EM&V Report: 2017 Conservation Programs

Prepared for:

Truckee Donner Public Utility District

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Table of Contents

List of Figures

List of Tables

1. Executive Summary

ADM Associates was contracted to evaluate the energy impacts of Truckee Donner Public Utility District's (TDPUD) 2017 energy efficiency program portfolio. The district implemented 13 energy and 5 water conservation programs with an ex post *gross* impact of 1,770,069 kWh and 240 kW in the 2017 program year. The portfolio net-to-gross ratio is 70%. Portfolio Total resource cost was $0.07 per kWh which resulted in an overall TRC of 2.4. A summary of the portfolio's performance for CY 2017 is provided in Table 1-1.

Table 1-1 Summary of Ex Post Gross Portfolio Performance

Annual Energy Savings [kWh]	Peak Demand Reductions [kW]	Annual Water Savings [CCF]	Lifecycle GHG Reductions [Tons]	Total Resource Cost [$/kWh]
1,770,069	240	14,089	9,247	$0.07

Our EM&V report is organized into the following sections:

- Section 1 provides the reader an executive summary of the evaluation's findings and recommendations.
- Section 2 describes the general approaches used for the impact evaluation.
- Section 3 details specific EM&V activities, evaluation findings & recommendations, and overall performance for each of TDPUD's residential programs.
- Section 4 details specific EM&V activities, evaluation findings & recommendations, and overall performance for each of TDPUD's commercial programs selected for evaluation.

1.1. Summary of Evaluation Findings

Detailed evaluation findings for specific programs can be found later in this report (Sections 3 and 4). This section provides a summary of the high-level findings pertinent to TDPUD's 2017 portfolio of programs.

- **Efficient Lighting Continues to be an important factor for portfolio.** This year we saw another large increase in LED lighting throughout TDPUD's residential and commercial programs – both in quantity and their contribution to overall portfolio impacts. Lighting standards and market adoption of LEDs are also increasing which continues to reduce the savings potential for "standard" bulb types (e.g. A19). In particular Phase II of the EISA standards are expected to become effective in 2020 which will significantly impact the cost effectiveness and savings potential for LED light bulbs.
- **Low number of Participants utilizing multiple programs.** ADM noted that the vast majority of program participants only participated in a single program from TDPUD's portfolio.

Figure 1-1 illustrates the count of participants which participated in 1, 2, 3, or 4 of TDPUD's programs in 2017. No customers were observed to have participated in more than 4 programs.

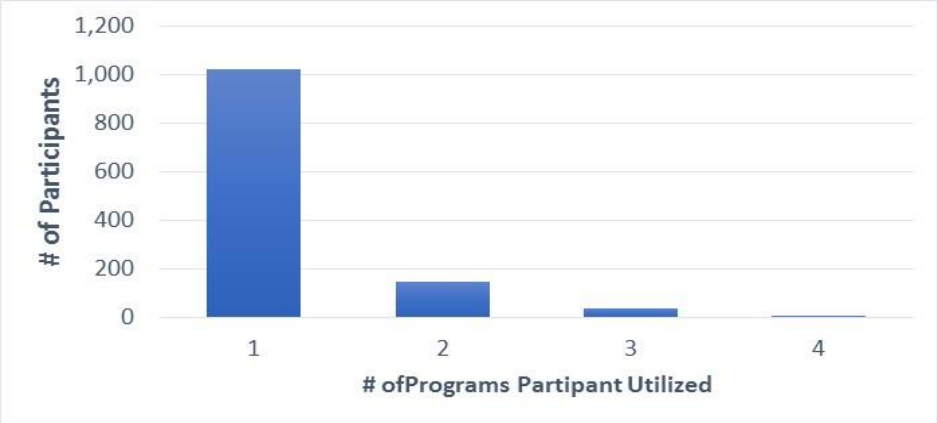

Figure 1-1 Cross Program Participation

The following table provides gross and net impacts by program:

Table 1-2 Summary of Program Impacts

Program		*Gross Impact Estimates*			*Net Impact Estimates*			*Resource Cost [$/kWh]*
		Energy [kWh]	Demand [kW]	Water [CCF]	Energy [kWh]	Demand [kW]	Water [CCF]	
Residential Electric	Residential Green Partners	267,740	22.8	0	179,386	15.29	0	$0.07
	Refrigerator Recycling Rebate	171,588	26.4	0	118,396	18.22	0	$0.05
	Event LEDS & Million CFLs	156,968	9.9	0	78,484	4.94	0	$0.10
	Green Schools Program	143,540	9.0	0	96,172	6.06	0	$0.03
	Lighting Rebate & POS	92,456	5.9	0	61,946	3.94	0	$0.03
	Energy Survey/RES	88,809	5.4	524	59,502	3.61	351	$0.24
	Appliance Rebate	48,673	5.6	0	32,124	3.70	0	$0.11
	ESP/INCOME qualified	14,635	0.8	143	14,635	0.85	143	$0.16
	LED Holiday Light Swap	9,549	0.0	0	8,690	0.00	0	$0.35
	Building Efficiency Rebates	2,501	5.9	0	1,851	4.36	0	$0.37
Residential Water	Misc. Water Measures	60,490	6.9	2,282	46,577	5.32	1,757	$0.05
	Leak Repair Rebate	35,450	4.0	10,152	27,297	3.12	7,817	$0.02
	Toilet Exchange Program	4,200	0.5	511	3,612	0.41	439	$1.09
	Toilet Rebate Program	2,948	0.3	359	2,535	0.29	309	$0.86
	He Clothes Washer Water	974	0.1	119	662	0.08	81	$1.45
Commercial	Commercial Refrigeration	296,440	34	0	204,544	23.35	0	$0.03
	Commercial Lighting	284,486	80	0	264,572	74.48	0	$0.04
	Green Partners LED/CFL	88,621	23	0	41,652	10.67	0	$0.11
Total		1,770,069	240	14,089	1,242,636	179	10,897	$0.07

The relative magnitudes of each program's contribution to the overall portfolio is illustrated in Figure 1-2. Figure 1-2 also identifies the relative impacts of each program sector

(Residential Electric, Residential Water, and Commercial Electric). A more detailed review of program impacts is included in Section 3 & Section 4 of this report. Specifically Figure 3-1, Figure 3-2, and Figure 4-1 compare program impacts and their cost effectiveness ($/kWh).

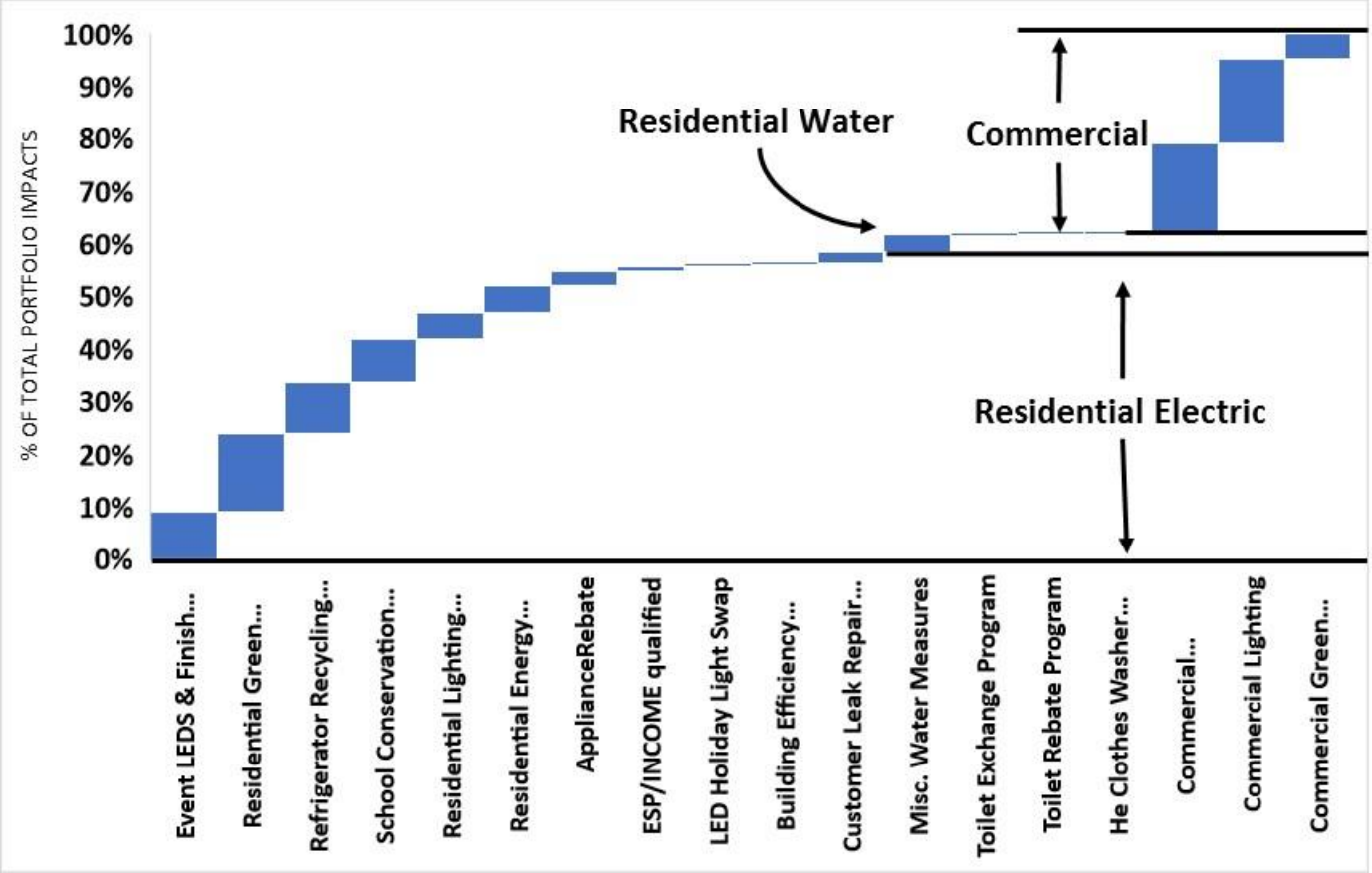

Figure 1-2 Disaggregated Impacts by Program

1.2. Summary of Evaluation Recommendations

Again, detailed recommendations specific to each program can be found within Sections 3 and 4. This section lists high level recommendations identified by this evaluation to improve program implementation in future program years:

- **Look into ECM Fan motors as a potential measure.** Though most homes in Truckee do not have central A/C thanks to very mild summers; residential homes with central heating see a significant increase in electricity usage during winter months due to Truckee's heating dominated climate. ECM fan motors are a significant efficiency improvement over *standard* shaded pole or split capacitor motors. ADM recommends that TDPUD consider adding efficient furnaces as a

measure. While potentially more expensive, additional opportunity exists in retrofitting existing motors to ECM motors as well.

- **Market Specialty and "Non-Standard" LED bulb types.** As LED lighting costs continue to drop and their consistency in quality increases the measure is improving in cost effectiveness. However; as lighting standards and market adoption are also increasing, LEDs applied in specialty and other 'non-standard' fixtures/bulb types represent the best opportunity to capture energy savings through programs targeting residential lighting.
- **Increase efforts to directly engage local business owners.** Program participants indicated program awareness through direct communication from PUD staff – which is in line with how the program has historically been marketed. As the program has matured, it will become more difficult to reach business which have not already participated in the program and additional penetration will require more creative or concerted marketing.

  One potential opportunity is in the form of a small commercial direct install program in which program staff canvas the town and provide commercial customers with LED light bulbs and a basic energy audit which can funnel into the custom, lighting, or refrigeration programs.
- **Prepare to phase out residential light bulbs as an Energy Efficiency Measure.** Currently Phase II of the EISA legislation is slated to become effective in 2020 which will significantly reduce the energy savings potential for residential light bulb replacements – rendering this measure no longer cost effective. Given the prominence of this program in TDPUDs portfolio we recommend TDPUD start the process of re-designing the portfolio and begin developing replacement programs/measures in advance of the 2020 backstop.
- **Continue to partner with local Public facilities to take Advantage of Prop 39 funds.** The California state legislature is currently considering a bill that would extend funding for the Prop 39 program beyond fiscal year 2017-2018, when it is currently set to expire. TDPUD should continue to partner with local schools and the community college to take advantage of these funds.

2. General Approach to EM&V

In real-time evaluations, the various EM&V activities occurring during a program year are used to administer the implementation of the program. Information from the EM&V activities is used to provide real-time feedback to make real-time adjustments in program implementation that will help ensure that program targets are met. The various activities involved in the real-time EM&V effort are as follows:

- QA / QC of program applications / projects
- Tracking and verification of measure installations
- Measurement of savings impacts for measures / projects
- Program evaluation
- Savings impacts
- Program process evaluation
- Cost-effectiveness

Figure 2-1 is a schematic showing how these real-time EM&V activities relate to program planning and implementation. While we are not performing a formal process evaluation in this project, the concurrent nature of this evaluation allowed us to provide real-time commentary on program processes as we worked with TDPUD in the impact evaluations.

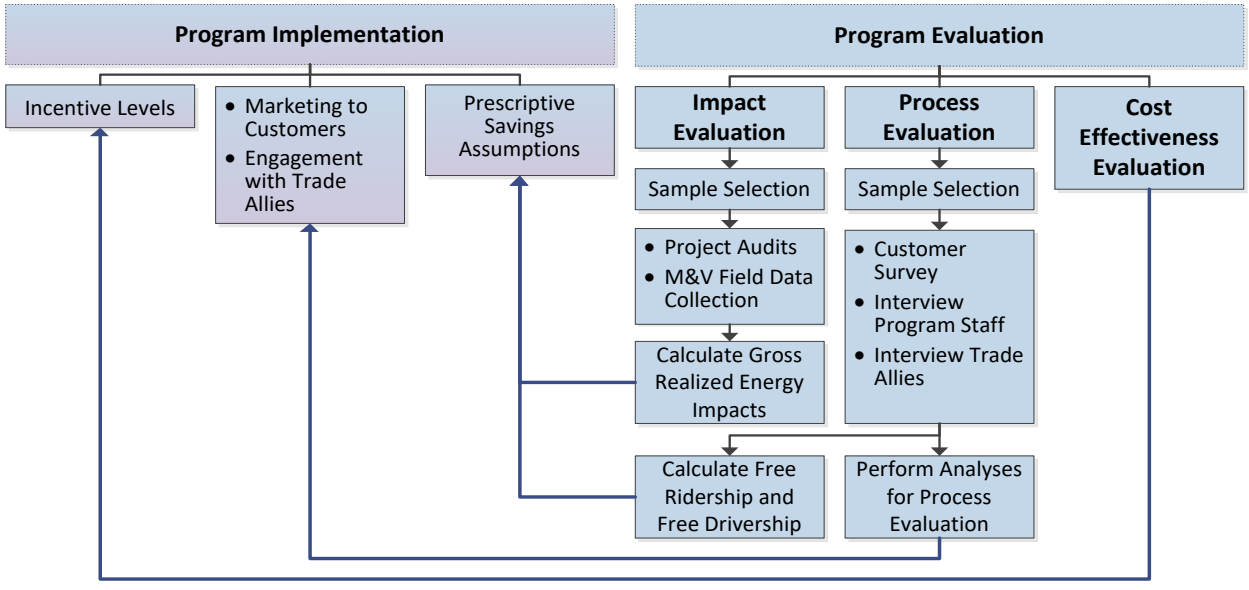

Figure 2-1 Integration of EM&V Activities with Program Planning and Implementation

All evaluation activities were informed by current EM&V industry standards. Additionally we review any literature relevant to the regulatory framework in which the programs were administered. Pertinent literature for this evaluation included:

- National Renewable Energy Laboratory, The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures, April 2013.
- Savings Estimation Technical Resource Manual for the California Municipal Utilities Association. Prepared by energy & resource solutions. May 2015.
- American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE). Measurement of Energy and Demand Savings, Guideline 14. June 2002.
- California Public Utilities Commission. The California Evaluation Framework. June 2004.
- International Performance Measurement and Verification Protocol. IPMVP Volume I: Concepts and Options for Determining Energy and Water Savings. 2007.
- National Action Plan for Energy Efficiency. Model Energy Efficiency Program Impact Evaluation Guide. Prepared by Steven R. Schiller, Schiller Consulting, Inc. December 2007.

