	11.25 68.06	14.94 98.65
HDD65 t-value	0.45 374.76	0.47 76.97	0.72 170.10	0.46 199.47	0.33 153.10	0.58 198.60
CDD75 t-value	2.54 541.37	2.55 117.89	4.32 271.14	2.78 300.06	2.13 261.02	2.73 232.32
Post t-value	0.01 0.52	-0.12 -0.79	-0.92 -11.06	0.69 13.04	0.56 11.81	0.22 2.88
Treat t-value	0.03 0.19	0.37 0.56	1.08 3.58	-0.18 -0.71	-0.04 -0.23	-0.05 -0.32
Post x Treat t-value	-0.39 -11.56	-0.19 -1.17	-0.35 -3.54	-0.08 -1.31	-0.26 -4.67	-0.06 -0.68
R-squared	0.74	0.74	0.64	0.76	0.70	0.53

[11] In the Tendril report entitled, *NV Energy's MyHome Report Program,* November 9, 2017.

[12] An industry standard white paper prepared by the Brattle Group recommends 12 months of treatment period billing data for treatment and control group members. Faruqui, Ahmad, Sanem, Sergici, "Measurement and Verification Principles for Behavior Based Efficiency Programs" May 2011, The Brattle Group.

Table 4-2 provides average annual kWh savings per participant; participant count; and annual kWh savings for the 2017 Home Energy Reports Program from the panel regression modeling.

Table 4-2. Summary of 2017 kWh Savings from Panel Regression Modeling

	High Consumption Participants			
Participant Group Subset	***Daily kWh Savings per Participant***	***Annual kWh Savings per Participant***	***Count of Participants***	***Ex-post kWh Savings***
wave 1	0.39	141.78	47,901	6,791,266
wave 2	0.00	0.00	2,640	0
wave 3	0.35	128.85	10,022	1,291,349
wave 4	0.00	0.00	13,100	0
wave 5	0.26	96.37	8,122	782,704
wave 6	0	0	12,204	0
Total	1.01	367.00	93,989	8,865,320

Ex-post verified kWh savings for the treatment group were determined by applying the daily average per household energy savings value calculated from the regression model to the treatment group population. Program-level, the program year 2017 *ex-post* verified kWh savings and *ex-ante* estimated kWh savings – and the realization rate for the program, i.e., the quotient of *ex-post* kWh and *ex-ante* kWh – are provided in Table 4-3.

At the program level, *ex-post* verified energy (kWh) savings are slightly more than implementation contractor claimed *ex-ante* energy (kWh) savings. Differences in data cleaning steps, as well as a variety of factors related to modeling details will contribute to the variance between *ex-ante* estimates and *ex-post* verified savings. Below is a summary of a data cleaning steps employed by ADM in preparing the model dataset utilized by ADM to determine *ex-post* kWh savings:

1. Initial data sets – The billing data that was provided directly by NV Energy covered the time range of mid-2014 through 2017. ADM combined this with the "historical" billing data that had previously been provided via Tendril covering the time range prior to mid-2014.
2. Filtering – ADM employed consumption and billing duration filters for outliers. Also, ADM dropped the small fraction of bills with E (estimated) or NA values for the estimate flag.
3. CDD base - ADM used a CDD base of 75°F instead of 65°F based on previous analysis of the best fitting CDD base for single family homes in NPC that was conducted as part of ADM's evaluation of NV Energy's *Residential High-Efficiency AC Program*.
4. Pre and post period definitions – For each account with treatment starting in 2014, ADM defined the "pre" period as one year prior to treatment start and the "post" period as 2017. For wave 6 of 2017 participants, the pre-period was defined as one year prior to treatment start and the post-period as the remainder of 2017.

Table 4-3. Summary of Program-Level 2017 Energy kWh Savings

Participant Group	Ex-Ante kWh Savings	Ex-post kWh Savings	Variance	Realization Rate
High Consumption Participants	8,424,471	8,865,320	440,849	105%

The 93,989 participants in the 2017 Home Energy Reports program achieved 2017 full-year energy savings of 8,865,320 kWh. This is more than the 5,861,614 kWh savings which ADM projected in the June 13, 2017 M&V report for the 2016 *Home Energy Reports Program* as shown in Table 4-4.

Table 4-4. Reconciliation of Ex-Post Verified Savings for 2017

Ex-post verified calendar-year 2017 energy savings:	8,865,320 kWh
Previously projected calendar-year 2017 energy savings:	5,861,614 kWh
The Difference, i.e., additional 2017 savings compared to previous M&V report:	3,003,706 kWh

Measure life is expected to be 3.5 years from the beginning of the treatment period.[13] Table 4-6 presents the program level *ex-post* verified energy savings for the 2017 *Home Energy Reports Program*.

Table 4-6. Summary of Program Level Ex-Post Verified kWh Savings

Year	Ex-post kWh Savings
2014	2,103,998
2015	7,726,917
2016	8,515,557
2017	8,865,320
2018	6,090,089
Total (Lifetime) Savings	33,301,881

4.1.2 CALCULATED PEAK DEMAND (kW) SAVINGS

Critical peak demand (kW) savings were determined using the ratio between previous year's reported kWh and kW savings as described in Section 3.2.8. The annual critical peak demand savings for this program in 2017 was 3,014 kW.

4.1.3 CALCULATION OF *EX-POST* PRECISION

After completing the analysis of energy savings resulting from the program, we achieved an *ex-post* precision of better than ±10% at the 90% confidence level. Statistical analysis of participants' monthly billing data yields the most accurate and precise determination of actual energy savings that were achieved through the distribution of HERs.

[13] Measure life is discussed in section 3.2.5 in this report.

Analyzing participants' billing data across the whole program achieves optimal precision, given that 1) sampling error is minimized when analyzing billing data for a census of control and treatment group participants and 2) measurement error is null or near zero given that NV Energy billing data is correct.[14]

4.2. EMAIL CHALLENGE FINDINGS

ADM reviewed data provided by the implementer related to challenged emails that were delivered to supplement the HERs through additional customer engagement with energy conservation.

Seven email challenges were sent periodically to a random selection of HERs recipients as shown in Table 4-7. ADM determined the rate at which email challenge recipients committed to completing the challenge. Email challenge 30 had the highest click-through rate (13%).

Table 4-7: Challenge Email Commitment Rate

Challenge Number	***Challenge***	***Number Committed to Challenge***	***No. Sent Challenge Email***	***Percent Committed to Challenge***
28	When was the last time you changed your furnace filter?	2,737	34,212	8%
29	This Valentine's Day – Keep energy efficiency close to your heart	1,243	31,078	4%
30	Save energy and money when you wash your clothes	4,018	30,904	13%
31	Shift into savings for FREE	923	30,774	3%
32	Summer starts with Memorial Day	1,841	30,675	6%
33	4th of July means summer has arrived!	3,476	49,660	7%
34	HEROS for Nevada's Seniors	3,282	46,883	7%
35	the new NV Energy Website Is Here	1,435	47,848	3%

[14] ADM confirms this by inspecting and testing NV Energy billing data prior to actual analysis of the billing data.

5. CONCLUSIONS AND RECOMMENDATIONS

This chapter presents conclusions and recommendations.

5.1 CONCLUSIONS

The 2017 *Home Energy Report Program* specifically targeted one treatment group of high consumption participants. The high consumption group of participants was deployed in six waves. ADM only found statistically significant savings for waves 1, 3, and 5 of the high consumption group.

At the program level, *ex-post* verified energy (kWh) savings were 8,865,320 with a realization rate of 105%. The program level savings were attributable solely to the waves 1, 3, and 5 of the high consumption participants. ADM found no statistically significant savings for the remainder of the participant groups.

The program implementation team (i.e., Tendril and NV Energy program management) continued to work collaboratively and effectively to achieve a clear understanding of M&V approaches and algorithms utilized to measure energy savings achieved by the program.

5.2 RECOMMENDATIONS

For 2018, NV Energy is redesigning the Home Energy Reports program. ADM will collaborate with NVE Energy to determine the updated M&V plan for the 2018 program year.

APPENDIX A: SAVINGS PER MONTH BY RATE CLASS

ADM has intentionally not provided in 2017 the typical content reported in previous years for Appendix A because savings by month by rate class are used for NV Energy's process for reporting savings in their filings. It is ADM's understanding that savings will not be reported for 2017 and thus kWh savings by rate class and month were not needed.

APPENDIX B: EXAMPLE HOME ENERGY REPORT

▸ Report for:

▸ Report Period:

▸ Account:

MyHome Energy Report

NVEnergy

We're putting all of our energy into your energy

▸ Purpose of this report

- Help you better understand your electric usage
- Compare your energy use with similar homes
- Share energy saving tips and ideas
- **Help you save money**

▸ Questions?

We're here to help

- ▸ **Visit : nvenergy.com/MyHomeEnergyReport**
- ▸ **Email : MyHomeEnergyReport@nvenergy.com**
- ▸ **Call : 1-844-806-8660 | Mon-Sat 8 a.m. to 6 p.m.**

Compare your energy usage

Usage profile for

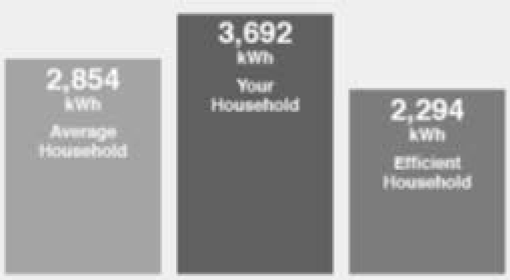
JOE SMITH

June 03, 2014 - July 02, 2014

Compare your electricity usage:

Whose electricity usage is being compared to mine?

- 3295 nearby households
- Single family homes
- Non-electric heating
- 3800 - 3900 sq. ft.
- Built in 1992 - 2003
- Based on public records
- Your information is not shared with other customers



▸ **You spent $95 more than the average home. We'd like to help you be more efficient, use the tips on this report to lower your next bill.**

Take action

Recycle your second refrigerator or freezer

Save up to **$100** per year

Most backup refrigerators are at least 10 years old and use a lot of energy. Many families keep a second refrigerator to hold extra drinks or to use in the basement or garage during parties. If you're one of them, retire that second fridge and you'll be surprised how much energy you save. To learn more, visit: nvenergy.com/refrigerator–myher

Keep your shades closed in the summer

Save up to **$55** per year

Sunny windows can account for 40 percent of unwanted heat and can make your air conditioner work two to three times harder. You can minimize this heat by closing your blinds or curtains on sunny days. Focus on south and west facing windows as these allow the most amount of heat into your home. To learn more, visit: nvenergy.com/savemyway–myher

Your energy usage

Your electricity usage is decreasing compared to a year ago. However, you are spending about $2238 more per year on electricity than similar homes. Start saving energy and money now by using the tips on this report.

More ways to save

Be mPowered. Save Energy

Just in time for the hot summer months, mPowered features innovative technology that can lower the cooling costs for an average home by up to 15 percent.

- We provide you with a smart thermostat
- Control your thermostat with a smart phone or computer
- NV Energy calls "energy events" which adjust the thermostat up a few degrees
- Earn credits on your bill by the end of the year by participating in "energy events"

See if you are eligible at:
nvenergy.com/mpowered-myher

New MyAccount Tools

NV Energy is bringing a whole new meaning to the term power tools. New tools on our website:

- Tell you how much energy you're using each week
- Provide detailed information on power outages
- Send Weekly Billing Summaries and reminders on when your bill reaches a designated dollar or usage amount

You no longer have to be in the dark about power outages either. Our new online Outage Center will notify you as a MyAccount user via email or text when an outage occurs at your home. You may also report an outage and get updates.

See the tutorial videos explaining these new tools at: **nvenergy.com/videos-myher** Visit MyAccount today.

Printed on recycled content paper

NVEnergy
NV Energy
P.O. Box 800
Las Vegas, NV 89151
We're putting all of our energy into your energy

APPENDIX C: EXAMPLE CHALLENGE EMAIL

NVEnergy

MyHome Energy Report

We're putting all of our energy into your energy

NV Energy is here to help you save energy and money. Here's this month's challenge:

Need to keep your toes toasty and feet cozy during the chilly weather? Then just pull on a pair of warm socks instead of turning up the thermostat.

What to do:

Next time you feel a chill, put on a pair of warm socks before turning up the thermostat. Cold floors can make you feel chillier, so bundle up with a pair of warm socks and wear your house slippers for added comfort.

Why it matters:

Every degree you turn up your thermostat leads to more energy use and a higher heating bill. When you get in the habit of adding layers of clothing before heading to the thermostat, you will save energy every time. You may be surprised by how nice it feels to be bundled a bit on a chilly day - and how nice it feels when your low heating bill arrives!

Happy Holidays and please visit us at nvenergy.com/savemyway-myher for more tips on how to save.

I'll do this | I've done this

Figure F-1: Challenge Email Example

APPENDIX D: HOME ENERGY REPORTS DISTRIBUTION MAPS

This appendix provides maps that show the distribution of HERs in northern Nevada during 2017. The markers on the maps are in units of percent of total distribution. Percentages are not displayed for areas that received less than one percent of the total HERs distributed to each specific treatment group.

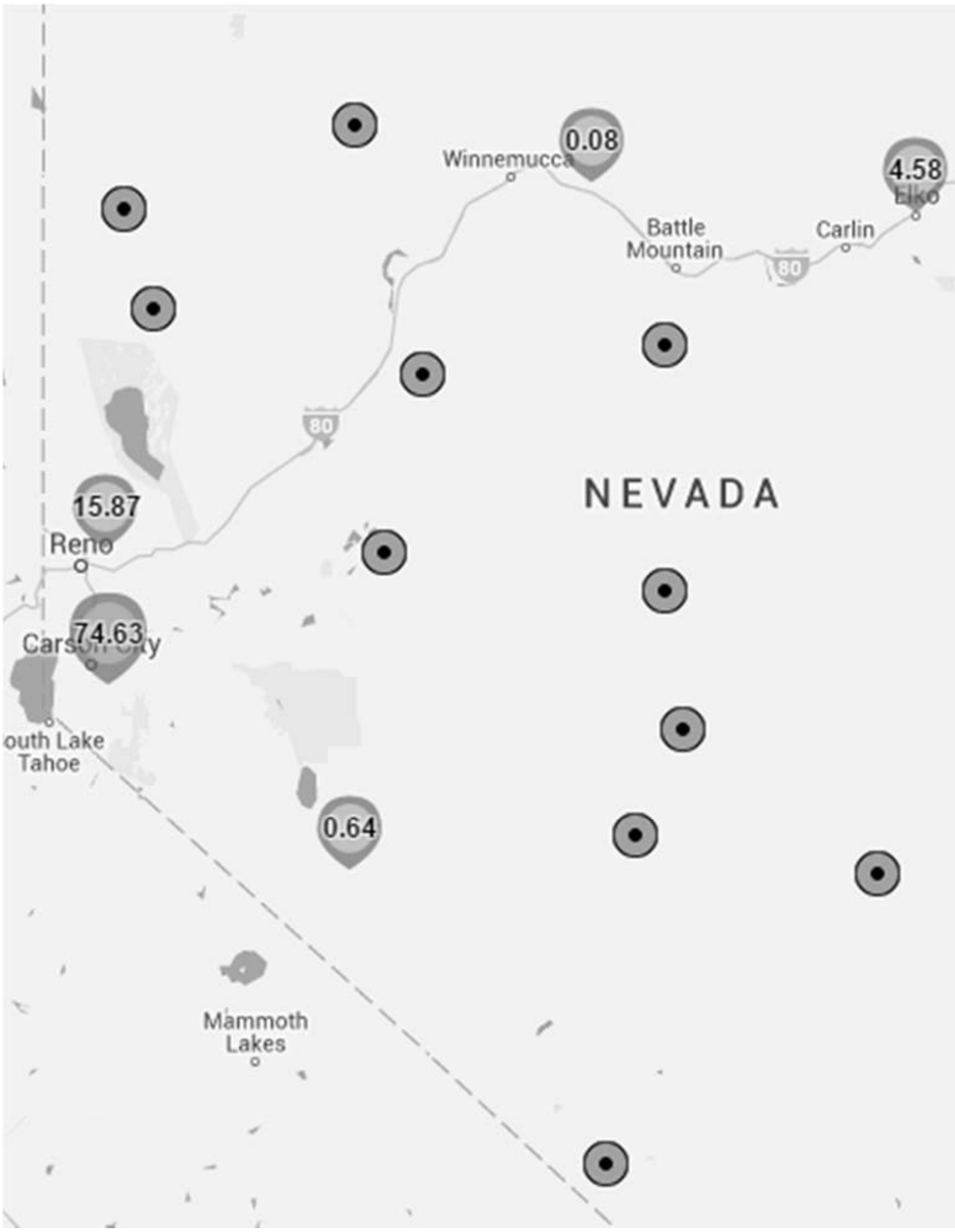


Figure G-1: HERs Distribution Map for the first three waves to Receive HERs in 2017

Figure G-2: HERs Distribution Map for wave 4 in 2017

Figure G-3: HERs Distribution Map for wave 5 In 2017

DSM-9

Home Energy Assessments
NV Energy – Southern Nevada (NPC)
Program Year 2017

Measurement and Verification Report
March 29, 2018

Prepared for:

Prepared by:

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Table of Contents

1. EXECUTIVE SUMMARY

This measurement and verification ("M&V") report provides the results of the ADM Associates Inc. ("ADM") 2017 evaluation of the NV Energy ("NVE") *Home Energy Assessments ("HEA") Program* for the southern Nevada service territory, Nevada Power Company ("NPC").

The *Home Energy Assessments (HEA) Program* provides NVE customers with two distinct versions of residential energy assessment services. Both program elements are opt-in services available to all NVE customers: a) 'In-Home Assessments' and b) 'Online Assessments'.

As NVE's independent, third-party M&V contractor, ADM's analyses for the 2017 *HEA Program* included:

- Propensity score matching of program participants to a control group, and a difference in differences ("DiD") econometric panel data model to determine energy savings.
- Participants were surveyed to determine what actions they took as the result of the 2017 *HEA Program*, and to assess participants' satisfaction with the program.

1.1 IN-HOME ASSESSMENTS

NVE started providing its residential customers In-Home Assessments services in 2015. However, program year 2017 is the first year for which ADM is determining energy (kWh) and demand (kW) savings for In-Home Assessments.

In-Home Assessments services and activities are intended to achieve a positive outcome in response to NVE residential customers who express complaints related to high energy bills. When providing In-Home Assessments services, the NVE home energy consultant performs a walk-through energy assessment and audit of the premises with the customer; the NVE consultant reviews the results of the audit with the customer and provides the customer a checklist of items examined along with recommendations to save energy. An important aspect of the audit is the dialogue between the NVE home energy consultant and the customer, including specific discussions related to energy conservation opportunities.

ADM determined the following ex-post verified energy (kWh) and peak demand (kW) savings for 2017 In-Home Assessments:

- 825,374 kWh for 2017 (first-year savings)
- 2,216,280 kWh for 2018 (full-year savings)
- 1,390,906 kWh for 2019 (less than full-year savings, due to a 2-year measure life)
- 4,432,560 kWh lifetime savings (twice full-year savings, given a 2-year measure life)
- 824 kW summer critical peak demand savings

1.2 ONLINE ASSESSMENTS

Program year 2017 is the first year NVE offered its residential customers Online Assessments services, which were introduced to NVE customers starting in August 2017.

The Online Assessments service provides NVE customers access to an online, self-service home energy assessments tool which enables customers to perform their own comprehensive energy assessments of their residences. The online tool compares each customer's energy use with similar homes, tracks energy use over time, and employs proprietary algorithms to analyze the customer's energy consumption history. The online tool is essentially designed to discover opportunities for energy conservation, then recommend specific steps that the customer can take to lower electricity bills. The online tool features visually assisted choices to make the energy assessment procedure as user-friendly as possible for customers. The online tool also guides customers to participate in NV Energy's demand-side management ("DSM") programs and provides customers with a customized list of various other energy conservation measures, both with and without cost.

ADM analyzed energy (kWh) and peak demand (kW) savings for Online Assessments and determined that there were no statistically significant kWh or kW savings for 2017 participants. ADM found that the lack of post period data caused the determination of no savings. In other words, due to the Online Assessments activity ramping up during the latter part of the 2017 calendar year, there wasn't enough post period data for a statistically significant result from the regression analysis. Post period data included the months of September to December 2017. During 2018, when additional post period data becomes available, we will perform an additional study of the same population of 2017 Online Assessments participants.

1.3 SUMMARY OF PROGRAM-LEVEL SAVINGS

Table 1 provides a summary of program-level energy impacts for the 2017 HEA Program.

Table 1: Summary of Program Level Annual Energy (kWh) Savings

Program Component or Measure	***Ex-Post Annual Energy (kWh) Savings***	***Expected Measure Life***	***Ex-Post Lifetime Energy (kWh) Savings***	***Ex-Post Peak Demand (kW) Savings***
In-Home Assessments	2,216,280	2.0	4,432,560	823.6
Online Assessments	0	0	0	0.0
Total, *HEA Program*	**2,216,280**	**2.0**	**4,432,560**	**823.6**

2. PROGRAM BACKGROUND

This chapter provides a description of the program design and 2017 activity for the *Home Energy Assessments (HEA) Program*, a behavioral program. The *HEA Program* aims to provide NVE customers information and opportunities that enable program participants to take positive actions – i.e., behavioral changes and related actions – which will achieve measurable, verifiable energy (kWh) savings. Program objectives also include motivating customers to increase their awareness and adoption of NVE's other energy conservation programs, and to strengthen NVE's relationships with its customers. The *HEA Program* includes In-Home Assessments and Online Assessments.

2.1 IN-HOME ASSESSMENTS

In-Home Assessments services and activities are intended to achieve a positive outcome in response to NVE residential customers who express complaints related to high energy bills.

In-Home Assessments focus on evaluating each participating customer's energy consumption while meeting with the customer in their residence, and providing real-time, actionable solutions and energy efficiency education. The home energy auditor listens to the concerns of the customer, performs a Home Energy Audit, then provides the residential customer with a checklist of recommendations to reduce their monthly electricity consumption. The interaction between the auditor and customer provides an opportunity for NVE's customers to ask questions about energy efficiency and to learn about NVE's demand side management programs.

In 2017, NVE contracted with implementation contractors Green Chips, Mad Dash, Scope Services, and Duct Testers to deliver this behavioral-based program targeted at residential customers. An additional member of the *HEA Program* implementation team is an NVE employee who handles customer complaints that are directed to the Commission (which the Commission routes to NVE for positive disposition and reporting). In 2017, NVE completed 6,285 In-Home Assessments in southern Nevada.

2.2 ONLINE ASSESSMENTS

The Online Assessments portion of the *HEA program* provided customers with information about their home's energy use, compared that energy use to a group of similar households (both average and most efficient neighbors), and educated them on practices or behaviors to reduce their energy use through the online self-serve home energy assessments tool. It was expected that through this education, customers would be encouraged to implement measures or adopt practices that could lead to more efficient energy use in their homes. Online Assessments were designed to also encourage residential customers to participate in other NVE demand side management programs.

In 2017, a total of 54,154 NVE residential customers statewide used the online tool. Data provided to ADM did not include a field for NPC versus SPPC participants. ADM received premise ID data and monthly billing data for a sample of NPC participants, from which we determined there were not statistically significant savings for 2017 participants. This is a typical first-year result for a behavioral program that ramped up during the latter part of its first calendar year. In other words, for a first-year behavioral program, it isn't unusual for post period data that's limited to September through December to be insufficient for determining a statistically significant savings signal from the regression analysis.

3. M&V METHODOLOGY

This chapter provides a description of ADM's methodology for performing the M&V analysis of the 2017 *HEA Program*. Our M&V analysis utilized a difference in differences ("DiD") econometric panel data model to determine energy (kWh) savings. The DiD econometric analysis methodology provides for a statistically reliable comparison of the treatment group to a control group, with respect to the two groups' average change over time in energy (kWh) consumption. To ensure that the control group is representative of the treatment group, ADM employed propensity score matching to identify the optimal control group residence for each treatment group (i.e., 2017 *HEA Program* participant) residence.

3.1 CONTROL GROUP MATCHING

The control group serves as a baseline on energy consumption for the program participants during the pre and post period in the modeling analysis. ADM requested monthly billing data and assessor data for a pool of control group candidates from NVE. The data is used to select a control group that have similar property characteristics and energy consumption. Propensity score matching is then used to match the participant and control properties based on average daily consumption during the summer and winter season and the age of the home.

Propensity score matching is a method by which the control group is "matched" to the treatment group via a propensity score, which is essentially an estimate, derived from observed characteristics, of a customer's likelihood of participating in the HEA program. The probit model below was used to estimate the propensity scores for all customers.

$$Participation = \alpha + \beta \cdot [SummerkWh] + \rho \cdot [WinterkWh] + \gamma \cdot [Age\ of\ Building] + \varepsilon$$

Equation 1

Where,

- $Participation$ is a binary variable that is 1 if the customer is a HEA program participant and 0 if they are a non-participant;
- $SummerkWh$ is a continuous variable that captures the customer's pre-assessment, weather normalized, average daily consumption during the summer months;
- $WinterkWh$ is a continuous variable that captures the customer's pre-assessment, weather normalized average daily consumption during the summer months;
- $Age\ of\ Building$ is a discrete variable detailing the number of years old the premise is at the time of the evaluation;
- ε is an error term;
- β is a coefficient showing the changes in propensity to participate in the HEA program that occurs for a change in the $SummerkWh$ variable;

- ρ is a coefficient showing the changes in propensity to participate in the HEA program that occurs for a change in the $WinterkWh$ variable; and
- γ is a coefficient showing the changes in propensity to participate in the HEA program that occurs for a change in the $Building\ Age$ variable.

After the propensity scores were estimated, for each treatment premise $p,$ a k-nearest neighbors algorithm is used to find the $k = 1$ closest propensity score from among the control premises. It should also be noted that in addition to the propensity scores, treatment members and control group members were matched exactly with respect to their zip code.

3.2 CONTROL GROUP VALIDITY TESTING

ADM tested the participant and control groups of the 2017 *Home Energy Assessments (HEA) Program* for statistically significant differences in the pre-program year to ensure the validity of the comparison. This testing examined the data for a statistical difference in mean kWh usage by normalized season kwh value. Each season has a resulting T-Stat and p-Value to check for any difference. There were no statistical differences in mean normalized kWh usage by season at the p=0.01 (99% confidence level). These statistics are presented in Table 2.

Table 2: Control Group Validity Testing Results

In-Home Assessments				
Season	***Normalized Control kWh***	***Normalized Treatment kWh***	***T-stat (Control-Trt)***	***P-value***
Normalized Summer kWh	3.80	3.82	-0.4156	0.6777
Normalized Winter kWh	4.87	5.02	-1.9214	0.055
Online Assessments				
Season	***Normalized Control kWh***	***Normalized Treatment kWh***	***T-stat (Control-Trt)***	***P-value***
Normalized Summer kWh	3.52	3.70	-1.5578	0.1196
Normalized Winter kWh	4.37	4.84	-2.4346	0.0151

3.3 CALCULATION OF ANNUAL KWH SAVINGS

To determine annual kWh savings, a panel regression modeling of program participants' monthly billing data is used. The data cleaning steps and description of the panel regression approach is presented in the following section.

3.3.1 PREPARATION OF DATA

ADM incorporated the following types of data into the preparation of the dataset that is the panel regression model input:

- Monthly billing data (raw data, which was provided by NVE) for all treatment and control group participants for the period January 1, 2016, through December 31, 2017.
- Regional weather data.
- Customer information:
  - Premise rate code
  - Premise address
  - Customer billing address
  - Customer ID
  - Account ID
  - Meter ID
  - Monthly kWh consumption
- *Home Energy Assessments (HEA) Program* delivery data for the 2017 program year.
  - Date each treatment group member received their first energy assessment service.
- A cross-participation dataset compiled by ADM, which included all participants in NVE's other residential DSM programs.

ADM performed the following steps to prepare the data for the 2017 *HEA Program* evaluation.

- Verified participants during 2017.
- Merged the participants dataset with the raw billing data provided by NVE.
- Create the matched control group using propensity score matching.
- Cleaned the billing data of duplicate bills and information placed in the wrong columns.
- Removed customers with less than 11 bills during the pre-program year.
- Removed customers with less than 11 bills during program year.
- Removed outliers for observations with average daily usage greater than an order of magnitude from the median usage.

3.3.2 CROSS-PARTICIPATION CHECK

ADM removed from the regression analysis any participants that also participated in NVE's other residential demand side management programs. The percentage of treatment group members in NVE's other DSM programs for the HEA participants was 60% as indicated in Table 3.

Table 3: Treatment Group Members in NV Energy's Other DSM Programs

Programs	***Treatment Group Count***	***Count of Treatment Group in Other DSM Programs***	***Percent of Treatment Group in Other DSM Programs***
In-Home Assessments	6,285	3, 420	54%
Online Assessments	1,660	1,380	83%
Total	**7,945**	**4,800**	**60%**

3.3.3 PANEL REGRESSION MODEL

The mixed effects panel regression model specified in Equation 2 is used to determine daily average energy (kWh) savings for treatment group members in the *HEA program*.

$$AEC_{i,t} = \beta_1 CDD_{i,t} + \beta_2 HDD_{i,t} + \beta_3 Post_{i,t} + \beta_4 Treat_{i,t} + \beta_5 Post_{i,t} * Treat_{i,t} + \alpha_i \text{Customer}_i + E_{i,t}$$ *Equation 2*

In Equation 2, the subscript ***i*** denotes individual customers while the subscript ***t*** serves as a time index related to the quantity of monthly utility bills that are available for a given customer ***i*.** In other words, ***t*** = 1, 2, 3, …, ***T(i)***, with ***T*** representing the total quantity or count of monthly utility bills included in the regression analysis for customer ***i*.** For example, when we use a total of two years or 24 months of pre and post monthly utility bills in the regression analysis, ***T*** is 24.

The regression model is defined as "mixed effects" because the model decomposes its parameters into fixed effects (i.e., HDD, CDD, Post, Treat, and its various interactions) and random effects (i.e., the individual customer's base usage). A fixed effect is assumed to be constant and independent of the sample, while random effects are assumed to be sources of variation (other than natural measurement error) that are uncorrelated with the fixed effects. The variables included in the regression model are specified in Table 4.

In the model, the first billing period after the beginning of treatment is considered the "deadband period". Observations that occur in the deadband period are not included in the mixed effects panel regression. For the treatment and control group members, the post period begins in the first billing period following the deadband period. The post variable is defined as a 0 in the billing periods prior to the beginning of treatment and a 1 for billing periods following the beginning of treatment.

Table 4: Description of Coefficients Estimated by Regression Model

Variable	***Variable Description***
Average Electricity Consumption ($AEC_{i,t}$)	Average daily use of electricity for period t for a customer (determined by dividing total usage over a billing period by number of days in that period)
Customer	A panel of dummy variables that is a 1 if customer i is the i in $AEC_{i,t}$ or a 0 otherwise.
Cooling Degree Days (CDD)	Cooling degree days per day (determined by dividing total cooling degree days over a billing period by number of days in that period)
Heating Degree Days (HDD)	Heating degree days per day (determined by dividing total heating degree days over a billing period by number of days in that period)
Post	Post is a dummy variable that is 0 if the monthly period is before the customer received assessment and 1 if the monthly period is after the customer received their assessment. Similarly, for the control group, the post variable is defined as a 0 for the previous year and a 1 for the program year.
Treat	Treat is a dummy variable that is 0 if the customer is a member of the control group and a 1 if the customer is a member of the treatment group.
E_t	E_t is an error term

3.3.4 ESTIMATING COEFFICIENTS OF THE REGRESSION MODEL

The pre (2016) and post (2017) periods included data for January 1, 2016, through the end of December 2017. Table 5 describes the coefficients that were determined by using the mixed effects panel model shown in Equation 2.

Table 5: Description of Variables Used in Regression Model

Coefficient	***Coefficient Description***
α_1	α_1 is a coefficient that represents the grand mean (i.e., mean of the unique customer-specific intercepts). The customer-specific intercepts control for any customer-specific differences.
β_1	β_1 is a coefficient that adjusts for the customer's cooling season weather-sensitive usage.
β_2	β_2 is a coefficient that adjusts for the customer's heating season weather-sensitive usage.
β_3	β_3 is a coefficient that adjusts for whether customer $\boldsymbol{i}$'s monthly billing data in period $\boldsymbol{t}$ is in the pre or post period.
β_4	β_4 is a coefficient that adjusts for whether customer $\boldsymbol{i}$ is in the treatment group or the control group.
β_5	β_5 is a coefficient that adjusts for the interactive effect between whether customer $\boldsymbol{i}$'s monthly billing data in period $\boldsymbol{t}$ is in the pre or post period and whether customer $\boldsymbol{i}$ was in the treatment or control group during period $\boldsymbol{t}$. The value of β_5 is the kWh savings per customer per day if it is significant.

3.3.5 DETERMINATION OF EFFECTIVE USEFUL LIFE ("EUL")

EUL or measure life is expected to be approximately 2.0 years from the beginning of the treatment period for the HEA program. This is ADM's determination, as the independent, third-party evaluator; our determination is based on having evaluated numerous, generally similar behavioral programs in recent years.

Behavioral programs may demonstrate persistence of savings beyond 2.0 years. However, it is ADM's professional judgment that it is a relatively conservative determination for this first evaluation of the *HEA Program* to allow for the EUL of 2.0 years. In 2018 and future years, ADM will study persistence of savings for the *HEA Program* treatment group, which will result in a more accurate determination of EUL over time.

3.3.6 DETERMINING THE ENERGY SAVINGS CURVE

To allocate energy (kWh) savings per month by rate class and critical peak demand (kW) savings per month by rate class, ADM developed a program-specific "Energy Savings Curve" which is depicted in Figure 3-1 below. This Energy Savings Curve is developed from the 2016 *Home Energy Reports ("HERs") Program*. ADM has evaluated the *HERs Program* for several years; similar to the *HEA Program*, the *HERs Program* is a behavioral program in which NVE customers are provided actionable recommendations for saving energy and money in their homes. Given that the *HEA Program* is a behavioral-based program, the inherent assumption is that its Energy Savings Curve is the same as the NV Energy customers' actual energy usage for any given period, including hourly energy usage. This may be a conservative assumption.

For additional discussion of Energy Savings Curves, see Appendix C.

The *HEA Program* Energy Savings Curve in Figure 1 shows that the savings attributable to the 2017 *HEA Program* are greatest during summer or peak cooling months.

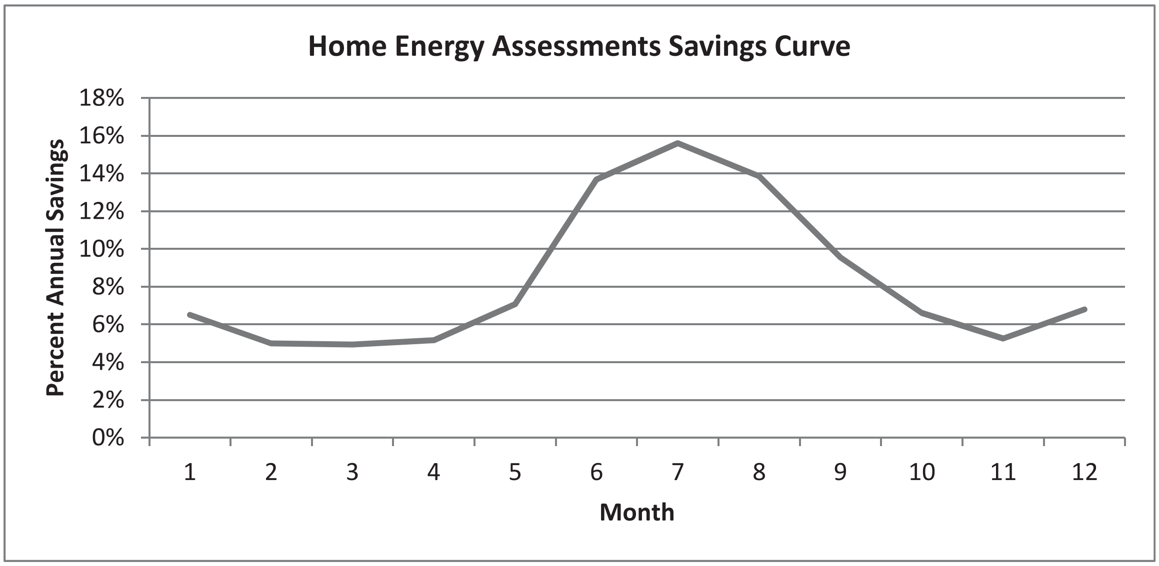

Figure 1: Annual Savings Curve for the 2017 HEA Program

Table 6 below provides location of the Energy Savings Curve and the source of those curves which are used to determine the allocation of kWh and critical peak kW savings per month and rate class.