The various activities undertaken for this impact evaluation are shown in Figure 2-2. This section discusses our:

- General approach to gross impact evaluation for TDPUD's programs, and
- General Net-to-gross methodology

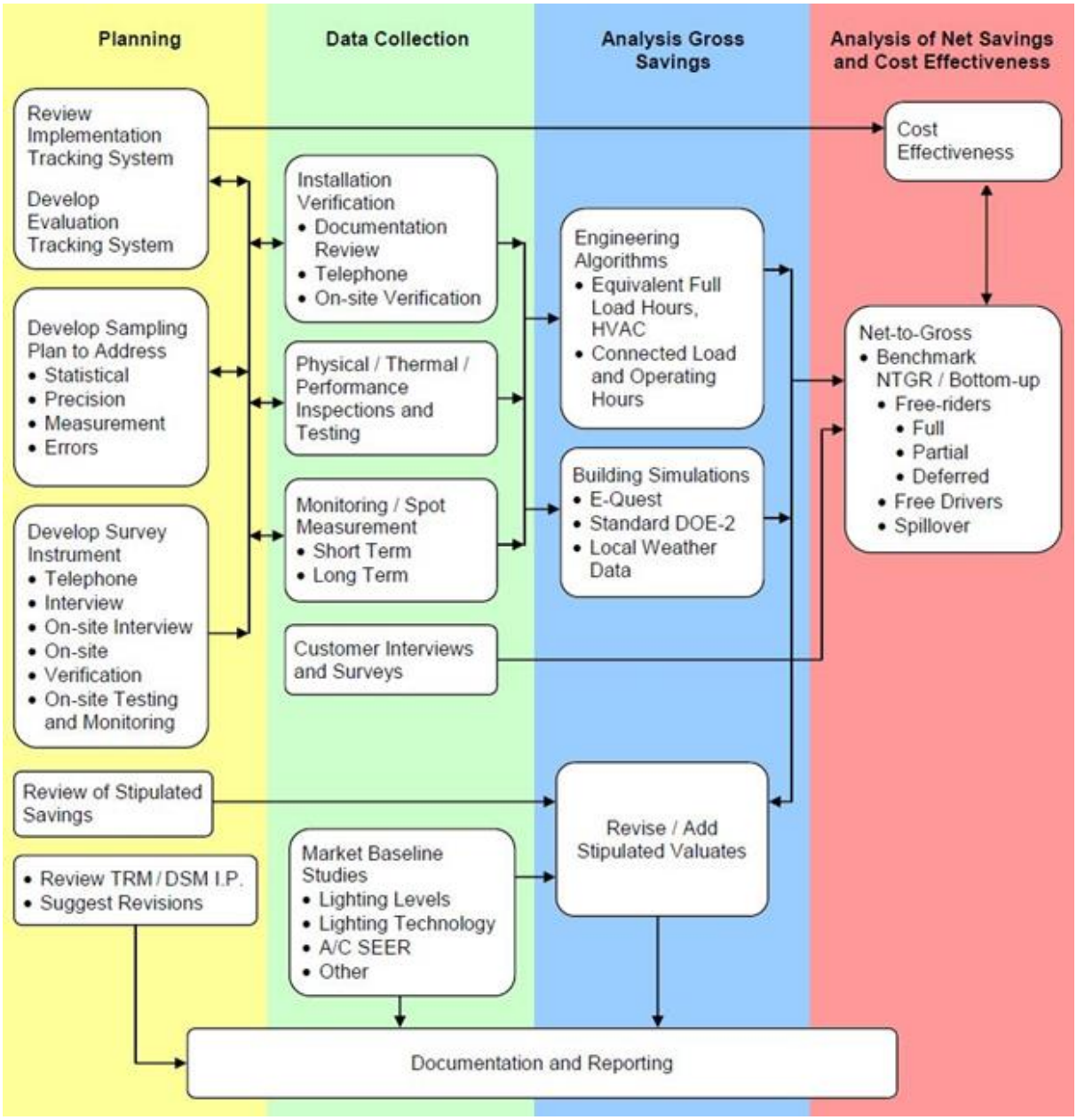

Figure 2-2 Flow Diagram for Impact Evaluation Activities

2.1. Gross Impact Analysis Methods

As delineated in the taxonomy presented in the Model Energy Efficiency Program Impact Evaluation Guide, there are three major approaches to determining gross savings for a program.

- 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 where there is general agreement on the hours of use.

- A *site-specific M&V approach* involves (1) selecting a representative sample of customers or sites that participated in a project; (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 IPMVP; and (3) applying the results of estimating the savings for the sample to the entire population in the project.
- A *large-scale data analysis approach* involves estimating energy savings and demand reductions by applying one or more statistical methods to measured energy consumption utility meter billing data and independent variable data. This approach usually (a) involves analysis of a census of project sites versus 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.

ADM examined documentation for each program to identify the types of energy efficiency measures from which savings were expected to be realized and which of these three types of analysis are most appropriate for estimating savings for those measures. We took account of several factors.

- The magnitude of expected savings from program measures affects the choice of savings estimation approach in that analysis of billing data may not be sufficient to detect savings of small magnitude for some measures.
- The number and complexity of the measures and technologies being promoted through a project 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.

Note that due to limited evaluation resources ADM worked with TDPUD to identify specific evaluation goals for this evaluation cycle. It was determined that a sub-set of the smaller programs would receive a desk review only such that evaluation resources could be spent targeting programs (and measures) representing the majority of energy impacts.

A minority of programs account for the majority of portfolio impacts. Consequently, ADM allocated more resources to programs with the largest impacts in order to minimize uncertainty in the overall evaluation results within the available resources. In the remainder of this section we discuss a more detailed application of the EM&V methods used in our analysis of the TDPUD portfolio. Note that specific applications of these methods are discussed for each program in Sections 3 and 4.

2.1.1. **Deemed Savings Approach**

For most of the measures, unit-level savings due to installation of the measures are well documented and allow the use of such savings as deemed values from the CMUA TRM. For the evaluation of these programs, we identified appropriate unit-level savings for program measures. For this review, we used information from program documentation as well as from the CMUA TRM, the DEER, the Regional Technical Forum, and measure databases/TRMs from other states. We identified savings calculations and estimates (1) whose methodologies used for calculating savings were appropriate, and (2) whose assumptions are reasonable and appropriate. In reviewing the methodologies for calculating energy savings, we focused on the main factors that determine energy use.

We verified measure installations by reviewing program tracking data and conducting customer surveys for statistically valid samples of projects from the program. When sampling, we focused on (1) projects accounting for a significant portion of estimated savings and (2) projects for which savings estimates seem most uncertain. The sample was selected so that results were representative of the population of projects to ±10% precision at the 90% confidence level.

2.1.2. **Site-specific M&V Approach**

A site-specific approach involves the following steps:

- Selecting a representative sample of customers or sites that participated in a program;
- Determining the savings for each customer or site in the sample, usually by using one or more of M&V Options defined in the IPMVP; and
- Applying the results of estimating the savings for the sample to the entire population in the program.

The above steps were tailored to each program evaluated in this manner (this accounts for the unique characteristics of each program). With the site-specific approach, we collect important items of data needed for the analysis of gross savings through on-site data collection. Using comprehensive data collection forms, our field personnel collected data from several sources during the on-site visit:

- We first collected data through interviews with the staff of the site. The interview with site staff provides information on occupancy schedules, lighting schedules, ventilation schedules, equipment schedules, operational practices, maintenance practices, and other factors that are associated with energy use at the site.
- We reviewed documents or records at the site. This includes reviewing basic building plans and architectural drawings. These data also include information on

process equipment, HVAC systems and equipment, on lighting and on hot water systems from mechanical, electrical and plumbing plans.

- We visually inspected control settings, lighting levels, inventory of end use appliances and equipment, ventilation rates, building population, occupancy level, and other parameters.

During the on-site visit, we collect additional information about factors that affect energy use by end-uses. Data on these factors are needed in order to analyze and to verify the energy savings of rebated measures. Data also are needed that pertain to the present pattern of energy use at a site. We use electricity use data for the site to establish this pattern. We ask facility personnel to sign a waiver form that will allow us to request electric use data from the serving utility for twelve previous months (if available). (We use monthly data over a year in order to establish any seasonal aspects in the pattern of energy use.)

Our field personnel also take photographs of a site and of its electrical and mechanical systems during the on-site visit. Our experience has been that photographs taken during a visit are a highly useful means of verifying the data that are collected.

If appropriate, we conduct monitoring at a sub-sample of the sites selected for the onsite data collection. The sites chosen for monitoring are those sites with projects where there is some uncertainty about the values for important factors that affect the level of savings. For example, we may use monitoring to obtain information on operating hours for some types of lighting measures. To better inform the selection of sites for monitoring, we review any documentation that may have prepared for the sites chosen for the on-site sample. Based on this review, we determine whether monitoring measures at a site will be required to verify savings. The split between certainty and non-certainty sites is determined through the analysis of actual project data.

To verify savings for measures installed at project sites, we use methods that depend on the type of measure. Categories of measures include the following:

- Lighting;
- HVAC;
- Motors;
- VFDs;
- Compressed-Air;
- Refrigeration; and
- Process Improvements.

The general methods used by this evaluation to assess site-level impacts are summarized in Table 2-2:

Table 2-1 Typical Methods to Determine Savings for Custom Measures

Type	*Method to Determine Savings*
Lighting	ADM's lighting evaluation model, which uses data on wattages before and after installation of measures and hours-of-use data from field monitoring.
HVAC (including packaged units, chillers, cooling towers, controls/EMS)	eQUEST energy simulation model, which automates the analysis of energy use in buildings. eQUEST uses DOE-2 as its analytical engine for estimating HVAC loads and includes a pre-processor that uses billing data for a site to prepare a benchmark for the site.
Motors and VFDs	Measurements of power and run-time obtained through monitoring
Compressed Air Systems	Engineering analysis, with monitored data on load factor and schedule of operation
Refrigeration	Simulations with DOE2.2 refrigeration engineering analysis models and/or engineering analysis using monitored data
Process Improvements	Engineering analysis, with monitored data on load factor and schedule of operation

Activities specified in the Table above produce verified gross savings calculations for each sampled project. ADM developed estimates of program-level gross savings by applying a ratio estimation procedure in which achieved savings rates estimated for the sample projects were applied to the program-level expected savings.

We obtain the primary data needed to estimate savings and peak impacts by making on-site visits to a sample of sites, survey program participants, and/or reviewing program documentation (including invoices, cut-sheets, applications, etc.). The appropriate deployment of monitoring equipment was determined on a project-specific basis as part of the M&V planning for each sampled project.

We use site visits to accomplish two major things. First, our field personnel verify that the energy efficiency measures for which incentives were given were indeed installed, that they were installed correctly, and that they still function properly. Second, they collect the data needed to analyze the energy savings and kW impacts for the installed measures.

- For measures with deemed savings values (e.g., IPMVP Option A, or those for which values are included in a TRM), we make on-site verification visits to confirm the as-installed and used conditions that provide the expected savings. For

projects where most measures have deemed savings values, no IPMVP metering or monitoring assessment was conducted.

- For measures for which deemed savings values are not available, we use site visits to accomplish two major things. First, our field personnel verify that the energy efficiency measures for which incentives were given were indeed installed, that they were installed correctly, and that they still function properly. Second, they collect the data needed to analyze the energy savings and kW impacts for the installed measures.

We have well-developed and tested procedures in place for collecting the data needed for detailed analysis of the energy performance of energy efficiency measures. The focus of our site visit data collection is to obtain appropriate information to analyze the performance of the different types of energy systems at a facility. This includes collecting information on the quantity, sizing, servicing, and scheduling for HVAC, lighting, refrigeration, motors, process and other equipment. We also collect information on the capabilities of building control systems (e.g., whether centralized or distributed, capabilities for control monitoring, automation possibilities, and expansion possibilities).

We have designed and use a standardized form for on-site data collection that ensures that the information needed to analyze energy efficiency measures is collected for each facility visited. Because we have done extensive M&V work for a variety of utility energy efficiency programs, we have a good understanding of the nature of the data that need to be collected during site visits and the procedures to use to collect that data most cost effectively. We extract items of information from the tracking systems that need to be provided to the field staff to facilitate error-free and efficient site visits.

As part of the data collection, we also may conduct monitoring of specific measures, as applicable and where it is feasible. If a site is selected for field monitoring, the field personnel will have all the proper equipment available for installation at the time of the visit. We install the equipment with minimal intrusion on the participant's operation.

2.2. Method of Net Savings Analysis for Each Program

The basic issue in net savings analysis is determining what part of the gross savings, achieved by program participants, can be attributed to the effects of the program. The savings induced by the program are the "net" savings that are attributable to the program.

Net savings may be less than gross savings because of free ridership impacts, which arose to the extent that participants in a program would have adopted energy efficiency measures and achieved the observed energy changes even in the absence of the program. Free riders for a program are defined as those participants that would have installed the same energy efficiency measures without the program.

The goal of the net-to-gross analysis was to estimate the impacts of energy efficiency measures attributable to the energy efficiency programs that were net of free ridership. That is, because the energy savings realized by free riders are not induced by the program, these savings should not be included in the estimates of the program's actual impacts. Without adjustment for free ridership, some savings that would have occurred naturally would be attributed to the program. The measurement of the net impact of the program requires estimation of the marginal effect of the program over and above the "naturally occurring" patterns for installation and use of energy efficient equipment.

ADM employed two methods of Net-to-Gross analysis for the programs implemented by TDPUD. The first method was used on programs for which the evaluation applied a *Deemed* evaluation approach and the second for programs receiving a site specific evaluation approach. These two approaches are discussed in this section.

2.2.1. Net-To-Gross Approach Programs Evaluated using a *Deemed Savings* Method

Rather than apply a binary scoring (0% vs. 100% free-ridership), the Evaluators applied a free-ridership probability to program participants, based upon four factors:

(1) Financial ability to purchase high efficiency equipment absent the rebate

(2) Importance of the rebate in the decision-making process

(3) Prior planning to purchase high efficiency equipment

(4) Demonstrated behavior in purchasing similar equipment absent a rebate

In this methodology, Part (1) is essentially a gateway value, in that if a participant does not have the financial ability to purchase energy efficient equipment absent a rebate, the other components of free-ridership become moot. As such, if they could not have afforded the high efficiency equipment absent the rebate, free-ridership is scored at 0%. If they did have the financial capability, we then examine the other three components, each contributing an equal scoring of 33% to free-ridership. It should be noted that having financial ability does not necessarily imply free-ridership; it just opens the possibility that other factors could contribute. A participant that was financially able to purchase high efficiency lighting, for example, could still be scored at 0% free-ridership if it is demonstrated that:

(1) The rebate factored into their decision-making process;

(2) They did not have prior plans to install high efficiency equipment before learning of the available rebates; and

(3) They did not demonstrate prior behavior of purchasing similar equipment absent a rebate.

There are other contributing factors to free-ridership, specifically in instances of programs that provide outreach to customers. For example, if in a large commercial retrofit, a sponsoring utility provides assistance in energy efficiency measure recommendation, or in providing cost-benefit analysis of a measure to a business, these could factor into the decision-making in ways that mitigate free-ridership, in that there are cases where a participant did not need a rebate to participate, but was induced to participate by the sponsoring utility's efforts in recommending and/or evaluating energy efficiency measures for them. Additional issues such as this are addressed on a program-by-program basis in methodology sections to follow.

For residential programs, free-ridership is calculated as the average score determined for the sample of participants surveyed. For business programs, a weighted average is taken of verified kWh savings, as the free-ridership scores of high-savers contribute a larger share of the overall free-ridership rate. Once free-ridership is determined, the Evaluators then estimate the Net-to-Gross Ratio (NTGR), calculated as:

NTGR = 1 – % Free-Ridership

2.2.2. Net-To-Gross Approach for Programs Evaluated using a *Site-Specific Approach*.

Information was collected from a sample of program participants through a customer survey. Based on review of this information, the preponderance of evidence regarding free ridership inclinations was used to attribute a customer's savings to free ridership.

Several criteria were used for determining what portion of a customer's savings for a particular project should be attributed to free ridership. The first criterion was based on the response to the question: "Would you have been financially able to install the equipment or measures without the financial incentive from the energy efficiency program?" If a customer answered "No" to this question, a free ridership score of 0 was assigned to the project. That is, if a customer required financial assistance from the energy efficiency program to undertake a project, then that customer was not deemed a free rider.

For decision makers that indicated that they were able to undertake energy efficiency projects without financial assistance from the program, three factors were analyzed to determine what percentage of savings may be attributed to free ridership. The three factors are:

- Plans and intentions of firm to install a measure even without support from the program
- Influence that the program had on the decision to install a measure
- A firm's previous experience with a measure installed under the program

For each of these factors, binary variables were developed indicating whether or not a participant's behavior showed free ridership. These rules made use of answers to questions on the decision maker survey questionnaire.

The first factor required determining if a participant stated that his or her intention was to install an energy efficiency measure even without the program. The answers to a combination of several questions were used with a set of rules to determine whether a participant's behavior indicates likely free ridership. Two binary variables were constructed to account for customer plans and intentions: one, based on a more restrictive set of criteria that may describe a high likelihood of free ridership, and a second, based on a less restrictive set of criteria that may describe a relatively lower likelihood of free ridership.

The first, more restrictive criteria indicating customer plans and intentions that likely signify free ridership are as follows:

- The respondent answered "yes" to the following two questions: "Did you have plans to install the measure before participating in the program?" and "Would you have gone ahead with this planned installation of the measure even if you had not participated in the energy efficiency program?"
- The respondent answered "definitely would have installed" to the following question: "If the financial incentive from the energy efficiency program not been available, how likely is it that you would have installed [Equipment/Measure] anyway?"
- The respondent answered "did not affect timing of purchase and installation" to the following question: "How did the availability of information and financial incentives through the energy efficiency program affect the timing of your purchase and installation of [Equipment/Measure]?"
- The respondent answered "no, the program did not affect level of efficiency that we chose for equipment" in response to the following question: "How did the availability of information and financial incentives through the energy efficiency program affect the level of energy efficiency you chose for [Equipment/Measure]?

The second, less restrictive criteria indicating customer plans and intentions that likely signify free ridership are as follows:

- The respondent answered "yes" to the following two questions: "Did you have plans to install the measure before participating in the program?" and "Would you have gone ahead with this planned installation of the measure even if you had not participated in the energy efficiency program?"
- Either the respondent answered; "definitely would have installed", or "probably would have installed" to the following question: "If the financial incentive from the energy efficiency program had not been available, how likely is it that you would have installed [Equipment/Measure] anyway?"

- Either the respondent answered “did not affect timing of purchase and installation” to the following question: “How did the availability of information and financial incentives through the energy efficiency program affect the timing of your purchase and installation of [Equipment/Measure]?” or the respondent indicated that that while program information and financial incentives did affect the timing of equipment purchase and installation, in the absence of the program they would have purchased and installed the equipment within the next two years.
- The respondent answered “no, the program did not affect level of efficiency that we chose for equipment” in response to the following question: “How did the availability of information and financial incentives through the energy efficiency program affect the level of energy efficiency you chose for [Equipment/Measure]?

The second factor required determining if a customer reported that a recommendation from a program representative or past experience with the program was influential in the decision to install a particular piece of equipment or measure.

The criterion indicating that program influence may signify a lower likelihood of free ridership is that either of the following conditions are true:

- The respondent answered “very important” to the following question: “How important was previous experience with the energy efficiency program in making your decision to install [Equipment/Measure]?
- The respondent answered “yes” to the following question: “Did a representative of the energy efficiency program recommend that you install [Equipment/Measure]?”

The third factor required determining if a participant in the program indicated that he or she had previously installed an energy efficiency measure similar to one that they installed under the program without an energy efficiency program incentive during the last three years. A participant indicating that he or she had installed a similar measure is considered to have a likelihood of free ridership.

The criteria indicating that previous experience may signify a higher likelihood of free ridership are as follows:

- The respondent answered “yes” to the following question: “Before participating in the energy efficiency program, had you installed any equipment or measure similar to [Rebated Equipment/Measure] at your facility?”
- If a responded answered “no” to the following question: “Would you have been financially able to install [Rebated Equipment/Measure] without the financial incentive from the program?” a free ridership score of 0 was assigned to the project. That is, if a participant required financial assistance from the energy efficiency program to undertake a project, then that participant was judged to not be a free rider.

- Under this criterion, the other free ridership scoring criteria were applied only to projects for participants who answered "Yes" to the question: "Would you have been financially able to install the equipment or measures without the financial incentive from the energy efficiency program?" However, respondents who answered "No" to this question would be judged to have zero free ridership even if the other free ridership criteria were applied, due to the nature of their specific survey responses.

- Table 2-4 shows the free-ridership scores that are associated with different combinations of free-ridership indicator variable values.

Table 2-2 Free-ridership Scoring Matrix: Site-Specific Approach

Had Plans and Intentions to Install Measure without the program? (Definition 1)	*Had Plans and Intentions to Install Measure without the program? (Definition 2)*	*The program had influence on Decision to Install Measure?*	*Had Previous Experience with Measure?*	*Free Ridership Score*
Y	N/A	Y	Y	100%
Y	N/A	N	N	100%
Y	N/A	N	Y	100%
Y	N/A	Y	N	67%
N	Y	N	Y	67%
N	N	N	Y	33%
N	Y	N	N	33%
N	Y	Y	N	0%
N	N	N	N	0%
N	N	Y	N	0%
N	N	Y	Y	0%

2.3. Sampling

Sampling is necessary to evaluate savings for the TDPUD portfolio insomuch as verification of a census of program participants is typically cost-prohibitive. As per evaluation standard practice, samples are drawn in order to ensure 90% confidence at the +/- 10% precision level. Programs are evaluated on one of three bases:

- Census of all participants
- Simple Random Sample
- Stratified Random Sample

2.3.1. **Census of Participants**

A census of participant data is used for select programs where such review is feasible. In such instances. We interview the complete population of participants.

2.3.2. **Simple Random Sampling**

For programs with relatively homogenous measures (largely in the residential portfolio), the Evaluators conducted a simple random sample of participants. The sample size for verification surveys is calculated to meet 90% confidence and 10% precision (90/10). The sample size to meet 90/10 requirements is calculated based on the coefficient of variation of savings for program participants. Coefficient of Variation (CV) is defined as:

$$CV = \frac{Mean_x}{Standard\ Deviation_x}$$

Where x is the average kWh savings per participant. Without data to use as a basis for a higher value, it is typical to apply a CV of .5 in residential program evaluations. The resulting sample size is estimated at:

$$n_0 = \left(\frac{1.645 * CV}{RP}\right)^2$$

Where,

1.645 = Z Score for 90% confidence interval in a normal distribution

CV = Coefficient of Variation

RP = Required Precision, 10% in this evaluation

With 10% required precision (RP), this calls for a sample of 68 for programs with a sufficiently large population. However, in some instances, programs did not have sufficient participation to make a sample of this size cost-effective. In instances of low participation, the Evaluators then applied a finite population correction factor, defined as:

$$n = \frac{n_0}{1 + {}^{n_0}/_N}$$

Where

n_0 = Sample Required for Large Population

N = Size of Population

n = Corrected Sample

For example, if a program were to have only 100 participants, the finite population correction would result in a final required sample size of 41. ADM applied finite population correction factors in instances of low participation in determining samples required for surveying or onsite verification.

2.3.3. **Stratified Random Sampling**

For the TDPUD commercial portfolio, Simple Random Sampling is not an effective sampling methodology as the CV observed in commercial programs are typically very

high because the distributions of savings are generally positively skewed. Often, a relatively small number of projects account for a high percentage of the estimated savings for the program.

To address this situation, we use a sample design for selecting projects for the M&V sample that takes such skewness into account. With this approach, we select a number of sites with large savings for the sample with certainty and take a random sample of the remaining sites. To further improve the precision, non-certainty sites are selected for the sample through systematic random sampling. That is, a random sample of sites remaining after the certainty sites have been selected is selected by ordering them according to the magnitude of their savings and using systematic random sampling. Sampling systematically from a list that is ordered according to the magnitude of savings ensures that any sample selected will have some units with high savings, some with moderate savings, and some with low savings. Samples cannot result that have concentrations of sites with atypically high savings or atypically low savings.

3. EM&V Approach: Residential Programs

In this chapter, we discuss the EM&V results (including findings and recommendations) for each residential program. Programs are listed in order of contribution to the overall portfolio. Note that several programs received a desk review only as their evaluation was either outside the scope of this report, or their size relative to the portfolio was such that the evaluation resources were better spent elsewhere. Results across each of the residential programs are summarize in Table 3-1.

Table 3-1 Summary of Residential Program Results

Resource Conserved	*Program Name*	*Gross Impacts [kWh]*	*Evaluation Approach*	*Survey*	*% of Portfolio*	*% Change from 2016*
Electric	Residential Green Partners	267,740	Option A	Y	24%	1543%
Electric	Refrigerator Recycling Rebate	171,588	Option A	N	16%	18%
Electric	Event LEDS & Million CFLs	156,968	Option A	N	14%	-25%
Electric	Green Schools Program	143,540	Option A	N	13%	329%
Electric	Lighting Rebate & POS	92,456	Option A	Y	8%	-64%
Electric	Residential Energy Survey/RES	88,809	Option A	Y	8%	7%
Electric	Appliance Rebate	48,673	Option A	N	4.4%	11%
Electric	ESP/INCOME qualified	14,635	Option A	N	1%	-15%
Electric	LED Holiday Light Swap	9,549	Option A	N	1%	-14%
Electric	Building Efficiency Rebates	2,501	Option A	N	0.2%	1%
Water	Misc. Water Measures	60,490	Option A	N	5.5%	24%
Water	Customer Leak Repair Rebate	35,450	Option A	N	3.2%	163%
Water	Toilet Exchange Program	4,200	Option A	Y	0.4%	-54%
Water	Toilet Rebate Program	2,948	Option A	Y	0.3%	-33%
Water	He Clothes Washer Water Rebate	974	Option A	N	0.1%	72%
	Total Residential Sector:	**1,100,522**			**100 %**	

Programs are grouped according to the primary conservation resource they target and then according to the magnitudes of their verified gross impacts. Each of the above programs are compared against one another in Figure 3-1and Figure 3-2, showing both their annual gross impacts and net resource costs ($/kWh).