Table 6: Energy Savings Curves Specific to 2017 Home Energy Assessments Program

Energy Savings Curve	Source	Applicability
Program-level curve for PY2017 *Home Energy Assessments Program*	PY2016 NPC *Home Energy Reports* program-level energy savings curve from PY2016 HERs ***kW Guru™*** file	*Home Energy Assessments Program* residential test group

3.3.7 CALCULATION OF CRITICAL PEAK DEMAND (kW) SAVINGS

The critical peak demand period per month for NPC is defined as the hour in each month when system load is most likely to reach a critical peak. Critical peak demand (kW) savings are calculated per month and by rate class utilizing I program savings determinations and the 8760-hour energy savings curve. For each 2017 participant in this program, *ex-post* annualized energy savings are allocated to the rate class, and to the specific energy savings curve for that measure. The result is a two-dimensional matrix providing per-rate-class savings per hour for all 8,760 hours of the typical calendar year. The results are then inspected for each month to identify the maximum average hourly demand by an hour per month shown in

Table *7*.

Table 7: Critical Peak Demand Hour per Month (NPC)

Month	Hour (NPC)	Ending at:
January	19	19:00
February	19	19:00
March	20	20:00
April	20	20:00
May	17	17:00
June	17	17:00
July	17	17:00
August	17	17:00
September	17	17:00
October	19	19:00
November	19	19:00
December	19	19:00

Summer critical peak demand reduction is defined as the maximum kW reduction that could be expected during any day in July during the hour ending at 5:00 pm. For this program, annual summer critical peak demand reduction is 824 kW. Complete ex-post critical peak demand (kW) savings by month and by rate class are provided in Appendix A. For more information on how ADM calculates summer critical peak demand, see Appendix B.

3.3.8 SURVEY SAMPLING METHODOLOGY

NVE sent a survey questionnaire to a sample of customers who had an In-Home Assessment performed at their residences. The NVE survey asked customers to rate their satisfaction with the service they had received. ADM analyzed 640 surveys returned by In-Home Assessment participants from southern and northern Nevada. The results of our analysis of the survey data are discussed in section 4.2.

4. M&V RESULTS

This chapter presents results and findings from ADM's data collection and analyses related to the 2017 *Home Energy Assessments (HEA) Program*.

4.1 ENERGY (KWH) AND DEMAND (KW) IMPACT ANALYSIS

This section reports the findings from the M&V analysis of energy (kWh) and demand (kW) impacts for the 2017 *Home Energy Assessments (HEA) Program.*

In-Home Assessments

ADM performed a mixed effects panel regression analysis for In-Home Assessments participants and found statistically significant savings of 0.9661 kWh per residence per day, or 352.63 kWh per residence per year.

Online Assessments

ADM performed a mixed effects panel regression analysis for Online Assessments participants but found no statistically significant energy (kWh) savings. ADM found that the lack of post period data caused the determination of no savings. In other words, due to the Online Assessments activity ramping up during the latter part of the 2017 calendar year, there wasn't enough post period data for a statistically significant result from the regression analysis. During 2018, when sufficient post period data becomes available, we will perform an additional study of the same population of 2017 Online Assessments participants.

4.1.1 CALCULATED KWH SAVINGS

ADM found statistically significant energy savings for In-Home Assessments, for which Table 8 provides the results of the mixed-effects panel regression modeling. The *Post x Treat* column of Table 8 contains the modeled energy savings.

Table 8: Results of Mixed Effects Panel Regression Modeling

Programs	Intercept (t-value)	HDD65 (t-value)	CDD75 (t-value)	Post (t-value)	Treat (t-value)	Post x Treat (t-value)	R-squared
In-Home Assessments	17.1833 (37.15)	0.4134 (36.33)	2.3226 (304.10)	0.4211 (3.22)	1.4019 (2.22)	**-0.9661** (-3.51)	0.7649
Online Assessments	16.3419 (9.44)	0.3259 (8.03)	2.1888 (79.73)	-0.0051 (-0.01)	-0.076 (-0.03)	1.8076 (1.62)	0.7762

Table 9 provides average annual energy (kWh) savings per participant, participant count, and program-level annual kWh savings for the 2017 *HEA Program*. Verified energy (kWh) savings for the treatment groups were determined by applying the daily average per household energy (kWh) savings value calculated from the regression model to the treatment group population.

Table 9: Summary of Annual kWh Savings from Regression Analysis

Program	Ex-Post Daily Energy (kWh) Savings	Average Annual kWh Savings per Participant	Count of Participants	Ex-post Annual Energy (kWh) Savings
In-Home Assessments	0.9661	352.63	6,285	2,216,280
Online Assessments	0	0	1,660	0
Total			**7,945**	**2,216,280**

Effective Useful Life ("EUL") of the In-Home Assessments measure is expected to be 2.0 years from the beginning of the treatment period.[1] Table 10 presents the program level ex-post verified energy (kWh) savings for the 2017 In-Home Assessments. Given that all measures were implemented before the end of the 2017 calendar year, and we assume an EUL of 2.0 years, the lifetime savings occurs by the end of 2019. Thus, we assume there is no savings after 2019.

However, persistence of savings will be analyzed in 2018 and 2019, as it is possible that an analysis of additional post-period data may indicate that energy (kWh) savings for In-Home Assessments persists for a time interval exceeding 2.0 years.

Table 10: Summary of Program Level Ex-Post Verified Energy (kWh) Savings

Year	Ex-Post Energy (kWh) Savings
2017	825,374
2018	2,216,280
2019	1,390,906
Total (Lifetime) Savings	**4,432,560**

4.1.2 CALCULATED CRITICAL PEAK DEMAND (KW) SAVINGS

Critical peak demand savings (kW savings) were calculated by month and by rate class, utilizing ex-post verified energy (kWh) savings that were disaggregated into 8,760 hourly bins with an appropriate program-level, 8,760-hour energy savings curve. The annual summer critical peak demand savings for this program was 824 kW. The complete table of ex-post verified critical peak demand (kW) savings by month and rate class are provided in Appendix A.

4.1.3 CALCULATION OF *EX-POST* PRECISION

Our analysis of the 2017 *HEA Program* energy savings achieved an *ex-post* precision of better than ±0.1 percent at the 90 percent confidence level. Statistical analysis of participants' monthly

[1] Measure life is discussed in section 3.3.5 in this report.

billing data yields the most accurate and precise determination of actual energy savings achieved through the 2017 *HEA Program*. Analyzing participants' billing data across the whole program achieves optimal precision, given that, a) sampling error is minimized when analyzing billing data for a large sample of control and treatment group participants, and b) measurement error is null or near zero given that NVE billing data is correct.[2]

4.2 PARTICIPANT SURVEYS

ADM analyzed 640 surveys returned by NVE customers; following are the results of our analysis.

- Respondents reported that they heard about Home Energy Assessment mainly through emailed advertisement (50 percent), TV, radio, or print ads (18 percent), NVE's customer care representatives (12 percent), family or friend (6 percent), and NVE's community event (3 percent).
- 89 percent of respondents reported that their PowerShift Energy Advisor resolved their questions and concerns to satisfaction.
- 87 percent of respondents reported that they feel more knowledgeable about ways to save energy after speaking with their PowerShift Energy Advisor.
- 92 percent of respondents reported that their PowerShift Energy advisor emailed or contacted them the day before to confirm their appointment.
- 98 percent of respondents reported that their PowerShift Energy Advisor was on time for their appointment.
- 98 percent of respondents reported that their Powershift Energy Advisor was knowledgeable, courteous, professional, clean and presentable.
- 92 percent of respondents reported that the information they received from their PowerShift Energy Advisor was helpful.
- 90 percent of respondents reported that they would recommend NVE's Home Energy Assessments to their friends and family.
- Respondents reported that the PowerShift Energy Advisor discussed the following NVE products and services with them: Free Smart Thermostats (79 percent), Time of Use (31 percent), MyAccount (28 percent), Home Air Conditioning Rebates (26 percent), Equal Payment Plan (12 percent), Electric Vehicles (4 percent), Paperless Billing (8 percent), Solar Rebates (8 percent), Select a due date (4 percent).

Customers' responses were evaluated using 11-point Likert scales measured on a continuum from heavily negative (0) to heavily positive (10). Table 11 provides a summary of responses to the customer satisfaction questions in the survey.

[2] ADM confirms this by inspecting and testing NV Energy billing data prior to actual analysis of the billing data.

Table 11: Home Energy Assessments Survey Summary Statistics: Customer Satisfaction

Survey Questions	Mean	90% Confidence Interval	N
Overall, how satisfied were you with your Home Energy Assessment?	8.87	8.5-9.2	623
How satisfied would you say you are with NVE?	8.54	8.2-8.9	618

Note: Scale anchor points were as follows: heavily negative attitudes (0) to heavily positive attitudes (10) with a Neutral midpoint of 5 on the 11-point scale

5. CONCLUSIONS AND RECOMMENDATIONS

This chapter presents conclusions and recommendations.

5.1 CONCLUSIONS

The *Home Energy Assessments (HEA) Program* consists of two parts: In-Home Assessments and Online Assessments. For the 2017 program, ADM determined that there is statistically significant savings for In-Home Assessments, but no statistically significant savings for Online Assessments.

Program-level ex-post verified annual energy savings are 2,216,280 kWh, i.e., 0.9961 kWh/day or 352.62 kWh/year per residence for 6,285 southern Nevada participants.

Survey data for the 2017 *HEA Program* indicates that the In-Home Assessments participants reported increased satisfaction with NVE because of the program.

5.2 RECOMMENDATIONS

In-Home Assessments

ADM recommends that NVE:

1. Deliver the monthly billing data updates on the same schedule as the monthly billing updates are currently being delivered to the implementation team.
2. Monthly provide ADM with an Excel file for each Energy Efficiency Consultation form for each In-Home Assessments participant.

Online Assessments

ADM recommends that the Online Assessments implementation team should:

1. Provide ADM with monthly updates to unique online tool visitors along with their first visited date.
2. Provide ADM with a monthly returning visitors list.
3. Provide ADM any engagement or survey data that is being collected.

Persistence of Savings and EUL Determination

EUL or measure life is expected to be approximately 2.0 years from the beginning of the treatment period for the *HEA Program*. However, to ensure an accurate determination of EUL over time ADM will study the persistence of savings for the *HEA Program* treatment group. In 2018, the persistence study will include the following key element: ADM will analyze additional post-period billing data for 2017 Online Assessments participants to determine whether there is statistically significant savings for the Online Assessments subset of the 2017 *HEA Program*.

6. APPENDIX A: SAVINGS PER MONTH BY RATE CLASS

This appendix provides monthly savings by rate class for calendar years 2017 through 2019.

Table A-1: Energy (kWh) Savings per Month by Rate Class, Calendar Year 2017 (First Year)

Rate Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
RS	4,264	9,244	12,744	15,417	27,956	75,848	116,705	134,361	111,936	91,813	87,915	137,170	**825,374**
Total	**4,264**	**9,244**	**12,744**	**15,417**	**27,956**	**75,848**	**116,705**	**134,361**	**111,936**	**91,813**	**87,915**	**137,170**	**825,374**

Table A-2: Energy (kWh) Savings per Month by Rate Class, Calendar Year 2018 (Full Year)

Rate Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
RS	144,134	110,543	109,271	114,403	156,787	303,276	345,882	307,034	211,538	146,381	116,459	150,574	**2,216,280**
Total	**144,134**	**110,543**	**109,271**	**114,403**	**156,787**	**303,276**	**345,882**	**307,034**	**211,538**	**146,381**	**116,459**	**150,574**	**2,216,280**

Table A-3: Energy (kWh) Savings per Month by Rate Class, Calendar Year 2019

Rate Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
RS	139,870	101,299	96,526	98,986	128,830	227,428	229,177	172,673	99,602	54,567	28,544	13,403	**1,390,906**
Total	**139,870**	**101,299**	**96,526**	**98,986**	**128,830**	**227,428**	**229,177**	**172,673**	**99,602**	**54,567**	**28,544**	**13,403**	**1,390,906**

Table A-4: 2017 Critical Peak Demand (kW) Savings per Month by Rate Class

Rate Tariff	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RS	264.8	241.3	196.5	265.8	481.8	783.2	823.6	776.2	610.9	359.2	227.9	271.3
Total	**264.8**	**241.3**	**196.5**	**265.8**	**481.8**	**783.2**	**823.6**	**776.2**	**610.9**	**359.2**	**227.9**	**271.3**

7. APPENDIX B: CALCULATION METHODOLOGY, CRITICAL PEAK DEMAND (KW) SAVINGS

B.1. OVERVIEW OF CALCULATION METHODOLOGY FOR KW SAVINGS

This section provides a description of analytical steps employed to determine critical peak demand savings per month by rate class for NVE's 2017 Demand Side Management ("DSM") programs. Critical peak demand (kW) savings per month per rate class is determined using essentially the same methodology that is used to disaggregate annual energy (kWh) savings into monthly kWh savings per rate class. Please see the following chapter for a more detailed description of the methodology for determining energy (kWh) savings per month per rate class.

For this program, given that treatment which provided savings (i.e., HEA assessment provided to treatment group) were installed during the 2017 calendar year, Table B-5 in the preceding section provides the full-year values or 2017 calendar-year values for critical peak kW savings per month and per rate class.

B.2. ANALYTICAL STEPS AT THE MEASURE LEVEL

At the measure level, for every record (i.e., individual measure) in DSM Central, ADM assigns an appropriate normalized 8,760 energy savings curve. A normalized energy savings curve is comprised of 8,760 hourly fractions summing to exactly 1 (unity).[3] For each measure, ADM determines *ex-post* annual kWh savings, which is then multiplied by each of the 8,760 hourly fractions to disaggregate the annual kWh into 8,760 hourly kW bins.

B.3. ANALYTICAL STEPS AT THE PROGRAM LEVEL

To determine program-level demand (kW) reduction for a given hourly kW bin, ADM sums the hourly kW bin across all measures in the program. For example, the program-level kW reduction for the hour ending at 5PM on the 200th day of the year is the sum of kW for all measures in the program during that hour on that day.

To determine monthly critical peak demand (kW) reduction for the program, ADM inspects program-level kW reduction during the one-hour critical peak demand period that is defined for each month of the year. The following table provides the monthly critical peak demand periods for NPC and Sierra, which were determined from ADM's analysis of peak system load data provided by NV Energy.

[3] ADM has developed a library of normalized energy savings curves that are appropriate for northern and southern Nevada. Many of the residential energy savings curves were derived from NV Energy's program-specific data, while others were derived from data provided in the 2008 California Database of Energy Efficiency Resources (2008 DEER).

Table C-1. Critical Peak Demand Period per Month, NV Energy

Month	***Critical Peak Period, NPC***		***Critical Peak Period, Sierra***	
	Hour	*Ending at:*	*Hour*	*Ending at:*
January	*19*	*19:00*	*19*	*19:00*
February	*19*	*19:00*	*19*	*19:00*
March	*20*	*20:00*	*20*	*20:00*
April	*20*	*20:00*	*21*	*21:00*
May	*17*	*17:00*	*17*	*17:00*
June	*17*	*17:00*	*17*	*17:00*
July	*17*	*17:00*	*17*	*17:00*
August	*17*	*17:00*	*17*	*17:00*
September	*17*	*17:00*	*17*	*17:00*
October	*19*	*19:00*	*20*	*20:00*
November	*19*	*19:00*	*19*	*19:00*
December	*19*	*19:00*	*19*	*19:00*

For example, the critical peak demand period for July is the hour from 16:00:01 or 4:00:01 PM to 17:00:00 or 5:00:00 PM. To determine July's program-level critical peak kW savings, ADM inspects average hourly kW reduction during 4:00:01 to 5:00:00 PM for every day in July: the highest value represents July's critical peak kW savings. The same procedure is followed for all months of the year. *Summer critical peak demand savings is defined as July's critical peak kW savings;* the rationale for doing so is that historical data reveals that during any given year, NVE's peak system demand in either territory will typically occur during a July day between 4:00:01 to 5:00:00 PM.

To determine the monthly kW reduction *per rate class*, each program-level monthly critical peak kW savings value is disaggregated into *rate class bins* by correlating monthly kW savings for a given measure to the measure's assigned customer rate class as listed in DSM Central.

Calculations for energy (kWh) savings – and for demand (kW) reduction – per month per rate class require complex algorithms that are executed in massive Excel files, which are also known as ***kW guru***™ files.

B.4. ANALYSIS OF SYSTEM-LEVEL CRITICAL PEAK DEMAND PERIODS

ADM analyzed NVE's system-level critical peak hours to determine a consistent reference for peak demand impacts of M&V evaluation of all NV Energy programs. ADM's analysis encompassed Sierra Pacific Power Company ("Sierra") in the north and Nevada Power Company ("NPC") in the south.

Hourly system load data from 1985 through 2011 for Sierra and from 1999 through 2011 for NPC was provided by NV Energy. In analyzing the hourly load data, it was determined that the system peaks for Sierra in 1985 were only half of what they have been in the more recent ten-year period. The percentage change in daily system peaks between summer and winter were smaller in the 80's and 90's than in the more recent ten-year period. Therefore, ADM concluded that the use of system load data from the recent ten-year period provides the best basis for predicting what to expect during an EEM's remaining useful life; following that rationale, data prior to the most recent ten years was excluded from ADM's analysis. In both service territories, the highest system peak occurred in 2007, and system peaks have declined moderately since.

The hourly load data for the recent ten-year period was thoroughly reviewed and except for "spring ahead" hours (when clock times change from Standard Time to Daylight Savings Time), it was determined that the data was consistent and appropriate. The data for "spring ahead" hours are inconsistent, with values given as follows: (1) the value from the preceding hour is used and is an acceptable means of handling the data; and (2) a zero, which is an inaccurate value that would pull down the average. For this analysis, zero values were converted to blanks, and therefore not included in the averaging calculation. Overall this is a minor issue that did not impact ADM's final analysis of system-level critical peak hours.

ADM determined that system load characteristics vary by season. To accommodate the seasonal variations, the hour of peak system load was determined for each month. ADM concluded that a one-hour peak demand period per month is appropriate.

The final determination of the appropriate peak demand hour per month per territory is provided above; see the table in the preceding section of this appendix. The designated peak demand hour per month per territory was utilized for M&V analyses of energy efficiency programs implemented in 2017. Subject to ADM's periodic re-checking of system load data, it is expected that the designated peak demand hour per month per territory will continue to be utilized for subsequent program years.

This M&V methodology update occurred for the following reason. Compared to the three-hour critical peak demand window used for M&V analyses of 2010 programs, the updated critical peak demand definition (i.e., one hour per month per territory) provides a more accurate determination of energy efficiency programs' contributions to reducing system peak demand. In other words, the one-hour peak kW reduction will align with the actual hour of system peak.

NVE's hourly system load data demonstrated well-defined peaks during summer and winter months. However, certain transition months – such as May in northern Nevada – have a nearly identical double peak. It is obvious that specific weather conditions during any given year cause one or the other of the two peaks to predominate. In the final analysis, transition months have far less peak demand than summer months, so a transition month peak hour is essentially insignificant to the determination of the system peak hour, which will typically occur in July and occasionally occur in August (but never in May).

ADM also analyzed hourly system load by various day types. The day type that exhibited highest average demand was selected as the appropriate day type for final determination of peak hour. The day types investigated were (1) All Days, (2) Weekdays, (3) Non-Holiday Weekdays (i.e., Workdays) and (4) Weekend & Holidays. A curve for each month was developed by day type. All days for a given day type were averaged for a given month by hour of the day to develop an average 24-hour load curve. For the north and south the summer peak typically occurs during hour 17, which is the hour that ends at 17:00 (5:00 PM). The greatest summer peak demand is the highest peak demand experienced by both companies.

The analysis determined that of the four day types, Workdays averaged the highest system demand for most hours of the day. Generally, the peak hour calculated from the average Workday curve was identified as the peak hour for the month for the given territory. The peak hours for two transition months in each territory were adjusted to maintain a more consistent set of peak hours. Adjustments were made for May and June for Sierra and April and November for NPC. The selection of the peak hour for these months were based on differences of less than 1 percent in the average demand in MW between the mathematical peak hour and the assigned peak hour.

To validate these decisions ADM also analyzed all-time record peak days and an average of the day from each month that the peak occurred. The second method thus included ten days in the calculation of the average. The results from these analyses supported the average Workday results. Analysis files have not been included in this report due to the large size of spreadsheets.

8. APPENDIX C: DETERMINING ENERGY (KWH) SAVINGS PER MONTH BY RATE CLASS

This chapter provides a detailed description of ADM's analytical steps for determining the energy (kWh) savings per month per rate class values that are provided in the M&V reports for program year 2017.[4]

C.1. APPORTIONMENT OF ANNUAL ENERGY SAVINGS BY RATE CLASS

NV Energy's DSM programs generally include populations of customers from more than one rate class. NV Energy tracks the rate class for each identifiable customer participating in DSM programs. However, participant information is not known for certain DSM programs, such as the *Residential Energy Efficient Lighting Program* or other "upstream" or "midstream" programs where incentives are provided through contractual arrangements with manufacturers or distributors of the rebated products. For DSM programs for which participant information is not known, ADM collected participant information at the point of sale or conducted customer surveys to identify the proportions of participants that belong to various rate classes.

C.2. APPORTIONMENT OF ANNUAL ENERGY SAVINGS BY MONTH

ADM developed a methodology that utilizes *energy savings curves* to calculate the portion of annual energy savings that occurs during each month of the year. An energy savings curve describes the temporal nature of energy savings. For example, on any given day the energy savings achieved by an LED exit sign are approximately 1/365 of the verified annual energy savings for that LED exit sign. On the other hand, an efficient air conditioner may not save any energy during the month of January, but may achieve 35 percent of its annual energy savings in the month of July alone. ADM constructed appropriate energy savings curves from metered data collected during M&V of NV Energy DSM programs (or other programs if appropriate), customer billing data, calibrated DOE2 simulations and engineering calculations. The energy savings curves were coupled with project implementation dates on a record-by-record basis to produce accurate determinations of the energy savings achieved for each month of the year.

C.3. HIGH LEVEL SUMMARY OF ADM'S CALCULATION METHODOLOGY

Monthly energy (kWh) savings for each program were calculated by applying an appropriate hourly or daily energy savings curve to each program participant's ex-post verified energy savings, then aggregating kWh savings for each month. The energy savings curve distributes a participant's energy savings over time. Its shape is therefore dependent on not only the measure installed (i.e., lighting vs. HVAC), but also on the building type and sometimes its location.

The overall process by which ADM calculated monthly kWh savings was to (1) download from DSM Central all program tracking data, i.e., ex-ante expected kWh savings, measure type, measure completion date, rate class, etc., (2) calculate ex-post values per participant, (3) assign an energy savings curve to each

[4] The Public Utilities Commission of Nevada (PUCN) requires NV Energy to report energy (kWh) savings per month and per rate class for each Demand Side Management (DSM) program.

participant's ex-post savings to distribute ex-post energy savings by rate class over each of the 8,760 hours in a year, and (4) aggregate ex-post verified savings for the purpose of presenting savings by month and by rate class.

ADM also calculated first-year kWh savings for each program by combining measure startup date (from DSM Central) with the aforementioned process. A detailed description of the steps involved in tabulating first-year kWh savings is provided in section C.5 below.

C.4. ENERGY SAVINGS CURVES

DEFINITION

The phrase 'energy savings curve' is used to describe the temporal dependence of energy savings. The curves are typically hourly (1 × 8760 array), daily (1 × 365 array), or monthly (1 × 12 array). The energy savings curves are often normalized such the sum of all array elements is unity. When normalized, each element describes the fraction of annual savings that is expected to occur in a given hour, day, or month.

NOMENCLATURE

Note that if the term 'load shape' is encountered in the spreadsheets that are used to tally monthly energy savings by program and rate class, one should take it to be the same as 'energy savings curve' as described herein. The reason for the usage of the term 'load shape' is twofold:

- Energy savings curves are *differential load shapes* describing differences in electricity loads resulting from the implementation of energy efficiency measures; in other words, energy savings curves indicate the *shape over time of electricity that is saved or not used*. Notably, energy that is *not used due to energy efficiency actions* (i.e., "saved" energy) is sometimes called 'Negawatts'. A 'Negawatt' saved is meant to represent a negative form of a 'Megawatt' of power that would have been used if the energy efficiency actions had not occurred.
- An energy savings curve for a measure may or may not be synchronous with the load curve of the base case technology against which savings are determined.
    1. There are energy efficiency measures (EEMs) for which the normalized savings curve is synchronous and proportional to the normalized load shape or curve of the base case technology. Examples of such EEMs include CFLs versus incandescent lights if it is assumed that (1) there are null or negligible interactive effects and (2) pre- and post-retrofit usage schedules are identical. If the savings curve for an EEM is synchronous with the base case technology load shape, then the two curves have identical shapes.
    2. For other EEMs, the energy savings curve is asynchronous with the load curve of the base case technology. Examples of EEMs with asynchronous savings curves include economizers, occupancy sensors, and control systems. For such measures, the shape of the energy savings curve is different from the shape of the base case technology.

As part of our evaluation effort ADM determines for each EEM whether to use normalized energy savings curves that are either synchronous or asynchronous with the normalized load shape of the base case technology.

C.5. TABULATING MONTHLY ENERGY (KWH) SAVINGS PER RATE CLASS

Normalized daily energy savings curves are utilized for this task. A normalized daily energy savings curve is comprised of 365 daily fractions summing to exactly 1 (unity). For each measure, ADM determines *ex-post* annual kWh savings, which is then multiplied by each of the 365 daily energy savings curve fractions to disaggregate annual kWh into 365 daily kWh bins.

FIRST-YEAR kWh SAVINGS

'First-year' kWh savings are savings that occur during the same calendar year in which a conservation program was implemented. For NV Energy a program year is the same as a calendar year. Thus 'first-year' kWh savings for a measure installed during a given program year are equal to that measure's kWh savings during the same given calendar year.

The following calculations are performed to tabulate 'first-year' kWh savings attributable to a given customer rate class. For any given NV Energy program:

- For each rate class, for each day of the 'first-year' kWh savings, identify all measures that have been implemented (or 'installed' or 'started up') by the subject day.
- For each rate class, for each day of the 'first year,' for all measures that that have been installed by the subject day, multiply the *ex-post* verified 'typical-year' annualized kWh savings[5] for each measure type by that measure's daily kWh bin. In other words, multiply the measure-level annual kWh by the measure-level daily bin from the appropriate energy savings curve.
- For each rate class, tally all measure-level daily kWh savings to determine program-level daily kWh savings.
- For each rate class, for any given month of 'first year,' tally all measure-level daily kWh savings occurring during that month to determine program-level monthly kWh savings for that calendar year.
- For each rate class, the first-year kWh savings is the program-level monthly kWh savings for that rate class summed across all 12 months of the 'first year.'

[5] 'Typical-year' annualized kWh savings is 365 consecutive days of energy savings – usually a full calendar year other than Leap Year – attributed to an energy efficiency measure(s) for which ex-post verified kWh savings will occur during a multi-year measure life. For example, an NV Energy conservation measure installed during the 2017 program year (i.e., during the 2017 calendar year) will normally provide kWh savings starting on its date of installation. 'First-year' savings is the savings that occurs during the 2017 calendar year. 'Full-year' savings is the savings occurring during the succeeding calendar year.

'Typical-Year' Energy (kWh) Savings

'Typical-year' energy (kWh) savings represents 365 consecutive days of energy savings attributed to a measure(s) or program for which *ex-post* verified savings will occur across a multi-year measure life.[6]

The following calculations are performed to tabulate 'typical-year' energy (kWh) savings attributable to a given customer rate class.

- For each rate class, for each hour (or day) of calendar years occurring after the 'first year,' multiply *ex-post* verified 'typical-year' energy (kWh) savings for each measure type by that measure's hourly (or daily) kWh bin. In other words, multiply the measure-level annual kWh by the measure-level hourly (or daily) bin from the appropriate energy savings curve.[7]
- For each rate class, tally all measure-level hourly (or daily) kWh savings to determine program-level hourly (or daily) kWh savings.
- For each rate class, for any given month, sum all measure-level hourly (or daily) kWh savings occurring in that month to determine program-level monthly kWh savings.
- For each rate class, 'typical-year' kWh savings is the program-level monthly kWh savings for that rate class summed across all 365 days of any non-Leap Year subsequent to the 'first year.'
- For any given program, 'full-year' kWh savings for a Leap Year will be marginally higher than 'full-year' kWh savings for a 'typical year' or non-Leap Year. Thus, we always use a non-Leap Year when we quantify 'typical-year' kWh savings.

Following is an example of the determination of daily kWh savings generated by a program. Let's consider a hypothetical program that targets two energy efficiency (EE) measures: residential lighting and residential cooling. For this hypothetical program, Table D-1 below provides a simple comparison of the measures' respective:

- 'typical-year' energy savings;
- daily bin value in its energy savings curve for a specific day – February 1st – of any given year[8] after the EE measures were installed;
- energy (kWh) savings during February 1st of any given year after the EE measures were installed.

[6] The distinction between 'typical year' and 'full year' is that a 'typical year' is a 365-day year. A Leap Year is not a 'typical year'. Instead, a Leap Year is a 'full year' that has 366 days.

[7] When tallying kWh savings per month per rate class, the use of hourly bins or daily bins is equally correct and accurate. ADM typically uses daily bins (which are created from hourly bins) in our kW guru™ Excel files simply because a workstation processor can complete the billions of computations in a large kW guru™ file relatively faster when the number of computations is based on 365 daily bins instead of 8760 hourly bins per calendar year. Hourly bins in kW guru™ files (i.e., the 8760 hourly bins per 'typical year') exist for the following two purposes: 1) they are summed across the 24 hours of each day to create the aforementioned daily bins; and 2) they provide the hourly resolution that enables us to analyze and report critical peak demand (kW) savings per month per rate class for any specified kW-reporting period.

[8] The daily bin value for February 1 represents the February 1 daily fraction of 'typical-year' annual energy (kWh) savings.

In Table C-1 below, the assumption is that 1,000,000 kWh of annual energy savings (‘typical-year’ savings as reported in M&V reports) were achieved through distribution of LEDs and 500,000 kWh of annual (typical-year) energy savings were achieved through implementation of high efficiency air conditioning (AC) measures. Energy (kWh) savings on February 1st are obtained by multiplying ‘typical-year’ kWh savings by the entries corresponding to February 1st in the respective normalized energy savings curves. ***In this example, the daily bin for space cooling is zero because no space cooling is expected to occur on February 1st.***

Table C-1. Sample Calculation of Energy Savings Achieved for a Given Rate Class on February 1 for a Hypothetical Program Targeting Residential Lighting and Space Cooling.

Comparison for “Indoor Lighting” vs. “Space Cooling” Measures	**EE Measure = “Indoor Lighting”**	**EE Measure = “Space Cooling”**
‘Typical-year’ energy savings (annual kWh):	1,000,000	500,000
Feb. 1 daily bin value in each EE measure’s energy savings curve:	0.0030	0.0000
Feb. 1 energy (kWh) savings in a typical year:	3,000	0

For each program, such calculations are performed for each rate class, energy savings curve and hour (or day). Hourly (or daily) results are then aggregated at the monthly level.

LEAP YEAR SAVINGS

To account for the extra day in February in Leap Years, one of the following methods is used. Either method produces accurate and very similar *ex-post* verified energy savings determinations for Leap Years.

- Energy savings during the month of February in a Leap Year is taken to be equal to 29/28 of energy savings during the month of February in a typical non-Leap Year.
- Or, energy savings on the day of February 29 in a Leap Year is assumed to be the same as energy savings on the previous day (February 28).

9. APPENDIX D: HEA PARTICIPANT SURVEYS

NV Energy In-Home Assessments Participants SURVEY

1. How did you hear about Home Energy Assessments?

- TV, radio, or print ads
- NV Energy's community event
- Emailed advertisement
- NV Energy's customer care representatives
- Family or friend
- Other (please specify)

2. Did your PowerShift Energy Advisor resolve your questions and/or concerns to your satisfaction?

- Yes
- No
- I don't know

3. After speaking with your PowerShift Energy Advisor, do you feel more knowledgeable about ways to save energy?

- Yes
- No
- I don't know

4. My PowerShift Energy Advisor emailed or contacted me the day before to confirm my appointment.

- Yes
- No
- I don't know

5. My PowerShift Energy Advisor was on time for my appointment.

- Yes

- No
- I don't know

6. My PowerShift Energy Advisor was knowledgeable, courteous, professional, clean, and presentable.

- Yes
- No
- I don't know

7. The information I received from my PowerShift Energy Advisor was helpful.

- Yes
- No
- I don't know

8. I would recommend NV Energy's Home Energy Assessments to my friends and family.

- Yes
- No
- I don't know

9. Which of the following NV Energy products and services did your PowerShift Energy Advisor discuss with you? Select all that apply.

- [ ] Free Smart Thermostats
- [ ] Home Air Conditioning Rebates
- [ ] MyAccount
- [ ] Equal Payment Plan
- [ ] Paperless Billing
- [ ] Select a due date
- [ ] Time of Use
- [ ] Electric Vehicles
- [ ] Solar Rebates

Other (please specify)

10. Based on your overall experience with your Home Energy Assessment, how satisfied would you say you are? Using a 1 to 10 scale, where 1 means you are extremely dissatisfied and 10 means you are extremely satisfied, how satisfied would you say you are with your Home Energy Assessment?

○ ○ ○ ○ ○ ○ ○ ○ ○ ○

11. Based on your overall experience with NV Energy, how satisfied would you say you are? Using a 1 to 10 scale, where 1 means you are extremely dissatisfied and 10 means you are extremely satisfied, how satisfied would you say you are with NV Energy?

◉ ○ ○ ○ ○ ○ ○ ○ ○ ○

12. Do you have any other questions, comments, or suggestions you would like to share with NV Energy?

DSM-10

Home Energy Assessments
NV Energy – Northern Nevada (SPPC)
Program Year 2017

Measurement and Verification Report
March 29, 2018

Prepared for:

NV Energy

Prepared by:

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Table of Contents

1. EXECUTIVE SUMMARY

This measurement and verification ("M&V") report provides the results of the ADM Associates Inc. ("ADM") 2017 evaluation of the NV Energy ("NVE") *Home Energy Assessments ("HEA") Program* for the northern Nevada service territory, Sierra Pacific Power Company ("SPPC").

The *Home Energy Assessments (HEA) Program* provides NVE customers with two distinct versions of residential energy assessment services. Both program elements are opt-in services available to all NVE customers: a) 'In-Home Assessments' and b) 'Online Assessments'.

As NVE's independent, third-party M&V contractor, ADM's analyses for the 2017 *HEA Program* included:

- Propensity score matching of program participants to a control group, and a difference in differences ("DiD") econometric panel data model to determine energy savings.
- Participants were surveyed to determine what actions they took as the result of the 2017 *HEA Program*, and to assess participants' satisfaction with the program.

1.1 IN-HOME ASSESSMENTS

NVE started providing its residential customers In-Home Assessments services in 2015. However, program year 2017 is the first year for which ADM is determining energy (kWh) and demand (kW) savings for In-Home Assessments.