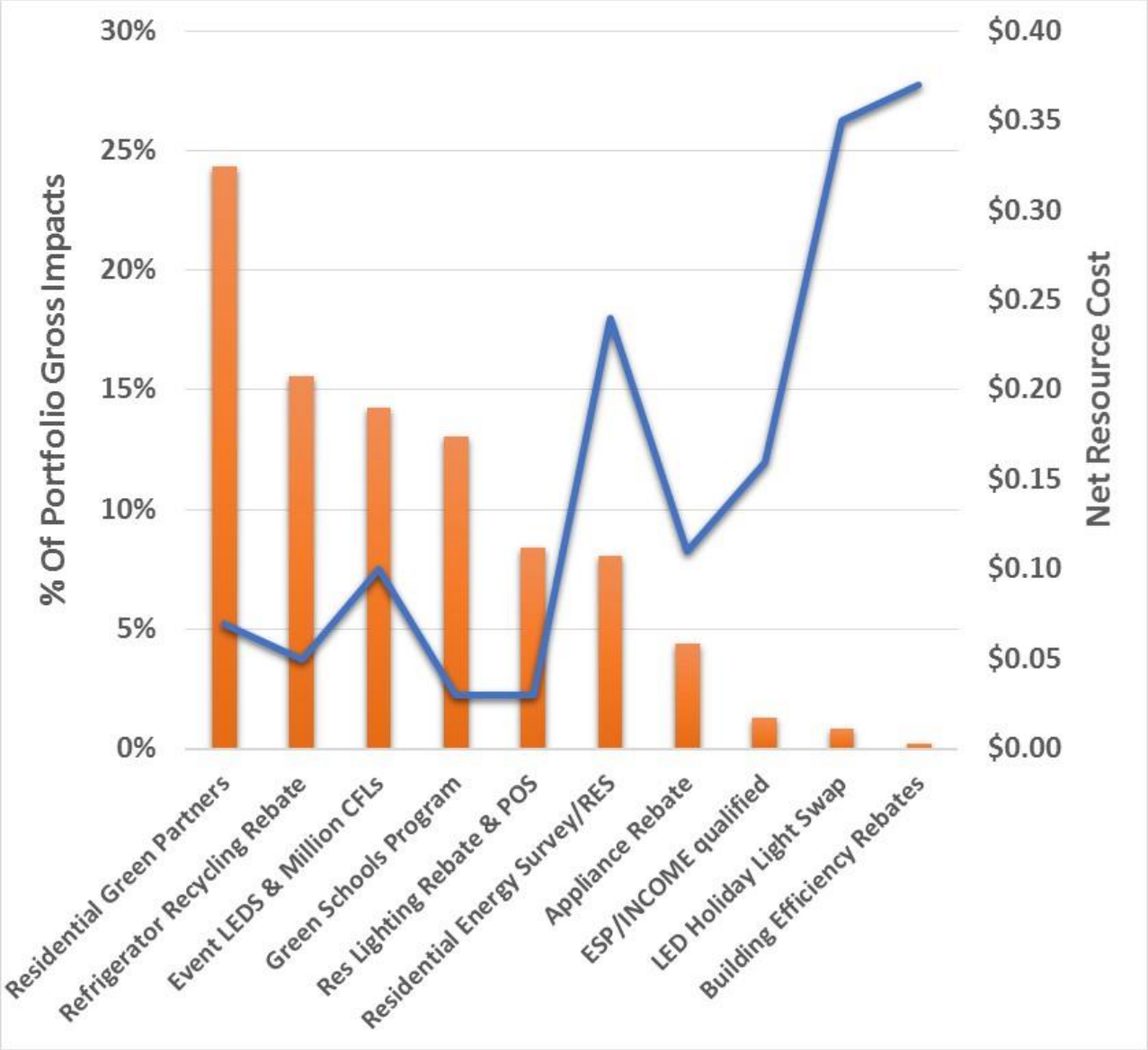

Figure 3-1 Comparing Gross Impacts and Net Resource Costs Across Residential Electric Programs

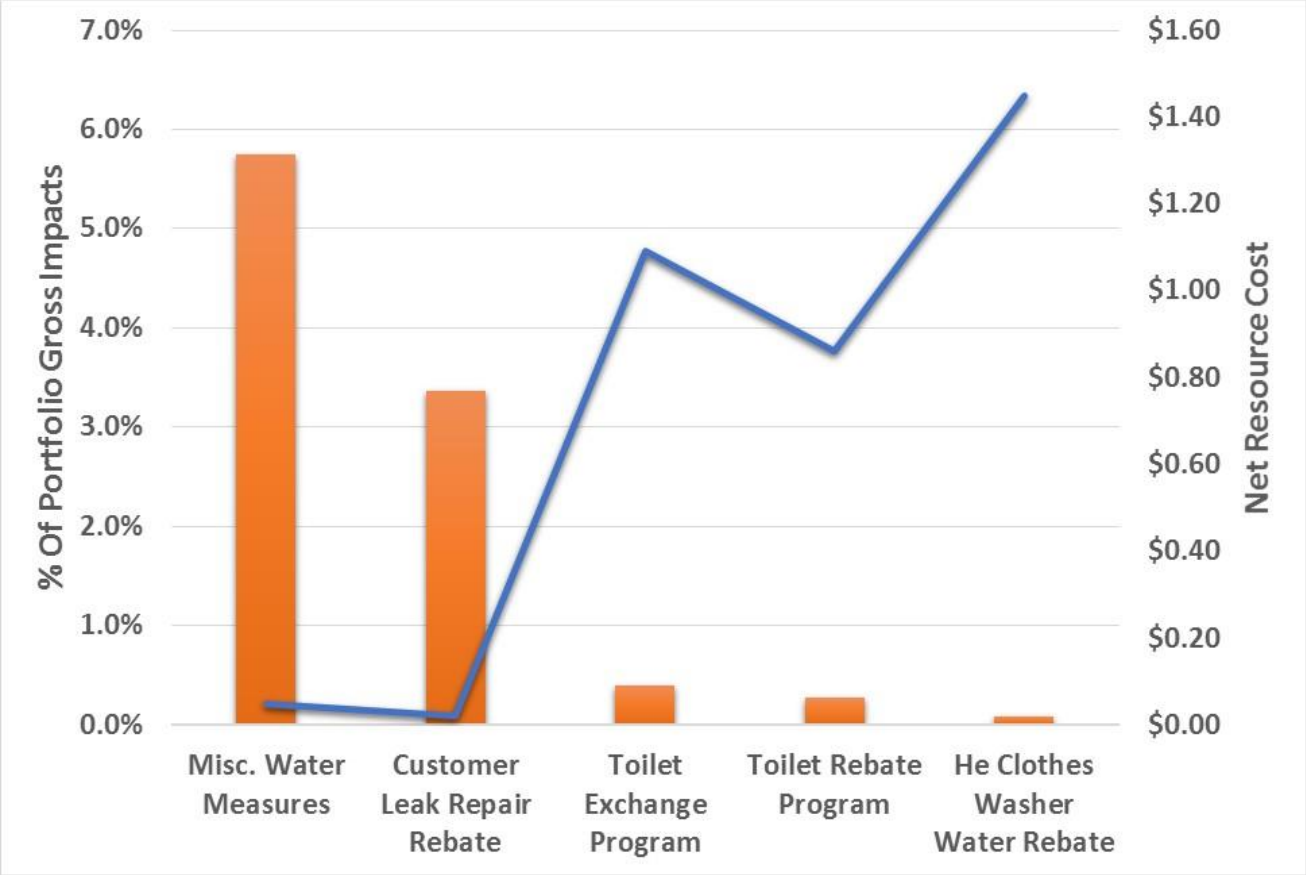

Figure 3-2 Comparing Gross Impacts and Net Resource Costs Across Residential Water Programs

3.1. Residential – Green Partners Program

Table 3-2 Residential - Green Partners: Summary Table

Final Bulb count:	9,607
Ex Post Gross Energy Savings [kWh]:	267,740
Ex Post Gross Demand Savings [kW]:	23
Total Resource Cost [$/kWh]:	$0.07
Net-To-Gross Ratio:	67%
Contribution to Residential Portfolio:	28%
General EM&V Approach	Option A

The Residential Green Partners (Green Partners) program encourages customers to replace incandescent and halogen light bulbs with energy efficient lighting by distributing, in person and for free, 5-types of LEDs 5 types LED bulbs including 2 A style (800 and 1600 lumen), globe, BR30, and Candelabra bulbs to customers who visit the TDPUD Conservation Department. LED give-a-ways include up to 16 mix-n-match specialty LEDs. An additional 16 min-n-match LEDs are available per customer if they have received a Residential Energy Survey prior to August 2017 to receive the LEDs.

3.1.1. Sampling Methodology

For programs with relatively homogenous measures, ADM conducted a simple random sample of participants. Specifically, ADM chose participants with email addresses to conduct an online survey. ADM contacted 67 participants out of the total participants of the Green Partners program. Note that this year's evaluation saw a much lower then average response rate in our survey effort resulting in an insufficient number of completions from which to draw statistically significant results. As such, we reviewed our most recent survey efforts to develop Hours of Operation (HOU), Installation Rates (ISR), and the Net-To-Gross ratio.

3.1.2. Gross Impact Evaluation Methods and Results

ADM leveraged a *Deemed Savings* approach to this program in which we applied the following formula to estimate gross impacts:

$$kWh_{Sav} = (kW_{Base} - kW_{CFL}) * Hrs * HCIF * ISR$$

$$kW_{Sav} = (kW_{Base} - kW_{CFL}) * CDF * HCIF * ISR$$

Where:

kWh_{Sav}	Are the annual energy impacts for the project
kW_{Sav}	Are the peak demand reductions

kW_{Base} Is the connected load of the baseline light bulb[1]

kW_{CFL} Is the connected load of the installed light bulb[2]

Hrs Are the annual hours of operation[3]

HCIF Heating/Cooling Interactive Factor[4]

CDF Is the Coincident Demand Factor

ISR Is the *In-Service Rate*

The *In-Service Rate* was derived using customer surveys to identify how many of the bulbs received had been installed. The Coincident Demand Factor (CDF), and interactive factors (HCIF) were sourced from the DEER and then applied to program results. The Ex Post gross impacts are provided in Table 3-3.

Table 3-3 Gross Impacts for Residential Green Partners Program

Gross Ex Post Annual Energy Impacts [kWh]	*Gross Ex Post Peak Demand Reductions [kW]*
267,740	23

3.1.3. **Net Impact Methods and Results**

In addition to gross savings, ADM estimated associated net-to-gross ratios (NTGRs) for this program based on results from a participant survey. The net-to gross analysis for the Green Partners program was conducted using the methodologies outlined in Section 2.1.1.1. The participant survey included several questions designed to elicit information on free-ridership, which in turn is used to estimate net-to-gross ratio. These questions corresponded with financial ability to purchase the equipment, timing of program awareness, likelihood of purchase without the incentive, and timing of the purchase. For residential programs, free-ridership is calculated as the average score determined for the sample of participants surveyed. Survey responses were scored based on the survey answers and the type of measures they received and installed.

As noted earlier, ADM received an insufficient number of completions in this year's survey to derive 2017 specific results. Thus, we compiled data collected by ADM for this program over the previous couple of years to report and average NTG. Note that one of the recommendations we include seeks to improve future response rates for this (and other) programs.

[1] Assessed using an assumed baseline wattage based on the wattage/type of the installed bulb and further informed through surveys

[2] Based on the records kept in the tracking system and further informed by the surveys

[3] Per DEER 2013 for appropriate building type

[4] Per DEER 2013 for appropriate building type

Table 3-4 NTGR and Net Impacts for Green Partners Program: Residential - Green Partners

Free Ridership Estimate	*NTGR Ratio*	*Ex Post Net Annual Energy Savings [kWh]*	*Ex Post Net Peak Demand Reductions [kW]*
33%	67%	179,386	15.3

3.1.4. Evaluation Findings and Program Recommendations

The following represent ADM's key findings for the CY 2017 evaluation of the Green Partners program:

- **Large Percentage of A19 LED Bulbs.** The evaluation found that while the program has successfully transitioned to primarily distribute LED light bulbs, about 60% of these bulbs are A19 which are the most heavily impacted by both EISA standards and Net-to-Gross considerations.

The evaluation team has the following recommendations to improve program performance in future program cycles:

- **Consider phasing out A19 bulbs in favor of specialty sockets.** As efficient lighting saturates the residential market (e.g. CFLs and LEDs) the first sockets to reach saturation are A19. Many A19 LED bulbs are replacing either CFLs or pre-existing LEDs at this point which indicates that future free-ridership rates will be significantly higher for this bulb-type.
- **Prepare to phase out residential light bulbs as an Energy Efficiency Measure.** Currently Phase II of the EISA legislation is slated to become effective in 2020 which will significantly reduce the energy savings potential for residential light bulb replacements – rendering this measure no longer cost effective. Given the prominence of this program in TDPUDs portfolio we recommend TDPUD start the process of re-designing the portfolio and begin developing replacement programs/measures in advance of the 2020 backstop.
- **Increase promotion of TDPUD residential programs.** We have noted that the most common sources for program awareness historically have come from the utility web-site, bill inserts, or through direct communication with utility staff. Program participation would benefit from additional marketing efforts targeting local residents.

3.2. Residential - Refrigerator Recycle

Table 3-5 Residential - Refrigerator Recycle: Summary Table

Final Project Count:	158
Ex Post Gross Energy Savings [kWh]:	171,588
Ex Post Gross Demand Savings [kW]:	26.4
Total Resource Cost [$/kWh]:	$0.05
Net-To-Gross Ratio:	69%
Contribution to Residential Portfolio:	16%
General EM&V Approach:	Option A

The Refrigerator Recycle program promotes the recycling of older, working refrigerators and freezers by providing customers with free pickup and a $30 rebate. This program is implemented through a 3rd party vendor. The vendor is responsible for verification of customer eligibility, scheduling, verification of unit operation, pick up from the customer and delivery to a recycling facility. The program is available to customers during vendor regular business hours.

3.2.1. Sampling Methodology

For the past several evaluation cycles ADM has surveyed participants of this program to develop net-to-gross estimates and support the gross savings estimates. This year we determined that these resources could be focused on other programs as an historical pool of data is available in support of the Refrigerator Recycle program.

3.2.2. Gross Impact Evaluation Methods and Results

ADM leveraged a *Deemed Savings* approach to this program in which we applied the following formula to estimate gross impacts:

$$kWh_{Sav} = UES_{kWh} * N$$

$$kW_{Sav} = kWh_{Sav} * f_{kW}$$

Where:

kWh_{Sav}	Are the annual energy impacts for the project
kW_{Sav}	Are the peak demand reductions
UES_{kWh}	Is the unit energy savings estimate for the measure
f_{kW}	Is a factor used to convert annual kWh to peak demand savings.[5] f_{kW} = *0.000154 kW/kWh*

[5] This factor derived using entries from DEER 2015 for this measure: $f_{kW} = kW_{DEER} / kWh_{DEER}$

N Is the number of rebated units.

UES values for this program were therefore derived using secondary literature research and carried over from the most recent previous evaluation cycles. The final values used for this evaluation are listed in Table 3-6.

Table 3-6 List of UES Estimates: Residential - Refrigerator Recycle

Equipment	*UES (kWh/Unit)*
Refrigerator	1,083
Freezer	1,089

3.2.3. Net Impact Methods and Results

The net-to gross analysis for the Refrigerator Recycling program was conducted using the methodologies outlined in 2.1.1.1. Determining the net effects of the program rebate requires estimating the percentage of energy savings from unit removal that would have occurred without program intervention. These questions corresponded with what respondents' behavior without the program. For residential programs, free-ridership is calculated as the average score determined for the sample of participants surveyed.

As noted earlier, Gross and Net savings calculations were supported by data gathered by ADM in the most recent two survey cycles.