In-Home Assessments services and activities are intended to achieve a positive outcome in response to NVE residential customers who express complaints related to high energy bills. When providing In-Home Assessments services, the NVE home energy consultant performs a walk-through energy assessment and audit of the premises with the customer; the NVE consultant reviews the results of the audit with the customer and provides the customer a checklist of items examined along with recommendations to save energy. An important aspect of the audit is the dialogue between the NVE home energy consultant and the customer, including specific discussions related to energy conservation opportunities.

ADM determined the following ex-post verified energy (kWh) and peak demand (kW) savings for 2017 In-Home Assessments:

- 316,958 kWh for 2017 (first-year savings)
- 906,596 kWh for 2018 (full-year savings)
- 589,638 kWh for 2019 (less than full-year savings, due to a 2-year measure life)
- 1,813,192 kWh lifetime savings (twice full-year savings, given a 2-year measure life)
- 293 kW summer critical peak demand savings

1.2 ONLINE ASSESSMENTS

Program year 2017 is the first year NVE offered its residential customers Online Assessments services, which were introduced to NVE customers starting in August 2017.

The Online Assessments service provides NVE customers access to an online, self-service home energy assessments tool which enables customers to perform their own comprehensive energy assessments of their residences. The online tool compares each customer's energy use with similar homes, tracks energy use over time, and employs proprietary algorithms to analyze the customer's energy consumption history. The online tool is essentially designed to discover opportunities for energy conservation, then recommend specific steps that the customer can take to lower electricity bills. The online tool features visually assisted choices to make the energy assessment procedure as user-friendly as possible for customers. The online tool also guides customers to participate in NV Energy's demand-side management ("DSM") programs and provides customers with a customized list of various other energy conservation measures, both with and without cost.

ADM analyzed energy (kWh) and peak demand (kW) savings for Online Assessments and determined that there were no statistically significant kWh or kW savings for 2017 participants. ADM found that the lack of post period data caused the determination of no savings. In other words, due to the Online Assessments activity ramping up during the latter part of the 2017 calendar year, there wasn't enough post period data for a statistically significant result from the regression analysis. Post period data included the months of September to December 2017. During 2018, when additional post period data becomes available, we will perform an additional study of the same population of 217 Online Assessments participants.

1.3 SUMMARY OF PROGRAM-LEVEL SAVINGS

Table 1 provides a summary of program-level energy impacts for the 2017 HEA Program.

Table 1: Summary of Program Level Annual Energy (kWh) Savings

Program Component or Measure	***Ex-Post Annual Energy (kWh) Savings***	***Expected Measure Life***	***Ex-Post Lifetime Energy (kWh) Savings***	***Ex-Post Peak Demand (kW) Savings***
In-Home Assessments	906,596	2.0	1,813,192	293.3
Online Assessments	0	0	0	0.0
Total, *HEA Program*	**906,596**	**2.0**	**1,813,192**	**293.3**

2. PROGRAM BACKGROUND

This chapter provides a description of the program design and 2017 activity for the *Home Energy Assessments (HEA) Program*, a behavioral program. The *HEA Program* aims to provide NVE customers information and opportunities that enable program participants to take positive actions – i.e., behavioral changes and related actions – which will achieve measurable, verifiable energy (kWh) savings. Program objectives also include motivating customers to increase their awareness and adoption of NVE's other energy conservation programs, and to strengthen NVE's relationships with its customers. The *HEA Program* includes In-Home Assessments and Online Assessments.

2.1 IN-HOME ASSESSMENTS

In-Home Assessments services and activities are intended to achieve a positive outcome in response to NVE residential customers who express complaints related to high energy bills.

In-Home Assessments focus on evaluating each participating customer's energy consumption while meeting with the customer in their residence, and providing real-time, actionable solutions and energy efficiency education. The home energy auditor listens to the concerns of the customer, performs a Home Energy Audit, then provides the residential customer with a checklist of recommendations to reduce their monthly electricity consumption. The interaction between the auditor and customer provides an opportunity for NVE's customers to ask questions about energy efficiency and to learn about NVE's demand side management programs.

In 2017, NVE contracted with implementation contractors Green Chips, Mad Dash, Scope Services, and Duct Testers to deliver this behavioral-based program targeted at residential customers. An additional member of the *HEA Program* implementation team is an NVE employee who handles customer complaints that are directed to the Commission (which the Commission routes to NVE for positive disposition and reporting). In 2017, NVE completed 3,133 In-Home Assessments in northern Nevada.

2.2 ONLINE ASSESSMENTS

The Online Assessments portion of the *HEA program* provided customers with information about their home's energy use, compared that energy use to a group of similar households (both average and most efficient neighbors), and educated them on practices or behaviors to reduce their energy use through the online self-serve home energy assessments tool. It was expected that through this education, customers would be encouraged to implement measures or adopt practices that could lead to more efficient energy use in their homes. Online Assessments were designed to also encourage residential customers to participate in other NVE demand side management programs.

In 2017, a total of 54,154 NVE residential customers statewide used the online tool. Data provided to ADM did not include a field for NPC versus SPPC participants. ADM received premise ID data and monthly billing data for a sample of NPC participants, from which we determined there were not statistically significant savings for 2017 participants. This is a typical first-year result for a behavioral program that ramped up during the latter part of its first calendar year. In other words, for a first-year behavioral program, it isn't unusual for post period data that's limited to September through December to be insufficient for determining a statistically significant savings signal from the regression analysis.

3. M&V METHODOLOGY

This chapter provides a description of ADM's methodology for performing the M&V analysis of the 2017 *HEA Program*. Our M&V analysis utilized a difference in differences ("DiD") econometric panel data model to determine energy (kWh) savings. The DiD econometric analysis methodology provides for a statistically reliable comparison of the treatment group to a control group, with respect to the two groups' average change over time in energy (kWh) consumption. To ensure that the control group is representative of the treatment group, ADM employed propensity score matching to identify the optimal control group residence for each treatment group (i.e., 2017 *HEA Program* participant) residence.

3.1 CONTROL GROUP MATCHING

The control group serves as a baseline on energy consumption for the program participants during the pre and post period in the modeling analysis. ADM requested monthly billing data and assessor data for a pool of control group candidates from NVE. The data is used to select a control group that have similar property characteristics and energy consumption. Propensity score matching is then used to match the participant and control properties based on average daily consumption during the summer and winter season and the age of the home.

Propensity score matching is a method by which the control group is "matched" to the treatment group via a propensity score, which is essentially an estimate, derived from observed characteristics, of a customer's likelihood of participating in the HEA program. The probit model below was used to estimate the propensity scores for all customers.

$$Participation = \alpha + \beta \cdot [SummerkWh] + \rho \cdot [WinterkWh] + \gamma \cdot [Age\ of\ Building] + \varepsilon$$

Equation 1

Where,

- $Participation$ is a binary variable that is 1 if the customer is a HEA program participant and 0 if they are a non-participant;
- $SummerkWh$ is a continuous variable that captures the customer's pre-assessment, weather normalized, average daily consumption during the summer months;
- $WinterkWh$ is a continuous variable that captures the customer's pre-assessment, weather normalized average daily consumption during the summer months;
- $Age\ of\ Building$ is a discrete variable detailing the number of years old the premise is at the time of the evaluation;
- ε is an error term;
- β is a coefficient showing the changes in propensity to participate in the HEA program that occurs for a change in the $SummerkWh$ variable;

- ρ is a coefficient showing the changes in propensity to participate in the HEA program that occurs for a change in the $WinterkWh$ variable; and
- γ is a coefficient showing the changes in propensity to participate in the HEA program that occurs for a change in the $Building\ Age$ variable.

After the propensity scores were estimated, for each treatment premise p, a k-nearest neighbors algorithm is used to find the $k = 1$ closest propensity score from among the control premises. It should also be noted that in addition to the propensity scores, treatment members and control group members were matched exactly with respect to their zip code.

3.2 CONTROL GROUP VALIDITY TESTING

ADM tested the participant and control groups of the 2017 *Home Energy Assessments (HEA) Program* for statistically significant differences in the pre-program year to ensure the validity of the comparison. This testing examined the data for a statistical difference in mean kWh usage by normalized season kwh value. Each season has a resulting T-Stat and p-Value to check for any difference. There were no statistical differences in mean normalized kWh usage by season at the p=0.01 (99% confidence level). These statistics are presented in Table 2.

Table 2: *Control Group Validity Testing Results*

In-Home Assessments				
Season	***Normalized Control kWh***	***Normalized Treatment kWh***	***T-stat (Control-Trt)***	***P-value***
Normalized Summer kWh	5.88	6.08	-1.7903	0.0735
Normalized Winter kWh	1.27	1.33	-2.5599	0.0105
Online Assessments				
Season	***Normalized Control kWh***	***Normalized Treatment kWh***	***T-stat (Control-Trt)***	***P-value***
Normalized Summer kWh	5.95	5.82	0.2606	0.7949
Normalized Winter kWh	1.20	1.23	-0.3409	0.7336

3.3 CALCULATION OF ANNUAL KWH SAVINGS

To determine annual kWh savings, a panel regression modeling of program participants' monthly billing data is used. The data cleaning steps and description of the panel regression approach is presented in the following section.

3.3.1 PREPARATION OF DATA

ADM incorporated the following types of data into the preparation of the dataset that is the panel regression model input:

- Monthly billing data (raw data, which was provided by NVE) for all treatment and control group participants for the period January 1, 2016, through December 31, 2017.
- Regional weather data.
- Customer information:
  - Premise rate code
  - Premise address
  - Customer billing address
  - Customer ID
  - Account ID
  - Meter ID
  - Monthly kWh consumption
- *Home Energy Assessments (HEA) Program* delivery data for the 2017 program year.
  - Date each treatment group member received their first energy assessment service.
- A cross-participation dataset compiled by ADM, which included all participants in NVE's other residential DSM programs.

ADM performed the following steps to prepare the data for the 2017 *HEA Program* evaluation.

- Verified participants during 2017.
- Merged the participants dataset with the raw billing data provided by NVE.
- Create the matched control group using propensity score matching.
- Cleaned the billing data of duplicate bills and information placed in the wrong columns.
- Removed customers with less than 11 bills during the pre-program year.
- Removed customers with less than 11 bills during program year.
- Removed outliers for observations with average daily usage greater than an order of magnitude from the median usage.

3.3.2 CROSS-PARTICIPATION CHECK

ADM removed from the regression analysis any participants that also participated in NVE's other residential demand side management programs. The percentage of treatment group members in NVE's other DSM programs for the HEA participants was 42% as indicated in Table 3.

Table 3: Treatment Group Members in NV Energy's Other DSM Programs

Programs	***Treatment Group Count***	***Count of Treatment Group in Other DSM Programs***	***Percent of Treatment Group in Other DSM Programs***
In-Home Assessments	3,133	1,385	44%
Online Assessments	376	75	20%
Total	**3,509**	**1,460**	**42%**

3.3.3 PANEL REGRESSION MODEL

The mixed effects panel regression model specified in Equation 2 is used to determine daily average energy (kWh) savings for treatment group members in the *HEA program*.

$$AEC_{i,t} = \beta_1 CDD_{i,t} + \beta_2 HDD_{i,t} + \beta_3 Post_{i,t} + \beta_4 Treat_{i,t} + \beta_5 Post_{i,t} * Treat_{i,t} + \alpha_i \text{Customer}_\text{i} + E_{i,t} \qquad \text{Equation 2}$$

In Equation 2, the subscript ***i*** denotes individual customers while the subscript ***t*** serves as a time index related to the quantity of monthly utility bills that are available for a given customer ***i*.** In other words, ***t*** = 1, 2, 3, …, ***T(i)***, with ***T*** representing the total quantity or count of monthly utility bills included in the regression analysis for customer ***i*.** For example, when we use a total of two years or 24 months of pre and post monthly utility bills in the regression analysis, ***T*** is 24.

The regression model is defined as "mixed effects" because the model decomposes its parameters into fixed effects (i.e., HDD, CDD, Post, Treat, and its various interactions) and random effects (i.e., the individual customer's base usage). A fixed effect is assumed to be constant and independent of the sample, while random effects are assumed to be sources of variation (other than natural measurement error) that are uncorrelated with the fixed effects. The variables included in the regression model are specified in Table 4.

In the model, the first billing period after the beginning of treatment is considered the "deadband period". Observations that occur in the deadband period are not included in the mixed effects panel regression. For the treatment and control group members, the post period begins in the first billing period following the deadband period. The post variable is defined as a 0 in the billing periods prior to the beginning of treatment and a 1 for billing periods following the beginning of treatment.

Table 4: Description of Coefficients Estimated by Regression Model

Variable	***Variable Description***
Average Electricity Consumption ($AEC_{i,t}$)	Average daily use of electricity for period t for a customer (determined by dividing total usage over a billing period by number of days in that period)
Customer	A panel of dummy variables that is a 1 if customer i is the i in $AEC_{i,t}$ or a 0 otherwise.
Cooling Degree Days (CDD)	Cooling degree days per day (determined by dividing total cooling degree days over a billing period by number of days in that period)
Heating Degree Days (HDD)	Heating degree days per day (determined by dividing total heating degree days over a billing period by number of days in that period)
Post	Post is a dummy variable that is 0 if the monthly period is before the customer received assessment and 1 if the monthly period is after the customer received their assessment. Similarly, for the control group, the post variable is defined as a 0 for the previous year and a 1 for the program year.
Treat	Treat is a dummy variable that is 0 if the customer is a member of the control group and a 1 if the customer is a member of the treatment group.
E_t	E_t is an error term

3.3.4 ESTIMATING COEFFICIENTS OF THE REGRESSION MODEL

The pre (2016) and post (2017) periods included data for January 1, 2016, through the end of December 2017. Table 5 describes the coefficients that were determined by using the mixed effects panel model shown in Equation 2.

Table 5: Description of Variables Used in Regression Model

Coefficient	***Coefficient Description***
α_1	α_1 is a coefficient that represents the grand mean (i.e., mean of the unique customer-specific intercepts). The customer-specific intercepts control for any customer-specific differences.
β_1	β_1 is a coefficient that adjusts for the customer's cooling season weather-sensitive usage.
β_2	β_2 is a coefficient that adjusts for the customer's heating season weather-sensitive usage.
β_3	β_3 is a coefficient that adjusts for whether customer $\boldsymbol{i}$'s monthly billing data in period $\boldsymbol{t}$ is in the pre or post period.
β_4	β_4 is a coefficient that adjusts for whether customer $\boldsymbol{i}$ is in the treatment group or the control group.
β_5	β_5 is a coefficient that adjusts for the interactive effect between whether customer $\boldsymbol{i}$'s monthly billing data in period $\boldsymbol{t}$ is in the pre or post period and whether customer $\boldsymbol{i}$ was in the treatment or control group during period $\boldsymbol{t}$. The value of β_5 is the kWh savings per customer per day if it is significant.

3.3.5 DETERMINATION OF EFFECTIVE USEFUL LIFE ("EUL")

EUL or measure life is expected to be approximately 2.0 years from the beginning of the treatment period for the HEA program. This is ADM's determination, as the independent, third-party evaluator; our determination is based on having evaluated numerous, generally similar behavioral programs in recent years.

Behavioral programs may demonstrate persistence of savings beyond 2.0 years. However, it is ADM's professional judgment that it is a relatively conservative determination for this first evaluation of the *HEA Program* to allow for the EUL of 2.0 years. In 2018 and future years, ADM will study persistence of savings for the *HEA Program* treatment group, which will result in a more accurate determination of EUL over time.

3.3.6 DETERMINING THE ENERGY SAVINGS CURVE

To allocate energy (kWh) savings per month by rate class and critical peak demand (kW) savings per month by rate class, ADM developed a program-specific "Energy Savings Curve" which is depicted in Figure 3-1 below. This Energy Savings Curve is developed from the 2016 *Home Energy Reports ("HERs") Program*. ADM has evaluated the *HERs Program* for several years; similar to the *HEA Program*, the *HERs Program* is a behavioral program in which NVE customers are provided actionable recommendations for saving energy and money in their homes. Given that the *HEA Program* is a behavioral-based program, the inherent assumption is that its Energy Savings Curve is the same as the NV Energy customers' actual energy usage for any given period, including hourly energy usage. This may be a conservative assumption.

For additional discussion of Energy Savings Curves, see Appendix C.

The *HEA Program* Energy Savings Curve in Figure 1 shows that the savings attributable to the 2017 *HEA Program* are greatest during summer or peak cooling months.

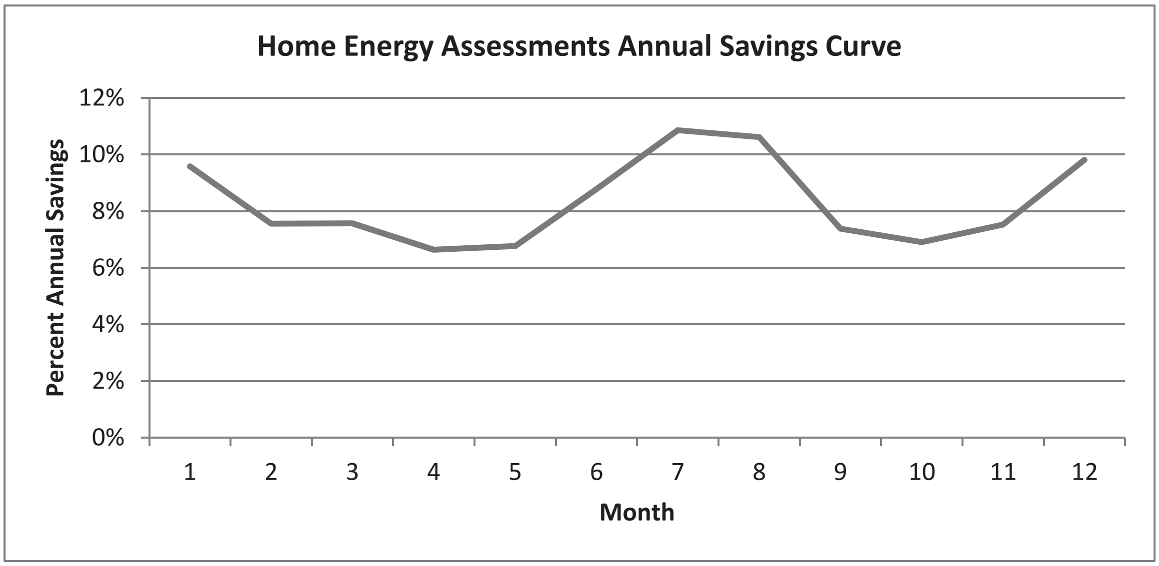

Figure 1: Annual Savings Curve for the 2017 HEA Program

Table 6 below provides location of the Energy Savings Curve and the source of those curves which are used to determine the allocation of kWh and critical peak kW savings per month and rate class.

Table 6: Energy Savings Curves Specific to 2017 Home Energy Assessments Program

Energy Savings Curve	Source	Applicability
Program-level curve for PY2017 *Home Energy Assessments Program*	PY2016 SPPC *Home Energy Reports* program-level energy savings curve from PY2016 HERs ***kW Guru™*** file	*Home Energy Assessments Program* residential test group

3.3.7 CALCULATION OF CRITICAL PEAK DEMAND (kW) SAVINGS

The critical peak demand period per month for SPPC is defined as the hour in each month when system load is most likely to reach a critical peak. Critical peak demand (kW) savings are calculated per month and by rate class utilizing I program savings determinations and the 8760-hour energy savings curve. For each 2017 participant in this program, ex-post annualized energy savings are allocated to the rate class, and to the specific energy savings curve for that measure. The result is a two-dimensional matrix providing per-rate-class savings per hour for all 8,760 hours of the typical calendar year. The results are then inspected for each month to identify the maximum average hourly demand by an hour per month shown in

Table *7*.

Table 7: Critical Peak Demand Hour per Month (SPPC)

Month	Hour (SPPC)	Ending at:
January	19	19:00
February	19	19:00
March	20	20:00
April	21	21:00
May	17	17:00
June	17	17:00
July	17	17:00
August	17	17:00
September	17	17:00
October	20	20:00
November	19	19:00
December	19	19:00

Summer critical peak demand reduction is defined as the maximum kW reduction that could be expected during any day in July during the hour ending at 5:00 pm. For this program, annual summer critical peak demand reduction is 293 kW. Complete ex-post critical peak demand (kW) savings by month and by rate class are provided in Appendix A. For more information on how ADM calculates summer critical peak demand, see Appendix B.

3.3.8 SURVEY SAMPLING METHODOLOGY

NVE sent a survey questionnaire to a sample of customers who had an In-Home Assessment performed at their residences. The NVE survey asked customers to rate their satisfaction with the service they had received. ADM analyzed 640 surveys returned by In-Home Assessment participants from southern and northern Nevada. The results of our analysis of the survey data are discussed in section 4.2.

4. M&V RESULTS

This chapter presents results and findings from ADM's data collection and analyses related to the 2017 *Home Energy Assessments (HEA) Program.*

4.1 ENERGY (KWH) AND DEMAND (KW) IMPACT ANALYSIS

This section reports the findings from the M&V analysis of energy (kWh) and demand (kW) impacts for the 2017 *Home Energy Assessments (HEA) Program.*

In-Home Assessments

ADM performed a mixed effects panel regression analysis for In-Home Assessments participants and found statistically significant savings of 0.7928 kWh per residence per day, or 289.37 kWh per residence per year.

Online Assessments

ADM performed a mixed effects panel regression analysis for Online Assessments participants but found no statistically significant energy (kWh) savings. ADM found that the lack of post period data caused the determination of no savings. In other words, due to the Online Assessments activity ramping up during the latter part of the 2017 calendar year, there wasn't enough post period data for a statistically significant result from the regression analysis. During 2018, when sufficient post period data becomes available, we will perform an additional study of the same population of 2017 Online Assessments participants.

4.1.1 CALCULATED KWH SAVINGS

ADM found statistically significant energy savings for In-Home Assessments, for which Table 8 provides the results of the mixed-effects panel regression modeling. The *Post x Treat* column of Table 8 contains the modeled energy savings.

Table 8: Results of Mixed Effects Panel Regression Modeling

Programs	Intercept (t-value)	HDD65 (t-value)	CDD75 (t-value)	Post (t-value)	Treat (t-value)	Post x Treat (t-value)	R-squared
In-Home Assessments	12.8780 (28.94)	0.4227 (62.31)	2.4744 (96.78)	0.4960 (4.02)	0.7720 (1.33)	-0.7928 (-2.81)	0.6909
Online Assessments	0.4356 (8.95)	0.3259 (11.83)	3.0880 (22.22)	-0.0418 (-0.08)	-1.4450 (-0.551)	-1.4990 (-0.615)	0.5631

Table 9 provides average annual energy (kWh) savings per participant, participant count, and program-level annual kWh savings for the 2017 *HEA Program*. Verified energy (kWh) savings for the treatment groups were determined by applying the daily average per household energy (kWh) savings value calculated from the regression model to the treatment group population.

Table 9: Summary of Annual kWh Savings from Regression Analysis

Program	***Ex-Post Daily Energy (kWh) Savings***	***Average Annual kWh Savings per Participant***	***Count of Participants***	***Ex-post Annual Energy (kWh) Savings***
In-Home Assessments	0.7928	289.37	3,133	906,596
Online Assessments	0	0	376	0
Total			**3,509**	**906,596**

Effective Useful Life ("EUL") of the In-Home Assessments measure is expected to be 2.0 years from the beginning of the treatment period.[1] Table 10 presents the program level ex-post verified energy (kWh) savings for the 2017 In-Home Assessments. Given that all measures were implemented before the end of the 2017 calendar year, and we assume an EUL of 2.0 years, the lifetime savings occurs by the end of 2019. Thus, we assume there is no savings after 2019.

However, persistence of savings will be analyzed in 2018 and 2019, as it is possible that an analysis of additional post-period data may indicate that energy (kWh) savings for In-Home Assessments persists for a time interval exceeding 2.0 years.

Table 10: Summary of Program Level Ex-Post Verified Energy (kWh) Savings

Year	**Ex-Post Energy (kWh) Savings**
2017	316,958
2018	906,596
2019	589,638
Total (Lifetime) Savings	**1,813,192**

4.1.2 CALCULATED CRITICAL PEAK DEMAND (KW) SAVINGS

Critical peak demand savings (kW savings) were calculated by month and by rate class, utilizing ex-post verified energy (kWh) savings that were disaggregated into 8,760 hourly bins with an appropriate program-level, 8,760-hour energy savings curve. The annual summer critical peak demand savings for this program was 293 kW. The complete table of ex-post verified critical peak demand (kW) savings by month and rate class are provided in Appendix A.

4.1.3 CALCULATION OF *EX-POST* PRECISION

Our analysis of the 2017 *HEA Program* energy savings achieved an *ex-post* precision of better than ±0.1 percent at the 90 percent confidence level. Statistical analysis of participants' monthly

[1] Measure life is discussed in section 3.3.5 in this report.

billing data yields the most accurate and precise determination of actual energy savings achieved through the 2017 *HEA Program*. Analyzing participants' billing data across the whole program achieves optimal precision, given that, a) sampling error is minimized when analyzing billing data for a large sample of control and treatment group participants, and b) measurement error is null or near zero given that NVE billing data is correct.[2]

4.2 PARTICIPANT SURVEYS

ADM analyzed 640 surveys returned by NVE customers; following are the results of our analysis.

- Respondents reported that they heard about Home Energy Assessment mainly through emailed advertisement (50 percent), TV, radio, or print ads (18 percent), NVE's customer care representatives (12 percent), family or friend (6 percent), and NVE's community event (3 percent).
- 89 percent of respondents reported that their PowerShift Energy Advisor resolved their questions and concerns to satisfaction.
- 87 percent of respondents reported that they feel more knowledgeable about ways to save energy after speaking with their PowerShift Energy Advisor.
- 92 percent of respondents reported that their PowerShift Energy advisor emailed or contacted them the day before to confirm their appointment.
- 98 percent of respondents reported that their PowerShift Energy Advisor was on time for their appointment.
- 98 percent of respondents reported that their Powershift Energy Advisor was knowledgeable, courteous, professional, clean and presentable.
- 92 percent of respondents reported that the information they received from their PowerShift Energy Advisor was helpful.
- 90 percent of respondents reported that they would recommend NVE's Home Energy Assessments to their friends and family.
- Respondents reported that the PowerShift Energy Advisor discussed the following NVE products and services with them: Free Smart Thermostats (79 percent), Time of Use (31 percent), MyAccount (28 percent), Home Air Conditioning Rebates (26 percent), Equal Payment Plan (12 percent), Electric Vehicles (4 percent), Paperless Billing (8 percent), Solar Rebates (8 percent), Select a due date (4 percent).

Customers' responses were evaluated using 11-point Likert scales measured on a continuum from heavily negative (0) to heavily positive (10). Table 11 provides a summary of responses to the customer satisfaction questions in the survey.

[2] ADM confirms this by inspecting and testing NV Energy billing data prior to actual analysis of the billing data.

Table 11: Home Energy Assessments Survey Summary Statistics: Customer Satisfaction

Survey Questions	Mean	90% Confidence Interval	N
Overall, how satisfied were you with your Home Energy Assessment?	8.87	8.5-9.2	623
How satisfied would you say you are with NVE?	8.54	8.2-8.9	618

Note: Scale anchor points were as follows: heavily negative attitudes (0) to heavily positive attitudes (10) with a Neutral midpoint of 5 on the 11-point scale

5. CONCLUSIONS AND RECOMMENDATIONS

This chapter presents conclusions and recommendations.

5.1 CONCLUSIONS

The *Home Energy Assessments (HEA) Program* consists of two parts: In-Home Assessments and Online Assessments. For the 2017 program, ADM determined that there is statistically significant savings for In-Home Assessments, but no statistically significant savings for Online Assessments.

Program-level ex-post verified annual energy savings are 316,958 kWh, i.e., 0.7928 kWh/day or 289.37 kWh/year per residence for 3,133 northern Nevada participants.

Survey data for the 2017 *HEA Program* indicates that the In-Home Assessments participants reported increased satisfaction with NVE because of the program.

5.2 RECOMMENDATIONS

In-Home Assessments

ADM recommends that NVE:

1. Deliver the monthly billing data updates on the same schedule as the monthly billing updates are currently being delivered to the implementation team.
2. Monthly provide ADM with an Excel file for each Energy Efficiency Consultation form for each In-Home Assessments participant.

Online Assessments

ADM recommends that the Online Assessments implementation team should:

1. Provide ADM with monthly updates to unique online tool visitors along with their first visited date.
2. Provide ADM with a monthly returning visitors list.
3. Provide ADM any engagement or survey data that is being collected.

Persistence of Savings and EUL Determination

EUL or measure life is expected to be approximately 2.0 years from the beginning of the treatment period for the *HEA Program*. However, to ensure an accurate determination of EUL over time ADM will study the persistence of savings for the *HEA Program* treatment group. In 2018, the persistence study will include the following key element: ADM will analyze additional post-period billing data for 2017 Online Assessments participants to determine whether there is statistically significant savings for the Online Assessments subset of the 2017 *HEA Program*.

6. APPENDIX A: SAVINGS PER MONTH BY RATE CLASS

This appendix provides monthly savings by rate class for calendar years 2017 through 2019.

Table A-1: Energy (kWh) Savings per Month by Rate Class, Calendar Year 2017 (First Year)

Rate Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
D-1	1,751	4,187	6,282	7,756	9,816	17,272	30,818	39,500	34,291	37,178	47,776	80,332	316,958
Total	**1,751**	**4,187**	**6,282**	**7,756**	**9,816**	**17,272**	**30,818**	**39,500**	**34,291**	**37,178**	**47,776**	**80,332**	**316,958**

Table A-2: Energy (kWh) Savings per Month by Rate Class, Calendar Year 2018 (Full Year)

Rate Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
D-1	86,908	68,515	68,617	60,170	61,325	79,613	98,461	96,265	66,902	62,625	68,243	88,950	**906,596**
Total	**86,908**	**68,515**	**68,617**	**60,170**	**61,325**	**79,613**	**98,461**	**96,265**	**66,902**	**62,625**	**68,243**	**88,950**	**906,596**

Table A-3: Energy (kWh) Savings per Month by Rate Class, Calendar Year 2019

Rate Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
D-1	85,157	64,328	62,335	52,414	51,510	62,341	67,644	56,765	32,611	25,447	20,468	8,618	**589,638**
Total	85,157	64,328	62,335	52,414	51,510	62,341	67,644	56,765	32,611	25,447	20,468	8,618	**589,638**

Table A-4: 2017 Critical Peak Demand (kW) Savings per Month by Rate Class

Rate Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
D-1	185.4	171.3	149.2	121.4	139.0	245.2	293.3	260.7	192.0	136.0	159.5	185.4
Total	**185.4**	**171.3**	**149.2**	**121.4**	**139.0**	**245.2**	**293.3**	**260.7**	**192.0**	**136.0**	**159.5**	**185.4**

7. APPENDIX B: CALCULATION METHODOLOGY, CRITICAL PEAK DEMAND (KW) SAVINGS

B.1. OVERVIEW OF CALCULATION METHODOLOGY FOR KW SAVINGS

This section provides a description of analytical steps employed to determine critical peak demand savings per month by rate class for NVE's 2017 Demand Side Management ("DSM") programs. Critical peak demand (kW) savings per month per rate class is determined using essentially the same methodology that is used to disaggregate annual energy (kWh) savings into monthly kWh savings per rate class. Please see the following chapter for a more detailed description of the methodology for determining energy (kWh) savings per month per rate class.

For this program, given that treatment which provided savings (i.e., HEA assessment provided to treatment group) were installed during the 2017 calendar year, Table B-5 in the preceding section provides the full-year values or 2017 calendar-year values for critical peak kW savings per month and per rate class.

B.2. ANALYTICAL STEPS AT THE MEASURE LEVEL

At the measure level, for every record (i.e., individual measure) in DSM Central, ADM assigns an appropriate normalized 8,760 energy savings curve. A normalized energy savings curve is comprised of 8,760 hourly fractions summing to exactly 1 (unity).[3] For each measure, ADM determines *ex-post* annual kWh savings, which is then multiplied by each of the 8,760 hourly fractions to disaggregate the annual kWh into 8,760 hourly kW bins.

B.3. ANALYTICAL STEPS AT THE PROGRAM LEVEL

To determine program-level demand (kW) reduction for a given hourly kW bin, ADM sums the hourly kW bin across all measures in the program. For example, the program-level kW reduction for the hour ending at 5PM on the 200th day of the year is the sum of kW for all measures in the program during that hour on that day.

To determine monthly critical peak demand (kW) reduction for the program, ADM inspects program-level kW reduction during the one-hour critical peak demand period that is defined for each month of the year. The following table provides the monthly critical peak demand periods for NPC and Sierra, which were determined from ADM's analysis of peak system load data provided by NV Energy.

[3] ADM has developed a library of normalized energy savings curves that are appropriate for northern and southern Nevada. Many of the residential energy savings curves were derived from NV Energy's program-specific data, while others were derived from data provided in the 2008 California Database of Energy Efficiency Resources (2008 DEER).

Table C-1. Critical Peak Demand Period per Month, NV Energy

Month	***Critical Peak Period, NPC***		***Critical Peak Period, Sierra***	
	Hour	*Ending at:*	*Hour*	*Ending at:*
January	*19*	*19:00*	*19*	*19:00*
February	*19*	*19:00*	*19*	*19:00*
March	*20*	*20:00*	*20*	*20:00*
April	*20*	*20:00*	*21*	*21:00*
May	*17*	*17:00*	*17*	*17:00*
June	*17*	*17:00*	*17*	*17:00*
July	*17*	*17:00*	*17*	*17:00*
August	*17*	*17:00*	*17*	*17:00*
September	*17*	*17:00*	*17*	*17:00*
October	*19*	*19:00*	*20*	*20:00*
November	*19*	*19:00*	*19*	*19:00*
December	*19*	*19:00*	*19*	*19:00*

For example, the critical peak demand period for July is the hour from 16:00:01 or 4:00:01 PM to 17:00:00 or 5:00:00 PM. To determine July's program-level critical peak kW savings, ADM inspects average hourly kW reduction during 4:00:01 to 5:00:00 PM for every day in July: the highest value represents July's critical peak kW savings. The same procedure is followed for all months of the year. *Summer critical peak demand savings is defined as July's critical peak kW savings;* the rationale for doing so is that historical data reveals that during any given year, NVE's peak system demand in either territory will typically occur during a July day between 4:00:01 to 5:00:00 PM.

To determine the monthly kW reduction *per rate class*, each program-level monthly critical peak kW savings value is disaggregated into *rate class bins* by correlating monthly kW savings for a given measure to the measure's assigned customer rate class as listed in DSM Central.

Calculations for energy (kWh) savings – and for demand (kW) reduction – per month per rate class require complex algorithms that are executed in massive Excel files, which are also known as ***kW guru***™ files.

B.4. ANALYSIS OF SYSTEM-LEVEL CRITICAL PEAK DEMAND PERIODS

ADM analyzed NVE's system-level critical peak hours to determine a consistent reference for peak demand impacts of M&V evaluation of all NV Energy programs. ADM's analysis encompassed Sierra Pacific Power Company ("Sierra") in the north and Nevada Power Company ("NPC") in the south.

Hourly system load data from 1985 through 2011 for Sierra and from 1999 through 2011 for NPC was provided by NV Energy. In analyzing the hourly load data, it was determined that the system peaks for Sierra in 1985 were only half of what they have been in the more recent ten-year period. The percentage change in daily system peaks between summer and winter were smaller in the 80's and 90's than in the more recent ten-year period. Therefore, ADM concluded that the use of system load data from the recent ten-year period provides the best basis for predicting what to expect during an EEM's remaining useful life; following that rationale, data prior to the most recent ten years was excluded from ADM's analysis. In both service territories, the highest system peak occurred in 2007, and system peaks have declined moderately since.

The hourly load data for the recent ten-year period was thoroughly reviewed and except for "spring ahead" hours (when clock times change from Standard Time to Daylight Savings Time), it was determined that the data was consistent and appropriate. The data for "spring ahead" hours are inconsistent, with values given as follows: (1) the value from the preceding hour is used and is an acceptable means of handling the data; and (2) a zero, which is an inaccurate value that would pull down the average. For this analysis, zero values were converted to blanks, and therefore not included in the averaging calculation. Overall this is a minor issue that did not impact ADM's final analysis of system-level critical peak hours.