Table 3-7 NTGR and Net Impacts for Refrigerator Recycling Program

Free Ridership	*NTG Ratio*	*Ex Post Net Annual Energy Savings [kWh]*	*Ex Post Net Peak Demand Reductions [kW]*
.31	.69	118,396	18.2

3.2.4. Evaluation Findings and Program Recommendations

The following represent ADM's key findings for the CY 2017 evaluation of the Refrigerator Recycling program:

- **Tracking Data Now Includes Additional Data.** The program tracking data has been updated to include more detailed information about the units being recycled as recommended in previous evaluations.

The evaluation team has the following recommendations to improve program performance in future program cycles:

- **Retailer Updates.** Keeping retailers updated on program specific details such as application deadlines and qualifying units will continue the success of this program.
- **Increase promotion of TDPUD residential programs.** We have noted that the most common sources for program awareness historically have come from the

utility web-site, bill inserts, or through direct communication with utility staff. Program participation would benefit from additional marketing efforts targeting local residents.

3.3. Residential – Event LEDs & Million CFLs

Table 3-8 Event LEDs & Million CFLs: Summary Table

Final Project Count [Bulbs]:	5,279
Ex Post Gross Energy Savings [kWh]:	156,968
Ex Post Gross Demand Savings [kW]:	9.9
Total Resource Cost [$/kWh]:	$0.10
Net-To-Gross Ratio:	50%
Contribution to Residential Portfolio:	15%
General EM&V Approach	Desk Review

The Million CFL program provides free 13 Watt CFL spirals at give-away events to persons who come into the utility offices and request them. While 2017 was the final year for CFL giveaways, the program has transitioned to an LED giveaway program. Furthermore, the program has been designed to minimize the risk of bulb leakage out of TDPUD territory as participants are required to verify their customer status while giveaway events are specifically targeted towards those with a heavy local presence. This includes handing them out at the Truckee Home & Building Show, Chamber Mixers, and other community events.

3.3.1. Gross Impact Evaluation Methodology and Results

ADM conducted a desk review of the program, using program documentation and tracking data to estimate annual impacts. ADM leveraged a *Deemed Savings* approach to this program in which we applied the following formula to estimate gross impacts:

$$kWh_{Sav} = \text{UES} * \text{N}$$

$$kW_{Sav} = \text{UES} * \text{N}$$

Where:

kWh_{Sav}	Are the annual energy impacts for the project
kW_{Sav}	Are the peak demand reductions
UES	Unit Energy Savings estimate
N	Is the number of measures implemented

Program impacts were estimated using the results from the Residential Green Partners CFL program described in Section 3.3. The assumptions are listed in Table 3-9.

Table 3-9 Summary of Savings Estimates: Million CFLs

Parameter	*Value*
Unit Energy Estimate [kWh/Year]	30
Unit Demand Savings Estimate [kW]	.002

CFL and LED inventory levels were reviewed and CFLs given away through other programs were cross-checked against the quantities identified for the program. In total, 5,279 bulbs were confirmed to have been given away through this program in CY 2017.

3.3.2. **Net Impact Methods and Results**

ADM applied the Net-To-Gross value derived for the Residential Green Partners program given its similarities to this one. The NTG ratio applied was 0.50. Program NTGR and associated Net savings values are shown in Table 3-10.

Table 3-10 NTGR and Gross Impacts for Million CFLs Program

Free Ridership Estimate	*NTGR Estimate (1-FR)*	*Ex Post Net Annual Energy Savings [kWh]*	*Ex Post Net Peak Demand Reductions [kW]*
0.50	0.50	78,484	4.9

3.3.3. **Evaluation Findings and Program Recommendations**

The evaluation team has the following findings for this program:

- **Large Percentage of A19 LED Bulbs.** The evaluation found that while the program has successfully transitioned to primarily distribute LED light bulbs, these bulbs are A19 which are the most heavily impacted by both EISA standards and Net-to-Gross considerations.
- **Giveaway Events have been selected to specifically target local residents.** In response to previous evaluation recommendations staff specifically targeted community events which would have high local participation. Furthermore, event staff surveyed participants to ensure that they were TDPUD customers to reduce/eliminate the potential for leakage.

The evaluation team has the following recommendations to improve program performance in future program cycles:

- **Prepare to phase out residential light bulbs as an Energy Efficiency Measure.** Currently Phase II of the EISA legislation is slated to become effective in 2020 which will significantly reduce the energy savings potential for residential light bulb replacements – rendering this measure no longer cost effective. Given the

prominence of this program in TDPUDs portfolio we recommend TDPUD start the process of re-designing the portfolio and begin developing replacement programs/measures in advance of the 2020 backstop.

3.4. Residential – Green Schools Program

Table 3-11 Residential – Green Schools Program: Summary Table

Project Count (Bulb):	3,744
Ex Post Gross Energy Savings [kWh]:	143,540
Ex Post Gross Demand Savings [kW]:	9.0
Total Resource Cost [$/kWh]:	$0.03
Net-To-Gross Ratio:	67%
Contribution to Residential Portfolio:	14%
General EM&V Approach	Desk Review

The Green Schools program promotes energy and water conservation through an innovative series of programs designed to both educate students and deliver, for free, energy and water savings measures. The program is run in collaboration with the Sierra Watershed Education Program (SWEP) Green Teams, the Envirolution Club Trashion Show, and Truckee Tahoe Unified School District. The Green Teams are sustainability clubs at local elementary schools that utilize educational projects to empower students and teacher to be good global citizens, working to ensure adequate resources for a clean and healthy environment. SWEP educators, along with high school mentors, facilitate weekly sustainability club meetings exploring service learning projects including energy and water conservation.

3.4.1. Gross Impact Evaluation Methods and Results

ADM conducted a desk review of the program, using program documentation and tracking data to estimate annual impacts. ADM leveraged a *Deemed Savings* approach to this program in which we applied the following formula to estimate gross impacts:

$$kWh_{Sav} = \text{UES} * \text{N}$$

$$kW_{Sav} = \text{UES} * \text{N}$$

Where:

kWh_{Sav}	Are the annual energy impacts for the project
kW_{Sav}	Are the peak demand reductions
UES	Unit Energy/Demand Savings estimate
N	Is the number of measures implemented

Program impacts were estimated using the results and assumptions from the Residential Green Partners program described in Section 3.3. The assumptions are listed in Table 3-12.

Table 3-12 Summary of Savings Estimates: Green Schools Program

Parameter	*UES kWh [kWh/Year]*	*UES kW [kW/Year]*
LED A19	25	0.0017

In total, 3,744 LEDs were given away through this program in CY 2017.

3.4.2. **Net Impact Methods and Results**

ADM applied the Net-To-Gross value derived for the Residential Green Partners Program to the Green Schools program given their similarities. The NTG ratio applied was 0.67. Program NTGR and associated Net savings values are shown in Table 3-13.

Table 3-13 NTGR and Gross Impacts for Green Schools Program

Free Ridership Estimate	*NTGR Estimate (1-FR)*	*Ex Post Net Annual Energy Savings [kWh]*	*Ex Post Net Peak Demand Reductions [kW]*
.33	.67	96,172	6.1

3.4.3. **Evaluation Findings and Program Recommendations**

The evaluation team has the following findings for this program:

- **Prepare to phase out residential light bulbs as an Energy Efficiency Measure.** Currently Phase II of the EISA legislation is slated to become effective in 2020 which will significantly reduce the energy savings potential for residential light bulb replacements – rendering this measure no longer cost effective. Given the prominence of this program in TDPUDs portfolio we recommend TDPUD start the process of re-designing the portfolio and begin developing replacement programs/measures in advance of the 2020 backstop.

3.5. Residential - Lighting Rebate & Point of Sale

Table 3-14 Residential Lighting Rebate: Summary Table

Final Bulb Count[6]:	3,770
Ex Post Gross Energy Savings [kWh]:	92,456
Ex Post Gross Demand Savings [kW]:	5.9
Total Resource Cost [$/kWh]:	$0.03
Net-To-Gross Ratio:	67%
Contribution to Residential Portfolio:	9%
General EM&V Approach:	Option A

The TDPUD Residential Lighting Rebate Program encourages customers to replace incandescent and halogen light bulbs with energy efficient lighting by providing incentives for Light Emitting Diode (LED) screw-in or plug in bulbs. In 2017, the Residential lighting program continued to include a point-of-sale component through a local hardware store in which the cost of select LED bulbs were bought down. The point-of-sale component distributed 1,223 LED bulbs.

3.5.1. Sampling Methodology

For programs with relatively homogenous measures, ADM conducted a simple random sample of participants. Specifically, ADM chose participants with email addresses to conduct an online survey. ADM contacted 67 participants out of the total participants of the Residential Lighting Program. Note that this year's evaluation saw a much lower than average response rate in our survey effort resulting in an insufficient number of completions from which to draw statistically significant results. As such, we reviewed our most recent survey efforts to develop Hours of Operation (HOU), Installation Rates (ISR), and the Net-To-Gross ratio.

3.5.2. Gross Impact Evaluation Methods and Results

ADM leveraged a *Deemed Savings* approach to this program in which we applied the following formula to estimate gross impacts:

$$kWh_{Sav} = (kW_{Base} - kW_{CFL}) * Hrs * HCIF * ISR$$

$$kW_{Sav} = (kW_{Base} - kW_{CFL}) * CDF * HCIF * ISR$$

[6] The Residential Lighting Program included a point of sale component in 2017 which is reflected in the quantities listed here.

Where:

kWh_{Sav}	Are the annual energy impacts for the project
kW_{Sav}	Are the peak demand reductions
kW_{Base}	Is the connected load of the baseline light bulb[7]
kW_{CFL}	Is the connected load of the installed light bulb[8]
Hrs	Are the annual hours of operation
HCIF	Heating/Cooling Interactive Factor[9]
CDF	Is the Coincident Demand Factor
ISR	Is the *In-Service Rate*

Due to similarities between this program and the Green Partners program, as well as the small size of this program relative to the others, ADM leveraged our findings from the Green Partners program to inform the assumptions used to estimate gross impacts for the Lighting Rebate Program. Annual Hours of use were used per historical survey results from the Green Partners Program, the CDF and HCIFs were used from DEER, and per bulb energy savings estimates were determined and applied.

3.5.3. **Net Impact Methods and Results**

In addition to gross savings, ADM estimated associated net-to-gross ratios (NTGRs) for this program based on results from a participant survey. The net-to gross analysis for the Residential Lighting program was conducted using the methodologies outlined in Section 2.1.1.1. The participant survey included several questions designed to elicit information on free-ridership, which in turn is used to estimate net-to-gross ratio. These questions corresponded with financial ability to purchase the equipment, timing of program awareness, likelihood of purchase without the incentive, and timing of the purchase. For residential programs, free-ridership is calculated as the average score determined for the sample of participants surveyed. Survey responses were scored based on the survey answers and the type of measures they received and installed.

As noted earlier, ADM received an insufficient number of completions in this year's survey to derive 2017 specific results. Thus, we compiled data collected by ADM for this program over the previous couple of years to report and average NTG. Note that one of the recommendations we include seeks to improve future response rates for this (and other) programs.

[7] Assessed using an assumed baseline wattage based on the wattage/type of the installed bulb and further informed through surveys

[8] Based on the records kept in the tracking system and further informed by the surveys

[9] Per DEER 2013 for appropriate building type

Table 3-15 NTGR and Gross Impacts for Residential Lighting Program

Free Ridership Estimate	*NTGR Estimate (1-FR)*	*Ex Post Net Annual Energy Savings [kWh]*	*Ex Post Net Peak Demand Reductions [kW]*
.33	.67	61,946	3.9

3.5.4. **Evaluation Findings and Program Recommendations**

The evaluation team has the following findings for this program:

- **Many A19 LED Bulbs.** The evaluation found that while the program has successfully transitioned to primarily distribute LED light bulbs, many bulbs were A19 which are the most heavily impacted by both EISA standards and Net-to-Gross considerations.

The evaluation team has the following recommendations to improve program performance in future program cycles:

- **Consider phasing out A19 bulbs in favor of specialty sockets.** As efficient lighting saturates the residential market (e.g. CFLs and LEDs) the first sockets to reach saturation are A19. Many A19 LED bulbs are replacing either CFLs or pre-existing LEDs at this point which indicates that future free-ridership rates will be significantly higher for this bulb-type.
- **Prepare to phase out residential light bulbs as an Energy Efficiency Measure.** Currently Phase II of the EISA legislation is slated to become effective in 2020 which will significantly reduce the energy savings potential for residential light bulb replacements – rendering this measure no longer cost effective. Given the prominence of this program in TDPUDs portfolio we recommend TDPUD start the process of re-designing the portfolio and begin developing replacement programs/measures in advance of the 2020 backstop.

3.7. Residential Energy Survey

Table 3-16 Residential Energy Survey: Summary Table

Final Measure Count:	10,366
Ex Post Gross Energy Savings [kWh]:	88,809
Ex Post Gross Demand Savings [kW]:	5.4
Ex Post Gross Water Savings [CCF]:	524
Total Resource Cost [$/kWh]:	$0.24
Net-To-Gross Ratio	67%
Contribution to Residential Portfolio:	8%
General EM&V Approach	Option A

The TDPUD provides residential energy surveys to non-income limited customers through the Residential Energy Survey (RES) Program. All residential energy surveys include a free energy survey and free energy and water-saving measures. The energy survey is a visual inspection only. Any measures recommended during the survey, which the District is providing for the program, are given to the residents at the time of survey. Customers are responsible for installing these free measures within 10 days of the receipt of these measures. Customers are also informed of District programs that they may benefit from and provided with associated literature.

3.7.1. Sampling Methodology

ADM conducted a simple random sample of participants for online survey. Specifically, ADM chose participants with email addresses to conduct an online survey. ADM contacted 67 participants out of the total participants of the RES Program. Note that this year's evaluation saw a much lower than average response rate in our survey effort resulting in an insufficient number of completions from which to draw statistically significant results. As such, we reviewed our most recent survey efforts to develop Hours of Operation (HOU), Installation Rates (ISR), and the Net-To-Gross ratio.

3.7.2. Gross Impact Evaluation Methods and Results

ADM leveraged a *Deemed Savings* approach to this program in which we applied the following formula to estimate gross impacts:

$$kWh_{Sav} = \text{UES} * \text{N}$$

$$kW_{Sav} = \text{UES} * \text{N}$$

Where:

kWh_{Sav} Are the annual energy impacts for the project

kW_{Sav} Are the peak demand reductions

UES Is the Unit energy savings estimate for the measure

N Is the number of measures implemented

Several measures were offered through this program and various combinations/quantities were observed for each participant. ADM developed UES estimates for each measure as listed in Table 3-17.

Table 3-17 List of UES estimates for Measures offered in RES Program

Measure	*Unit Energy Savings [kWh]*		*Unit Demand Savings [kW]*	
	No Hot Water	W/ Hot Water	No Hot Water	W/ Hot Water
DR30 15/65	27	27	0.0018	0.0018
Globe G25 9/40	18	18	0.0012	0.0012
PAR 38 120/23	61	61	0.0040	0.0040
R20 14/50	22	22	0.0015	0.0015
R30 15/65	27	27	0.0018	0.0018
Spiral 13/60	26	26	0.0017	0.0017
Spiral 23/100	61	61	0.0040	0.0040
LED: A19 9/60	22	22	0.0019	0.0019
LED: A19 15/100	40	40	0.0034	0.0034
LED: Globe 6/40	17	17	0.0015	0.0015
LED:BR30 8/65	26	26	0.0022	0.0022
LED: Candelabra 4/40	25	25	0.0021	0.0021
Swivel Aerators	2.51	44.06	0	0
Bathroom Aerators	2.51	44.06	0	0
Kitchen Aerators	10.30	219.17	0	0
Showerheads	10.80	275.97	0	0
Spray Nozzle	3.90	3.90	0	0

The assumptions and sources used to develop each of the UES estimates in Table 3-17 can be found in the Excel workbook used to analyze the program's impacts. This workbook can be made available to TDPUD upon request.

3.7.3. **Net Impact Methods and Results**

In addition to gross savings, ADM estimated associated net-to-gross ratios (NTGRs) for this program based on results from a participant survey. The net-to gross analysis for the Residential Energy Survey program was conducted using the methodologies outlined in

Section 2.1.1.1. The participant survey included several questions designed to elicit information on free-ridership, which in turn is used to estimate net-to-gross ratio. These questions corresponded with financial ability to purchase the equipment, timing of program awareness, likelihood of purchase without the incentive, and timing of the purchase. For residential programs, free-ridership is calculated as the average score determined for the sample of participants surveyed. Survey responses were scored based on the survey answers and the type of measures they received and installed.

As noted earlier, ADM received an insufficient number of completions in this year's survey to derive 2017 specific results. Thus, we compiled data collected by ADM for this program over the previous couple of years to report and average NTG. Note that one of the recommendations we include seeks to improve future response rates for this (and other) programs. Net savings values are shown in Table 3-18.

Table 3-18 Net Impact Summary: RES Energy Survey Program

Free-ridership	*Net-to-Gross Ratio*	*Net Annual Savings (kWh)*	*Net Peak Demand Savings (kW)*	*Net Water Savings (CCF)*
.33	.67	59,502	3.6	351

3.7.4. **Evaluation Findings and Program Recommendations**

The following represent ADM's key findings for the CY 2017 evaluation of the Residential Energy Survey program:

- **Large Percentage of A19 LED Bulbs.** The evaluation found that while the program has successfully transitioned to primarily distribute LED light bulbs, about 60% of these bulbs are A19 which are the most heavily impacted by both EISA standards and Net-to-Gross considerations.

The evaluation team has the following recommendations to improve program performance in future program cycles:

- **Consider phasing out A19 bulbs in favor of specialty sockets.** As efficient lighting saturates the residential market (e.g. CFLs and LEDs) the first sockets to reach saturation are A19. Many A19 LED bulbs are replacing either CFLs or pre-existing LEDs at this point which indicates that future free-ridership rates will be significantly higher for this bulb-type.
- **Increase promotion of TDPUD residential programs.** We have noted that the most common sources for program awareness historically have come from the utility web-site, bill inserts, or through direct communication with utility staff. Program participation would benefit from additional marketing efforts targeting local residents.

3.8. Residential – Energy Saving Partners Program

Table 3-19 Residential - ESP Residential Survey: Summary Table

Final Mesaure Count:	1,286
Ex Post Gross Energy Savings [kWh]:	14,635
Ex Post Gross Demand Savings [kW]:	0.8
Ex Post Gross Water Savings [CCF]:	143
Total Resource Cost [$/kWh]:	$0.16
Net-To-Gross Ratio:	100%
Contribution to Residential Portfolio:	1%
General EM&V Approach	Desk Review

The TDPUD provides residential energy surveys to qualified income-limited customers through the Energy Saving Partners (ESP). All residential energy surveys include a free energy survey and free energy and water-saving measures. The energy survey is a visual inspection only. Income-limited customers are qualified by an intermediary agency who will pre-qualify applicants for this program. Any measures recommended during the survey, which the District is providing for the program, are given to the residents at the time of survey. Customers are responsible for installing these free measures within 10 days of the receipt of these measures. Customers are also informed of District programs that they may benefit from and provided with associated literature. ESP program participants are eligible for a one-time credit per service address equal to their highest energy charge in the past 12-months not to exceed $200. If they do not have 12-month of billing history, District may use the prior 12-month energy usage history for the service address. Customers who have received an ESP credit, but have moved to a new service address are eligible for a credit and survey at the new address 2 years after the initial credit. 2009 program participants are eligible for a second credit and survey at the same address as the original survey. ESP qualifications guidelines are consistent with the Nevada County Low-Income criteria, other local low income organization criteria (food stamps, MediCal) or proof of 25% or greater loss of household income due to change in employment status. Second home owners (non-permanent resident rate) do not qualify.

3.8.1. Sampling Methodology

For programs with relatively homogenous measures, ADM conducted a simple random sample of participants. Specifically, ADM chose participants with email addresses to conduct an online survey. ADM contacted 67 participants out of the total participants of the RES Program. Note that this year's evaluation saw a much lower than average response rate in our survey effort resulting in an insufficient number of completions from which to draw statistically significant results. As such, we reviewed our most recent survey

efforts to develop Hours of Operation (HOU), Installation Rates (ISR), and the Net-To-Gross ratio.

3.8.2. Gross Impact Evaluation Methods and Results

ADM leveraged a *Deemed Savings* approach to this program in which we applied the following formula to estimate gross impacts:

$$kWh_{Sav} = \text{UES} * \text{N}$$

$$kW_{Sav} = \text{UES} * \text{N}$$

Where:

kWh_{Sav}	Are the annual energy impacts for the project
kW_{Sav}	Are the peak demand reductions
UES	Is the Unit energy savings estimate for the measure
N	Is the number of measures implemented

Several measures were offered through this program. ADM also observed that various combinations/quantities of each were implemented among program participants. ADM developed UES estimates for each measure as listed in Table 3-20.

Table 3-20 List of UES estimates for Measures offered in ESP Program

Measure	*Savings Per [kWh]*		*Savings Per [kW]*	
	No Hot Water	W/ Hot Water		No Hot Water
DR30 15/65	27	27	DR30 15/65	27
Globe G25 9/40	18	18	Globe G25 9/40	18
PAR 38 120/23	61	61	PAR 38 120/23	61
R20 14/50	22	22	R20 14/50	22
R30 15/65	27	27	R30 15/65	27
Spiral 13/60	26	26	Spiral 13/60	26
Spiral 23/100	61	61	Spiral 23/100	61
LED: A19 9/60	22	22	0.0019	0.0019
LED: A19 15/100	40	40	0.0034	0.0034
LED: Globe 6/40	17	17	0.0015	0.0015
LED:BR30 8/65	26	26	0.0022	0.0022
LED: Candelabra 4/40	25	25	0.0021	0.0021
LED: A19 9/60	22	22	0.0019	0.0019
Swivel Aerators	2.51	44.06	Swivel Aerators	2.51
Bathroom Aerators	2.51	44.06	Bathroom Aerators	2.51
Kitchen Aerators	10.30	219.17	Kitchen Aerators	10.30

The assumptions and sources used to develop each of the UES estimates in Table 3-20 can be found in the Excel workbook used to analyze the program's impacts. This workbook can be made available to TDPUD upon request.

3.8.3. **Net Impact Methods and Results**

Industry best practices state that low-income programs are deemed 100% for NTGR. ADM applied the associated net-to-gross ratios (NTGRs) for this program based on industry best practices. These values were multiplied by gross per-unit kWh. Net savings values are shown in Table 3-21.

Table 3-21 NTGR and Net Impacts for Energy Savings Partners Program

Free Ridership	*NTG Ratio*	*Ex Post Net Annual Energy Savings [kWh]*	*Ex Post Net Peak Demand Reductions [kW]*	*Ex Post Net Water Savings [CCF]*
0.00	1.00	14,635	0.9	142

3.8.4. Evaluation Findings and Program Recommendations

The following represent ADM's key findings for the CY 2017 evaluation of Energy Saving Partners program:

- **Large Percentage of A19 LED Bulbs.** The evaluation found that while the program has successfully transitioned to primarily distribute LED light bulbs, about 60% of these bulbs are A19 which are the most heavily impacted by both EISA standards and Net-to-Gross considerations.

The evaluation team has the following recommendations to improve program performance in future program cycles:

- **Consider phasing out A19 bulbs in favor of specialty sockets.** As efficient lighting saturates the residential market (e.g. CFLs and LEDs) the first sockets to reach saturation are A19. Many A19 LED bulbs are replacing either CFLs or pre-existing LEDs at this point which indicates that future free-ridership rates will be significantly higher for this bulb-type.
- **Increase promotion of TDPUD residential programs.** We have noted that the most common sources for program awareness historically have come from the utility web-site, bill inserts, or through direct communication with utility staff. Program participation would benefit from additional marketing efforts targeting local residents.

3.9. Residential – LED Holiday Light Exchange

Table 3-22 Residential – LED Holiday Light Exchange: Summary Table

Project Count:	1,058
Ex Post Gross Energy Savings [kWh]:	9,549
Ex Post Gross Demand Savings [kW]:	0.0
Total Resource Cost [$/kWh]:	$0.35
Net-To-Gross Ratio:	91%
Contribution to Residential Portfolio:	1%
General EM&V Approach	Desk Review

The Holiday Swap program provides customers with energy efficient LED holiday lights. Customers bring in their own, inefficient, lights and TDPUD staff exchange them for more efficient LED variants. Four different types of LED holiday lights were available through the program which included C6 LED White, C6 LED Multi-Color, 5MM Mini Warm White, and 5MM Mini Multi-Color strands.

3.9.1. Gross Impact Evaluation Methods and Results

ADM conducted a desk review of the program, using program documentation and tracking data to estimate annual impacts. ADM leveraged a *Deemed Savings* approach to this program in which we applied the following formula to estimate gross impacts:

$$kWh_{Sav} = \mathrm{UES} * \mathrm{N}$$

Where:

kWh_{Sav}	Are the annual energy impacts for the project
UES	Unit Energy Savings estimate
N	Is the number of measures implemented

The program UES estimate was derived using an engineering equation (IPMVP Option A) for each of the 3 types of non-LED holiday lights replaced through this program. The equation for each light took the following form:

$$\mathrm{UES} = \mathrm{N}_{Bulbs} * \Delta P_{Bulb} * Hrs$$

Where:

UES_{Bulb}	Energy Savings Estimate
N_{Bulbs}	Is the number of bulbs per strand
ΔP_{Bulb}	Is the delta power (kW) between the non-LED and LED bulbs

Hrs Annual operating hours per strand

The UES determined for this measure was 9.0 kWh/Year-strand. Residential strands were assumed to operate 10 hours per day for 31 days a year and business strands were assumed to operate 8 hours per day for 31 days a year.

3.9.2. Net Impact Methods and Results

Net impacts were not reviewed directly for this program. The applied NTG ratio is 0.91 and was derived from the PY 2013 evaluation report for this program. Program NTGR and associated Net savings values are shown in Table 3-23.

Table 3-23 NTGR and Net Impacts for LED Holiday Light Exchange Program

Free Ridership Estimate	*NTGR Estimate (1-FR)*	*Ex Post Net Annual Energy Savings [kWh]*	*Ex Post Net Peak Demand Reductions [kW]*
9%	91%	8,690	0

3.9.3. Evaluation Findings and Program Recommendations

The evaluation team has the following recommendations to improve program performance in future program cycles:

- **Increase promotion of TDPUD residential programs.** We have noted that the most common sources for program awareness historically have come from the utility web-site, bill inserts, or through direct communication with utility staff. Program participation would benefit from additional marketing efforts targeting local residents.

3.1. Residential - Building Efficiency

Table 3-24 Residential - Building Efficiency: Summary Table

Final Project Count:	39
Ex Post Gross Energy Savings [kWh]:	2,501
Ex Post Gross Demand Savings [kW]:	5.9
Total Resource Cost [$/kWh]:	$0.37
Net-To-Gross Ratio:	74%
Contribution to Residential Portfolio:	0.2%
General EM&V Approach	Desk Review

EPA estimates that homeowners can typically save up to 10% of total energy costs by air sealing their homes and adding insulation. Additionally, sealing and insulating ducts can save as much as 20% of the energy for heating/cooling. Customers who test and repair their home's envelope or duct system to save energy received rebates through this program.

3.1.1. Gross Impact Evaluation Methods and Results

ADM leveraged a *Deemed Savings* approach to this program in which we applied the following formula to estimate gross impacts:

$$kWh_{Sav} = UES_{kWh} * N$$

$$kW_{Sav} = UES_{kW} * N$$

Where:

kWh_{Sav}	Are the annual energy impacts for the project
kW_{Sav}	Are the peak demand reductions
$UES_{kWh/kW}$	Is the per unit energy/demand savings estimate for each measure.
N	Is the number of measures implemented

Two separate UES values were determined for this program (one for each measure offered). Based on the information available from each site, the best available source for UES estimates was the CMUA TRM. Table 3-25 summarizes the UES values used for Duct leakage and Table 3-26 provides the same for envelope mitigation.

Table 3-25 UES Values used for Duct Repair Measure

Climate Zone	*kWh*	*KW*
CZ16	118	0.278

Table 3-26 UES Values used for Envelope Mitigation Measure

Climate Zone	*Sngl Story 15 %*	*Sngl Story 30 %*	*2 Story 15 %*	*2 Story 30 %*
CZ16	10.8	20.8	13.6	29.2

3.1.2. **Net Impact Methods and Results**

The applied NTG ratio is 74% for Duct Repair and 80% for Building Envelope Mitigation, and was derived from the PY 2013 evaluation report for this program. These values were multiplied by gross per-unit kWh to derive program net savings [kWh] and net peak demand reduction [kW]. Program NTGR and associated Net savings values are shown in Table 3-27.

Table 3-27 NTGR and Gross Impacts for Building Efficiency Rebate Program

	Free Ridership Estimate	*NTG Ratio*	*Ex Post Gross Annual Energy Savings [kWh]*	*Ex Post Gross Peak Demand Reductions [kW]*
Duct Repair	26%	74%	849	2
Building Envelope Mitigation	20%	80%	1,652	3.9

3.1.3. **Evaluation Findings and Program Recommendations**

The evaluation team has the following recommendations to improve program performance in future program cycles:

- **Increase promotion of TDPUD residential programs.** We have noted that the most common sources for program awareness historically have come from the utility web-site, bill inserts, or through direct communication with utility staff. Program participation would benefit from additional marketing efforts targeting local residents.