ADM determined that system load characteristics vary by season. To accommodate the seasonal variations, the hour of peak system load was determined for each month. ADM concluded that a one-hour peak demand period per month is appropriate.

The final determination of the appropriate peak demand hour per month per territory is provided above; see the table in the preceding section of this appendix. The designated peak demand hour per month per territory was utilized for M&V analyses of energy efficiency programs implemented in 2017. Subject to ADM's periodic re-checking of system load data, it is expected that the designated peak demand hour per month per territory will continue to be utilized for subsequent program years.

This M&V methodology update occurred for the following reason. Compared to the three-hour critical peak demand window used for M&V analyses of 2010 programs, the updated critical peak demand definition (i.e., one hour per month per territory) provides a more accurate determination of energy efficiency programs' contributions to reducing system peak demand. In other words, the one-hour peak kW reduction will align with the actual hour of system peak.

NVE's hourly system load data demonstrated well-defined peaks during summer and winter months. However, certain transition months – such as May in northern Nevada – have a nearly identical double peak. It is obvious that specific weather conditions during any given year cause one or the other of the two peaks to predominate. In the final analysis, transition months have far less peak demand than summer months, so a transition month peak hour is essentially insignificant to the determination of the system peak hour, which will typically occur in July and occasionally occur in August (but never in May).

ADM also analyzed hourly system load by various day types. The day type that exhibited highest average demand was selected as the appropriate day type for final determination of peak hour. The day types investigated were (1) All Days, (2) Weekdays, (3) Non-Holiday Weekdays (i.e., Workdays) and (4) Weekend & Holidays. A curve for each month was developed by day type. All days for a given day type were averaged for a given month by hour of the day to develop an average 24-hour load curve. For the north and south the summer peak typically occurs during hour 17, which is the hour that ends at 17:00 (5:00 PM). The greatest summer peak demand is the highest peak demand experienced by both companies.

The analysis determined that of the four day types, Workdays averaged the highest system demand for most hours of the day. Generally, the peak hour calculated from the average Workday curve was identified as the peak hour for the month for the given territory. The peak hours for two transition months in each territory were adjusted to maintain a more consistent set of peak hours. Adjustments were made for May and June for Sierra and April and November for NPC. The selection of the peak hour for these months were based on differences of less than 1 percent in the average demand in MW between the mathematical peak hour and the assigned peak hour.

To validate these decisions ADM also analyzed all-time record peak days and an average of the day from each month that the peak occurred. The second method thus included ten days in the calculation of the average. The results from these analyses supported the average Workday results. Analysis files have not been included in this report due to the large size of spreadsheets.

8. APPENDIX C: DETERMINING ENERGY (KWH) SAVINGS PER MONTH BY RATE CLASS

This chapter provides a detailed description of ADM's analytical steps for determining the energy (kWh) savings per month per rate class values that are provided in the M&V reports for program year 2017.[4]

C.1. APPORTIONMENT OF ANNUAL ENERGY SAVINGS BY RATE CLASS

NV Energy's DSM programs generally include populations of customers from more than one rate class. NV Energy tracks the rate class for each identifiable customer participating in DSM programs. However, participant information is not known for certain DSM programs, such as the *Residential Energy Efficient Lighting Program* or other "upstream" or "midstream" programs where incentives are provided through contractual arrangements with manufacturers or distributors of the rebated products. For DSM programs for which participant information is not known, ADM collected participant information at the point of sale or conducted customer surveys to identify the proportions of participants that belong to various rate classes.

C.2. APPORTIONMENT OF ANNUAL ENERGY SAVINGS BY MONTH

ADM developed a methodology that utilizes *energy savings curves* to calculate the portion of annual energy savings that occurs during each month of the year. An energy savings curve describes the temporal nature of energy savings. For example, on any given day the energy savings achieved by an LED exit sign are approximately 1/365 of the verified annual energy savings for that LED exit sign. On the other hand, an efficient air conditioner may not save any energy during the month of January, but may achieve 35 percent of its annual energy savings in the month of July alone. ADM constructed appropriate energy savings curves from metered data collected during M&V of NV Energy DSM programs (or other programs if appropriate), customer billing data, calibrated DOE2 simulations and engineering calculations. The energy savings curves were coupled with project implementation dates on a record-by-record basis to produce accurate determinations of the energy savings achieved for each month of the year.

C.3. HIGH LEVEL SUMMARY OF ADM'S CALCULATION METHODOLOGY

Monthly energy (kWh) savings for each program were calculated by applying an appropriate hourly or daily energy savings curve to each program participant's ex-post verified energy savings, then aggregating kWh savings for each month. The energy savings curve distributes a participant's energy savings over time. Its shape is therefore dependent on not only the measure installed (i.e., lighting vs. HVAC), but also on the building type and sometimes its location.

The overall process by which ADM calculated monthly kWh savings was to (1) download from DSM Central all program tracking data, i.e., ex-ante expected kWh savings, measure type, measure completion date, rate class, etc., (2) calculate ex-post values per participant, (3) assign an energy savings curve to each

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[4] The Public Utilities Commission of Nevada (PUCN) requires NV Energy to report energy (kWh) savings per month and per rate class for each Demand Side Management (DSM) program.

participant's ex-post savings to distribute ex-post energy savings by rate class over each of the 8,760 hours in a year, and (4) aggregate ex-post verified savings for the purpose of presenting savings by month and by rate class.

ADM also calculated first-year kWh savings for each program by combining measure startup date (from DSM Central) with the aforementioned process. A detailed description of the steps involved in tabulating first-year kWh savings is provided in section C.5 below.

C.4. ENERGY SAVINGS CURVES

DEFINITION

The phrase 'energy savings curve' is used to describe the temporal dependence of energy savings. The curves are typically hourly (1 × 8760 array), daily (1 × 365 array), or monthly (1 × 12 array). The energy savings curves are often normalized such the sum of all array elements is unity. When normalized, each element describes the fraction of annual savings that is expected to occur in a given hour, day, or month.

NOMENCLATURE

Note that if the term 'load shape' is encountered in the spreadsheets that are used to tally monthly energy savings by program and rate class, one should take it to be the same as 'energy savings curve' as described herein. The reason for the usage of the term 'load shape' is twofold:

- Energy savings curves are *differential load shapes* describing <u>differences</u> in electricity loads resulting from the implementation of energy efficiency measures; in other words, energy savings curves indicate the *shape over time of electricity that is saved or not used*. Notably, energy that is *not used due to energy efficiency actions* (i.e., "saved" energy) is sometimes called 'Negawatts'. A 'Negawatt' saved is meant to represent a negative form of a '<u>Megawatt' of power that would have been used if the energy efficiency actions had not occurred</u>.
- An energy savings curve for a measure may or may not be synchronous with the load curve of the base case technology against which savings are determined.
    1. There are energy efficiency measures (EEMs) for which the normalized savings curve is synchronous and proportional to the normalized load shape or curve of the base case technology. Examples of such EEMs include CFLs versus incandescent lights if it is assumed that (1) there are null or negligible interactive effects and (2) pre- and post-retrofit usage schedules are identical. If the savings curve for an EEM is synchronous with the base case technology load shape, then the two curves have identical shapes.
    2. For other EEMs, the energy savings curve is asynchronous with the load curve of the base case technology. Examples of EEMs with asynchronous savings curves include economizers, occupancy sensors, and control systems. For such measures, the shape of the energy savings curve is different from the shape of the base case technology.

As part of our evaluation effort ADM determines for each EEM whether to use normalized energy savings curves that are either synchronous or asynchronous with the normalized load shape of the base case technology.

C.5. TABULATING MONTHLY ENERGY (KWH) SAVINGS PER RATE CLASS

Normalized daily energy savings curves are utilized for this task. A normalized daily energy savings curve is comprised of 365 daily fractions summing to exactly 1 (unity). For each measure, ADM determines *ex-post* annual kWh savings, which is then multiplied by each of the 365 daily energy savings curve fractions to disaggregate annual kWh into 365 daily kWh bins.

FIRST-YEAR kWh SAVINGS

'First-year' kWh savings are savings that occur during the same calendar year in which a conservation program was implemented. For NV Energy a program year is the same as a calendar year. Thus 'first-year' kWh savings for a measure installed during a given program year are equal to that measure's kWh savings during the same given calendar year.

The following calculations are performed to tabulate 'first-year' kWh savings attributable to a given customer rate class. For any given NV Energy program:

- For each rate class, for each day of the 'first-year' kWh savings, identify all measures that have been implemented (or 'installed' or 'started up') by the subject day.
- For each rate class, for each day of the 'first year,' for all measures that that have been installed by the subject day, multiply the *ex-post* verified 'typical-year' annualized kWh savings[5] for each measure type by that measure's daily kWh bin. In other words, multiply the measure-level annual kWh by the measure-level daily bin from the appropriate energy savings curve.
- For each rate class, tally all measure-level daily kWh savings to determine program-level daily kWh savings.
- For each rate class, for any given month of 'first year,' tally all measure-level daily kWh savings occurring during that month to determine program-level monthly kWh savings for that calendar year.
- For each rate class, the first-year kWh savings is the program-level monthly kWh savings for that rate class summed across all 12 months of the 'first year.'

[5] 'Typical-year' annualized kWh savings is 365 consecutive days of energy savings – usually a full calendar year other than Leap Year – attributed to an energy efficiency measure(s) for which ex-post verified kWh savings will occur during a multi-year measure life. For example, an NV Energy conservation measure installed during the 2017 program year (i.e., during the 2017 calendar year) will normally provide kWh savings starting on its date of installation. 'First-year' savings is the savings that occurs during the 2017 calendar year. 'Full-year' savings is the savings occurring during the succeeding calendar year.

'Typical-Year' Energy (kWh) Savings

'Typical-year' energy (kWh) savings represents 365 consecutive days of energy savings attributed to a measure(s) or program for which *ex-post* verified savings will occur across a multi-year measure life.[6]

The following calculations are performed to tabulate 'typical-year' energy (kWh) savings attributable to a given customer rate class.

- For each rate class, for each hour (or day) of calendar years occurring after the 'first year,' multiply *ex-post* verified 'typical-year' energy (kWh) savings for each measure type by that measure's hourly (or daily) kWh bin. In other words, multiply the measure-level annual kWh by the measure-level hourly (or daily) bin from the appropriate energy savings curve.[7]
- For each rate class, tally all measure-level hourly (or daily) kWh savings to determine program-level hourly (or daily) kWh savings.
- For each rate class, for any given month, sum all measure-level hourly (or daily) kWh savings occurring in that month to determine program-level monthly kWh savings.
- For each rate class, 'typical-year' kWh savings is the program-level monthly kWh savings for that rate class summed across all 365 days of any non-Leap Year subsequent to the 'first year.'
- For any given program, 'full-year' kWh savings for a Leap Year will be marginally higher than 'full-year' kWh savings for a 'typical year' or non-Leap Year. Thus, we always use a non-Leap Year when we quantify 'typical-year' kWh savings.

Following is an example of the determination of daily kWh savings generated by a program. Let's consider a hypothetical program that targets two energy efficiency (EE) measures: residential lighting and residential cooling. For this hypothetical program, Table D-1 below provides a simple comparison of the measures' respective:

- 'typical-year' energy savings;
- daily bin value in its energy savings curve for a specific day – February 1st – of any given year[8] after the EE measures were installed;
- energy (kWh) savings during February 1st of any given year after the EE measures were installed.

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[6] The distinction between 'typical year' and 'full year' is that a 'typical year' is a 365-day year. A Leap Year is not a 'typical year'. Instead, a Leap Year is a 'full year' that has 366 days.

[7] When tallying kWh savings per month per rate class, the use of hourly bins or daily bins is equally correct and accurate. ADM typically uses daily bins (which are created from hourly bins) in our kW guru™ Excel files simply because a workstation processor can complete the billions of computations in a large kW guru™ file relatively faster when the number of computations is based on 365 daily bins instead of 8760 hourly bins per calendar year. Hourly bins in kW guru™ files (i.e., the 8760 hourly bins per 'typical year') exist for the following two purposes: 1) they are summed across the 24 hours of each day to create the aforementioned daily bins; and 2) they provide the hourly resolution that enables us to analyze and report critical peak demand (kW) savings per month per rate class for any specified kW-reporting period.

[8] The daily bin value for February 1 represents the February 1 daily fraction of 'typical-year' annual energy (kWh) savings.

In Table C-1 below, the assumption is that 1,000,000 kWh of annual energy savings ('typical-year' savings as reported in M&V reports) were achieved through distribution of LEDs and 500,000 kWh of annual (typical-year) energy savings were achieved through implementation of high efficiency air conditioning (AC) measures. Energy (kWh) savings on February 1st are obtained by multiplying 'typical-year' kWh savings by the entries corresponding to February 1st in the respective normalized energy savings curves. ***In this example, the daily bin for space cooling is zero because no space cooling is expected to occur on February 1st.***

Table C-1. Sample Calculation of Energy Savings Achieved for a Given Rate Class on February 1 for a Hypothetical Program Targeting Residential Lighting and Space Cooling.

Comparison for "Indoor Lighting" vs. "Space Cooling" Measures	**EE Measure = "Indoor Lighting"**	**EE Measure = "Space Cooling"**
'Typical-year' energy savings (annual kWh):	1,000,000	500,000
Feb. 1 daily bin value in each EE measure's energy savings curve:	0.0030	0.0000
Feb. 1 energy (kWh) savings in a typical year:	3,000	0

For each program, such calculations are performed for each rate class, energy savings curve and hour (or day). Hourly (or daily) results are then aggregated at the monthly level.

LEAP YEAR SAVINGS

To account for the extra day in February in Leap Years, one of the following methods is used. Either method produces accurate and very similar *ex-post* verified energy savings determinations for Leap Years.

- Energy savings during the month of February in a Leap Year is taken to be equal to 29/28 of energy savings during the month of February in a typical non-Leap Year.
- Or, energy savings on the day of February 29 in a Leap Year is assumed to be the same as energy savings on the previous day (February 28).

9. APPENDIX D: HEA PARTICIPANT SURVEYS

NV Energy In-Home Assessments Participants SURVEY

1. How did you hear about Home Energy Assessments?

- TV, radio, or print ads
- NV Energy’s community event
- Emailed advertisement
- NV Energy’s customer care representatives
- Family or friend
- Other (please specify)

2. Did your PowerShift Energy Advisor resolve your questions and/or concerns to your satisfaction?

- Yes
- No
- I don't know

3. After speaking with your PowerShift Energy Advisor, do you feel more knowledgeable about ways to save energy?

- Yes
- No
- I don't know

4. My PowerShift Energy Advisor emailed or contacted me the day before to confirm my appointment.

- Yes
- No
- I don't know

5. My PowerShift Energy Advisor was on time for my appointment.

- Yes

- No
- I don't know

6. My PowerShift Energy Advisor was knowledgeable, courteous, professional, clean, and presentable.

- Yes
- No
- I don't know

7. The information I received from my PowerShift Energy Advisor was helpful.

- Yes
- No
- I don't know

8. I would recommend NV Energy's Home Energy Assessments to my friends and family.

- Yes
- No
- I don't know

9. Which of the following NV Energy products and services did your PowerShift Energy Advisor discuss with you? Select all that apply.

- [ ] Free Smart Thermostats
- [ ] Home Air Conditioning Rebates
- [ ] MyAccount
- [ ] Equal Payment Plan
- [ ] Paperless Billing
- [ ] Select a due date
- [ ] Time of Use
- [ ] Electric Vehicles
- [ ] Solar Rebates

Other (please specify)

10. Based on your overall experience with your Home Energy Assessment, how satisfied would you say you are? Using a 1 to 10 scale, where 1 means you are extremely dissatisfied and 10 means you are extremely satisfied, how satisfied would you say you are with your Home Energy Assessment?

11. Based on your overall experience with NV Energy, how satisfied would you say you are? Using a 1 to 10 scale, where 1 means you are extremely dissatisfied and 10 means you are extremely satisfied, how satisfied would you say you are with NV Energy?

12. Do you have any other questions, comments, or suggestions you would like to share with NV Energy?

DSM-11

Direct Installation Program
NV Energy – Southern Nevada (NPC)
Program Year 2017 (PY2017)

Measurement & Verification Report

March 6, 2018

Prepared for:

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TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

This measurement and verification ("M&V") report provides verified *ex post* energy and demand impacts achieved by the *Direct Installation Program* that NV Energy offered its southern Nevada ("Nevada Power Company" or "NPC") customers during 2017. This M&V report is provided by ADM Associates, Inc. ("ADM"), an independent, third-party contractor that provides evaluation and M&V services and reports for numerous electric and gas utility clients.

The *Direct Installation Program* is a demand side management ("DSM") program. This program aims to directly install low-cost energy efficiency measures when an NV Energy-dispatched field technician is already visiting a customer's home to provide other services, such as in-home assessment services, a technology installation, or a quality control inspection. A total of 392 southern Nevada customers received installations as a part of this program in 2017.

ADM employed various engineering analyses to determine the *ex post* verified energy kilowatt hour ("kWh") and demand kilowatt ("kW") impacts for this program. Detailed descriptions of ADM's engineering analyses are provided in this report.

For 2017 program, *ex post* verified energy savings are 63,498 kWh annually. First-year energy savings, i.e., the energy saved during the 2017 calendar year, was 6,961 kWh. Summer critical peak demand kilowatt ("kW") savings provided by this program total 17 kW.

The *ex post* verified annual energy savings of 63,498 kWh represents a realization rate of 94 percent. The variance between the *ex post* and *ex ante* energy kW savings was caused by the use of a single *ex ante* savings per unit value of 32 kWh for all LEDs installed by the program. ADM subsequently verified *ex post* kWh savings per unit averaging significantly less than 32 kWh per unit for a subset of LED bulbs installed in the 2017 program, e.g., certain LEDs saved 20 kWh.

For the M&V analyses associated with this 2017 program, the required statistical confidence interval is precision of ±10% at the 90 percent confidence level (also called "90/10 confidence"). After completing the analysis of energy savings achieved by the program, ADM determined that the achieved *ex post* precision is ±6.43 percent at the 90 percent confidence level.

Table 1-1 on the following page provides a summary of the final *ex post* verified energy impacts for the final population of participants in the 2017 NPC *Direct Installation Program*.

Table 1-1. Summary of Energy Impacts

Measure Type	***Quantity Installed***	***Ex Post First-Year (2017) Savings (kWh)***	***Annual Energy Savings (kWh)***		***Effective Useful Life (EUL), Years***	***Lifetime Energy Savings (kWh)***	
			Ex Ante	***Ex Post***		***Ex Ante***	***Ex Post***
Air Filter/Furnace Filter	382	298	18,336	18,336	2	36,672	36,672
LED (7W A19)	384	1,188	12,365	7,732	6	74,189	46,390
LED (9W A19)	938	4,698	30,204	30,588	6	181,222	183,530
LED (11W A19)	98	460	3,156	2,994	6	18,934	17,964
Photocell	143	28	438	438	8	3,507	3,507
Refrigerator Thermometer	315	242	1,890	1,890	3	5,670	5,670
Air Conditioner Refrigerant Line Insulation	76	47.1	1,520	1,520	10	15,200	15,200
Total	**2,336**	**6,961**	**67,908**	**63,498**	**4.9**	**335,393**	**308,933**

2. PROGRAM BACKGROUND

The *Direct Installation Program* was provided by NV Energy to its southern Nevada customers during 2017. This program aims to directly install low-cost energy efficiency measures when an NV Energy-dispatched field technician is already visiting a customer's home to provide other services, such as in-home assessment services, a technology installation, or a quality control inspection. A total of 392 southern Nevada customers received installations as a part of this program in 2017.

NV Energy provided customers the following energy efficiency measures, which were directly installed in the customers' homes by field technicians.

- Air Filter/Furnace Filter change out: 4 to 5 filter sizes which captures 80 percent of all filter replacement requirements are provided to customers.
- LED Lighting: Philips 7 W, 9 W, and 11 W A19.
- Photocells: GE Automatic Light Control (Model Number: 18265). The photocell is installed in each socket of indoor and outdoor lighting fixtures with rain-tight.
- Refrigerator thermometer: Go Green Refrigerator Thermometer (4 pack) (Model Number: PRF102-12-4pk or equivalent).
- Air conditioner refrigerant line insulation on outside condenser unit.

In 2017, there were 392 customers in southern Nevada that received direct installations -of some or all of the energy efficient measures specified above.

3. M&V METHODOLOGY

This chapter provides a description of the M&V methodology applied by ADM in the evaluation of the 2017 *Direct Installation Program*. The M&V approach for the *Direct Installation Program* is aimed at measuring the following:

- Counts of the energy efficient measures installed
- Dates the measures were installed
- Average annual kWh savings per measure
- Average kW reduction per measure

3.1 VERIFICATION OF MEASURES INSTALLED

ADM verified program activity and installations of the energy efficiency measures provided by this program in 2017. ADM's verification work was based on using the checklist report provided by NV Energy and then conducting field verifications and telephone surveys. The verification effort commenced with ADM's review of the checklist of the reported installed measures. After the program-reported data was reviewed, *ex ante* values for program measures were verified. There were no duplicate entries. The counts of installed measures reported in the checklist for 2017 are shown in Table 3-1.

Table 3-1. Energy Efficient Measures Installed

Measure Type	***Quantity Reported as Installed***
Air Filter/Furnace Filter	382
LED (7W A19)	384
LED (9W A19)	938
LED (11W A19)	98
Photocell	143
Refrigerator Thermometer	315
Air Conditioner Refrigerant Line Insulation	76
Total	**2,336**

A random sample was selected to ensure that 90 percent confidence with ±10 percent relative precision (or better) would be achieved by the program. In accordance with the generally accepted random-sampling formula provided in Equation 1 below, given that this program population included 392 participants, the minimum sample needed was 58 participants.

Equation 1

$$n_0 = \frac{N \times \frac{1}{4}}{(N-1)\times\frac{D^2}{Z^2_{\alpha/2}}+\frac{1}{4}} = 58$$

Where:

n_0 = Minimum sample size

N = Population size, 392

$Z\alpha/2$ = Z value at 90% confidence interval, 1.645

¼ = *p* is the population proporation. The maximum value of *p(1-p)* at *p*=1/2, a conservative estimate for sample size

D = Relative Precision (0.10)

ADM also conducted a brief a telephone survey to verify that customers received the program-reported measures and that the measures were directly installed by NV Energy-dispatched field technicians. In particular, the verification survey determined that the installation was recalled by customers and briefly explored participant satisfaction with respect to the installation. In total, the participant survey collected verification data regarding measures eligibility for 55 customers. In addition to the telephone survey, seven customers were checked for program eligibility during a ride-along verification activity with the program's implementation contractor, Mad Dash, Inc. Therefore, we sampled a total of 62 participants (i.e., 55+7), which exceeds the required sample size of 58. The survey instrument is provided in Appendix A.

Table 3-2 provides an itemized list of the measures that were sampled for the purposes of eligibility verification.

Table 3-2. Eligibility Verification Sample Size by Method

Measure Type	***Phone Survey***	***Ride-Alongs***	***Total***
Air Filter/Furnace Filter	36	6	42
LED (All Types)	52	42	94
Photocell	7	12	19
Refrigerator Thermometer	35	9	44
Air Conditioner Refrigerant Line Insulation	8	2	10
Total	**138**	**71**	**209**

All 55 respondents who completed the participant survey verified that they had installed the energy efficiency measures that the program reported having provided in 2017.

Based on the results of the telephone survey, the ride-along visits, and customer data provided by NV Energy, ADM determined the following measure-specific verification rates for the measures installed through the program during 2017. Verification rate represents the percentage of measures actually installed through the program.

- Percentage of installed Air Filter/Furnace Filters: 100 percent
- Percentage of installed LEDs: 100 percent
- Percentage of installed Photocells: 100 percent
- Percentage of installed Refrigerator Thermometers: 100 percent
- Percentage of installed Air Conditioner Refrigerant Pipe Wrap: 100 percent

In accordance with the sampling plan described in this section, ADM's verification effort satisfied the minimum requirement. Therefore, the above verification rates (all of which are 100 percent) were applied to the entire program population. Table 3-3 reports the numbers of energy efficient measures installed through the program during 2017.

Table 3-3. Energy Efficient Measures Verified

Measure Type	***Quantity Reported as Recycled***	***Percent of Verified Measures as Program-Eligible***	***Quantity of Installed Measures Verified as Program-Eligible***
Air Filter/Furnace Filter	382	100%	382
LED (7W A19)	384	100%	384
LED (9W A19)	938	100%	938
LED (11W A19)	98	100%	98
Photocell	143	100%	143
Refrigerator Thermometer	315	100%	315
Air Conditioner Refrigerant Line Insulation	76	100%	76
Total	**2,336**		**2,336**

3.2 CALCULATING ANNUAL KWH SAVINGS

To determine annual kWh savings of the program, ADM employed engineering analyses to investigate energy savings and demand reductions associated with the program. The *ex post* verified savings associated with each measure type were determined using the engineering algorithms below. The results of the engineering analyses were compared to other, related NV Energy programs (e.g., *Residential Energy Efficient Lighting Program (2016), Residential Air Conditioning (AC) Program*, etc.).

- **Air Filter/Furnace Filter change out**: The savings estimates were based on reduced furnace blower fan motor power requirements for winter and summer use of the blower fan motor. This measure applied to central forced air furnaces, central air conditioning and heat pump systems. Where homes did not have air conditioning or heat pump systems for cooling, only the annual heating savings applied. The algorithms[1] are shown below:

Equation 2

$$\Delta kWh/yr = \Delta kWh/yr_{heat} + \Delta kWh/yr_{cool}$$
$$\Delta kWh/yr_{heat} = kW_{motor} \times EFLH_{heat} \times EI \times ISR$$
$$\Delta kWh/yr_{cool} = kW_{motor} \times EFLH_{cool} \times EI \times ISR$$

$$\Delta kW_{peak} = \frac{\Delta\, kWh/yr_{cool}}{EFLH_{cool}} \times CF$$

Where,

kW_{motor} = Average motor full load electric demand (kW), 0.17

$\Delta kWh/yr_{heat}$ = The annual kWh savings generated by Heating

$\Delta kWh/yr_{cool}$ = The annual kWh savings generated by Cooling

$EFLH_{Heat}$ = Estimated Full Load Hours (Heating)

$EFLH_{Cool}$ = Estimated Full Load Hours (Cooling)

EI = Efficiency Improvement, 10 percent

ISR= In-service Rate, ADM assumes that 50 percent of customers keep changing the filter frequently

CF= The ratio of the simultaneous maximum demand of a group of electrical appliances or consumers within a specified period, to the sum of their individual maximum demands within the same period, 0.75.

For this M&V analysis, $EFLH_{Heat}$ and $EFLH_{Cool}$ values from M&V analyses of the 2016 *Residential Air Conditioning Program* were utilized. Also, from M&V analyses of the 2016 *Residential Air Conditioning Program*, the average unit capacity for southern Nevada households was assumed to be 4 tons. Table 3-4 provides $EFLH_{Heat}$ and $EFLH_{Cool}$ values[2] based on home and cooling/heating system type.

[1] Section 2.2.7, Residential Measures in 2016 Technical Reference Manual, State of Pennsylvania

[2] EFLH values are determined by the following method:

a) Weather data was used to identify heating, cooling, and shoulder seasons;
b) Shoulder-season energy usage was subtracted from total energy usage during heating and cooling seasons;
c) Average system sizes were determined from program participants' data;
d) For each HVAC system, average system efficiency was used to determine full load or system capacity;
e) EFLH equals total cooling or heating energy consumption divided by system capacity.

Table 3-4: EFLH (Heating/Cooling) by Home and System Type from M&V Analyses of the 2016 Residential High Efficiency AC Program)

Group	$EFLH_{Heat}$	$EFLH_{Cool}$	Total Hours
Multifamily (Air Conditioner, Strip Heat)	365	846	1,211
Single-Family (Air Conditioner, Gas)	426	1,050	1,476
Single-Family (Heat Pump)	426	1,015	1,441

- **LED Lighting**: ADM employed engineering analyses to determine *ex post* verified energy savings. *Ex post* verified energy savings per LED were calculated with methods developed by ADM and consistent with chapter 6 of *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures*. The calculations used the following equation:

Equation 3

$$Annual\ kWh\ savings = \left(\frac{DeltaW_{HAL} * \mathrm{POP_{HAL}} + DeltaW_{CFL} * \mathrm{POP_{CFL}}}{1000}\right) * HOUannual * HCIF * ISR$$

Where,

W_{HAL} = EISA 2007 compliant halogen baseline wattage

W_{CFL} = CFL baseline wattage

W_{LED} = LED rated wattage [3]

$DeltaW_{HAL} = W_{HAL} - W_{LED}$

$DeltaW_{CFL} = W_{CFL} - W_{LED}$

POP_{CFL} = proportion of CFL bulbs replaced determined by surveys to be 18.4%

POP_{HAL} = proportion of EISA 2007 compliant halogen or incandescent bulbs replaced determined by surveys to be 74.9 percent

1000 = conversion factor for Watts per kW

HOU_{annual} = daily hours of use (2.82)* 365= 1029.3

HCIF = “Heating & Cooling Interactive-effects Factor” disapproved by the Public Utilities Commission, or the “Commission” [4]

[3] For example, if the LED is 7.5 W and the comparable baseline bulb is a 28 W halogen, then the wattage difference or delta watts is 28 - 7.5 or 20.5 W.

[4] In its March 23, 2012, Order in Docket Nos. 11-07026 and 11-07027 the Commission disapproved the use of HCIF for residential lighting.

ISR = "In-Service Rate" is the percentage of LEDs installed during a specific timeframe; the maximum ISR for NV Energy's southern territory is 99 percent, i.e., it is assumed that 1 percent of LEDs sold or distributed through the Program will never be installed.

- **Photocells**[5]: ADM assumed that LED was the main lighting measures during post-installation period in customer's house, and the efficiency improvement rate from photocell was 10 percent.

Equation 4

$$\Delta kWh/yr = EI * \Delta kWh/yr_{LED}$$

EI = Efficiency Improvement, 10 percent

$\Delta kWh/yr_{LED}$ = The annual kWh savings generated by LED

- **Refrigerator thermometer**[6]: ADM assumed that the average annual energy usage of a refrigerator is 600kWh per unit for a customer in southern Nevada, and the efficiency improvement rate from the thermometer was 1 percent.

Equation 5

$$\Delta kWh/yr = EI * \Delta kWh/yr_{Refrigerator}$$

EI = Efficiency Improvement, 1%

$\Delta kWh/yr_{Refrigerator}$ = The annual kWh savings generated by a Refrigerator

- **Air conditioner refrigerant line insulation on outside condenser unit**[7]: For this M&V analysis, $EFLH_{Heat}$ and $EFLH_{Cool}$ values from M&V analyses of the *2016 Residential Air Conditioning program* were utilized. Also, from M&V analyses of the *2016 Residential Air Conditioning program*, the ratio of energy consumption in kW to the rate of heat removal in tons at the rated condition was 1.5; the tonnage per house was 4, and the efficiency improvement rate was 0.5 percent.

Based on the engineering algorithms above, Table 3-5 shows the *ex post* annual energy savings per unit of each measure category that were applied to this program.

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[5] ADM has developed a measure matrix of residential energy efficient measures savings based on ADM industry experience that are appropriate for Northern and Southern Nevada.

[6] Ibid

[7] Ibid

Table 3-5: Ex Post Savings per Measure Category

Measure	*Annual Energy Savings (kWh[8])*	*Annual Energy Reduction (kW[9])*	*Effective Useful Life*
Air Filter/Furnace Filter	48	0.022	2
LED (7W A19)	20	0.020	6
LED (9W A19)	33	0.032	6
LED (11W A19)	37	0.030	6
Photocells	3	0.003	8
Refrigerator Thermometer	6	0.001	3
AC Refrigerant Line Insulation	20	0.009	10

3.3 DETERMINING ENERGY SAVINGS CURVES

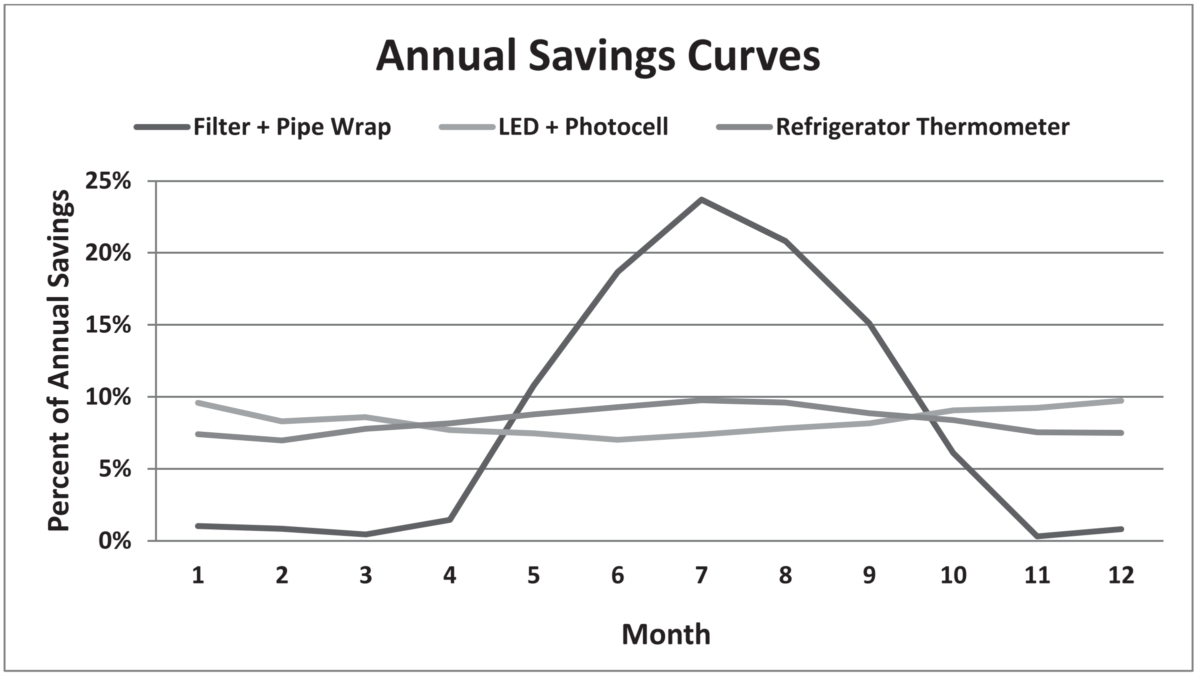
ADM developed a methodology that utilizes *energy savings curves* to calculate the portion of annual energy savings that occurs during each month of the year. An energy savings curve describes the temporal nature of energy savings. For example, on any given day the energy savings achieved by a LED are approximately 1/365 of the verified annual energy savings for that LED. On the other hand, an efficient air conditioner may not save any energy during the month of January but may achieve 35 percent of its annual energy savings in the month of July alone. ADM constructed appropriate energy savings curves from metered data collected during M&V of other NV Energy DSM programs (*Residential Energy Efficient Lighting Program (2016), Residential Air Conditioning Program, and Second Refrigerator Collection and Recycling Program (2015)*), customer billing data, calibrated DOE2 simulations and engineering calculations. The energy savings curves were coupled with installation dates on a record-by-record basis to produce accurate determinations of the energy savings achieved for each month of the year.

The resulting normalized, annual savings curves are depicted in Figure 1 below.

[8] Annual Energy Savings (kWh) per unit.

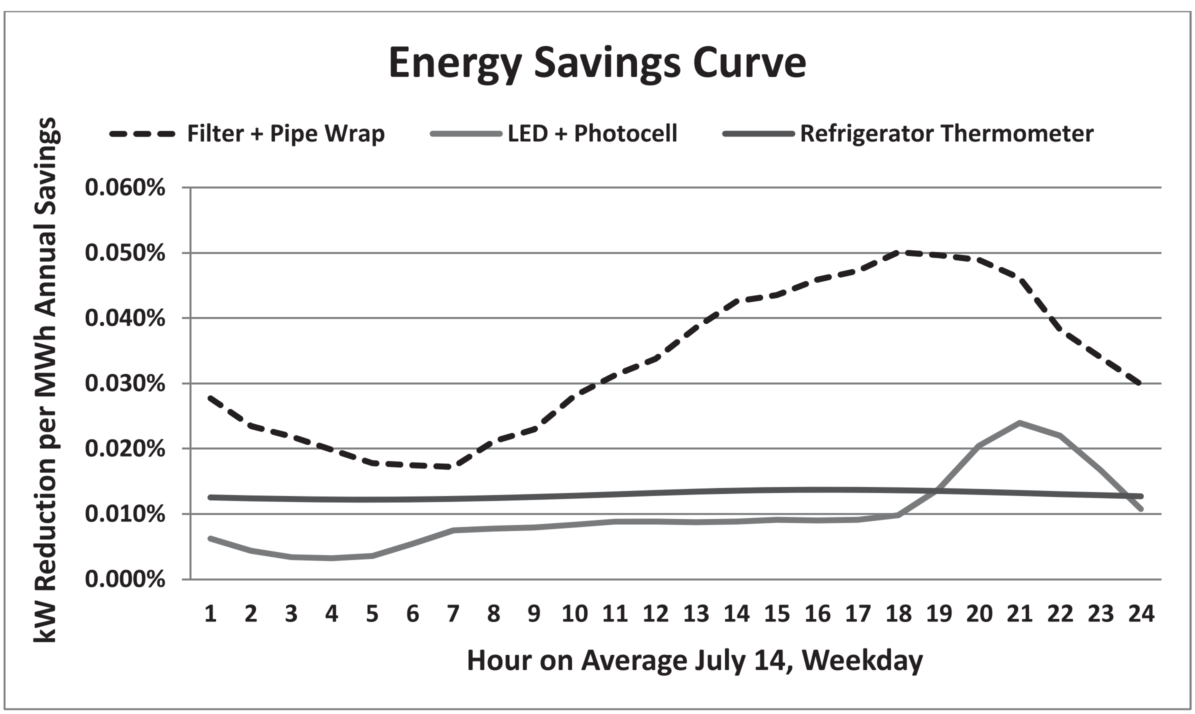
[9] Annual Energy Reduction (kW) per unit.

Figure 1. Annual Savings Curve for the NPC Direct Install Measure



For the PY2017 population of installed measures, a program-level daily energy savings curve for a typical summer day is graphed in Figure 2 below.

Figure 2. Average Peak Period Daily Savings Curve



3.4 CALCULATING FIRST-YEAR KWH SAVINGS

First-year kWh savings were calculated by determining what percentage of the year remained when each measure was installed. For each measure, the number of days remaining in the year was used along with the normalized energy savings curve described above to determine the share of annualized kWh savings realized during the 2017 calendar year. First-year kWh savings were summed by month across each customer rate class in the program population to determine the first-year kWh savings per month per rate class. The first-year kWh savings table is provided in Appendix B.

Please refer to Appendix D for a detailed description of ADM's analytical steps for determining the energy (kWh) savings per month per rate class, which also provides first-year kWh savings for the 2017 calendar year.

3.5 CALCULATION OF CRITICAL PEAK DEMAND SAVINGS

The critical peak demand period per month, provided below in Table 3-6, is the hourly period per month during which NV Energy has historically experienced maximum system-level demand.

Table 3-6. Critical Peak Demand Period per Month, NPC

Month	***Hour (NPC)***	***Ending at:***
January	19	19:00
February	19	19:00
March	20	20:00
April	20	20:00
May	17	17:00
June	17	17:00
July	17	17:00
August	17	17:00
September	17	17:00
October	19	19:00
November	19	19:00
December	19	19:00

Critical peak demand (kW) savings are calculated per month and per rate class utilizing *ex post* program savings determinations and appropriate measure-level 8760-hour energy savings curves.

For each 2017 participant in this program, *ex post* annualized energy savings per measure were allocated to the participant's rate class, and to the specific energy savings curve for that measure. The result is a two-dimensional matrix providing per-rate-class savings per hour for all 8,760 hours of a typical calendar year (a typical year is a non-Leap Year). The results were then inspected for each month to identify the maximum average hourly demand (kW) savings during each month's designated peak demand hour.

Summer critical peak demand (kW) savings is defined as the maximum kW reduction that could be expected in a typical year during the hour ending at 5 PM on any given day in July. For this program, summer critical peak demand savings is 17 kW.

The complete *ex post* critical peak demand savings per month and per rate class are provided in Appendix B. For a detailed discussion of ADM's analytical steps for determining critical peak demand (kW) savings, please refer to Appendix C.

3.6 DETERMINATION OF EFFECTIVE USEFUL LIFE ("EUL")

ADM determined the effective useful life (EUL) of each measure based on the most recent related NV Energy residential energy efficiency programs (e.g., *Residential Energy Efficient Lighting program, Residential Air Conditioning program*, etc.) and ADM engineers' M&V experience. The assumptions were relatively conservative for the population of measures that were installed through this program. EUL values are displayed in Table 3-7 on the following page.

Table 3-7: EUL of Measure Category

Measure	***Effective Useful Life (EUL)***
Air Filter/Furnace Filter	2
LED Lighting	6
Photocells	8
Refrigerator Thermometer	3
AC Refrigerant Line Insulation	10
Program-Level EUL (a weighted average of EULs above)	4.9

4. ENERGY IMPACT FINDINGS

This chapter provides verified *ex post* determinations of the energy impacts of the 2017 program.

4.1 ENERGY IMPACTS AND VARIANCES

Table 4-1 presents *ex ante* and *ex post* energy savings, along with program-year realization rates.

Table 4-1. Annual Energy Impact Summary

Measure Type	***Ex Ante Energy Savings (kWh)***	***Ex Post Energy Savings (kWh)***	***Peak Demand (kW) Reductions***	***Realization Rate***
Air Filter/Furnace Filter	18,336	18,336	11.90	100%
LED (7W A19)	12,365	7,732	0.75	63%
LED (9W A19)	30,204	30,588	2.98	101%
LED (11W A19)	3,156	2,994	0.29	95%
Photocell	438	438	0.04	100%
Refrigerator Thermometer	1,890	1,890	0.27	100%
Air Conditioner Refrigerant Line Insulation	1,520	1,520	0.99	100%
Total	**67,908**	**63,498**	**17**	**94%**

Table 4-2 summarizes the first-year kWh impact of the 2017 *Direct Installation Program* in southern Nevada. As stated in the methodology section above, this is based on the installation dates listed, with the annual savings per unit scaled by the percentage of the year remaining during 2017 calendar year.

Table 4-2. First Year & Lifetime Energy Savings Summary (Ex Post)

Measure Type	***First-Year (2017) Energy Savings (kWh)***	***Annual Energy Savings (kWh)***	***Effective Useful Life (EUL), Years***	***Lifetime Energy Savings (kWh)***
Air Filter/Furnace Filter	298	18,336	2	36,672
LED (7W A19)	1,188	7,732	6	46,390
LED (9W A19)	4,698	30,588	6	183,530
LED (11W A19)	460	2,994	6	17,964
Photocell	28	438	8	3,507
Refrigerator Thermometer	242	1,890	3	5,670
Air Conditioner Refrigerant Line Insulation	47	1,520	10	15,200
Total	**6,961**	**63,498**		**308,933**

4.2 IMPACT BY RATE CLASS

Energy efficient measures installed through the 2017 program provided savings in one rate class, RS. The class, along with its annual kWh savings realized through the *Direct Installation Program*, is presented in Table 4-3 below.

Table 4-3. Energy Impacts by Rate Class

Rate Class	***First-year (2017) Savings (kWh)***	***Annual Energy Savings (kWh)***
RS	6,961	63,498
Total	**6,961**	**63,498**

Additionally, ADM determined monthly savings results for the first year and years 2017 through 2020. These results are provided in Appendix B.

5. KEY FINDINGS

This chapter presents key findings and recommendations associated with the M&V analyses described in this M&V report.

5.1 KEY FINDINGS

Key findings from the M&V work are as follows:

For program year 2017, the savings from Air Filter/Furnace Filter were the major contribution to the total energy savings, which represented 60 percent of the total energy savings in 2017.

For LED lightings, the overall realization rate among all types of bulbs was approximately 90 percent. The variance between the *ex post* and *ex ante* energy (kWh) savings was caused by the use of a single *ex ante* savings per unit value of 32 kWh for all LEDs installed by the program. ADM determined verified *ex post* kWh savings of 20 kWh per unit for the 7W LEDs, which was the direct cause of the relatively low realization rate for the LED category.

For Photocell and Air Conditioner Refrigerant Line Insulation, the total number of installations and savings were lower than for other measures. The savings from Photocell represented 0.07 percent of the total energy savings in 2017; the savings from Air Conditioner Refrigerant Line Insulation represented 5.79 percent.

The program-level realization rate is 94 percent, with the following *ex post* verified energy impacts:

- 63,498 kWh savings per year
- 6,961 first-year kWh savings
- 17 kW summer critical peak demand savings

5.2 RECOMMENDATIONS

ADM provides the following recommendation for the *Direct Installation Program*:

- **Continue to coordinate with other programs to promote the *Direct Installation Program*.** For example, work with other rebate or in home assessment programs implemented by NV Energy to market the *Direct Installation Program*. An example would be home energy audit and in-home Assessment programs, which identify ways for a homeowner to reduce energy usage; if an old appliance exists in the home, it could present an opportunity to recommend participation in the *Direct Installation Program*.

- **Coordinate with the implementers to collect more detailed information and values about the replaced materials and installed energy efficient measures**. For example, ADM recommends to collect the unit wattage of the replaced light bulbs and the existing light bulbs of the installed photocell. Additionally, NV Energy should consider collecting the make, model, and type of the existing refrigerators. This will allow ADM to obtain more accurate calculation of *ex post* savings for the energy efficient measures.

APPENDIX A: SURVEY FORM

This appendix provides a copy of the survey form used in the telephone surveys.

2017 NV Energy
Direct Installation Program
Telephone Survey Form

Interviewer: ______________________ Date of Interview: _____/_____/_____
Phone Number: ___________________ Respondent: ________________
Address: _________________________

Hello, my name is _____, and I am calling on behalf of NV Energy. I am conducting a brief survey regarding NV Energy's Direct Installation Program. May I speak with [Customer's Name]? It should take less than 10 minutes and your feedback is very important to us.

(If the customer is not available, please ask for another adult that familiar with household's participation in the Direct Installation Program.)

1. Yes
2. No

PROGRAM PARTICIPATION VERIFICATION

1. Do you recall having energy efficient measures, such as an air filter, LED light bulb, or refrigerator thermometer installed by NV Energy? (Select all that apply.)
    1. Air Filter/Furnace Filter Change Out;
    2. LED Lighting;
    3. Photocell;
    4. Refrigerator Thermometer;
    5. Air Conditioner Refrigerant Pipe Wrap;
    6. No. [If answer No, terminate the survey.]

ENERGY EFFICIENT MEASURES VERIFICATION

Air Filter/Furnace Filter Change Out

[If 1 is selected in Question 1, ask this section.]

2. How often do you change the filter? ______

3. How many hours per day do you use your Air conditioner during summer months (approximate hours)?
   - Air conditioner hours per day (summer): ______

4. How many hours per day do you use your Furnace or Heater during winter months (approximate hours)?
   - Furnace/Heater hours per day (winter): ______

LED Lighting

[If 2 is selected in Question 1, ask this section.]

5. How many LED light bulbs did NV Energy install? ______

6. What is the type and wattage of the old light bulb, and how many did you have replaced for each type? (**If the customer doesn't know or remember, please skip this question**.)

Bulb Type	**Wattage Per Bulb**	**Number of Replacement**
LED		
CFL		
Incandescent		
Halogen		
Other, specify: ______		

7. Where are the LED bulbs installed? (Select all that apply.)
   1. Kitchen;
   2. Dining Room;
   3. Living Room;
   4. Other, specify: ______

Photocell

[If 3 is selected in Question 1, ask this section.]

8. How many photocells did NV Energy install? ______

9. What is the bulb type of the light fixture where the photocell(s) is installed?
   1. LED;

2. CFL;
3. Incandescent;
4. Halogen;
5. Other, specify: ______

10. What is the wattage of each light bulb? ______

11. How many bulb does each fixture have? ______

Refrigerator Thermometer

[If 4 is selected in Question 1, ask this section.]

12. What is the type of your refrigerator?
    1. Top Freezer;
    2. Bottom Freezer;
    3. Side by Side;
    4. French Door Refrigerator;
    5. Counter Depth Refrigerator;
    6. Compact Refrigerator;
    7. Freezerless Refrigerator;
    8. Other, specify: ______

13. Was your refrigerator new when you purchased it, or was it pre-owned?
    1. New;
    2. Pre-owned

14. What is the brand of your refrigerator? ______

15. When did you purchase your refrigerator? ______ (approximate year)

[If 2 is selected in Question 13, ask Question 16.]

16. How old is your refrigerator? ______ (approximate number of year)

17. Is your refrigerator Energy Star Rated, or energy efficient?
    1. Yes
    2. No

Air Conditioner Refrigerant Pipe Wrap

[If 5 is selected in Question 1, ask this section.]

18. How long is the pipe wrap? (up to six feet) ______

PROGRAM SATISFACTION

19. How satisfied were you with the newly installed energy efficient product(s)?

   a. Very Satisfied;
   b. Somewhat Satisfied;
   c. Neutral;
   d. Somewhat Unsatisfied;
   e. Very Unsatisfied;
   f. Don't Know.

[If d or e is selected in Question 19, ask Question 20.]

20. Why you are not satisfied with product(s)? ______

21. How satisfied were you with the scheduling of the installation?

   a. Very Satisfied;
   b. Somewhat Satisfied;
   c. Neutral;
   d. Somewhat Unsatisfied;
   e. Very Unsatisfied;
   f. Don't Know.

[If d or e is selected in Question 21, ask Question 22.]

22. Why you are not satisfied with product(s)? ______

23. How satisfied were you with the process of installation?

   a. Very Satisfied;
   b. Somewhat Satisfied;
   c. Neutral;
   d. Somewhat Unsatisfied;
   e. Very Unsatisfied;
   f. Don't Know.

[If d or e is selected in Question 23, ask Question 23.]

24. Why you are not satisfied with product(s)? ______

Thank you for taking our survey. Your response is very important to us. Have a great day.

APPENDIX B: SAVINGS PER MONTH BY RATE CLASS

This appendix provides monthly savings by rate class for the years 2017-2020.

Table B-1. Monthly kWh Savings by Rate Class – 2017 (First Year)

Rate Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
RS	-	-	-	-	-	-	-	-	166	1,116	2,002	3,678	6,961
Total	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**166**	**1,116**	**2,002**	**3,678**	**6,961**

Table B-2. Monthly kWh Savings by Rate Class – 2018 (Full Year)

Rate Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
RS	4,344	3,757	3,820	3,655	5,422	6,813	7,971	7,578	6,571	5,148	4,054	4,364	63,498
Total	**4,344**	**3,757**	**3,820**	**3,655**	**5,422**	**6,813**	**7,971**	**7,578**	**6,571**	**5,148**	**4,054**	**4,364**	**63,498**

Table B-3. Monthly kWh Savings by Rate Class – 2019 (Full Year)

Rate Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
RS	4,344	3,757	3,820	3,655	5,422	6,813	7,971	7,578	6,571	5,148	4,054	4,364	63,498
Total	**4,344**	**3,757**	**3,820**	**3,655**	**5,422**	**6,813**	**7,971**	**7,578**	**6,571**	**5,148**	**4,054**	**4,364**	**63,498**

Table B-4. Monthly kWh Savings by Rate Class – 2020 (Full Year and Leap Year)

Rate Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
RS	4,344	3,885	3,809	3,755	5,447	6,873	7,952	7,522	6,561	5,072	4,056	4,365	63,638
Total	**4,344**	**3,885**	**3,809**	**3,755**	**5,447**	**6,873**	**7,952**	**7,522**	**6,561**	**5,072**	**4,056**	**4,365**	**63,638**

Table B-5. Critical Peak Demand (kW) Reduction per Month per Rate Class

Rate Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RS	8	8	11	11	13	16	17	16	13	12	8	8
Total	**8**	**8**	**11**	**11**	**13**	**16**	**17**	**16**	**13**	**12**	**8**	**8**

APPENDIX C: CALCULATION METHODOLOGY FOR CRITICAL PEAK DEMAND (KW) SAVINGS

C.1. OVERVIEW OF CALCULATION METHODOLOGY FOR KW SAVINGS

This section provides a description of analytical steps employed to determine critical peak demand savings per month per rate class for NV Energy's 2017 DSM programs. For the 2017 M&V reports, demand (kW) reduction per month per rate class is determined using essentially the same methodology that is used to disaggregate annual energy (kWh) savings into monthly kWh savings per rate class. Please see the following chapter for a more detailed description of the methodology for determining energy (kWh) savings per month per rate class.

M&V reports for 2017 DSM programs do not provide critical peak demand (kW) savings for the 2017 calendar year. To do so would provide an incomplete, potentially misleading picture of critical peak kW savings because each monthly kW reduction value would represent only a fraction of the total population of measures that are installed during the program year as a whole. Instead, M&V reports for 2017 DSM programs provide monthly critical peak kW savings values for 2017 – and for subsequent years for the life of the measures installed – which are representative of the whole population of measures installed by each program during the 2017 calendar year. This approach for reporting *"typical" (or "full year") coincident peak kW reduction* is the preferred approach for impact evaluations. For this program, Table B-5 (see Appendix B above) provides the full-year values or 2017 calendar-year values for critical peak kW savings per month and per rate class.

C.2. ANALYTICAL STEPS AT THE MEASURE LEVEL

At the measure level, for every record (i.e., individual measure) in DSM Central, ADM assigns an appropriate normalized 8,760 energy savings curve. A normalized energy savings curve is comprised of 8,760 hourly fractions summing to exactly 1 (unity). For each measure, ADM determines *ex post* annual kWh savings, which is then multiplied by each of the 8,760 hourly fractions to disaggregate the annual kWh into 8,760 hourly kW bins.

C.3. ANALYTICAL STEPS AT THE PROGRAM LEVEL

To determine program-level demand (kW) reduction for a given hourly kW bin, ADM sums the hourly kW bin across all measures in the program. For example, the program-level kW reduction for the hour ending at 5 PM on the 200th day of the year is the sum of kW for all measures in the program during that hour on that day.

To determine monthly critical peak demand (kW) reduction for the program, ADM inspects program-level kW reduction during the one-hour critical peak demand period that is defined for each month of the year. The following table provides the monthly critical peak demand periods for NPC and Sierra, which were determined from ADM's analysis of peak system load data provided by NV Energy.

Table C-1. Critical Peak Demand Period per Month, NV Energy

Month	***Critical Peak Period, NPC***		***Critical Peak Period, Sierra***	
	Hour	*Ending at:*	*Hour*	*Ending at:*
January	*19*	*19:00*	*19*	*19:00*
February	*19*	*19:00*	*19*	*19:00*
March	*20*	*20:00*	*20*	*20:00*
April	*20*	*20:00*	*21*	*21:00*
May	*17*	*17:00*	*17*	*17:00*
June	*17*	*17:00*	*17*	*17:00*
July	*17*	*17:00*	*17*	*17:00*
August	*17*	*17:00*	*17*	*17:00*
September	*17*	*17:00*	*17*	*17:00*
October	*19*	*19:00*	*20*	*20:00*
November	*19*	*19:00*	*19*	*19:00*
December	*19*	*19:00*	*19*	*19:00*

For example, the critical peak demand period for July is the hour from 16:00:01 or 4:00:01 PM to 17:00:00 or 5:00:00 PM. To determine July's program-level critical peak kW savings, ADM inspects average hourly kW reduction during 4:00:01 to 5:00:00 PM for every day in July: the highest value represents July's critical peak kW savings. The same procedure is followed for all months of the year. *Summer critical peak demand savings is defined as July's critical peak kW savings;* the rationale for doing so is that historical data reveals that during any given year, NV Energy's peak system demand in either territory will typically occur during a July day between 4:00:01 to 5:00:00 PM.

To determine the monthly kW reduction *per rate class*, each program-level monthly critical peak kW savings value is disaggregated into *rate class bins* by correlating monthly kW savings for a given measure to the measure's assigned customer rate class as listed in DSM Central.

Calculations for energy (kWh) savings – and for demand (kW) reduction – per month per rate class require complex algorithms that are executed in massive Excel files, which are also known as ***kW guru***™ files.

C.4. ANALYSIS OF SYSTEM-LEVEL CRITICAL PEAK DEMAND PERIODS

ADM analyzed NV Energy's system-level critical peak hours to determine a consistent reference for peak demand impacts of M&V evaluation of all NV Energy programs. ADM's analysis encompassed Sierra Pacific Power Company ("Sierra") in the north and Nevada Power Company ("NPC") in the south.

Hourly system load data from 1985 through 2011 for Sierra and from 1999 through 2011 for NPC was provided by NV Energy. In analyzing the hourly load data it was determined that the system peaks for Sierra in 1985 were only half of what they have been in the more recent ten-year period. The percentage change in daily system peaks between summer and winter were smaller in the 80's and 90's than in the more recent ten-year period. Therefore ADM concluded that the use of system load data from the recent ten-year period provides the best basis for predicting what to expect during an EEM's remaining useful life; following that rationale, data prior to the most recent ten years was excluded from ADM's analysis. In both service territories, the highest system peak occurred in 2007, and system peaks have declined moderately since.

The hourly load data for the recent ten-year period was thoroughly reviewed and, except for "spring ahead" hours (when clock times change from Standard Time to Daylight Savings Time), it was determined that the data was consistent and appropriate. The data for "spring ahead" hours are inconsistent, with values given as follows: (1) the value of the preceding hour is used and is an acceptable means of handling the data; and (2) a zero, which is an inaccurate value that would pull down the average. For this analysis, zero values were converted to blanks, and therefore not included in the averaging calculation. Overall this is a minor issue that did not impact ADM's final analysis of system-level critical peak hours.

ADM determined that system load characteristics vary by season. To accommodate the seasonal variations, the hour of peak system load was determined for each month. ADM concluded that a one-hour peak demand period per month is appropriate.

The final determination of the appropriate peak demand hour per month per territory is provided above; see the table in the preceding section of this appendix. The designated peak demand hour per month per territory was utilized for M&V analyses of energy efficiency programs implemented in 2011, 2012 and 2013. Subject to ADM's periodic re-checking of system load data, it is expected that the designated peak demand hour per month per territory will continue to be utilized for subsequent program years.

This M&V methodology update occurred for the following reason. Compared to the three-hour critical peak demand window used for M&V analyses of 2010 programs, the updated critical peak demand definition (i.e., one hour per month per territory) provides a more accurate determination of energy efficiency programs' contributions to reducing system peak demand. In other words, the one-hour peak kW reduction will align with the actual hour of system peak.

NV Energy's hourly system load data demonstrated well-defined peaks during summer and winter months. However, certain transition months – such as May in Northern Nevada – have a nearly identical double peak. It is obvious that specific weather conditions during any given year cause one or the other of the two peaks to predominate. In the final analysis, transition months have far less peak demand than summer months, so a transition month peak hour is essentially insignificant to the determination of the system peak hour, which will typically occur in July and occasionally occur in August (but never in May).

ADM also analyzed hourly system load by various day types. The day type that exhibited highest average demand was selected as the appropriate day type for final determination of peak hour. The day types investigated were (1) All Days, (2) Weekdays, (3) Non-Holiday Weekdays (i.e., Workdays) and (4) Weekend & Holidays. A curve for each month was developed by day type. All days for a given day type were averaged hourly for a given month of the day to develop an average 24 hour load curve. For the north and south, the summer peak typically occurs during hour 17, which is the hour that ends at 17:00 (5:00 PM). The greatest summer peak demand is the highest peak demand experienced by both companies.

The analysis determined that of the four-day types, Workdays averaged the highest system demand for most hours of the day. Generally, the peak hour calculated from the average Workday curve was identified as the peak hour for the month for the given territory. The peak hours for two transition months in each territory were adjusted to maintain a more consistent set of peak hours. Adjustments were made for May and June for Sierra and April and November for NPC. The selection of the peak hour for these months was based on differences of less than 1% in the average demand in MW between the mathematical peak hour and the assigned peak hour.

To validate these decisions ADM also analyzed all-time record peak days and an average of the day from each month that the peak occurred. The second method thus included ten days in the calculation of the average. The results from these analyses supported the average Workday results. Analysis files have not been included in this report due to the large size of spreadsheets.

APPENDIX D: DETERMINING ENERGY (KWH) SAVINGS PER MONTH PER RATE CLASS

This chapter provides a detailed description of ADM's analytical steps for determining the energy (kWh) savings per month per rate class values that are provided in the M&V reports for the program year 2017.[10]

D.1. APPORTIONMENT OF ANNUAL ENERGY SAVINGS BY RATE CLASS

NV Energy's DSM programs generally include populations of customers from more than one rate class. NV Energy tracks the rate class for each identifiable customer participating in DSM programs. However, participant information is not known for certain DSM programs, such as the *Consumer Electronics and Plug Loads* program or other "upstream" or "midstream" programs where incentives are provided through contractual arrangements with manufacturers or distributors of the rebated products. For DSM programs for which participant information is not known, ADM collected participant information at the point of sale or conducted customer surveys to identify the proportions of participants that belong to various rate classes.

D.2. APPORTIONMENT OF ANNUAL ENERGY SAVINGS BY MONTH

ADM developed a methodology that utilizes *energy savings curves* to calculate the portion of annual energy savings that occurs during each month of the year. An energy savings curve describes the temporal nature of energy savings. For example, on any given day the energy savings achieved by a LED exit sign are approximately 1/365 of the verified annual energy savings for that LED exit sign. On the other hand, an efficient air conditioner may not save any energy during the month of January but may achieve 35 percent of its annual energy savings in the month of July alone. ADM constructed appropriate energy savings curves from metered data collected during M&V of NV Energy DSM programs (or other programs if appropriate), customer billing data, calibrated DOE2 simulations and engineering calculations. The energy savings curves were coupled with project implementation dates on a record-by-record basis to produce accurate determinations of the energy savings achieved for each month of the year.

D.3. HIGH-LEVEL SUMMARY OF ADM'S CALCULATION METHODOLOGY

Monthly energy (kWh) savings for each program were calculated by applying an appropriate hourly or daily energy savings curve to each program participant's *ex post* verified energy savings, then aggregating kWh savings for each month. The energy savings curve distributes a participant's

[10] The Public Utilities Commission of Nevada (PUCN) requires NV Energy to report energy (kWh) savings per month and per rate class for each Demand Side Management (DSM) program.

energy savings over time. Its shape is, therefore, dependent on not only the measure installed (i.e., lighting vs. HVAC), but also on the building type and sometimes its location.

The overall process by which ADM calculated monthly kWh savings was to (1) download from DSM Central all program tracking data, i.e., *ex ante* expected kWh savings, measure type, measure completion date, rate class, etc., (2) calculate *ex post* values per participant, (3) assign an energy savings curve to each participant's *ex post* savings to distribute *ex post* energy savings by rate class over each of the 8,760 hours in a year, and (4) aggregate *ex post* verified savings for the purpose of presenting savings by month and by rate class.

ADM also calculated first-year kWh savings for each program by combining measure startup date (from DSM Central) with the aforementioned process. A detailed description of the steps involved in tabulating first-year kWh savings is provided in section E.5 below.

D.4. ENERGY SAVINGS PROFILES

D.4.1. Definition

The phrase 'energy savings curve' is used to describe the temporal dependence of energy savings. The curves are typically hourly (1 × 8760 arrays), daily (1 × 365 arrays), or monthly (1 × 12 arrays). The energy savings curves are often normalized such the sum of all array elements is unity. When normalized, each element describes the fraction of annual savings that is expected to occur in a given hour, day, or month.

D.4.2. Nomenclature

Note that if the term 'load shape' is encountered in the spreadsheets that are used to tally monthly energy savings by program and rate class, one should take it to be the same as 'energy savings curve' as described herein. The reason for the usage of the term 'load shape' is twofold:

- Energy savings curves are *differential load shapes* describing <u>differences</u> in electricity loads resulting from the implementation of energy efficient measures; in other words, energy savings curves indicate the *shape over time of electricity that is saved or not used*. Note also that energy that is *not used due to energy efficiency actions* (i.e., "saved" energy) is sometimes called "Negawatts" – a "Negawatt" saved is meant to represent the negative form of a <u>"Megawatt" of power that would have been used if the energy efficiency actions had not occurred</u>.

- An energy savings curve for a measure may or may not be synchronous with the load curve of the base case technology against which savings are determined.
    1) There are energy efficient measures (EEMs) for which the normalized savings curve is synchronous and proportional to the normalized load shape or curve of the base case technology. Examples of such EEMs include CFLs versus incandescent

lights if it is assumed that (1) there are null or negligible interactive effects and (2) pre- and post-retrofit usage schedules are identical. If the savings curve for an EEM is synchronous with the base case technology load shape, then the two curves have identical shapes.

2) For other EEMs, the energy savings curve is asynchronous with the load curve of the base case technology. Examples of EEMs with asynchronous savings curves include economizers, occupancy sensors, and control systems. For such measures, the shape of the energy savings curve is different from the shape of the base case technology.

As part of our evaluation effort, ADM determines for each EEM whether to use normalized energy savings curves that are either synchronous or asynchronous with the normalized load shape of the base case technology.

D.5. TABULATING MONTHLY ENERGY (KWH) SAVINGS PER RATE CLASS

Normalized daily energy savings curves are utilized for this task. A normalized daily energy savings curve is comprised of 365 daily fractions summing to exactly 1 (unity). For each measure, ADM determines *ex post* annual kWh savings, which is then multiplied by each of the 365 daily energy savings curve fractions to disaggregate annual kWh into 365 daily kWh bins.

D.5.1. First-Year kWh Savings

'First-year' kWh savings are savings that occur during the same calendar year in which a conservation program was implemented. For NV Energy a program year is the same as a calendar year. Thus 'first-year' kWh savings for a measure installed during the 2017 program year are equal to that measure's kWh savings during the 2017 calendar year.

The following calculations are performed to tabulate 'first-year' kWh savings attributable to a particular customer rate class. For any given 2017 NV Energy program:

- For each rate class, for each day of 2017, identify all measures that have been implemented (or 'installed' or 'started up') by the end of the prior day.
- For each rate class, for each day of 2017, for all measures that that have been installed by the prior day, multiply the *ex post* verified 'typical-year' annualized kWh savings[11]

[11] 'Typical-year' annualized kWh savings is 365 consecutive days of energy savings – usually a full calendar year other than Leap Year – attributed to an energy efficient measure(s) for which *ex post* verified kWh savings will occur during a multi-year measure life. For example, an NV Energy conservation measure installed during the 2017 program year (i.e., during the 2017 calendar year) will normally provide kWh savings starting on its date of installation. 'First-year' savings is the savings that occur during the 2017 calendar year. 'Full-year' savings is the savings occurring during subsequent calendar years.

for each measure type by that measure's daily kWh bin. In other words, multiply the measure-level annual kWh by the measure-level daily bin from the appropriate energy savings curve.

- For each rate class, tally all measure-level daily kWh savings to determine program-level daily kWh savings.

- For each rate class, for any given month of 2017, tally all measure-level daily kWh savings occurring during that month to determine program-level monthly kWh savings during the 2017 calendar year.

- For each rate class, the first-year kWh savings is the program-level monthly kWh savings for that rate class summed across all 12 months of 2017.

D.5.2. Typical-Year kWh Savings

'Typical-year' energy (kWh) savings represents 365 consecutive days of energy savings attributed to a measure(s) or program for which *ex post* verified savings will occur across a multi-year measure life.[12]

The following calculations are performed to tabulate 'typical-year' energy (kWh) savings attributable to a particular customer rate class. For any given 2017 NV Energy program, all measures would have been implemented or installed during the calendar year 2017.

- For each rate class, for each hour (or day) of 2017 and subsequent years, multiply *ex post* verified 'typical-year' energy (kWh) savings for each measure type by that measure's hourly (or daily) kWh bin. In other words, multiply the measure-level annual kWh by the measure-level hourly (or daily) bin from the appropriate energy savings curve.

- For each rate class, tally all measure-level hourly (or daily) kWh savings to determine program-level hourly (or daily) kWh savings.

- For each rate class, for any given month, sum all measure-level hourly (or daily) kWh savings occurring in that month to determine program-level monthly kWh savings.

- For each rate class, 'typical-year' kWh savings is the program-level monthly kWh savings for that rate class summed across all 365 days of any non-Leap Year subsequent to the 2017 calendar year.

[12] The distinction between 'typical year' and 'full year' is that a 'typical year' is a 365-day year. A Leap Year is not a 'typical year' – instead, a Leap Year is a 'full year' that has 366 days. In M&V reports, the kWh savings tables (which show monthly savings per rate class) usually indicate titles such as "First Year 2017", "Full Year 2018 (Leap Year)", "Full Year 2019" and "Full Year 2020 (Leap Year)".

- For any given program, ‘full-year’ kWh savings for a Leap Year will be marginally higher than ‘full-year’ kWh savings for a ‘typical year’ or non-Leap Year. Thus, we always use a non-Leap Year when we quantify ‘typical-year’ kWh savings.

Following is an example of the determination of daily kWh savings generated by a program. Let’s consider a hypothetical program that targets two energy efficiency (EE) measures: residential lighting and residential cooling. For this hypothetical program, Table E-1 below provides a simple comparison of the measures’ respective:

- ‘typical-year’ energy savings;
- daily bin value in its energy savings curve for a specific day – February 1st – of any given year[13] after the EE measures were installed;
- energy (kWh) savings during February 1st of any given year after the EE measures were installed.

In Table D-1 below, the assumption is that 1,000,000 kWh of annual energy savings (‘typical-year’ savings as reported in M&V reports) were achieved through the distribution of CFLs and 500,000 kWh of annual (‘typical-year’) energy savings were achieved through implementation of high efficiency air conditioning (AC) measures. Energy (kWh) savings on February 1st are obtained by multiplying ‘typical-year’ kWh savings by the entries corresponding to February 1st in the respective normalized energy savings curves. ***In this example, the daily bin for space cooling is zero because no space cooling is expected to occur on February 1st.***

Table D-1. Sample calculation of energy savings achieved for a given rate class on February 1 for a hypothetical program targeting residential lighting and space cooling.

Comparison for “Indoor Lighting” vs. “Space Cooling” Measures	**EE Measure = “Indoor Lighting”**	**EE Measure = “Space Cooling”**
‘Typical-year’ energy savings (annual kWh):	1,000,000	500,000
Feb. 1 daily bin value in each EE measure’s energy savings curve:	0.0030	0.0000
Feb. 1 energy (kWh) savings in a typical year:	3,000	0

For each program, such calculations are performed for each rate class, energy savings curve and hour (or day). Hourly (or daily) results are then aggregated at the monthly level.

[13] The daily bin value for February 1 represents the February 1 daily fraction of ‘typical-year’ annual energy (kWh) savings.

D.5.3. Leap Year Savings

To account for the extra day in February in Leap Years, one of the following methods is used. Either method produces accurate and very similar *ex post* verified energy savings determinations for Leap Years.

- Energy savings during the month of February in a Leap Year is taken to be equal to 29/28 of energy savings during the month of February in a typical non-Leap Year.

- Or, energy savings on the day of February 29 in a Leap Year is assumed to be the same as energy savings on the previous day (February 28).

DSM-12

Residential High Efficiency Air Conditioning
NV Energy – Southern Nevada (NPC)
Program Year 2017

Measurement and Verification Report
May 3, 2018

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TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

This Measurement and Verification ("M&V") report presents the results of ADM Associates Inc.'s ("ADM") impact evaluation of the 2017 Residential High-Efficiency Air Conditioning Program in the NV Energy ("NVE") southern Nevada service territory ("NPC")[1]. In this report, ADM will describe its M&V analyses and results for the 2017 program.