3.2. Residential – Appliance

Table 3-28 Residential - Residential-Appliance: Summary Table

Final Project Count:	290
Ex Post Gross Energy Savings [kWh]:	48,673
Ex Post Gross Demand Savings [kW]:	5.6
Total Resource Cost [$/kWh]:	$0.11
Net-To-Gross Ratio:	66%
Contribution to Residential Portfolio:	4.4%
General EM&V Approach	Option A

The Appliance Rebate Program encourages customers to purchase energy efficient appliances by providing increasing incentives for more efficient appliances as identified by Energy Star and the Consortium of Energy Efficiency (CEE). Energy Star and CEE Tier 1 identify appliances that use less energy than the federal standard. CEE Tiers 2 & 3 identify super-efficient appliances that use significantly less energy than the federal standard and identify the most energy efficient of the Energy Star spectrum.

3.2.1. Gross Impact Evaluation Methods and Results

ADM leveraged a *Deemed Savings* approach to this program in which we applied the following formula to estimate gross impacts:

$$kWh_{Sav} = UES_{kWh} * N$$

$$kW_{Sav} = \frac{kWh_{Sav}}{8760}$$

Where:

kWh_{Sav}	Are the annual energy impacts for the project
kW_{Sav}	Are the peak demand reductions
UES_{kWh}	Is the unit energy savings estimate for the measure
N	Is the number of rebated units

UES values for this program were derived from the CMUA TRM. The final values used for this evaluation are listed in Table 3-29.

Table 3-29 List of UES Estimates: Appliance Rebates

Equipment	*UES (kWh/Unit)*
ES/CEE Tier 1 Clothes Washer	209
ES/CEE Tier 2 Clothes Washer	220
ES/CEE Tier 3 Clothes Washer	229
ES/CEE Tier 1 Dishwasher	39
ES/CEE Tier 1 Refrigerator	130
ES/CEE Tier 2 Refrigerator	162
ES/CEE Tier 3 Refrigerator	195

3.2.2. **Net Impact Methods and Results**

ADM used primary survey data collected over the most recent two evaluations to develop net savings estimates for this program.[10] The net-to gross analysis for the Appliance Rebate program was conducted using the methodologies outlined in 2.1.1.1. Determining the net effects of the program rebate requires estimating the percentage of energy savings from unit removal that would have occurred without program intervention. These questions corresponded with what respondents' behavior without the program. These values were multiplied by gross per-unit kWh to derive program net savings [kWh] and net peak demand reduction [kW]. Program NTGR and associated Net savings values are shown in Table 3-30.

Table 3-30 NTGR and Net Impacts for Appliance Rebate Program

Measure	*Free Ridership Estimate*	*NTGR Estimate (1-FR)*	*Ex Post Net Annual Energy Savings [kWh]*	*Ex Post Net Peak Demand Reductions [kW]*
Clothes Washer	45%	65%	14,680	1.7
Dishwasher	41%	60%	4,337	0.5
Refrigerator	33%	69%	13,013	1.5

[10] It should be noted that this survey effort also included participants in the Toilet Rebate and Water Leak Repair Programs.

3.3. Evaluation Findings and Program Recommendations for Residential Programs

The evaluation team has the following recommendations to improve Residential program performance in future program cycles:

- **Consider ECM Furnace fan measure.** Currently, furnaces in the highest efficiency brackets utilize multi-speed ECM fan motors to achieve such efficiency levels. Given Truckee's heating dominated climate, this represents a decent energy savings potential.
- **Increase promotion of TDPUD residential programs.** We have noted that the most common sources for program awareness historically have come from the utility web-site, bill inserts, or through direct communication with utility staff. Program participation would benefit from additional marketing efforts targeting local residents.

3.5. Residential – Misc. Water Measures

Table 3-31 Residential – Misc. Water Measures: Summary Table

Project Count:	1,773
Ex Post Gross Energy Savings [kWh]:	60,490
Ex Post Gross Demand Savings [kW]:	6.9
Ex Post Gross Water Savings [CCF]:	2,282
Total Resource Cost [$/kWh]:	$0.05
Net-To-Gross Ratio:	77%
Contribution to Residential Portfolio:	5.5%
General EM&V Approach	Desk Review

Encourages customers to replace high water use fixtures with water efficient fixtures by distributing, in person and for free, various measures. Water efficient measures are distributed to customers who visit the TDPUD Conservation Department or local events.

3.5.1. Gross Impact Evaluation Methods and Results

ADM leveraged a *Deemed Savings* approach to this program in which we applied the following formula to estimate gross impacts:

$$kWh_{Sav} = UES_{kWh} * N$$

$$kW_{Sav} = UES_{kW} * N$$

Where:

kWh_{Sav}	Are the annual energy impacts for the project
kW_{Sav}	Are the peak demand reductions
$UES_{kWh/kW}$	Is the per unit energy/demand savings estimate for each measure.
N	Is the number of measures implemented

UES estimates were derived using the energy intensity of water derived for TDPUD customers through a study performed in 2015. Additionally, various secondary sources were reviewed for appropriate water conservation estimates.

3.5.2. Net Impact Methods and Results

Net impacts were not reviewed directly for this program. The applied NTG ratio is 0.77 and was derived from the PY 2013 evaluation report for this program. Program NTGR and associated Net savings values are shown in Table 3-32.

Table 3-32 NTGR and Gross Impacts for Misc. Water Measures Program

Free Ridership Estimate	*NTGR Estimate (1-FR)*	*Ex Post Gross Annual Energy Savings [kWh]*	*Ex Post Gross Peak Demand Reductions [kW]*	*Ex Post Gross Water Savings [CCF]*
33%	77%	60,490	6.9	2,282

3.5.3. Evaluation Findings and Program Recommendations

The evaluation team has the following recommendations to improve program performance in future program cycles:

- **Increase promotion of TDPUD residential programs.** We have noted that the most common sources for program awareness historically have come from the utility web-site, bill inserts, or through direct communication with utility staff. Program participation would benefit from additional marketing efforts targeting local residents.

3.6. Residential - Water Leak Rebate

Table 3-33 Residential - Residential - Water Leak Rebate: Summary Table

Final Project Count:	21
Ex Post Gross Energy Savings [kWh]:	35,450
Ex Post Gross Demand Savings [kW]:	4.0
Ex Post Gross Water Savings [CCF]:	10,152
Total Resource Cost [$/kWh]:	$0.02
Net-To-Gross Ratio:	77%
Contribution to Residential Portfolio:	3.2%
General EM&V Approach	Desk Review

The Truckee Donner PUD began installing meters in the summer of 2009 as required by California State Law. One feature of the water meters is the ability to remotely detect water leaks on the customer-side of the water meter. We have found that over 10% of our customers have leaks on water or irrigation piping and/or fixtures. Water leaks can be very costly if not repaired. The Water Leak Repair Rebate is intended to help customers offset the cost of locating and repairing leaks that require the services of a licensed professional by offering a rebate of up to $100. This year customers received continuous flow email notifications and more promotion on the leak rebate program.

3.6.1. Gross Impact Evaluation Methods and Results

ADM leveraged a *Deemed Savings* approach to this program in which we applied the following formula to estimate gross impacts:

$$kWh_{Sav} = \text{UES} * \text{N}$$

$$kW_{Sav} = \text{UES} * \text{N}$$

Where:

kWh_{Sav}	Are the annual energy impacts for the project
kW_{Sav}	Are the peak demand reductions
UES	Unit Energy Savings estimate
N	Is the number of measures implemented

The UES estimates were developed by performing regression analysis on billing data from program participants (IPMVP Option C). The regression equation took the following form:

$$Q_{Day} = \beta_1 * SITE * Seas + \beta_2 * SITE * LK + \beta_3 * SITE * TEMP$$

Where:

Q_{Day}	Daily Water Consumption [Gallons]
SITE	Variable indicating difference in usage from one site to the next
Seas	Used to capture differences in usage correlated with seasonality
LK	Dummy variable representing the presence of a leak
TEMP	Average ambient temperature for time period

Figure 3-3 illustrates the water savings identified for each site through this regression. What remains unknown is how long these leaks would have persisted in the absence of the program as no non-participant data was reviewed. As such, the regressed average impact of .790 MG (3,686 kWh) per site is expected to be high. When several outlier sites are removed the average savings drops to 1,385 kWh per year which is slightly less than what was verified in the CY 2013 evaluation.

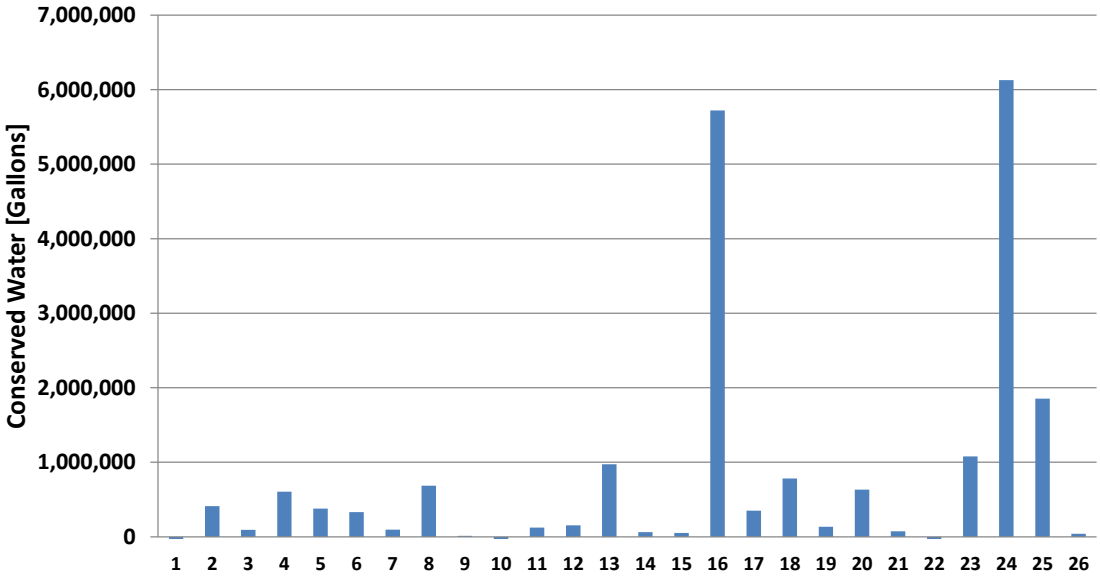

Figure 3-3 Estimated Annual Water Impacts [Gal] per Regression Analysis

Since the current Ex Ante estimate is based on a previous billing analysis (performed during the 2011 EM&V cycle), and since the current analysis would yield 1,688 kWh/Site if the lowest outlier is included in the mean per-site estimate, ADM concluded that an estimate of 361,628 gallons per year (1,688.11 kWh) per site is reasonable.

3.6.2. Net Impact Methods and Results

Net impacts were not reviewed directly for this program. The applied NTG ratio is 0.77 and was derived from the PY 2013 evaluation report for this program. Program NTGR and associated Net savings values are shown in Table 3-34.

Table 3-34 NTGR and Gross Impacts for Water Leak Rebate Program

Free Ridership Estimate	*NTGR Estimate (1-FR)*	*Ex Post Gross Annual Energy Savings [kWh]*	*Ex Post Gross Peak Demand Reductions [kW]*	*Ex Post Gross Water Savings [CCF]*
33%	77%	35,450	4.0	10,152

3.6.3. Evaluation Findings and Program Recommendations

The evaluation team has the following recommendations to improve program performance in future program cycles:

- **Increase promotion of TDPUD residential programs.** We have noted that the most common sources for program awareness historically have come from the utility web-site, bill inserts, or through direct communication with utility staff. Program participation would benefit from additional marketing efforts targeting local residents.

3.7. Residential - Toilet Exchange

Table 3-35 Residential -Toilet Exchange: Summary Table

Final Project Count:	107
Ex Post Gross Energy Savings [kWh]:	4,200
Ex Post Gross Demand Savings [kW]:	0.5
Ex Post Gross Water Savings [CCF]:	511
Total Resource Cost [$/kWh]:	$1.09
Net-To-Gross Ratio:	86%
Contribution to Residential Portfolio:	0.4%
General EM&V Approach	Desk Review

The Water Efficient Toilet Exchange Program encourages customers to replace high-water use toilets (greater than or equal to 3 gallons per flush) to low water use toilets by distributing low-flush toilets (1.28 gallons per flush) through a local vendor store front. The vendor provides, at their store, year-round at least two low-flush toilet options (round and oblong) to qualifying customers to exchange at no cost. The vendor is responsible for collecting and verifying eligibility of the old toilet, properly disposing of the old toilets, and providing monthly program reports documenting the District customers served, quantity of toilets provided and vendor invoice. The District verifies the customer's eligibility to participate in the program and provides them with an approved District Water-Efficient Toilet Exchange Program Customer Information Form.

3.7.1. Gross Impact Evaluation Methods and Results

ADM leveraged a *Deemed Savings* approach to this program in which we applied the following formula to estimate gross impacts:

$$kWh_{Sav} = UES * N$$

$$kW_{Sav} = \frac{kWh_{Sav}}{8760}$$

Where:

kWh_{Sav}	Are the annual energy impacts for the project
kW_{Sav}	Are the peak demand reductions
UES	Is the per unit energy savings estimate for each measure.
N	Is the number of measures implemented

Three separate UES estimates were derived based on the capacity of the toilet installed and on the toilet it replaced. ADM used engineering calculations to derive the unit energy

savings estimates along with secondary literature research to establish appropriate assumptions. The following formula was used to estimate the UES;

$$kWh_{Toilet} = F_{Person-Day} * N_{Persons} * (V_{Base} - V_{Post}) * 365 * \gamma$$

Where:

kWh_{Toilet}	Are the annual energy impacts for the retrofit
$F_{Person-Day}$	Is the number of flushes per person per day
$V_{Base/Post}$	Is the volume of water consumed per flush by baseline and post toilets.[11]
γ	Is the embedded energy content of water flushed

Final values for each of the three toilet volume combinations offered through the program are listed in Table 3-36.

Table 3-36 List of UES estimates for Each Toilet Volume Represented in the Program: Toilet Exchange/Rebate

Measure	*Gross Energy Impacts [kWh/Toilet]*	*Gross Water Impacts [Gal/Toilet]*
Toilet 1.6 GPF to 1.28 GPF/Dual-Flush	7	665
Toilet 3 GPF to 1.28 GPF/Dual Flush	39	3,575
Toilet 3 GPF to 1.6 GPF	32	2,910

3.7.2. **Net Impact Methods and Results**

As this program is implemented by a third party, and is nearly identical to the Toilet Rebate program, the net-to-gross ratio for the rebate program was used from the PY 2014 Evaluation. The Net-To-Gross rate applied to this program, and final net impacts are shown in Table 3-37.