NV Energy's Residential High-Efficiency Air Conditioning Program is a demand-side management ("DSM") program offering Las Vegas-area HVAC contractors technical training and customer rebates for providing various HVAC[2] repair and retrofit services to NVE customers. According to program tracking data, a total of 41,531 measures (26,198 HVAC) were installed as part of this program during the 2017 calendar year.

The program offered five major categories of measures in 2017:

1. Duct testing and sealing
2. Early replacement of functional, but inefficient, air conditioners and heat pumps with premium efficiency units
3. HVAC tune-up measures, including charge adjustment and coil cleaning
4. LED direct installs
5. Low flow showerhead and faucet aerator direct installs

The *ex post* electric savings for Duct Test and Sealing (DTS), Early Replacement, and Tune Ups were estimated via econometric analysis of utility meter data from a large sample of homes involved in the program.

The *ex post* savings for the remaining measures were estimated through Technical Review Manual (TRM) based engineering calculations.[3] Table 1-1 on the following page provides a summary of *ex post* savings for each measure category.

[1] NPC: Nevada Power Company

[2] HVAC: Heating, Ventilation, and Air Conditioning.

[3] Two measures had very low installation counts: Duct Return Modification (14 installs) and Heat Strip Lockouts (2 installs). A simple review of *ex ante* savings was performed for these measures.

Table 1-1: Ex Post Savings per Measure Category

Building Type	Measure	Total Installs	Annual Energy Savings (kWh)		EUL in Years	Lifetime Energy Savings (kWh)	
			Ex Ante	*Ex Post*		*Ex Ante*	*Ex Post*
Modeled HVAC Measures							
MF[4]	DTS-Tier 1 (All)	149	23,378	70,472	20	467,562	1,409,447
	DTS-Tier 2 (CCE[5])	626	176,801	151,345	20	3,536,024	3,026,908
	DTS-Tier 2 (Non-CCE)	727	205,327	261,151	20	4,106,532	5,223,030
	DTS-Tier 3 (CCE)	2,420	911,324	1,031,272	20	18,226,472	20,625,444
	DTS-Tier 3 (Non-CCE)	1,157	435,703	325,033	20	8,714,061	6,500,660
	Single Tier DTS (CCE)	1526	695,856	524,076	20	13,917,120	10,481,523
	Single Tier DTS (Non-CCE)	532	242,592	157,940	20	4,851,840	3,158,800
	Coil Cleaning Indoor	390	18,740	120,832	8	149,916	966,653
	Coil Cleaning Outdoor	854	41,035	268,669	8	328,278	2,149,352
	Refrigerant Charging	654	39,279	206,075	8	314,234	1,648,599
	CoolSaver Tune-Up	1,722	638,862	578,479	8	5,110,896	4,627,833
	CoolSaver Tune-Up + Refrigerant Adjustment	4,118	2,590,222	1,458,905	8	20,721,776	11,671,241
SF[6] + MH[7]	DTS-Tier 1	508	52,336	112,364	20	1,046,723	2,247,286
	DTS-Tier 2	1,486	360,068	896,210	20	7,201,364	17,924,198
	DTS-Tier 3	926	323,631	336,124	20	6,472,620	6,722,481
	Single Tier DTS	465	212,040	162,238	20	4,240,800	3,244,769
	Coil Cleaning Indoor	248	38,140	93,867	8	305,119	750,938
	Coil Cleaning Outdoor	382	58,748	143,549	8	469,982	1,148,391
	Refrigerant Charging	275	53,012	103,195	8	424,094	825,562
	CoolSaver Tune-Up	200	74,200	64,447	8	593,600	515,579
	CoolSaver Tune-Up + Refrigerant Adjustment	333	291,708	112,220	8	2,333,664	897,760
	Early Replacement	544	1,158,828	952,353	8	9,270,624	7,618,824
Direct Installs (counts by premise)							
SF + MF	General Purpose LEDs	1,978	169,427	167,244	20	3,388,538	3,344,871
	Reflector LEDs	26	11,108	11,213	20	222,154	224,266
	Low Flow Showerheads	6,669	2,005,534	1,716,285	9	18,049,803	15,446,569
	Low Flow Faucet Aerators	6,660	1,164,434	833,412	10	11,644,337	8,334,120
Miscellaneous Measures							
MF	Heat Strip Lockout	196	52,920	52,920	20	1,058,400	1,058,400
	Duct Return Modification	1	212	212	20	4,240	4,240
SF	Burn Outs	24	15,422	15,422	18	277,596	277,596
	New Build Installs	7	4,655	4,655	18	83,790	83,790
	Early Replacement	3	5,175	5,175	8	41,400	41,400
Totals							
		35,806	12,070,706[8]	10,937,357	13	147,573,559	142,200,530

[4] Multifamily

[5] CCE refers to Climate Control Experts.

[6] Single Family

[7] Mobile Home

[8] Table total does not match sum of line items due to rounding.

To summarize the main results of this study:

- The verified electric impacts for the Residential High Efficiency Air Conditioning Program were 10,937,357 kWh saved annually, based on forecasts of typical year weather, which represents a realization rate of 90.6%.
- Critical summer peak (or on-peak) demand savings were calculated by month and rate class. During summer 2017, the critical peak demand savings were 5,267 kW.
- The impact evaluation sample is constrained to participants through September 2017 of implementation. The remaining measures occurred too late in the calendar year (insufficient post-period cooling data) to enable an interval meter data analysis by February 2018.

2. PROGRAM BACKGROUND

The Residential High Efficiency Air Conditioning Program was designed to help customers reduce their energy consumption by incenting efficiency upgrades, high efficiency controls and system components, and for qualifying systems, replacement with high efficiency air conditioners or heat pumps.

The goal of the program was to identify energy savings opportunities associated with (electric) heating, ventilation, and air conditioning (HVAC) and to offer incentives to contractors for testing and repairing HVAC systems according to CLEAResult's program protocols.

CLEAResult was the implementer for the Residential High Efficiency Air Conditioning Program in 2017. In 2017, the program rebated the following energy efficiency measures:

- Duct Test and Seal
- Tune ups including Refrigerant Charging and Coil Cleaning during the early part of the year, and subsequently CoolSaver tune ups
- Rebates for "early replacement" of operational air conditioners/heat pumps that have cooling efficiencies[9] below energy efficiency ratios ("EER") of 8.0.
- LED direct installs
- Low flow showerhead and faucet aerator direct installs

The above measures were offered by participating HVAC contractors. To participate in the program, every technician had to participate in classroom and hands-on training and qualification courses with CLEAResult. There were a total of 24 partner contractors that participated in the program, although one company, Climate Control Experts was responsible for over 50% of the installed measures.

In 2017, the program provided 41,531 measures (26,198 HVAC) to 21,900 unique premises. The overall *ex ante* program impacts were energy savings of 12,070,706 kWh. There were 21 distinct measures types rebated by the program in 2017 as shown in Table 2-1 on the following page, arranged in descending order of measure count.

[9] To qualify, the rated efficiency must be below EER 8, or, the measured efficiency after all tune-up activities have been performed must be below EER 8.

Table 2-1. Measures, Counts, and Associated Ex Ante Energy Impacts

Measure	Measure Count[10]	Annual *Ex Ante* Energy Savings (kWh)
Low Flow Showerhead	6,669	2,005,534
Low Flow Aerator	6,660	1,164,434
CoolSaver Tune Up	6,373	2,364,383
Duct Sealing (Level 3)	4,503	1,670,658
CoolSaver Refrigerant Adjustment	4,451	1,230,609
Duct Sealing (Level 2)	2,839	742,196
Duct Sealing (Single Tier)	2,523	1,150,488
Diagnostic Evaluation	1,245	0
Coil Cleaning Outdoor	1,236	99,782
40W General Purpose LED	1,186	105,224
Refrigerant Charging	929	92,291
60W General Purpose LED	792	64,203
Duct Sealing (Level 1)	657	75,714
Coil Cleaning Indoor	638	56,879
HVAC Early Replacement	547	1,164,003
Heat Strip Lockout Install	196	52,920
Duct Testing by Contractor	29	0
Reflector LED	26	11,108
HVAC Burn Out	24	15,422
HVAC New Build Install	7	4,655
Duct Return Modification	1	212
Total	**41,531**	**12,070,706**[11]

[10]Counts here differ slightly from Table 1-1 as the previous table excludes measures with no savings (Diagnostic Evaluation and Duct Testing by Contractor) and combines measures that were modeled together (CoolSaver Tune Up + CoolSaver Refrigerant Adjustment at same property).

[11] Table total does not match sum of line items due to rounding.

3. OVERVIEW OF GROSS IMPACT EVALUATION METHODOLOGY

This chapter provides a description of the M&V methodology applied by ADM in the evaluation of NV Energy's 2017 Residential High Efficiency Air Conditioning Program. The impact evaluation efforts of the major program components are described in the following chapters.

3.1. DATA COLLECTION AND REPORTING REVIEW

ADM reviewed the data collection and reporting procedures for the program in spring of 2017. The main purpose of the review was to check that data on the key attributes of the affected HVAC systems were being collected both before and after a given energy efficiency measure. The review also confirmed that the collected data were being recorded and reported in DSM Central (NV Energy's database on DSM program participation). DSM Central is a comprehensive tracking and reporting system that facilitated both the analysis effort and the process of assigning verified energy savings to the entire set of participants.

Data were collected on both dwelling and equipment attributes. The typical data fields were as follows:

- Dwelling type (single-family, multi-family, or mobile home),
- HVAC system type (Air Conditioner, Heat Pump, or AC with electric resistance heating), and
- AC unit characteristics such as make, model, capacity, and efficiency.

The implementer also performed and recorded *in situ* measurements of the air conditioning efficiency both before and after AC tune-up measures. The duct leakage was measured before and after duct sealing activities and recorded in the DSM tracking database. The different HVAC systems encountered on each site are given unique numbers in the 2017 tracking database. Measure completion dates are available for each measure in the database.

3.2 SUMMARY OF M&V METHODOLOGIES

After reviews of the *ex ante* energy savings calculations and the program implementation plan, ADM created an evaluation plan with sample and methodology allocations designed to meet the desired level of statistical uncertainty and measurement rigor. We describe the M&V approach for each of the major program components below.

Duct Sealing, Tune-Ups, and Early Replacement

Duct Sealing, Tune Ups and Early Replacement measures account for 72% of *ex ante* program energy savings. Thus, ADM opted for the most rigorous applicable methodology: *pre*- and *post*-impact evaluation through analysis of utility meter data. The aggregation and analysis techniques are briefly described below.

ADM measured program impacts on participants utilizing utility meter data for 2016 and 2017. The analysis involved comparing weather-normalized post-measure energy usages relative to baseline usages for treatment and comparison groups. Separate comparison groups for the single-family and multi-family markets were derived from program participants who received treatment too late in the year (after September) to have sufficient cooling-season data to allow for impact measurement, as well as single family homes for which ADM already has meter data based on their inclusion in the control group for the *Residential Demand Response* program.

ADM cross-checked the treatment and comparison groups[12] against participation lists for other residential energy efficiency and demand response programs. While the cross-participation rates with other energy efficiency programs were low, these cross-participant homes were excluded from the modeling analysis. However, energy savings are still attributed to these homes.

ADM experimented with several data modeling approaches. The 15-minute interval meter data was aggregated to the hourly level to minimize information loss that would be associated with compression to a longer timeframe, while also allowing for straightforward incorporation of hourly weather data.

LED and Flow Direct Installs

Program-level energy (kWh) savings from installing Low-Flow Showerheads and Faucet Aerators employed calculations taken from the *State of Pennsylvania Technical Reference Manual* and adapted to suit southern Nevada.[13]

ADM employed engineering analyses to determine *ex post* verified energy savings for LED installs. *Ex post* verified energy savings per LED were calculated with methods developed by ADM and consistent with chapter 6 of *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures*.

3.2. SAMPLING METHODOLOGY

The *ex post* energy savings for the HVAC program components were determined through analysis of utility meter data. Utility meter data from nearly all participants were used to compute HVAC energy usages as part of the 2017 analysis, and these results were incorporated into the 2017 M&V. To develop data requests for utility meter data, CLEAResult provided a list of installed measures multiple times throughout the year. ADM requested interval meter data for all customers included in this measure list. ADM stratified the participant groups by measure and dwelling type (multi-family, single-family, and mobile homes) and in certain instances, contractor. In recent years, work completed by Climate Control Experts has tended to outperform other contractors and their measures were analyzed separately. ADM performed TRM-based engineering calculations for measure group evaluations that did not wholly rely on utility meter data analysis.

[12] See Section 6.2 for a detailed description of the comparison group selection methodology.

[13] *State of Pennsylvania Technical Reference Manual*, revised June 2016, pp 120-124

The number of sample points and achieved relative precisions on *ex post* energy savings are shown in Table 3-1 below.

Table 3-1. Number of Sample Points and Relative Precision (RP) per Measure Category

Building Type	Measure	Percent of Ex Post Impacts	Sample Points	CV[14]	R.P. at 90% Confidence Level
Modeled HVAC Measures					
MF	DTS-Tier 1 (All)	0.6%	59	2.5	54%
	DTS-Tier 2 (CCE)	1.4%	123	2.5	37%
	DTS-Tier 2 (Non-CCE)	2.4%	195	2.5	29%
	DTS-Tier 3 (CCE)	9.4%	270	2.5	25%
	DTS-Tier 3 (Non-CCE)	3.0%	131	2.5	36%
	Single Tier DTS (CCE)	4.8%	453	2.5	19%
	Single Tier DTS (Non-CCE)	1.4%	385	2.5	21%
	Coil Cleaning Indoor	1.1%	121	2.5	37%
	Coil Cleaning Outdoor	2.5%	121	2.5	37%
	Refrigerant Charging	1.9%	121	2.5	37%
	CoolSaver Tune-Up	5.3%	388	2.5	21%
	CoolSaver + Refrig. Adj.	13.3%	586	2.5	17%
SF + MH	DTS-Tier 1	1.0%	60	2.0	42%
	DTS-Tier 2	8.2%	185	2.0	24%
	DTS-Tier 3	3.1%	140	2.0	28%
	Single Tier DTS	1.5%	121	2.0	30%
	Coil Cleaning Indoor	0.9%	20	2.0	74%
	Coil Cleaning Outdoor	1.3%	20	2.0	74%
	Refrigerant Charging	0.9%	20	2.0	74%
	CoolSaver Tune-Up	0.6%	26	2.0	65%
	CoolSaver + Refrig. Adj.	1.0%	20	2.0	74%
	Early Replacement	8.7%	97	1.0	17%
Direct Installs					
MF	General Purpose LEDs	1.5%	70	0.5	10%
	Reflector LEDs	0.1%	70	0.5	10%
	Low Flow Showerheads	15.7%	102	0.5	8%
	Low Flow Faucet Aerators	7.6%	104	0.5	8%
Totals					
		99.3%			5.3%

[14] We use a coefficient of variation (CV) of 0.5 for LED Installation, Showerhead Installation, and Faucet Aerator Installation. For measures with savings determined through interval meter data analysis, we use a CV of 2.5 for multifamily homes and 2.0 for single-family homes, except for the Early Replacement measure, for which we use a CV of 1.0. We use large CVs to convey both statistical and measurement precision.

3.3. SURVEY METHODOLOGY

ADM conducted a brief survey of participants who received early replacement and low flow fixtures. A summary of survey respondents by measure type is included in Table 3-2. More detailed survey findings and their impact on savings calculations are included with the relevant measure findings in the following sections of this report.

Table 3-2. Number of Survey Respondents

Question	Respondents
Was your air conditioner still working when it was replaced?	70
How many faucets are there in your home?	102
How many showerheads are there in your home?	104
Records show that ___ LED Light Bulbs were installed. Is this correct?	58

The intent of the early replacement survey was to confirm that replaced units had not stopped working at the time of the new install as per the requirements. However, of the 70 survey respondents, 27 (39%) indicated that their AC unit was not working at the time of replacement. Modeling results were pro-rated to adjust savings for the corresponding fraction of participants.

With the low flow and lighting measures, savings were discounted for respondents who indicated that they had fewer faucets/showerheads/LEDs in their home than were reported as installed in the tracking data.

4. MEASUREMENT OF SAVINGS

4.1. GENERAL OVERVIEW OF MEASUREMENT APPROACH

Many DSM portfolios include programs or program components that target the residential HVAC market. These programs or program components are typically evaluated through one or more of the following methodologies, ordered in increasing level of rigor:

- Partially deemed savings (calculation review based on a Technical Reference Manual or other work paper) coupled with post-only verification through surveys, documentation reviews, or on-site visits.
- Energy simulation coupled with post-only on-site verification.
- Partial or full retrofit isolation with pre-service verification.
- Billing or interval meter data analysis.

Depending on circumstances regarding the scope and timing of implementation and the timing of evaluation activities, only some of the above options may be applicable. Methods such as partially deemed calculations, custom engineering calculations, or energy simulations are always available and may be coupled with verification surveys, inspections, or post-only measurements (such as duct blaster® tests or metering). Such methods are often available regardless of the timing of implementation relative to the cooling or heating seasons or the timing of EM&V report deadlines in relation to implementation. However, these methods may be subject to uncertainties regarding baseline conditions or uncertainties inherent in the partially deemed calculation assumptions.

Partial or full retrofit isolation is possible if enough measures are installed during the heating and/or cooling seasons so that comparable pre-installation and post-installation periods can inform the analysis. The sample size and composition of sampled contractors (particularly if services such as tune-ups or duct sealing are involved) must also be sufficiently large to enable generalization from the measured subset to the general population. For one example, billing analysis may only be possible if data on cooling or heating usage is available for a sufficient period of time after measure installations and if the number of participants is large enough to enable good signal to noise ratio.

ADM developed preferred analysis methodologies for each measure group in the program based upon inspection of program participation rates, timing of implementation, expected relative impacts of measures to household energy usage, and the expected overall contribution of a measure group to the overall program impacts. Table 4-1 on the following page lists the analysis methodologies for the various measure groups. The analyses and results are discussed in subsequent sections.

Table 4-1. Factors Considered in the Choice of Impact Evaluation Protocols

Measure Group	Percentage of Ex Ante Program Savings	Variability in Expected Savings	Evaluation Priority	Preliminary Estimated Savings Relative to Customer Electric Bill	Primary Approach
DTS	30%	High	High	~3%	Interval Meter Data Analysis
Tune-Ups	32%	High	High	~2%	Interval Meter Data Analysis
HVAC Replacement	10%	Medium	Medium	~20%	Interval Meter Data Analysis
LED Installation	1%	Medium	Low	<3%	TRM Calculation
Showerhead and Faucet Aerator Installation	26%	Medium	Low	<3%	TRM Calculation
Miscellaneous Measures	<1%	Low	Low	Variable based on measure	Ex Ante Review

5. DUCT SEALING, TUNE UPS, AND EARLY REPLACEMENT METHODOLOGY

5.1. INTRODUCTION

ADM conducted interval meter data analysis to analyze savings associated with the most prominent HVAC measures: Duct Test and Seal (DTS), Early Replacement, and Tune Ups. This is the most rigorous methodology available compared to other evaluation strategies such as deemed savings, energy simulation, or even monthly billing analysis.

ADM received meter data from NV Energy in a 15-minute interval format. That is, for each RDP, there is a consumption value (kWh) for each 15-minute window of time within the duration requested. ADM aggregated the data to hourly intervals, which reduces downstream computing demands and facilitates straightforward merging of hourly weather data while still providing a very high resolution of consumption patterns.

To determine energy savings for these measures, ADM utilized a mixed-effects difference-in-differences approach based hourly energy usage data for customers receiving them. For customers who received treatment in the early part of the year (prior to June 1), year-over-year models are used where the pre-period is summer 2016 and the post period is summer 2017. For customers receiving treatment in summer 2017, "in-season" models are used where the pre and post periods are immediately before and after the measure install.

ADM employs several techniques to validate that the selection criteria and data analysis methods do not bias results and to control for exogenous effects. If the data aggregation, selection, and analysis methods can be thought of as instruments, then there are some methods that are available to "calibrate" our tools.

In this evaluation effort, we employ a difference-in-differences approach when applicable. In the difference-in-differences approach, we apply all analysis selection criteria to a group of non-participants. The inherent assumption is that, if the non-participant group exhibits a net "energy savings", even after weather normalization, the net savings may be due to exogenous effects that influence both the treatment and control groups. For example, macroscopic economic or social trends may lead customers to use HVAC more sparingly.

5.2. COMPARISON GROUP DESIGNATION

ADM created comparison groups from two sources. The participants considered for analysis were divided into two groups according to dwelling type (multi-family or single-family/mobile homes). The distinction between dwelling types is founded upon natural separations among the groups in terms of energy usage patterns. Many of the participating contractors also tended to specialize in either single-family or multi-family sectors, so the categorization by dwelling type tends to form groups that are homogenous with respect to contractors.

For the multifamily analyses, there were customers in the treatment population that received their treatment too late in the year to be evaluated. This “in-treatment control” approach was chosen because it automatically provides a demographically similar comparison. Matching was conducted by running a regression analysis on each home, shown below, for all homes in both the treatment and control groups, and pairing each treatment home with the corresponding control home with the closest matching coefficient (a_1). If treatment homes were matched to the same control group home, all but one of those were dropped in the modeling to keep the modeling one-to-one.

$$kW = a_0 + a_1 * temperature$$

Equation 5-1: Matching Regression Equation

The idea behind this matching strategy was to capture a home’s average behavioral response due to ambient temperature changes.

For the single-family analyses, the pool of potential late treatment customers was much smaller and ADM instead utilized a large (~10k homes) random selection of customers from the *Residential Demand Response* Control Group (DRCG). In the single-family sector, there are fewer concerns regarding demographic differences between the treatment customers and the general population. One-to-one matching was performed in the single-family sector as well using a location-based strategy.[15] This involved geocoding a home’s address to find longitudinal and latitudinal coordinates and matching to a control home that was geographically the closest (done using the Haversine formula). Matching on distance has the benefit that it does not vary between the pre and post periods. If nearby homes can be reliably identified, short distances serve as a useful proxy for a host of demographic characteristics shared between treatment and control homes.

Figure 5-1 on the following page represents the distribution of distances when running the distance based matching algorithm on the single-family homes that received DTS measures during the early install period.

[15] There are logistical challenges to applying this strategy in the multifamily sector given the clustered nature of the large apartment complexes that tend to comprise most of the multifamily installs.

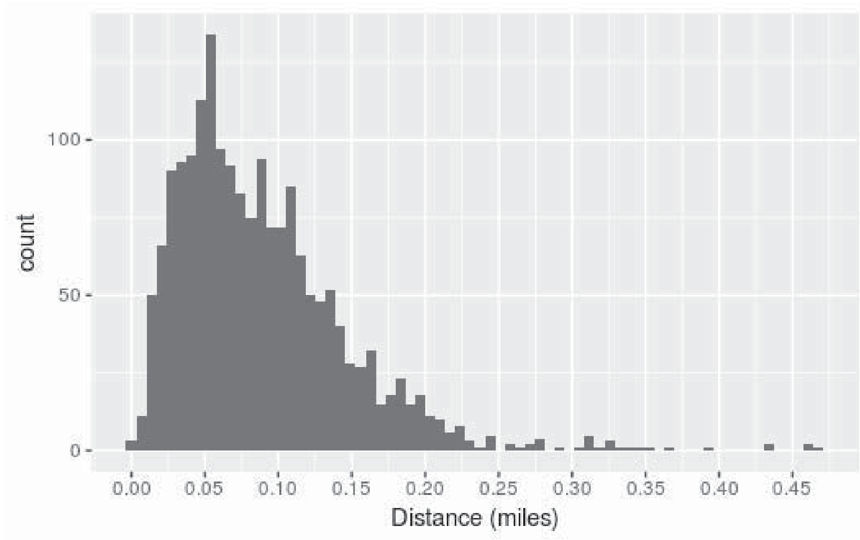

Figure 5-1: Example of matching distances

The spike in the distribution occurs at approximately 0.05 miles (~300 feet) and the mean of the distribution is 0.09 miles (~500 feet).

5.3. MODEL SPECIFICATION

The method of analysis is a regression over the participant and non-participant groups with the following model:

$$kW = a_0 + a_1 * treat + a_2 * post + a_3 * post * treat + \epsilon,$$

Where the terms in the above equation are described in Table 5-1 below.

Table 5-1: Description of model parameters[16].

Symbol	Meaning
kW	The average hourly demand based upon the coefficients and parameters described below. The model is based upon hourly data, so kW and kWh can be used interchangeably in this description.
$treat$	A dummy variable representing inclusion in either the treatment group (treat = 1) or the control group (treat = 0).
$post$	A dummy variable representing before (post = 0) or after (post = 1) the measure installation.
$post * treat$	A dummy interaction term that equals 1 when treatment customers are in the post period, and 0 otherwise. The coefficient on this term represents the reduction in energy use associated with the measure.
ϵ	The error

[16] *The post and/or treatment terms were dropped from models where they were found to be statistically insignificant.*

The key is to run the model on participants and non-participants alike and to identify the two groups with “dummy” variables. The dummy variable takes on discrete values (a “1” for a participant and a “0” for a non-participant) in order to distinguish participants from non-participants. To the extent that there are energy savings, they are captured as a departure from the pre-installation period energy usage patterns and assigned to the variable $post * treat$.

5.4. MODELED SAVINGS NORMALIZATION AND PROJECTION

Savings normalization consists of two steps necessary to transform the post period average hourly demand reduction values (referred to below as “model savings”) for each model based on differences between the populations of modeled homes vs. the overall treatment populations and the weather.

It is important to note the distinction between the model populations and the program populations. While ADM has moved towards utilizing a near census approach to the largest extent possible, the homes included in the model for a given measure will always be some subset of the homes included in the program. In general, this is due to factors such as removing homes based on the data cleaning process, as well as the constraints of the matching procedure. In an air conditioning evaluation, the largest driver of this difference is the necessity of post-install summer period consumption data. Any measures installed after a certain date will not have enough post period data to be included in the analysis. [17]

The first step in the process is to adjust the initial model savings based on the difference in tonnage between the homes in the models and the overall populations. Table 5-2[18] on the following page indicates the adjustment factors by each measure and sector.

[17] ADM conducted a detailed analysis of pre and post period CDD cutoffs as part of the PY2015 evaluation.

[18] This table includes some modeling runs that consist of homes that received various combinations of measures which were not used in the determination of savings associated with individual measures.

Table 5-2: Tonnage Normalization Adjustment Factors

Install Period	Building Type	Contractor Group	Measure	Model Savings (kW)	Avg. Model Tonnage	Avg. Program Tonnage	Adj. Factor
Early	MF	CCE	DTS-Tier 2	0.057	2.2480	2.1771	0.97
			DTS-Tier 3	0.097	2.2204	2.2098	1.00
		Not CCE	DTS-Tier 1	0.121	2.4407	2.3535	0.96
			DTS-Tier 2	0.091	2.4462	2.4228	0.99
			DTS-Tier 3	0.068	2.4504	2.4861	1.01
			Combo Tune-Ups (2 of 3)	0.160	2.3465	2.2739	0.97
			Combo Tune-Ups (3 of 3)	0.197	2.1379	2.1939	1.03
	SF	NA	DTS-Tier 1	0.057	3.8083	3.8852	1.02
			DTS-Tier 2	0.158	3.9027	3.9286	1.01
			DTS-Tier 3	0.094	4.0571	4.0865	1.01
			2 * DTS-Tier 1	0.104	3.4375	3.4046	0.99
			2 * DTS-Tier 2	0.235	3.3354	3.3074	0.99
			2 * DTS-Tier 3	0.083	3.4076	3.3366	0.98
			DTS-Tier 1 + Tier 3	0.197	3.2750	3.4714	1.06
			DTS-Tier 2 + Tier 3	0.252	3.4479	3.3790	0.98
			Combo Tune-Ups (x of 3)	0.252	3.9111	3.8333	0.98
			Combo Tune-Ups + DTS	0.419	3.9118	3.8625	0.99
			Early Replacement	0.629	3.9833	3.9063	0.98
Summer	MF	CCE	CoolSaver Tune-Up	0.081	2.2642	2.2486	0.99
			CoolSaver + Refrig. Adj.	0.086	2.2918	2.2452	0.98
			Above + Single Tier DTS	0.168	2.2686	2.2020	0.97
	All	All	Single Tier DTS	0.082			1.00
	SF	NA	CoolSaver Tune-Up	0.218	3.8077	3.7051	0.97
			CoolSaver + Refrig. Adj.	0.270	3.5500	3.6058	1.02
			Early Replacement	0.659	3.7232	3.7669	1.01
			2 * Early Replacement	1.558	3.3864	3.2770	0.97

As indicated, these adjustments tend to be small. The average adjustment factor is 0.99.

The next step in the process is to project the normalized model savings to annualized energy savings. ADM developed a methodology that utilizes *energy savings curves* to calculate the portion of annual energy savings that occurs during any given interval of the year. An energy savings curve describes the temporal nature of energy savings. Appendix E provides extensive details regarding this methodology.

While modeling savings in the summer captures a significant portion of the savings, it does not account for all of them. Energy savings curves allow for the projection of energy savings to the portions of the year not included in the post period. In particular, they capture any savings that occur in the winter with heat pumps and electric heat. Annualized savings are summarized in Table 5-3 below.

Table 5-3. Savings Projections

Install Period	Avg. Post Period		Building Type	Contractor Group	Measure	kWh Red'n in Post	Annual kWh Reduction			
	Start	Stop					% AC Curve	AC (kWh)	% HP Curve	HP (kWh)
Early	6/2/2017	9/29/2017	MF	CCE	DTS-Tier 2	157	77%	205	64%	246
					DTS-Tier 3	276	77%	359	64%	432
				Not CCE	DTS-Tier 1	332	77%	432	64%	519
					DTS-Tier 2	258	77%	336	64%	403
					DTS-Tier 3	196	77%	255	64%	306
					Combo Tune-Ups (2 of 3)	442	77%	574	64%	690
					Combo Tune-Ups (3 of 3)	578	77%	752	64%	904
			SF	NA	DTS-Tier 1	166	77%	215	64%	259
					DTS-Tier 2	453	77%	589	64%	708
					DTS-Tier 3	270	77%	352	64%	422
					2 * DTS-Tier 1	295	77%	383	64%	461
					2 * DTS-Tier 2	665	77%	864	64%	1,039
					2 * DTS-Tier 3	232	77%	301	64%	362
					DTS-Tier 1 + Tier 3	596	77%	775	64%	932
					DTS-Tier 2 + Tier 3	706	77%	917	64%	1,102
					Combo Tune-Ups (x of 3)	707	77%	919	64%	1,104
					Combo Tune-Ups + DTS	1,182	77%	1,536	64%	1,846
					Early Replacement	1,762	77%	2,291	64%	2,753
Summer	8/2/2017	9/30/2017	MF	CCE	CoolSaver Tune-Up	114	36%	316	30%	383
	7/31/2017	9/30/2017			CoolSaver + Refrig. Adj.	124	37%	331	31%	402
	8/21/2017	9/30/2017			Above + Single Tier DTS	157	23%	695	18%	857
	8/10/2017	9/30/2017	All	All	Single Tier DTS	99	29%	340	24%	416
	7/21/2017	9/30/2017	SF	NA	CoolSaver Tune-Up	361	45%	803	37%	969
	7/21/2017	9/30/2017			CoolSaver + Refrig. Adj.	468	45%	1,041	37%	1,256
	7/21/2017	9/30/2017			Early Replacement	1,136	45%	2,526	37%	3,047
	7/13/2017	9/30/2017			2 * Early Replacement	2,859	51%	5,605	42%	6,739

5.5. HIGH SEER AC PILOT STUDY RESULTS

NV Energy conducted a limited pilot study of ultra-high SEER AC replacements in the summer of 2017. The evaluation procedure was based on that described herein for HVAC measures but deviated slightly to attempt to provide savings on a home-by-home basis given that only two homes were available for study. It is important to note that savings provided here are meant to be informative, not conclusive, given the limited number of installations.

The High SEER evaluation involved the analysis of savings resulting from the installation of high efficiency (SEER 20 or above) air conditioning units in three single family homes, summarized in Table 5-3.

Table 5-3: Summary of ultra-high SEER sites

RDP[19]	Install Date	Old/Existing HVAC	New HVAC	Note
4434	7/3/2017	Goodman CPE48-1B, SEER 8, 4-Tons	Amana AVZC200481AD, SEER 20, 4-Tons (Heat Pump)	Replaced old unit with new unit
0443	7/14/2017	International Comfort Products NAC260AKA5, SEER 8, 5-Tons	Amana AVXC200601AD, SEER 20, 5-Tons (A/C)	Replaced old unit with new unit
3936	9/14/2017	York H1CA042s06A, SEER 8, 3.5-Tons York H1CA024S06B, SEER 8, 2-Tons	Fujitsu ASU12RLF1, 1-Ton (Indoor Unit) Fujitsu AOU12RLFW1, SEER 22, 1-Ton (Outdoor Unit - Heat Pump)	Added new unit to existing units

The third home was removed from the analysis due to the late installation date and the limited post period control data. ADM was provided with 15-minute interval meter data for the treatment homes and used the Demand Response Control Group (DRCG) pool as a control with a similar difference-in-differences modeling approach used for the HVAC Analysis.

The data was aggregated to hourly timestamps and each home was checked for anomalous data. Apparent vacation dates, when the home usage dropped significantly, were found in the meter data of the second home and removed from the analysis. Modeling the savings involved running the difference-in-differences regression model with the treatment home interval meter data and a control home that was found to match the pre-period usage under a cumulative sum matching method. This regression model was run 2,000 times for each treatment home with the top 2,000 best matching control group homes and the results were averaged. Savings found are summarized in Table 5-4 below.

[19] Only the last four digits of the RDP are presented here.

Table 5-4: Ultra-high SEER pilot results

RDP	Post Period		Model Savings	kWh Reduction in Post	% AC / % HP Curve	Annual Energy Savings (kWh)
	Start	Stop				
4434	7/4/2017	9/22/2017	1.925207	3,696	45%	8,255
0443	7/15/2017	9/22/2017	0.503534	834	45%	1,835

Significant savings were identified, an average of approximately 5,000 kWh per home, which is roughly double what is typically found in the Early Replacement measure. However, one of the homes (RDP – 4434) included in the analysis, exhibited significantly higher energy usage than the average usage seen in other homes included in the program analysis. This home also exhibited a significant reduction in usage and may not be representative of other homes that receive ultra-high SEER units. In contrast, the second home included in the ultra-high SEER pilot exhibited a much lower baseline period kWh usage than average and showed evidence of vacation days in the post installation interval meter data. The difference in savings between these two homes emphasize the variance that comes with analyzing the reduction in usage for a certain measure when only two homes are available as a treatment group. Circumstances for the particular homes can vary a great deal, thus so can savings. ADM recommends NV Energy continue pilot studies to further assess the savings associated with this measure.

6. DIRECT INSTALL METHODOLOGY

This chapter addresses the analysis of savings for the following measures:

- LED direct installs
- Low flow shower heads and aerator direct installs

6.1. LED DIRECT INSTALLS

ADM employed engineering analyses to determine *ex post* verified energy savings for the installation of LEDs. *Ex post* verified energy savings per LED was calculated with methods developed by ADM and consistent with chapter 6 of *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures*. The calculations used the following equation and halogen baseline:

$$Annual\ kWh\ savings = \left(\frac{DeltaW_{HAL} * POP_{HAL} + DeltaW_{CFL} * POP_{CFL}}{1000}\right) * HOUannual * HCIF * ISR$$

Where:

Term	Unit	Value
W_{HAL} = EISA 2007 compliant halogen baseline wattage	*W*	60W Equivalent = 43 40W Equivalent = 28 Reflector = 50
W_{LED} = LED rated wattage[20]	*W*	60W Equivalent = 10 40W Equivalent = 7.5 Reflector = 10
W_{CFL} = CFL baseline wattage	*W*	60W Equivalent = 14 40W Equivalent = 10 Reflector = 15
$DeltaW_{HAL} = W_{HAL} - W_{LED}$	*W*	60W Equivalent = 33 40W Equivalent = 20 Reflector = 40
$DeltaW_{CFL} = W_{CFL} - W_{LED}$	*˚F*	60W Equivalent = 4 40W Equivalent = 2 Reflector = 6
POP_{CFL} = proportion of CFL bulbs replaced determined by information from the contractor to be 40%.	˚%	40%
RE , Recovery efficiency of electric water heater	*Decimal*	0.98
POP_{HAL} = proportion of EISA 2007 compliant halogen or incandescent bulbs replaced determined by contractor interview to be 60%.	%	60%
1000 = conversion factor for Watts per kW	*Decimal*	1000
HOU_{annual} = annual hours of use	*Decimal*	1,029.3
HCIF = “Heating & Cooling Interactive-effects Factor” disapproved by Public Utilities Commission, or the “Commission” [21]	*decimal*	1.0
ISR = In-service Rate	*%*	100%

[20] For example, if the LED is 7.5 W and the comparable baseline bulb is a 28 W halogen, then the wattage difference or delta watts is 28 - 7.5 or 20.5 W.

[21] In its March 23, 2012 Order in Docket Nos. 11-07026 and 11-07027 the Commission disapproved the use of HCIF for residential lighting.

6.2. LOW FLOW SHOWERHEAD AND FAUCET AERATOR DIRECT INSTALLS

Program-level energy (kWh) savings from installing faucet aerators employed the following calculation taken from the state of Pennsylvania TRM and adapted to suit southern Nevada[22].

$$\Delta\,\text{kWh/yr} = ISR \times ELEC \left[\frac{(GPM_{base} - GPM_{low}) \times T_{person/day} \times N_{persons} \times 365\frac{days}{yr} \times DF \times (T_{out} - T_{in}) \times 8.3\frac{Btu}{gal{\cdot}°F}}{\#_{faucets} \times 3412\frac{Btu}{kWh}/RE}\right]$$

Where:

Term	Unit	Value
GPM_{base} , Average baseline flow rate of aerator (GPM)	$\frac{gallons}{minute}$	2.2
GPM_{low} , Average post measure flow rate of aerator (GPM)	$\frac{gallons}{minute}$	1.75
$T_{Person\text{-}Day}$, Average time of hot water usage per person per day (minutes)	$\frac{minutes}{day}$	6.1
$N_{Persons}$, Average number of persons per household	$\frac{persons}{house}$	SF=3.34 MF=2.11
T_{out} , Average mixed water temperature flowing from the faucet (ºF)	˚F	87.8
T_{in} , Average temperature of water entering the house (ºF)	˚F	71.4
RE , Recovery efficiency of electric water heater	*Decimal*	0.98
$\#_{faucets}$, Average number of faucets in the home	$\frac{faucets}{house}$	SF=4.0 MF=2.7
DF , Percentage of water flowing down drain	%	79.5%
ISR , In Service Rate	%	100%
ELEC , Percentage of homes with electric water heat	%	100%

Program-level energy (kWh) savings from installing Low-Flow Showerheads employed the following calculation, taken from the state of Pennsylvania TRM and adapted to suit southern Nevada.[23]

$$\Delta\,kWh/yr = ISR \times ELEC \times \left[\frac{(GPM_{base} - GPM_{low}) \times T_{person/day} \times N_{persons} \times N_{showers/day} \times 365\frac{days}{yr} \times (T_{out} - T_{in}) \times 8.3\frac{Btu}{gal{\cdot}°F}}{\#_{showers} \times 3412\frac{Btu}{kWh}/RE}\right]$$

[22] *State of Pennsylvania Technical Reference Manual*, revised June 2016, pp 114-119

[23] *State of Pennsylvania Technical Reference Manual*, revised June 2016, pp 120-124

Where:

Term	Unit	Value
GPM_{base} , Gallons per minute of baseline showerhead	$\frac{gallons}{minute}$	Default value = 2.5
GPM_{low} , Gallons per minute of low flow showerhead	$\frac{gallons}{minute}$	Default value = 1.5 or EDC Data Gathering
$T_{person/day}$, Average time of shower usage per person (minutes)	$\frac{minutes}{day}$	7.8
$N_{persons}$, Average number of persons per household	$\frac{persons}{house}$	Default SF=2.4 Default MF=1.9 Default unknown=2.4 Or EDC Data Gathering
$N_{\text{showers/day}}$, Average number of showers per person per day	$\frac{showers/person}{day}$	0.6
$\#_{showers}$, Average number of showers in the home	$\frac{showers}{house}$	Or EDC Data Gathering Default SF=1.3 Default MF=1.1 Default unknown = 1.2
T_{out} , Assumed temperature of water used by showerhead	$°F$	101
T_{in} , Assumed temperature of water entering house	$°F$	71.4
RE , Recovery efficiency of electric water heater	*Decimal*	Default: 0.98 HPWH: 2.1
ISR , In Service Rate	%	Variable
ELEC, Percentage of homes with electric water heat	%	Default: Unknown=43% Or EDC Data Gathering: Electric = 100% Fossil Fuel = 0.0%
$\%_{shower\ use,peak}$, percentage of daily shower use during PJM peak period	%	11.7%

It is important to note that in our surveying efforts, significant portions of respondents who received either low flow showerhead or aerator measures reported that they had fewer showerheads or aerators in their home than were reported as installed (29/102 cases for aerators, 15/104 cases for showerheads) and ex post savings have been reduced by these ratios.

7. ENERGY IMPACT FINDINGS

This chapter provides detailed results pertaining to the energy impacts of the program during 2017.

7.1. ENERGY IMPACTS AND VARIANCES

Table 7-1 presents *ex ante* and *ex post* energy savings, along with program-year realization rates and Table 7-2 summarizes the lifetime energy savings of the 2017 program.

During the 2017 program year, NV Energy and CLEAResult updated the *ex ante* savings based upon the *ex post* results from the prior year. In some instances, such as the tune up measures, where the savings were very low in the prior year and found to be much higher this year, realization rates appear rather large. Going forward, it may be beneficial to utilize the average of multiple years of *ex post* data to inform the *ex ante* estimates.

Table 7-1. Annual Energy Impact Summary

Building Type	Measure	Annual Energy Savings (kWh)		Variance	Realization Rate
		Ex Ante	*Ex Post*		
Modeled HVAC Measures					
MF	DTS-Tier 1 (All)	23,378	70,472	47,094	301%
	DTS-Tier 2 (CCE)	176,801	151,345	-25,456	86%
	DTS-Tier 2 (Non-CCE)	205,327	261,151	55,825	127%
	DTS-Tier 3 (CCE)	911,324	1,031,272	119,949	113%
	DTS-Tier 3 (Non-CCE)	435,703	325,033	-110,670	75%
	Single Tier DTS (CCE)	695,856	524,076	-171,780	75%
	Single Tier DTS (Non-CCE)	242,592	157,940	-84,652	65%
	Coil Cleaning Indoor	18,740	120,832	102,092	645%
	Coil Cleaning Outdoor	41,035	268,669	227,634	655%
	Refrigerant Charging	39,279	206,075	166,796	525%
	CoolSaver Tune-Up	638,862	578,479	-60,383	91%
	CoolSaver + Refrig. Adj.	2,590,222	1,458,905	-1,131,317	56%
SF + MH	DTS-Tier 1	52,336	112,364	60,028	215%
	DTS-Tier 2	360,068	896,210	536,142	249%
	DTS-Tier 3	323,631	336,124	12,493	104%
	Single Tier DTS	212,040	162,238	-49,802	77%
	Coil Cleaning Indoor	38,140	93,867	55,727	246%
	Coil Cleaning Outdoor	58,748	143,549	84,801	244%
	Refrigerant Charging	53,012	103,195	50,184	195%
	CoolSaver Tune-Up	74,200	64,447	-9,753	87%
	CoolSaver + Refrig. Adj.	291,708	112,220	-179,488	38%
	Early Replacement	1,158,828	952,353	-206,475	82%
Direct Installs					
MF	General Purpose LEDs	169,427	167,244	-2,183	99%
	Reflector LEDs	11,108	11,213	106	101%
	Low Flow Showerheads	2,005,534	1,716,285	-289,248	86%
	Low Flow Faucet Aerators	1,164,434	833,412	-331,022	72%
Miscellaneous					
MF	Heat Strip Lockout	52,920	52,920	0	100%
	Duct Return Modification	212	212	0	100%
SF	Burn Outs	15,422	15,422	0	100%
	New Build Installs	4,655	4,655	0	100%
	Early Replacement	5,175	5,175	0	100%
Totals					
		12,070,706[24]	10,937,357	-1,133,349	90.6%

[24] Table total does not match sum of line items due to rounding.

Table 7-2: Lifetime Energy Savings Summary (Ex Post)

Building Type	Measure	Total Installs	Ex Post Annual Energy Savings (kWh)	Expected Useful Life	Lifetime Energy Savings (kWh)
Modeled HVAC Measures					
MF	DTS-Tier 1 (All)	149	70,472	20	1,409,447
	DTS-Tier 2 (CCE)	626	151,345	20	3,026,908
	DTS-Tier 2 (Non-CCE)	727	261,151	20	5,223,030
	DTS-Tier 3 (CCE)	2,420	1,031,272	20	20,625,444
	DTS-Tier 3 (Non-CCE)	1,157	325,033	20	6,500,660
	Single Tier DTS (CCE)	1,526	524,076	20	10,481,523
	Single Tier DTS (Non-CCE)	532	157,940	20	3,158,800
	Coil Cleaning Indoor	390	120,832	8	966,653
	Coil Cleaning Outdoor	854	268,669	8	2,149,352
	Refrigerant Charging	654	206,075	8	1,648,599
	CoolSaver Tune-Up	1,722	578,479	8	4,627,833
	CoolSaver + Refrig. Adj.	4,118	1,458,905	8	11,671,241
SF + MH	DTS-Tier 1	508	112,364	20	2,247,286
	DTS-Tier 2	1,486	896,210	20	17,924,198
	DTS-Tier 3	926	336,124	20	6,722,481
	Single Tier DTS	465	162,238	20	3,244,769
	Coil Cleaning Indoor	248	93,867	8	750,938
	Coil Cleaning Outdoor	382	143,549	8	1,148,391
	Refrigerant Charging	275	103,195	8	825,562
	CoolSaver Tune-Up	200	64,447	8	515,579
	CoolSaver + Refrig. Adj.	333	112,220	8	897,760
	Early Replacement	544	952,353	8	7,618,824
Direct Installs					
MF	General Purpose LEDs	1,978	167,244	20	3,344,871
	Reflector LEDs	26	11,213	20	224,266
	Low Flow Showerheads	6,669	1,716,285	9	15,446,569
	Low Flow Faucet Aerators	6,660	833,412	10	8,334,120
Miscellaneous					
SF	Heat Strip Lockout	196	52,920	20	1,058,400
	Duct Return Modification	1	212	20	4,240
MF	Burn Outs	24	15,422	18	277,596
	New Build Installs	7	4,655	18	83,790
	Early Replacement	3	5,175	8	31,050
Totals					
		35,806	10,937,357	13	142,200,530

7.2. IMPACT BY RATE CLASS

The 2017 program provided savings in three primary rate classes and seven total rate classes. The classes, along with their quantities and share of annual kWh, are presented in Table 7-3 below.

Table 7-3: Ex Post Energy Impacts by Rate Class

Rate Class	Quantity of Measures	Ex Post Verified Annual Energy Savings (kWh)
RM	31,327	7,968,512
RS	5,385	2,764,338
RS_RM_NET	296	169,582
ORSTOU-A	49	20,881
ORSTOUA_NET	5	5,683
ORSTOU-B_(HEV)	7	3,953
ORSTOU-A_(HEV)	5	2,074
RHEVRRA_NET	2	1,416
RSL	2	703
ORSTOU-B	1	215
Total	**37,080**	**10,937,357**

Additionally, ADM determined monthly savings results for the first year and years 2018 through 2020. The monthly savings results are provided in Appendix A.

8. KEY FINDINGS AND RECOMMENDATIONS

This chapter presents key findings and recommendations associated with the M&V analyses described in this M&V report.

Remove Duct Blaster Testing in DTS

CFM reduction tiers were removed as part of the duct sealing measure in the latter part of 2017. (A tiered incentive scale based on reported CFM reductions can provide motivation to report inflated CFM reductions). However, having a single tier with a minimum CFM requirement based on duct blaster testing may allow the previously documented issues with duct sealing to persist, as contractors can potentially experience measurement error or even hypothetically manipulate data to report a higher than actual CFM reduction. If duct sealing is included in future program years, the suggestions below may be helpful.

Employ Targeting and Screening for Homes

ADM has provided NV Energy with examples of how targeting/screening homes for inclusion in the program could be accomplished. Implementation of simple strategies that incorporate site-specific baseline electric HVAC energy usage, as determined through billing data would have the potential to dramatically improve the magnitude and reliability of energy savings.

It may also be possible to dovetail the work NVE is conducting with Bidgely, on appliance disaggregation, to identify candidate homes where HVAC power consumption is relatively high and channel them into the Res. AC program.

Use Thermal Imaging Cameras to Identify and Document Leakage

The duct blaster testing process is cumbersome and time consuming. A thermal imaging camera would be a much simpler, effective tool to screen homes (possibly as a follow up to targeting) and identify leakage that would not require a crew of people and time spent sealing vents in order to make duct blaster measurements.

Continue Diversification of Energy Saving Measures

While not pertaining specifically to HVAC, diversification of measures through the expansion of the direct install components of the program was an effective strategy for reducing evaluation risk.

It may also be possible to increase the new HVAC unit installations in a cost-effective manner. For example, the program may attempt to induce homeowners to purchase premium efficiency air conditioners that are of smaller capacity than their pre-existing air conditioners. The reduction in tonnage would then offset some of the incremental cost associated with the high SEER. The primary savings mode would be through increased efficiency relative to code baseline efficiencies. This option may be facilitated through a "whole house" approach, as increased thermal integrity of the home achieved by duct sealing, insulation, or infiltration reduction may enable downsizing of the HVAC unit.

Tracking Savings and Attributes

It would be beneficial going forward to track and estimate *ex ante* energy savings by unit capacity, efficiency, and type. It would also be useful to track key data pertaining to AC system per residence that receives the DTS measure; and additional attributes such as "top floor residence" or "non- top floor residence". For multifamily residences, it might also be beneficial to require documentation of the compass orientation of the apartment wall containing the greatest window area, the window fraction of the wall and an estimate of shade provided for the wall – for a given multifamily residence, an unshaded south or west facing wall with a large area of windows will inflate AC load (and savings opportunity) compared to the AC load for a similar apartment that faces north with a small window area.

Closely tracking 2018 savings and attributes may help the program to improve the accuracy of identifying multifamily residences for which there are above average savings opportunities (and vice versa).

APPENDIX A: SAVINGS PER MONTH BY RATE CLASS

This appendix provides monthly savings by rate class for the years 2017-2020.

Table A-1. Monthly kWh Savings by Rate Class – 2017 (First Year)

Rate Class	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	**Total**
RM	98,596	193,647	279,135	233,949	379,178	572,270	773,064	837,972	742,090	502,303	295,586	432,909	**5,340,699**
RS	4,164	8,147	6,375	13,968	135,234	305,980	443,270	440,495	341,988	162,803	11,760	39,396	**1,913,580**
RS_RM_NET	2	209	240	601	6,300	16,050	23,269	23,340	19,785	9,732	711	2,542	**102,780**
ORSTOU-A	-	33	26	145	1,276	2,660	3,661	3,390	2,521	1,175	70	212	**15,169**
ORSTOUA_NET	-	0	2	6	45	77	253	500	613	290	18	47	**1,851**
ORSTOU-B_(HEV)	-	-	17	23	203	364	474	525	532	224	36	161	**2,560**
ORSTOU-A_(HEV)	-	-	5	19	144	250	322	296	217	99	4	16	**1,372**
RHEVRRA_NET	-	-	-	-	22	209	277	253	177	71	16	79	**1,104**
RSL	-	-	-	-	51	126	162	149	110	50	2	6	**656**
ORSTOU-B	-	-	-	-	16	39	50	46	34	15	1	2	**201**
Total	**102,763**	**202,037**	**285,800**	**248,710**	**522,469**	**898,024**	**1,244,801**	**1,306,967**	**1,108,066**	**676,764**	**308,205**	**475,369**	**7,379,973**

Table A-2. Monthly kWh Savings by Rate Class – 2018

Rate Class	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	**Total**
RM	475,525	417,395	340,992	273,510	685,522	1,044,497	1,301,821	1,210,383	931,742	555,836	296,759	434,530	**7,968,512**
RS	45,606	41,448	20,062	36,040	277,222	483,886	624,211	573,949	419,636	190,024	12,596	39,659	**2,764,338**
RS_RM_NET	2,987	2,710	1,284	2,141	16,910	29,616	38,241	35,149	25,656	11,553	753	2,582	**169,582**
ORSTOU-A	243	224	104	278	2,141	3,718	4,787	4,403	3,228	1,470	74	213	**20,881**
ORSTOUA_NET	53	50	23	77	589	1,019	1,311	1,206	885	405	18	47	**5,683**
ORSTOU-B_(HEV)	189	168	82	36	338	622	817	748	532	224	36	161	**3,953**
ORSTOU-A_(HEV)	19	18	8	28	215	372	478	440	323	148	7	17	**2,074**
RHEVRRA_NET	93	82	40	10	109	209	277	253	177	71	16	79	**1,416**
RSL	7	6	3	10	73	126	162	149	110	50	2	6	**703**
ORSTOU-B	2	2	1	3	22	39	50	46	34	15	1	2	**215**
Total	**524,725**	**462,103**	**362,598**	**312,133**	**983,141**	**1,564,103**	**1,972,154**	**1,826,725**	**1,382,324**	**759,796**	**310,261**	**477,295**	**10,937,357**

Table A-3. Monthly kWh Savings by Rate Class – 2019

Rate Class	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	Total
RM	475,525	417,395	340,992	273,510	685,522	1,044,497	1,301,821	1,210,383	931,742	555,836	296,759	434,530	**7,968,512**
RS	45,606	41,448	20,062	36,040	277,222	483,886	624,211	573,949	419,636	190,024	12,596	39,659	**2,764,338**
RS_RM_NET	2,987	2,710	1,284	2,141	16,910	29,616	38,241	35,149	25,656	11,553	753	2,582	**169,582**
ORSTOU-A	243	224	104	278	2,141	3,718	4,787	4,403	3,228	1,470	74	213	**20,881**
ORSTOUA_NET	53	50	23	77	589	1,019	1,311	1,206	885	405	18	47	**5,683**
ORSTOU-B_(HEV)	189	168	82	36	338	622	817	748	532	224	36	161	**3,953**
ORSTOU-A_(HEV)	19	18	8	28	215	372	478	440	323	148	7	17	**2,074**
RHEVRRA_NET	93	82	40	10	109	209	277	253	177	71	16	79	**1,416**
RSL	7	6	3	10	73	126	162	149	110	50	2	6	**703**
ORSTOU-B	2	2	1	3	22	39	50	46	34	15	1	2	**215**
Total	**524,725**	**462,103**	**362,598**	**312,133**	**983,141**	**1,564,103**	**1,972,154**	**1,826,725**	**1,382,324**	**759,796**	**310,261**	**477,295**	**10,937,357**

Table A-4. Monthly kWh Savings by Rate Class - 2020

Rate Class	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	Total
RM	475,525	426,700	340,992	273,510	685,522	1,044,497	1,301,820	1,210,383	931,742	555,836	296,759	434,530	**7,977,816**
RS	45,606	42,015	20,062	36,040	277,222	483,886	624,211	573,949	419,636	190,024	12,596	39,659	**2,764,905**
RS_RM_NET	2,987	2,743	1,284	2,141	16,910	29,616	38,241	35,149	25,656	11,553	753	2,582	**169,615**
ORSTOU-A	243	228	104	278	2,141	3,718	4,787	4,403	3,228	1,470	74	213	**20,885**
ORSTOUA_NET	53	51	23	77	589	1,019	1,311	1,206	885	405	18	47	**5,684**
ORSTOU-B_(HEV)	189	169	82	36	338	622	817	748	532	224	36	161	**3,954**
ORSTOU-A_(HEV)	19	19	8	28	215	372	478	440	323	148	7	17	**2,075**
RHEVRRA_NET	93	82	40	10	109	209	277	253	177	71	16	79	**1,417**
RSL	7	6	3	10	73	126	162	149	110	50	2	6	**703**
ORSTOU-B	2	2	1	3	22	39	50	46	34	15	1	2	**215**
Total	**524,725**	**472,015**	**362,598**	**312,133**	**983,141**	**1,564,103**	**1,972,154**	**1,826,725**	**1,382,324**	**759,796**	**310,261**	**477,295**	**10,947,269**

Table A-5. Critical Peak Demand (kW) Reduction per Month per Rate Class

Rate Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RM	993.1	1,117.9	864.8	876.4	2,251.6	3,036.7	3,391.2	3,037.5	2,434.6	1,573.3	480.2	850.0
RS	130.0	175.9	107.2	381.4	1,136.8	1,556.6	1,746.6	1,552.0	1,231.1	734.0	16.5	94.0
RS_RM_NET	8.6	11.6	7.1	23.1	69.7	95.6	107.3	95.3	75.5	44.9	1.0	6.2
ORSTOU-A	0.7	1.0	0.6	3.0	8.7	11.9	13.3	11.8	9.4	5.6	0.1	0.5
ORSTOUA_NET	0.2	0.2	0.1	0.8	2.4	3.2	3.6	3.2	2.6	1.5	0.0	0.1
ORSTOU-B_(HEV)	0.4	0.0	0.3	0.3	1.1	1.5	2.3	1.7	1.9	0.8	-	0.3
ORSTOU-A_(HEV)	0.0	0.0	0.0	0.3	0.6	0.8	1.3	0.9	1.1	0.5	-	0.0
RHEVRRA_NET	0.2	0.0	0.2	0.1	0.4	0.5	0.8	0.6	0.7	0.3	-	0.2
RSL	0.0	0.0	0.0	0.1	0.2	0.3	0.4	0.3	0.4	0.2	-	0.0
ORSTOU-B	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	-	0.0
Total	**1,133.3**	**1,306.5**	**980.2**	**1,285.4**	**3,471.5**	**4,707.3**	**5,266.9**	**4,703.5**	**3,757.4**	**2,361.3**	**497.7**	**951.4**

APPENDIX B: EFFECTIVE USEFUL LIFE

The expected useful lives and ("EUL") and remaining useful lives ("RUL") of long-lived measures are, as a matter of course, difficult to determine. ADM combined results from the most recent Residential Appliance Saturation Study ("RASS"), and AC mortality curves from ASHRAE to determine an RUL for the extant stock of air conditioners in Southern Nevada. Details are provided in this appendix. For other measures, ADM consulted the DEER Database and studies used in the DEER meta-analysis.[25] Table B-1 summarizes the results of analyses used to derive remaining useful life assessments for the various measures offered by the *Residential High Efficiency Air Conditioning Program.* The EUL values are within acceptable ranges for each measure offered by the program. As such, ADM does not recommend any adjustments to the scheme currently employed by NV Energy.

Table B-1 EUL and RUL of Equipment

Unit Type	Expected Useful Life (EUL) (Years)	ADM Estimate (Years)	Source/Comments
DTS	20	18 to 25	The range of retention study results cited in DEER October 2008 EUL summary.
Tune-ups	5	8	The EUL is conservative when compared to values for coil cleaning and refrigerant charging from DEER October 2008 EUL summary. However, tune-ups are a small part of the program.
BPM	10	8 to 10+	The RUL of extant stock would be the limiting factor. The BPM motor should have an EUL in excess of 15 years.
Early Replacement	8	8	Measure life limited by RUL of extant stock After RUL elapses, there should be another 12 years of savings calculated against code baseline.
LEDs	20 (General purpose) / 25 (Reflector)	20 (General purpose) / 25 (Reflector)	Values selected based on an agreement with Residential Lighting Program. After 2020, it is expected that the baseline lamp will effectively be a CFL due to the EISA "2020 backstop provision" which requires general service lamps to be 45 lm/watt. Reflectors are not subject to this backstop provision

This rest of this Appendix concerns the expected useful life (EUL) and the remaining useful life (RUL) of central air conditioners and heat pumps in southern Nevada. Both the EUL and RUL

[25] DEER RUL values, updated October 2008, http://www.deeresources.com/deer0911planning/downloads/EUL_Summary_10-1-08.xls

are inputted into the cost-effectiveness calculations for the *Residential High Efficiency AC* program.

B.1 CONTENTS OF THIS APPENDIX

This appendix provides the following estimations:

- The expected savings stream from the early replacement of a 4-ton air conditioner
- The expected savings stream from the early replacement of a 4-ton air heat pump

To arrive at these savings streams, one must know the following parameters:

1. Baseline unit Capacity, EER, HSPF, and RUL
2. Efficient Unit Capacity, EER, HSPF, and EUL
3. Code Baseline EER, HSPF – estimated at the end of Baseline RUL

The derivation of the baseline and efficient unit properties and the expected savings are described in the 2011 *Ex Ante Summary*, drafted by ADM in February 2011. The values from the report are summarized in the table below.

Table B-2. Basic Parameters for the Typical Early Replacement Measure

Parameter	***Value***
Typical Unit Capacity (tons)	4
Cooling Hours	1098
Heating Hours	633
Demand Coincidence Factor	0.75
Code EER	11
Code HSPF	7.7
Baseline EER	8
Baseline HSPF	6.9
Tier 2 EER	12.5
Tier 2 HSPF	8.5

This document describes the newly derived EUL, RUL, and code baseline estimations. The results are stated in the table below; the derivations are described later in this document.

Table B-3. EUL and RUL Results

Parameter	Value	Sources
Age of Old Unit	16.6 years	This document: 2008 RASS survey; Proctor Engineering documentation; ASHRAE 4560: Heat Pump Life Revisited
RUL of Old Unit	8.1 years	Same as above
EUL of New Unit	20.8 years	Same as above
Code EER (2015)	11.7	This document: ACEEE fact Sheet: http://www.aceee.org/files/pdf/1009hvac_fact.pdf

Using the parameters above, one may calculate the energy savings stream from air conditioners and heat pumps. The results are shown in the table below. Note that it is also possible to use the Weibull distribution to create approximate annual impacts that depend on the expected survival rates (e.g. taking into account the RUL and EUL distributions rather than their mean values). ADM can provide such comparisons upon NV Energy request.

Table B-4. Energy and Demand Impact Stream from the Early Replacement Measure

Year	Calendar Year	kWh Savings (CAC)	kWh Savings (Heat Pump)	kW Savings (CAC or Heat Pump)
1	2011	2,372	3,201	1.62
2	2012	2,372	3,201	1.62
3	2014	2,372	3,201	1.62
4	2014	2,372	3,201	1.62
5	2015	2,372	3,201	1.62
6	2016	2,372	3,201	1.62
7	2017	2,372	3,201	1.62
8	2018	2,372	3,201	1.62
9	2020	288	660	0.20
10	2020	288	660	0.20
11	2021	288	660	0.20
12	2022	288	660	0.20
13	2023	288	660	0.20
14	2024	288	660	0.20
15	2025	288	660	0.20
16	2026	288	660	0.20
17	2027	288	660	0.20
18	2028	288	660	0.20
19	2029	288	660	0.20
20	2030	288	660	0.20
21	2031	288	660	0.20

B.2 DERIVATION OF EUL AND RUL

This section describes the derivation of the EUL and RUL.

Appliance Survival Curves

In survival analysis and reliability engineering, Weibull distributions are often used to create survival curves. A Weibull distribution has the following form:

Equation 1: f(t) = f(t0)exp[(t-t0)/L]k

Where ***t*** is the time, ***L*** is the time constant of the decaying exponential and ***k*** is referred to herein as the *accelerated decrepitude factor*. Note that if k=1, we have a simple decaying exponential distribution.

At any time **t,** the fraction of surviving units is given by:

Equation 2: 1 – exp[(t-t0)/L]k

In particular, if one desires to know the half-life of the distribution, one may use substitute the equation **f(t) = 0.5 × f(t_0)** and solve. This result is:

Equation 3: (t-t0)=[{(t/L)k – ln(0.5)}(1/k) –t/L]×L

If one defines the EUL as the half-life of the Weibull distribution[26] (the time at which half of the original units have survived, and the other half has perished), then the **Equation 3** describes the RUL as a function of t, L, and k. If one sets t_0=0 in **Equation 3** describes the EUL.

Survival Curves for Air conditioners and Heat Pumps

We use two sources of data to construct the AC and HP survival curves. The results are compared and the more conservative scenario is chosen as the source for our EUL and RUL estimations.

Source 1: ASHRAE Publication 4560: Heat Pump Life Revisited

The first source of information is ASHRAE Journal article 4560: Heat Pump Life Revisited, published Jan 1, 2002. This article plots the mortality curve for heat pumps. This plot is recreated below. ADM reconstructed the distribution with a Weibull distribution with parameters L=24.5, k=3.5. The half-life for this fit (Figure B-1) is 22 years.

[26] This is not the only way to define lifetime, but it is more conservative than using the median life. In the particular distributions that we propose (L=24.5, k=3.5), the *weighted average life* and *half-life* are both within 5% of each other.

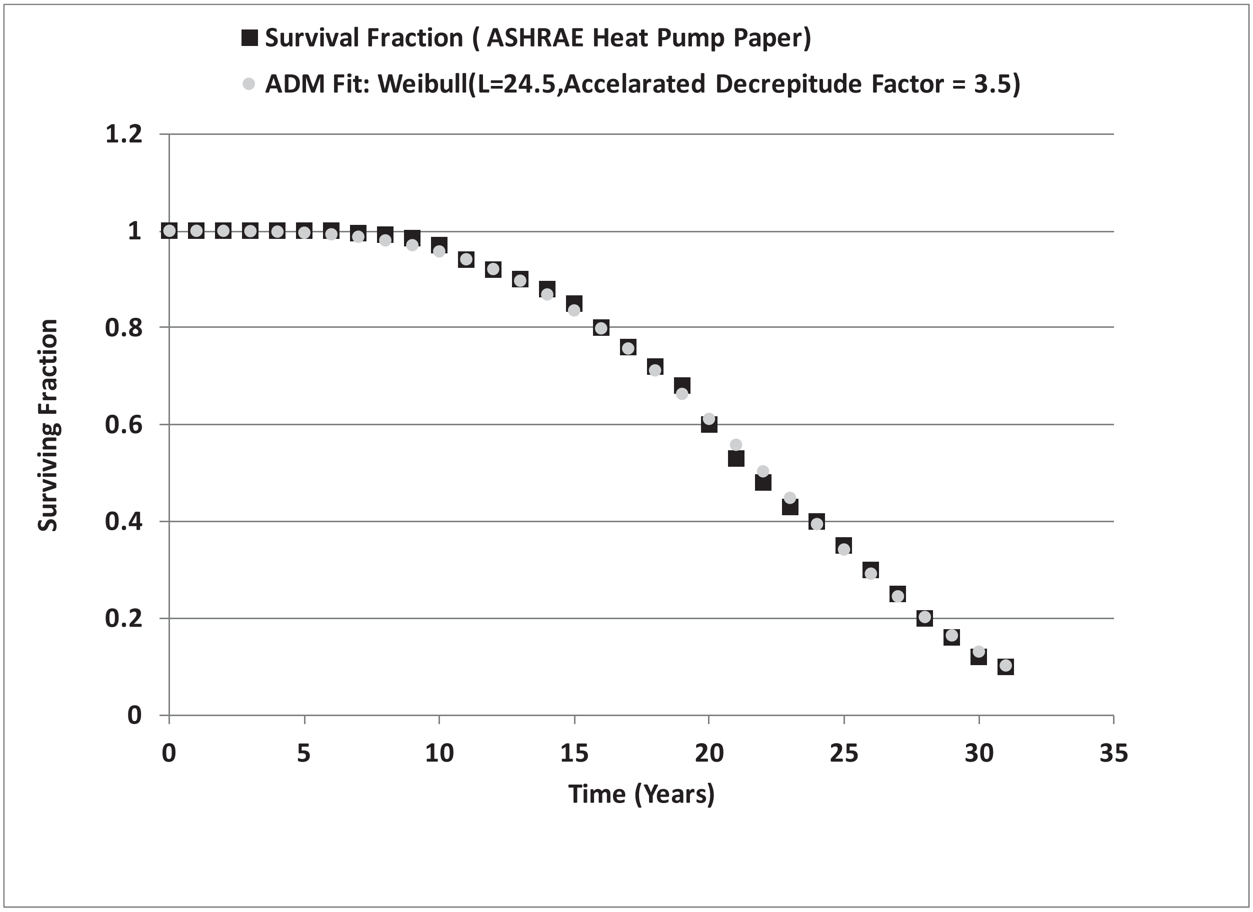

Figure B-1 Survival rate distribution for heat pumps (black squares) and fit to the distribution (gray dots)

Source 2: Nevada RASS Survey

The 2008 Residential Appliance Saturation Survey (RASS) survey for Nevada obtained information on housing vintage, air conditioner type, and air conditioner age. The age distributions, as reported by survey participants, are shown in Figure B-2.

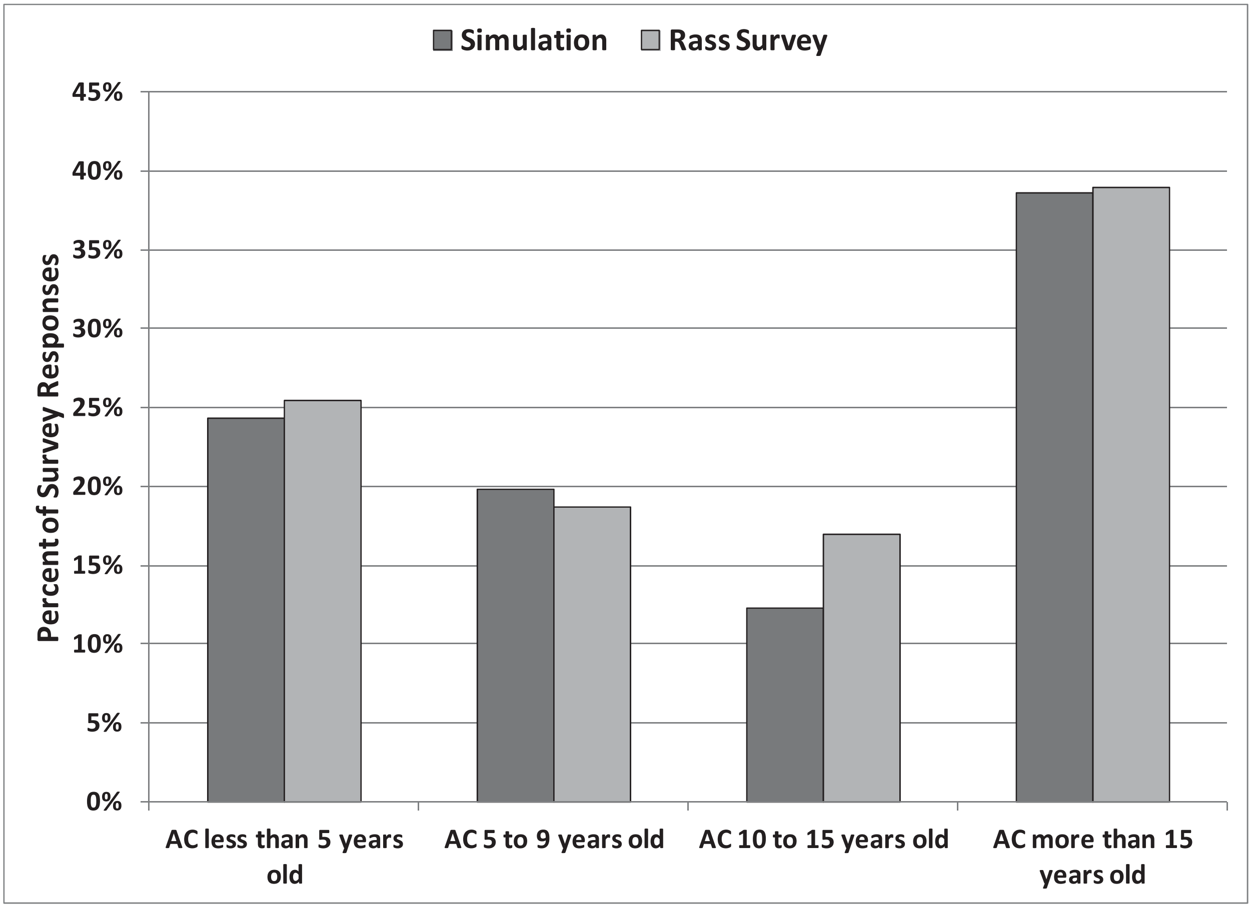

Figure B-2. Distribution of AC ages for homes built in the 1980s from RASS survey (light) and for homes built in 1985 in a simulation by ADM (dark)

Note that Figure B-3 implies that the older homes tend to have newer units and vice versa. This indicates that by 2008, a substantial proportion of the AC units that were originally specified for homes built in the 1960s have been replaced. Conversely, almost 40 percent of units installed between 1980 and 1990 (i.e., 18 to 28 years old as of the date of the 2008 RASS survey) are still operational. ADM reconstructed the distribution[27] with a Weibull distribution with parameters L=22, k=2.2.

[27] The reconstruction involves starting with a single distribution simulating new ACs in homes in 1985. For each year until 2008, the total number of years that expire in the prior years are accounted for in their own distributions.

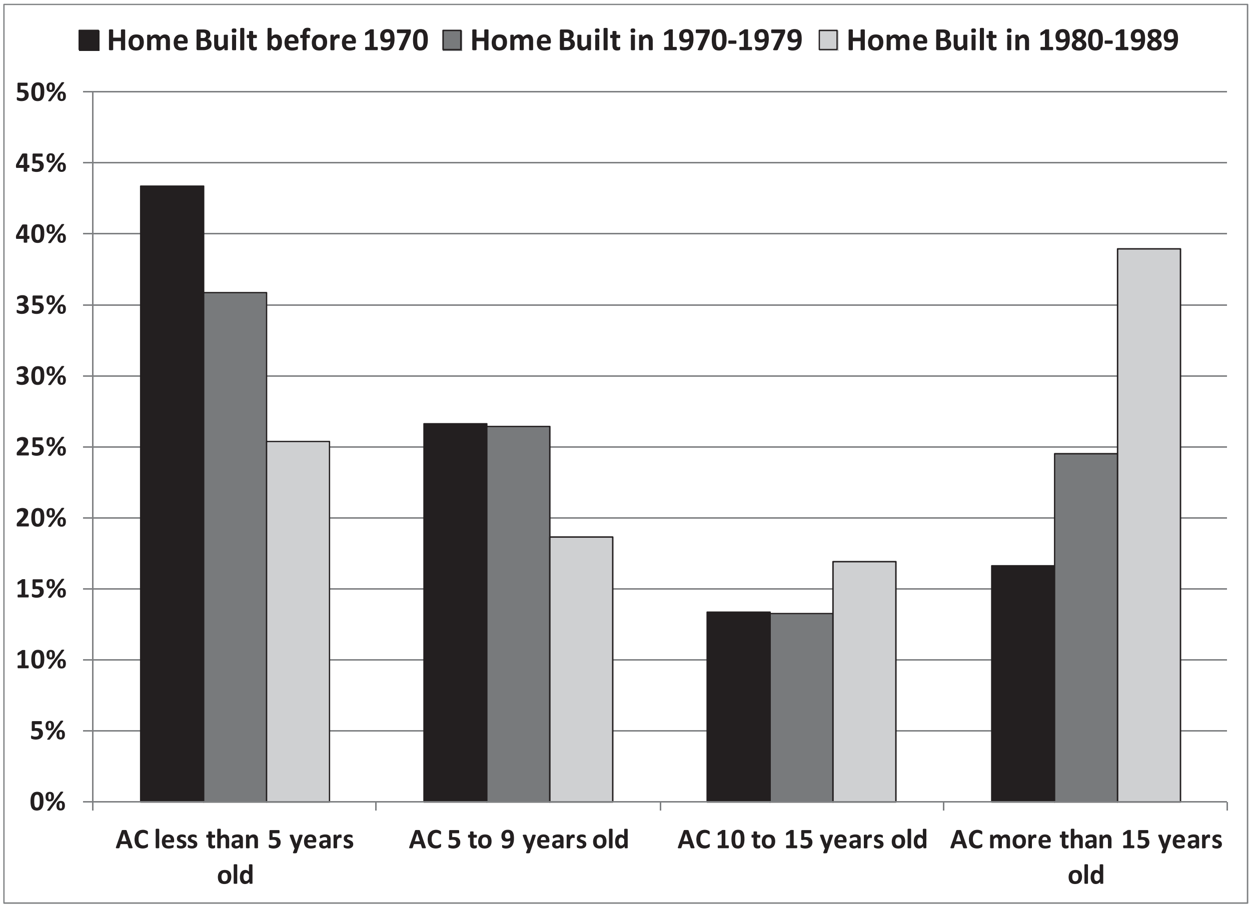

Figure B-3 AC age distributions for homes of various vintages

B.3 COMPARISON OF FINDINGS

The results from the fits to ASHRAE and 2008 RASS are summarized in the table below. Although the two distributions have different characteristics (the fit to ASHRAE, as depicted in Figure B-4, indicates accelerated decrepitude), the resulting EUL and RUL are in good agreement.

Table B-4. Comparison of Two Methodologies and Combined Results

Parameter	*Fit to ASHRAE*	*Fit to RASS*	*Average*
L	24.5	23	
k	3.5	2.2	
half-life	22.1	19.5	20.8
mean life	22.3	20.5	21.4
EUL	22.1	19.5	20.8
RUL	8.0	8.1	8.1
Average Age of Qualifying Unit	16.0	17.1	16.6

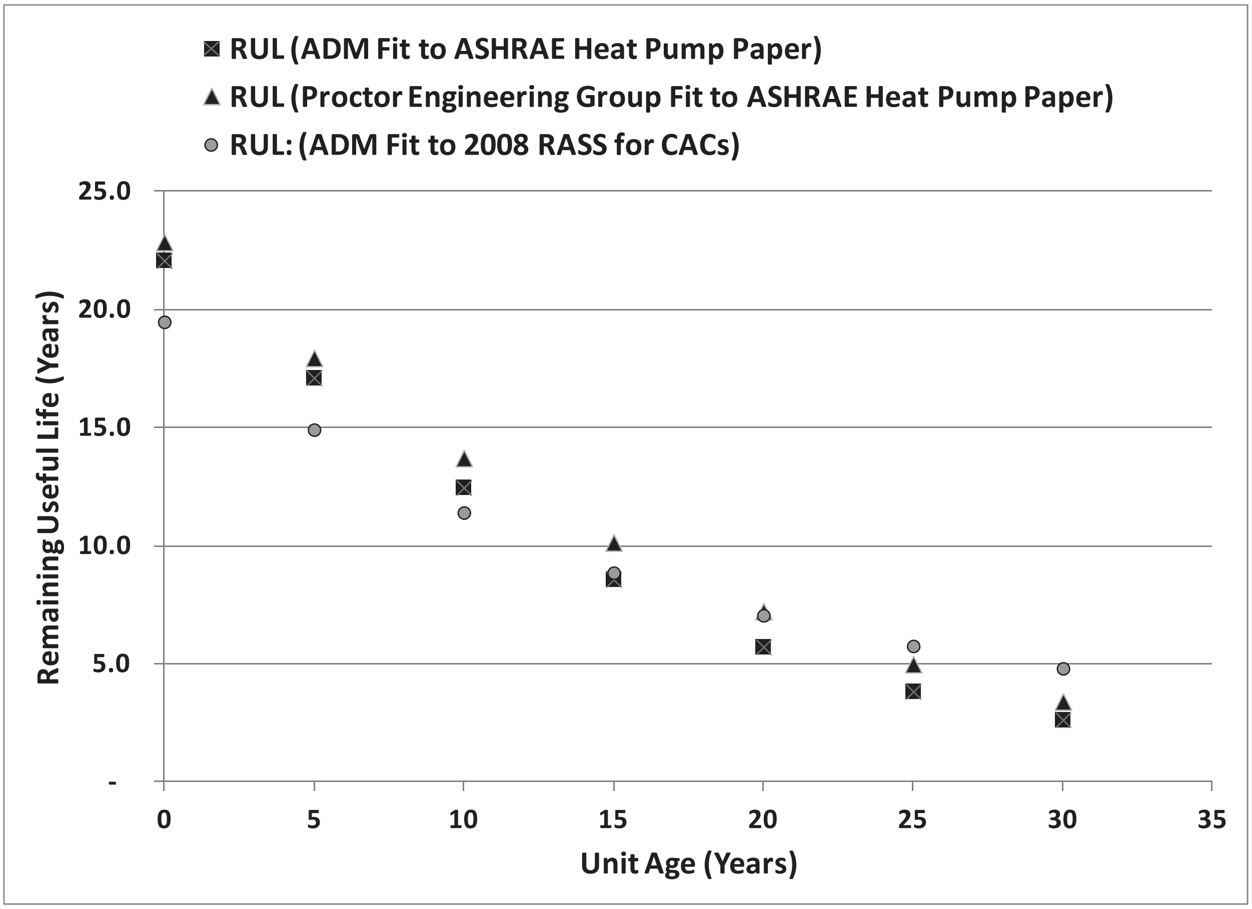

Figure B-4 Three varying RUL vs. Age distributions compared

APPENDIX C: DETERMINING BASELINE ANNUAL HVAC ENERGY USAGE

In this chapter, we provide estimates of this baseline usage for broad classes of *Residential High Efficiency Air Conditioning* participants by analyzing historical consumption data. The baseline energy usage calculations provided herein are provided for reference. They were updated as part of the 2015 evaluation, but the 2017 program evaluation does not explicitly rely upon them. The baseline energy usage determination process is described below.

C.1. DATA SOURCES AND STUDY DESIGN

The data used in this study are monthly energy usages, aggregated from 15-minute interval meter data, from over 5,000 *Residential High Efficiency Air Conditioning Program* participants from program year 2015. These bills were merged with building type, HVAC system type, quantity, and capacity information from the program tracking database.

The *Residential High Efficiency Air Conditioning* participants were divided into nine study groups, based on the characteristics of the participants' buildings and HVAC systems, as reported in the program tracking and reporting system. These group descriptions and sizes are in listed below in Table C-1.

Table C-1: Groupings for baseline study

Building Type	**Cooling Type**	**Heat Type**	**Total Premises**
Single Family	Air Conditioner	Gas	1,741
Single Family	Heat Pump	Heat Pump	408
Single Family	Air Conditioner	Strip Heat	29
Multifamily	Air Conditioner	Gas	1,033
Multifamily	Heat Pump	Heat Pump	1,876
Multifamily	Air Conditioner	Strip Heat	138
Mobile Home	Air Conditioner	Gas	429
Mobile Home	Heat Pump	Heat Pump	114
Mobile Home	Air Conditioner	Strip Heat	1
Total			**5,769**

The baseline usage for the six study groups was modeled using pooled regression, estimating the conditional mean of monthly energy usage, given the total number of cooling degree days and heating degree days:

$$kWh = \alpha \times DaysPerMonth + \beta \times HDD + \gamma \times CDD + \epsilon$$

In the equation above, *kWh, HDD, and CDD* are the monthly energy usage, cooling degree days, and heating degree days respectively, α, β, and γ represent the non-HVAC daily energy usage, the heating kWh per HDD, and the cooling kWh per CDD, respectively, and the last term is the error term. For each of the nine subgroups, the CDD and HDD bases are determined through minimization of the model relative root mean square.

C.2. NORMALIZED, ANNUALIZED BASELINE USAGE

The baseline usages represent normalized "typical year" usages according to a weather forecast model developed for the *Residential High Efficiency Air Conditioning* evaluation. The weather forecast model is described in Appendix E. The total energy usage is normalized to the average installed capacity of the HVAC systems for each group. This results in single point estimates in units of kWh per ton of capacity. Single point estimates are appropriate for program year 2015 because the installed capacities in each of the nine groups were relatively homogenous.

Table C-2 provides estimated per-ton baseline usage during a "typical" year, using the weather derived from the forecast model. Note that the heating energy usages for gas heated homes represent air handler energy usage and are derived from the corresponding heat-pump energy intensities by scaling typical heat pump kW per ton (approximately 1.7) to typical air handler kW per ton (approximately 0.16). This is necessary because the air handler does not use enough electric energy during the heating season to enable accurate estimation through regression methods[28].

[28] For a typical single-family home, the air handler will use approximately 300 kWh during the heating season, whereas the air conditioner will use nearly 6,000 kWh in the cooling season.

Table C-2: kWh-per-ton Baseline Usage during "Typical" Year

Group	Heating	Cooling	Total
Multifamily (AC, Gas)	100	1,292	1,392
Multifamily (AC, SH)	585	1,205	1,790
Multifamily (HP)	1,074	1,580	2,655
Mobile Home (AC, Gas)	50	1,318	1,368
Mobile Home (AC, SH))	978	1,139	2,117
Mobile Home (HP)	535	909	1,444
Single-Family (AC, Gas)	85	1,193	1,278
Single-Family (AC, SH))	1,228	1,526	2,754
Single-Family (HP)	911	1,236	2,148

APPENDIX D: CALCULATION METHODOLOGY FOR CRITICAL PEAK DEMAND (KW) SAVINGS

D.1. OVERVIEW OF CALCULATION METHODOLOGY FOR KW SAVINGS

This section provides a description of analytical steps employed to determine critical peak demand savings per month per rate class for NV Energy's 2016 DSM programs. For the 2016 M&V reports, demand (kW) reduction per month per rate class is determined using essentially the same methodology that is used to disaggregate annual energy (kWh) savings into monthly kWh savings per rate class. Please see the following chapter for a more detailed description of the methodology for determining energy (kWh) savings per month per rate class.

M&V reports for 2016 DSM programs do not provide critical peak demand (kW) savings for the 2016 calendar year. To do so would provide an incomplete, potentially misleading picture of critical peak kW savings because each monthly kW reduction value would represent only a fraction of the total population of measures that are installed during the program year as a whole. Instead, M&V reports for 2016 DSM programs provide monthly critical peak kW savings values for 2017 – and for subsequent years for the life of the measures installed – which are representative of the whole population of measures installed by each program during the 2016 calendar year. This approach for reporting *"typical" (or "full year") coincident peak kW reduction* is the preferred approach for impact evaluations. For this program, Table B-5 in the preceding section provides the full-year values for critical peak kW savings per month and per rate class.

D.2. ANALYTICAL STEPS AT THE MEASURE LEVEL

At the measure level, for every record (i.e., individual measure) in NV Energy's DSM Central tracking database ("DSM Central"), ADM assigns an appropriate normalized 8,760 energy savings curve. A normalized energy savings curve is comprised of 8,760 hourly fractions summing to exactly 1 (unity).[29] For each measure, ADM determines *ex post* annual kWh savings, which is then multiplied by each of the 8,760 hourly fractions to disaggregate the annual kWh into 8,760 hourly kW bins.

[29] ADM has developed a library of normalized energy savings curves that are appropriate for Northern and Southern Nevada. Many of the residential energy savings curves were derived from NV Energy's program-specific data, while others were derived from data provided in the 2008 California Database of Energy Efficiency Resources (2008 DEER).

D.3. ANALTICAL STEPS AT THE PROGRAM LEVEL

To determine program-level demand (kW) reduction for a given hourly kW bin, ADM sums the hourly kW bin across all measures in the program. For example, the program-level kW reduction for the hour ending at 5PM on the 200th day of the year is the sum of kW for all measures in the program during that hour on that day.

To determine monthly critical peak demand (kW) reduction for the program, ADM inspects program-level kW reduction during the one-hour critical peak demand period that is defined for each month of the year. The following table provides the monthly critical peak demand periods for NPC and Sierra, which were determined from ADM's analysis of peak system load data provided by NV Energy.

Table D-1. Critical Peak Demand Period per Month, NV Energy

Month	***Critical Peak Period, NPC***		***Critical Peak Period, Sierra***	
	Hour	*Ending at:*	*Hour*	*Ending at:*
January	*19*	*19:00*	*19*	*19:00*
February	*19*	*19:00*	*19*	*19:00*
March	*20*	*20:00*	*20*	*20:00*
April	*20*	*20:00*	*21*	*21:00*
May	*17*	*17:00*	*17*	*17:00*
June	*17*	*17:00*	*17*	*17:00*
July	*17*	*17:00*	*17*	*17:00*
August	*17*	*17:00*	*17*	*17:00*
September	*17*	*17:00*	*17*	*17:00*
October	*19*	*19:00*	*20*	*20:00*
November	*19*	*19:00*	*19*	*19:00*
December	*19*	*19:00*	*19*	*19:00*

For example, the critical peak demand period for July is the hour from 16:00:01 or 4:00:01 PM to 17:00:00 or 5:00:00 PM. To determine July's program-level critical peak kW savings, ADM inspects average hourly kW reduction during 4:00:01 to 5:00:00 PM for every day in July: the highest value represents July's critical peak kW savings. The same procedure is followed for all months of the year. *Summer critical peak demand savings is defined as July's critical peak kW savings;* the rationale for doing so is that historical data reveals that during any given year, NV Energy's peak system demand in either territory will typically occur during a July day between 4:00:01 to 5:00:00 PM.

To determine the monthly kW reduction *per rate class*, each program-level monthly critical peak kW savings value is disaggregated into *rate class bins* by correlating monthly kW savings for a given measure to the measure's assigned customer rate class as listed in DSM Central.

Calculations for energy (kWh) savings – and for demand (kW) reduction – per month per rate class require complex algorithms that are executed in massive Excel files, which are also known as ***kW guru***™ files.

D.4. ANALYSIS OF SYSTEM-LEVEL CRITICAL PEAK DEMAND PERIODS

ADM analyzed NV Energy's system-level critical peak hours to determine a consistent reference for peak demand impacts of M&V evaluation of all NV Energy programs. ADM's analysis encompassed Sierra Pacific Power Company ("Sierra") in the north and Nevada Power Company ("NPC") in the south.

Hourly system load data from 1985 through 2011 for Sierra and from 1999 through 2011 for NPC was provided by NV Energy. In analyzing the hourly load data, it was determined that the system peaks for Sierra in 1985 were only half of what they have been in the more recent ten-year period. The percentage change in daily system peaks between summer and winter were smaller in the 80's and 90's than in the more recent ten-year period. Therefore, ADM concluded that the use of system load data from the recent ten-year period provides the best basis for predicting what to expect during an EEM's remaining useful life; following that rationale, data prior to the most recent ten years was excluded from ADM's analysis. In both service territories, the highest system peak occurred in 2007, and system peaks have declined moderately since.

The hourly load data for the recent ten-year period was thoroughly reviewed and except for "spring ahead" hours (when clock times change from Standard Time to Daylight Savings Time), it was determined that the data was consistent and appropriate. The data for "spring ahead" hours are inconsistent, with values given as follows: (1) the value of the preceding hour is used and is an acceptable means of handling the data; and (2) a zero, which is an inaccurate value that would pull down the average. For this analysis, zero values were converted to blanks, and therefore not included in the averaging calculation. Overall this is a minor issue that did not impact ADM's final analysis of system-level critical peak hours.

ADM determined that system load characteristics vary by season. To accommodate the seasonal variations, the hour of peak system load was determined for each month. ADM concluded that a one-hour peak demand period per month is appropriate.

The final determination of the appropriate peak demand hour per month per territory is provided above; see the table in the preceding section of this appendix. The designated peak demand hour per month per territory was utilized for M&V analyses of energy efficiency programs implemented in 2011 and 2012. Subject to ADM's periodic re-checking of system load data, it is expected that the designated peak demand hour per month per territory will continue to be utilized for subsequent program years.

This M&V methodology update occurred for the following reason. Compared to the three-hour critical peak demand window used for M&V analyses of 2010 programs, the updated critical peak demand definition (i.e., one hour per month per territory) provides a more accurate determination of energy efficiency programs' contributions to reducing system peak demand. In other words, the one-hour peak kW reduction will align with the actual hour of system peak.

NV Energy's hourly system load data demonstrated well-defined peaks during summer and winter months. However, certain transition months – such as May in Northern Nevada – have a nearly identical double peak. It is obvious that specific weather conditions during any given year cause one or the other of the two peaks to predominate. In the final analysis, transition months have far less peak demand than summer months, so a transition month peak hour is essentially insignificant to the determination of the system peak hour, which will typically occur in July and occasionally occur in August (but never in May).

ADM also analyzed hourly system load by various day types. The day type that exhibited highest average demand was selected as the appropriate day type for final determination of peak hour. The day types investigated were (1) All Days, (2) Weekdays, (3) Non-Holiday Weekdays (i.e., Workdays) and (4) Weekend & Holidays. A curve for each month was developed by day type. All days for a given day type were averaged for a given month by hour of the day to develop an average 24-hour load curve. For the north and south, the summer peak typically occurs during hour 17, which is the hour that ends at 17:00 (5:00 PM). The greatest summer peak demand is the highest peak demand experienced by both companies.

The analysis determined that of the four day types, Workdays averaged the highest system demand for most hours of the day. Generally, the peak hour calculated from the average Workday curve was identified as the peak hour for the month for the given territory. Peak hours for two transition months in each territory were adjusted to maintain a more consistent set of peak hours; adjustments were made for May and June for Sierra and April and November for NPC. Determination of peak hour for these months was based on differences of less than 1 percent in average MW demand between mathematical peak hour and the assigned peak hour.

To validate these decisions ADM also analyzed all-time record peak days and an average of the day from each month that the peak occurred. The second method thus included ten days in the calculation of the average. The results from these analyses supported the average Workday results. Analysis files have not been included in this report due to the large size of spreadsheets.

APPENDIX E: DETERMINING ENERGY (KWH) SAVINGS PER MONTH BY CLASS

This chapter provides a detailed description of ADM's analytical steps for determining the energy (kWh) savings per month by rate class values that are provided in the M&V reports for program year 2017.[30]

E.1. APPORTIONMENT OF ANNUAL ENERGY SAVINGS BY RATE CLASS

NV Energy's DSM programs generally include populations of customers from more than one rate class. NV Energy tracks the rate class for each identifiable customer participating in DSM programs. However, participant information is not known for certain DSM programs, such as the *Consumer Electronics and Plug Loads* program or other "upstream" or "midstream" programs where incentives are provided through contractual arrangements with manufacturers or distributors of the rebated products. For DSM programs for which participant information is not known, ADM collected participant information at the point of sale or conducted customer surveys to identify the proportions of participants that belong to various rate classes.

E.2. APPORTIONMENT OF ANNUAL ENERGY SAVINGS BY MONTH

ADM developed a methodology that utilizes *energy savings curves* to calculate the portion of annual energy savings that occurs during each month of the year. An energy savings curve describes the temporal nature of energy savings. For example, on any given day the energy savings achieved by a LED exit sign are approximately 1/365 of the verified annual energy savings for that LED exit sign. On the other hand, an efficient air conditioner may not save any energy during the month of January but may achieve 35 percent of its annual energy savings in the month of July alone. ADM constructed appropriate energy savings curves from metered data collected during M&V of NV Energy DSM programs (or other programs if appropriate), customer billing data, calibrated DOE2 simulations and engineering calculations. The energy savings curves were coupled with project implementation dates on a record-by-record basis to produce accurate determinations of the energy savings achieved for each month of the year.

E.3. HIGH-LEVEL SUMMARY OF ADM'S CALCULATION METHODOLOGY

Monthly energy (kWh) savings for each program were calculated by applying an appropriate hourly or daily energy savings curve to each program participant's *ex post* verified energy savings, then aggregating kWh savings for each month. The energy savings

[30] The Public Utilities Commission of Nevada (PUCN) requires NV Energy to report energy (kWh) savings per month and per rate class for each Demand Side Management (DSM) program.

curve distributes a participant's energy savings over time. Its shape is, therefore, dependent on not only the measure installed (i.e., lighting vs. HVAC) but also on the building type and sometimes its location.

The overall process by which ADM calculated monthly kWh savings was to (1) download all program tracking data from DSM Central, i.e., *ex ante* expected kWh savings, measure type, measure completion date, rate class, etc., (2) calculate *ex post* values per participant, (3) assign an energy savings curve to each participant's *ex post* savings to distribute *ex post* energy savings by rate class over each of the 8,760 hours in a year, and (4) aggregate *ex post* verified savings for the purpose of presenting savings by month and by rate class.

ADM also calculated first-year kWh savings for each program by combining measure startup date (from DSM Central) with the aforementioned process. A detailed description of the steps involved in tabulating first-year kWh savings is provided in section F.5 below.

E.4. ENERGY SAVINGS PROFILES

E.4.1. Definition

The phrase 'energy savings curve' is used to describe the temporal dependence of energy savings. The curves are typically hourly (1 × 8760 array), daily (1 × 365 array), or monthly (1 × 12 array). The energy savings curves are often normalized such the sum of all array elements is unity. When normalized, each element describes the fraction of annual savings that is expected to occur in a given hour, day, or month.

E.4.2. Nomenclature

Note that if the term 'load shape' is encountered in the spreadsheets that are used to tally monthly energy savings by program and rate class, one should take it to be the same as 'energy savings curve' as described herein. The reason for the usage of the term 'load shape' is twofold:

Energy savings curves are *differential load shapes* describing differences in electricity loads resulting from the implementation of energy efficiency measures; in other words, energy savings curves indicate the *shape over time of electricity that is saved or not used*. Note also that energy that is *not used due to energy efficiency actions* (i.e., "saved" energy) is sometimes called "Negawatts" – a "Negawatt" saved is meant to represent the negative form of a "Megawatt" of power that would have been used if the energy efficiency actions had not occurred.

An energy savings curve for a measure may or may not be synchronous with the load curve of the base case technology against which savings are determined.

- There are energy efficiency measures (EEMs) for which the normalized savings curve is synchronous and proportional to the normalized load shape or curve of the base case technology. Examples of such EEMs include CFLs versus incandescent lights if it is assumed that (1) there are null or negligible interactive effects and (2) pre- and post-retrofit usage schedules are identical. If the savings curve for an EEM is synchronous with the base case technology load shape, then the two curves have identical shapes.

– For other EEMs, the energy savings curve is asynchronous with the load curve of the base case technology. Examples of EEMs with asynchronous savings curves include economizers, occupancy sensors, and control systems. For such measures, the shape of the energy savings curve is different from the shape of the base case technology.

As part of our evaluation effort, ADM determines for each EEM whether to use normalized energy savings curves that are either synchronous or asynchronous with the normalized load shape of the base case technology.

E.5. TABULATING MONTHLY ENERGY (KWH) SAVINGS PER RATE CLASS

Normalized daily energy savings curves are utilized for this task. A normalized daily energy savings curve is comprised of 365 daily fractions summing to exactly 1 (unity). For each measure, ADM determines *ex post* annual kWh savings, which is then multiplied by each of the 365 daily energy savings curve fractions to disaggregate annual kWh into 365 daily kWh bins.

E.5.1 First-Year kWh Savings

'First-year' kWh savings are savings that occur during the same calendar year in which a conservation program was implemented. For NV Energy a program year is the same as a calendar year. Thus 'first-year' kWh savings for a measure installed during the 2017 program year are equal to that measure's kWh savings during the 2017 calendar year.

The following calculations are performed to tabulate 'first-year' kWh savings attributable to a particular customer rate class. For any given 2017 NV Energy program:

For each rate class, for each day of 2017, identify all measures that have been implemented (or 'installed' or 'started up') by the end of the prior day.

For each rate class, for each day of 2017, for all measures that have been installed by the prior day, multiply the *ex post* verified 'typical-year' annualized kWh savings[31] for each

[31] 'Typical-year' annualized kWh savings is 365 consecutive days of energy savings – <u>usually a full calendar year</u> other than Leap Year – attributed to an energy efficiency measure(s) for which *ex post* verified kWh savings will occur during a multi-year measure life. For example, an NV Energy conservation measure installed during the 2017 program year (i.e., during the 2017 calendar year) will normally provide kWh savings starting on its date of installation. 'First-year' savings is the savings that occurs during the 2017 calendar year. 'Full-year' savings is the savings occurring during subsequent calendar years.

measure type by that measure's daily kWh bin. In other words, multiply the measure-level annual kWh by the measure-level daily bin from the appropriate energy savings curve.

For each rate class, tally all measure-level daily kWh savings to determine program-level daily kWh savings.

For each rate class, for any given month of 2017, tally all measure-level daily kWh savings occurring during that month to determine program-level monthly kWh savings during the 2017 calendar year.

For each rate class, the first-year kWh savings is the program-level monthly kWh savings for that rate class summed across all 12 months of 2017.

E.5.2. Typical-Year kWh Savings

'Typical-year' energy (kWh) savings represents 365 consecutive days of energy savings attributed to a measure(s) or program for which *ex post* verified savings will occur across a multi-year measure life.[32]

The following calculations are performed to tabulate 'typical-year' energy (kWh) savings attributable to a particular customer rate class. For any given 2017 NV Energy program, all measures would have been implemented or installed during calendar year 2017.

For each rate class, for each hour (or day) of 2017 and subsequent years, multiply *ex post* verified 'typical-year' energy (kWh) savings for each measure type by that measure's hourly (or daily) kWh bin. In other words, multiply the measure-level annual kWh by the measure-level hourly (or daily) bin from the appropriate energy savings curve.[33]

For each rate class, tally all measure-level hourly (or daily) kWh savings to determine program-level hourly (or daily) kWh savings.

For each rate class, for any given month, sum all measure-level hourly (or daily) kWh savings occurring in that month to determine program-level monthly kWh savings.

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[32] The distinction between 'typical year' and 'full year' is that a 'typical year' is a 365-day year. A Leap Year is not a 'typical year' – instead, a Leap Year is a 'full year' with 366 days. In M&V reports, the kWh savings tables (which show monthly savings per rate class) feature titles such as "Full Year 2017" versus "Full Year 2020 (Leap Year)".

[33] When tallying kWh savings per month per rate class, the use of hourly bins or daily bins is equally correct and accurate. ADM typically uses daily bins (which are created from hourly bins) in our ***kW guru™*** Excel files simply because a workstation processor can complete the billions of computations in a large ***kW guru*** file relatively faster when the number of computations is based on 365 daily bins instead of 8760 hourly bins per calendar year. The 8760 hourly bins per 'typical year' in ***kW guru*** files (i.e.,) exist for the following purposes: 1) they are summed across the 24 hours of each day to create daily bins; and 2) they provide hourly resolution, enabling us to analyze and report critical peak demand (kW) savings per month per rate class for any specified kW-reporting period.

For each rate class, 'typical-year' kWh savings is the program-level monthly kWh savings for that rate class summed across all 365 days of any non-Leap Year after the 2017 calendar year.

For any given program, 'full-year' kWh savings for a Leap Year will be marginally higher than 'full-year' kWh savings for a 'typical year' or non-Leap Year. Thus, we always use a non-Leap Year when we quantify 'typical-year' kWh savings.

Following is an example of the determination of daily kWh savings generated by a program. Let's consider a hypothetical program that targets two energy efficiency (EE) measures: residential lighting and residential cooling. For this hypothetical program, Table D-1 below provides a simple comparison of the measures' respective:

typical-year' energy savings;

daily bin value in its energy savings curve for a specific day – February 1st – of any given year[34] after the EE measures were installed;

energy (kWh) savings during February 1st of any given year after the EE measures were installed.

In Table E-1 below, the assumption is that 1,000,000 kWh of annual energy savings ('typical-year' savings as reported in M&V reports) were achieved through the distribution of CFLs and 500,000 kWh of annual ('typical-year') energy savings were achieved through implementation of high efficiency air conditioning (AC) measures. Energy (kWh) savings on February 1st are obtained by multiplying 'typical-year' kWh savings by the entries corresponding to February 1st in the respective normalized energy savings curves. ***In this example, the daily bin for space cooling is zero because no space cooling is expected to occur on February 1st.***

Table E-1. Sample calculation of energy savings achieved for a given rate class on February 1 for a hypothetical program targeting residential lighting and space cooling.

Comparison for "Indoor Lighting" vs. "Space Cooling" Measures	EE Measure = "Indoor Lighting"	EE Measure = "Space Cooling"
'Typical-year' energy savings (annual kWh):	1,000,000	500,000
Feb. 1 daily bin value in each EE measure's energy savings curve:	0.0030	0.0000
Feb. 1 energy (kWh) savings in a typical year:	3,000	0

For each program, such calculations are performed for each rate class, energy savings curve and hour (or day). Hourly (or daily) results are then aggregated at the monthly level.

[34] The daily bin value for Feb. 1 represents the February 1 daily fraction of 'typical-year' annual energy (kWh) savings.

E.5.3. Leap Year Savings

To account for the extra day in February in Leap Years, one of the following methods is used. Either method produces accurate, very similar *ex post* verified energy savings determinations for Leap Years.

Energy savings during the month of February in a Leap Year is taken to be equal to 29/28 of energy savings during the month of February in a typical non-Leap Year.

Or, energy savings on the day of February 29 in a Leap Year is assumed to be the same as energy savings on the previous day (February 28).

APPENDIX F: SURVEY INSTRUMENT

The following is the script for the NV Energy 2017 Residential AC Survey.

PHONE SURVEY INTRODUCTION

A1. Hello, my name is [INTERVIEWER NAME], and I am calling on behalf of [NV Energy]. May I speak with [NAME OF RESPONDENT]?

Yes	01	
No	02	[IF NOT AVAILABLE, ASK FOR ANOTHER ADULT FAMILIAR WITH HOUSEHOLD'S PARTICIPATION IN [NAME OF PROGRAM]]

A2. *Great, thank you. First, I want to assure you that I'm not selling anything. We are calling Residential AC program participants to verify information about the products and services received. If you live in a rental property, it is possible that your landlord participated by having upgrades done to your unit. May I take a few minutes to talk with you about the products and services you received? Your responses will be kept confidential.*

Yes	01	[PROCEED WITH INTERVIEW]
No	02	[THANK TERMINATE]
Refused	99	[THANK AND TERMINATE]

RESPONDENT BACKGROUND

The sole purpose of this phone survey is assisting NVE to verify, evaluate and to plan its future residential energy conservation services. You are assured that any information obtained shall remain confidential

LED Light Bulbs

B1. *Our records show that you had ____ LED Light Bulbs installed.* ***[REFER TO CONTACT LIST FOR QUANTITY]*** *Does that sound about right?*

Yes	01
No	02
Don't Know	98
Refused	99

B2. *How many LED light bulbs were installed?* ***[RECORD EXACT NUMBER]***

B3. *Are the LED light bulbs currently in use and working properly?*

Yes	01
No	02
Don't Know	98
Refused	99

B4. *Why are the LED light bulbs no longer in use? (Ex. Burnt out, removed due to inadequate brightness)*

B5. *Were any LED light bulbs removed?*

Yes	01
No	02
Don't Know	98
Refused	99

B6. *How many were removed?* ***[RECORD EXACT NUMBER]***

Low Flow Showerheads and Faucet Aerators

C1. *How many faucets are there in your home? Do not include bathtubs or showerheads*. ***[RECORD EXACT NUMBER]***

C2. *How many showerheads are there in your home?* ***[RECORD EXACT NUMBER]***

Early Replacement and Burnout

[IF EARLY REPLACEMENT, DISPLAY D1, ELSE IF BURNOUT DISPLAY D2, ELSE SKIP SECTION D AND DISPLAY END.]

D1. *Was your air conditioner still working when it was replaced?*

Yes	01
No	02
Don't Know	98
Refused	99

D2. *Was your air conditioner not working when it was replaced?*

Yes	01

No	02
Don't Know	98
Refused	99

This completes our phone survey. The information you provided will be used to improve NVE's energy efficiency services in the future.