[11] The embedded energy content of water was assumed to be .0047 kWh/Gal based on two years data on TDPUD's water distribution. Note that this is a conservative estimate as it does not include the cost of water conveyance through Truckee Sanitary District or the cost of processing at the Tahoe Truckee Sanitation Agency waste-water treatment plant. A study is currently on-going to establish final values for these additional components.

Table 3-37 Summary of NTG Ratio and Gross Impacts: Toilet Exchange Program

Free Ridership Estimate	*NTG Ratio*	*Ex Post Gross Annual Energy Savings [kWh]*	*Ex Post Gross Peak Demand Reductions [kW]*	*Ex Post Gross Gallons [CCF]*
14%	86%	4,200	0.5	511

3.7.3. Evaluation Findings and Program Recommendations

The evaluation team has the following recommendations to improve program performance in future program cycles:

- **Increase promotion of TDPUD residential programs.** We have noted that the most common sources for program awareness historically have come from the utility web-site, bill inserts, or through direct communication with utility staff. Program participation would benefit from additional marketing efforts targeting local residents.

3.8. Residential - Toilet Rebate

Table 3-38 Residential - Toilet Rebate: Summary Table

Final Project Count:	108
Ex Post Gross Energy Savings [kWh]:	2,948
Ex Post Gross Demand Savings [kW]:	0.3
Ex Post Gross Water Savings [CCF]:	359
Total Resource Cost [$/kWh]:	$0.86
Net-To-Gross Ratio:	86%
Contribution to Residential Portfolio:	0.3%
General EM&V Approach	Desk Review

The Water Efficient Toilet Rebate Program encourages customers to replace high-water use toilets to low water use toilets by providing increasing incentives for more efficient toilets. In 1992 the Federal toilet standards went into effect requiring toilets installed in residential new construction to use 1.6 gallons of water per flush or less. Many "older" homes and businesses still have high-water use toilets that use between 3 and 7 gallons per flush (GPF). Recent advancements have allowed toilets to use 1.28 gallons per flush or less while still providing equal or superior performance. This is 20 percent less water than the current 1.6 GPF federal standard.

3.8.1. Gross Impact Evaluation Methods and Results

ADM applied an identical gross impact method to the Toilet Rebate Program as was described in Section 3.7 for the Toilet Exchange Program. The UES estimates were identical as were the measure offerings.

3.8.2. Net Impact Methods and Results

As this program is implemented by a third party, and is nearly identical to the Toilet Exchange program, the net-to-gross ratio for the rebate program was used from the PY 2014 Evaluation. The Net-To-Gross rate applied to this program, and final net impacts are shown in Table 3-39.

Table 3-39 NTGR and Net Impacts for Toilet Rebate Program

Free Ridership Estimate	*NTG Ratio*	*Ex Post Gross Annual Energy Savings [kWh]*	*Ex Post Gross Peak Demand Reductions [kW]*	*Ex Post Gross Gallons [CCF]*
14%	86%	2,948	0.3	359

3.8.3. Evaluation Findings and Program Recommendations

The evaluation team has the following recommendations to improve program performance in future program cycles:

- **Increase promotion of TDPUD residential programs.** We have noted that the most common sources for program awareness historically have come from the utility web-site, bill inserts, or through direct communication with utility staff. Program participation would benefit from additional marketing efforts targeting local residents.

3.9. Residential – High Efficiency Washer Water Rebate

Table 3-40 Residential - High Efficiency Washer Water: Summary Table

Final Project Count:	72
Ex Post Gross Energy Savings [kWh]:	974
Ex Post Gross Demand Savings [kW]:	0.1
Ex Post Gross Water Savings [CCF]:	119
Total Resource Cost [$/kWh]:	$1.45
Net-To-Gross Ratio:	68%
Contribution to Residential Portfolio:	0.1%
General EM&V Approach	Desk Review

This program provides TDPUD customers incentives for purchasing water efficient clothes washing machines as identified by Energy Star and the Consortium of Energy Efficiency (CEE). Energy Star and CEE Tier 1 identify appliances that use less energy than the federal standard. CEE Tiers 2 & 3 identify super-efficient appliances that use significantly less energy than the federal standard and identify the most efficient of the Energy Star spectrum.

3.9.1. Gross Impact Evaluation Methods and Results

ADM leveraged a *Deemed Savings* approach to this program in which we applied the following formula to estimate gross impacts:

$$kWh_{Sav} = UES * N$$

$$kW_{Sav} = \frac{kWh_{Sav}}{8760}$$

Where:

kWh_{Sav}	Are the annual energy impacts for the project
kW_{Sav}	Are the peak demand reductions
UES	Is the per unit energy savings estimate for each measure.
N	Is the number of measures implemented

UES estimates were derived based on the CEE Tier of the installed unit. ADM used engineering calculations to derive the unit energy savings estimates along with secondary literature research to establish appropriate assumptions. The following formula was used to estimate the UES;

$$kWh_{Washer} = V_{Load} * \Delta WF * Cycles/Year * \gamma$$

Where:

kWh_{Washer}	Are the annual energy impacts for the retrofit
V_{Load}	The volume of water consumed in each load of laundry
ΔWF	The difference in Water Factor rating between the base and efficient unit
Cycles/Year	The number of washing loads run in a year.
γ	Is the embedded energy content of water used [12]

Final values for measure(s) offered through the program are listed in Table 3-41.

Table 3-41 List of UES estimates for Each Clothes Washer Represented in the Program: Clothes Washer Program

Measure	*Gross Energy Impacts [kWh/Washer]*	*Gross Water Impacts [Gal/Washer]*
Efficient Washer	5.9	1,232

3.9.2. **Net Impact Methods and Results**

Net impacts were not reviewed directly for this program. The applied NTG ratio is 0.68 and was derived from the PY 2013 evaluation report for this program. Program NTGR and associated Net savings values are shown in Table 3-42.

Table 3-42 NTGR and Gross Impacts for High Efficiency Clothes Washer Program

Free Ridership Estimate	*NTGR Estimate (1-FR)*	*Ex Post Gross Annual Energy Savings [kWh]*	*Ex Post Gross Peak Demand Reductions [kW]*	*Ex Post Gross Water Savings [CCF]*
32%	68%	974	0.1	119

3.9.3. **Evaluation Findings and Program Recommendations**

The following represent ADM's key findings for the CY 2017 evaluation of the High Efficiency Washer program:

- **Incentive Levels Contribute to Low TRC Test Results.** Currently the incentive levels for this measure are high relative to "typical" energy efficiency measures (which range between $.06 to $0.20 per Gross kWh).

[12] The embedded energy content of water was assumed to be .0047 kWh/Gal based on two years data on TDPUD's water distribution. Note that this is a conservative estimate as it does not include the cost of water conveyance through Truckee Sanitary District or the cost of processing at the Tahoe Truckee Sanitation Agency waste-water treatment plant. A study is currently on-going to establish final values for these additional components.

The evaluation team has the following recommendations to improve program performance in future program cycles:

- **Increase promotion of TDPUD residential programs.** We have noted that the most common sources for program awareness historically have come from the utility web-site, bill inserts, or through direct communication with utility staff. Program participation would benefit from additional marketing efforts targeting local residents.

4. EM&V Results: Commercial Programs

In this chapter we discuss the Evaluation results (including findings and recommendations) for each evaluated commercial program. Programs are listed in order of contribution to the overall portfolio. Results across each of the residential programs are summarize in Table 4-1.

Table 4-1 Summary of Residential Program Results

Program Name	*Gross Impacts [kWh]*	*Evaluation Approach*	*Survey*	*% of Portfolio*	*% Difference from 2016*
Commercial Refrigeration	296,440	Option A	Y	44%	*32%*
Commercial Lighting	284,486	Option A	Y	42%	48%
Commercial Green Partners LED/CFL	88,621	Option A	Y	13%	-56%
Total Commercial Sector:	**669,547**			**100 %**	**25 %**

Programs are grouped according to the magnitudes of their verified gross impacts. Each of the above programs are compared against one another in Figure 4-1, showing both their annual gross impacts and net resource costs ($/kWh).

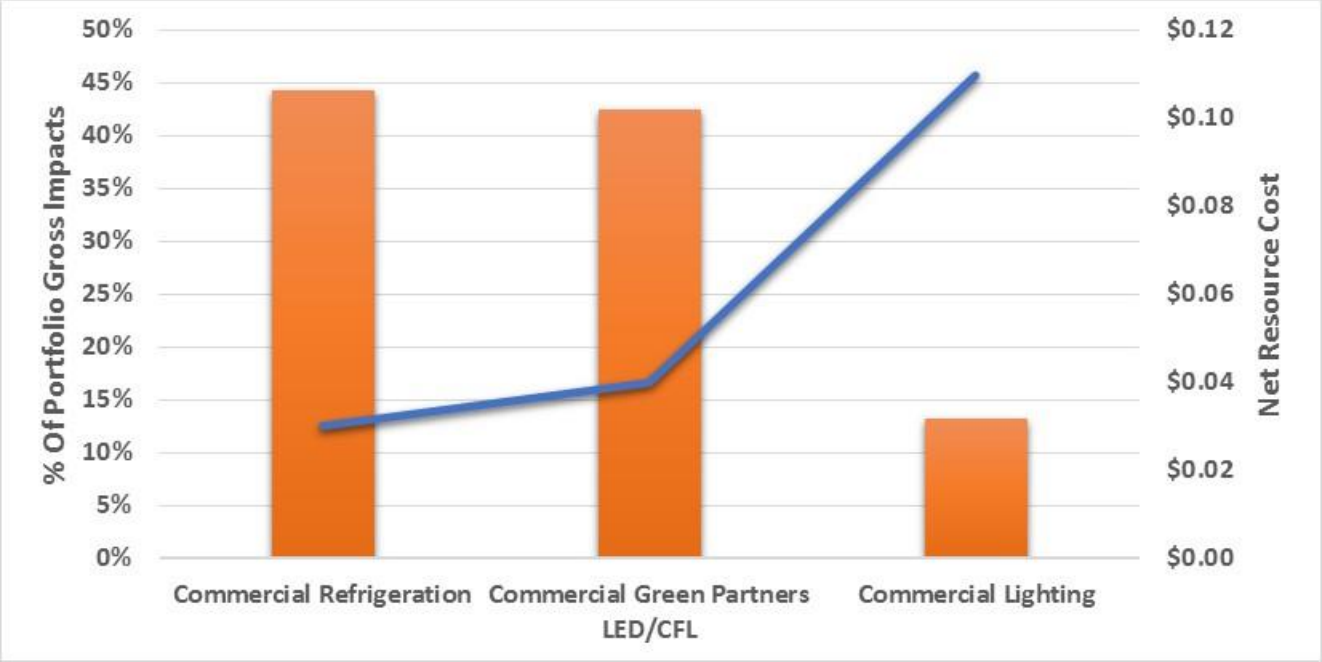

Figure 4-1 Comparing Annual Gross Impacts and Net Resource Costs Across Commercial Programs

4.1. Commercial – Refrigeration

Table 4-2 Commercial – Refrigeration: Summary Table

Project Count:	1
Ex Post Gross Energy Savings [kWh]:	296,440
Post Gross Demand Savings [kW]:	34
Contribution to Commercial Portfolio:	44$%
Total Resource Cost [$/kWh]:	$0.03
Net-To-Gross Ratio:	69%
General EM&V Approach	Site-Specific

The Commercial Refrigeration program provides energy-efficient refrigeration controls, motors, and case lighting. Customers receive a comprehensive refrigeration energy audit and proposal for energy efficient refrigeration measures from TDPUD's installation contractor.

4.1.1. Sample Design

Only a single customer participated in the Commercial Refrigeration program in CY2017. The evaluation reviewed a census of projects.

4.1.2. Gross Impact Methods and Results

ADM leveraged a *Site-Specific* savings approach to this program in which we identified the most appropriate IPMVP option for each sampled site. Table 4-3 summarizes the IPMVP Option and savings identified for each site evaluated.

Table 4-3 Summary of Results by Sampled Project (Gross Impacts): Refrigeration

Project #	*IPMVP Option*	*Gross Ex Post Energy Impacts [kWh]*	*Gross Ex Post Peak Reduction [kW]*
1	Option A	296,440	34

4.1.3. Net Impact Methods and Results

The customer was non-responsive to ADMs attempts at contacting for a phone survey. Therefore, a Net-To-Gross value of .69 was applied based on similar projects ADM has evaluated.

4.1.4. Evaluation Findings and Results

The following represent ADM's key findings for the CY 2017 evaluation of the Commercial Green Partners LED program:

- **Program tracking documentation continues to be very good.** Program staff maintained accurate and detailed records of bub counts, model numbers, wattages, etc. for each this project. This included a detailed copy of the Ex Ante calculations/assumptions.

4.2. Commercial - Green Partners LED

Table 4-4 Commercial - Green Partners LED: Summary Table

Project Count:	1,371
Ex Post Gross Energy Savings [kWh]:	88,621
Ex Post Gross Demand Savings [kW]:	23
Total Resource Cost [$/kWh]:	$0.11
Net-To-Gross Ratio:	47%
Contribution to Commercial Portfolio:	13 %
General EM&V Approach	Option A

The Commercial – Green Partners LED/CFL program provides efficient Light Emitting Diode (LED) free of charge to commercial customers. Bulbs are intended to replace existing incandescent and halogen bulbs. TDPUD conservation specialists visit businesses to evaluate lighting needs and provide solutions.

4.2.1. Sample Design

Given the similarity in survey results across recent program evaluations ADM decided to direct evaluation resources towards other programs and performed desk review of a census of participants for this program in CY 2017.

4.2.2. Gross Impact Methods and Results

ADM leveraged a *Deemed Savings* approach to this program in which we applied the following formula to estimate gross impacts:

$$kWh_{Sav} = (kW_{Base} - kW_{CFL}) * Hrs * HCIF * ISR$$

$$kW_{Sav} = (kW_{Base} - kW_{CFL}) * CDF * HCIF * ISR$$

where:

kWh_{Sav}	Are the annual energy impacts for the project
kW_{Sav}	Are the peak demand reductions
kW_{Base}	Is the connected load of the baseline light bulb[13]
kW_{CFL}	Is the connected load of the installed light bulb[14]

[13] Assessed using an assumed baseline wattage based on the wattage/type of the installed bulb and further informed through surveys

[14] Based on the records kept in the tracking system and further informed by the surveys

Hrs	Are the annual hours of operation[15]
HCIF	Heating/Cooling Interactive Factor[16]
CDF	Is the Coincident Demand Factor
ISR	Is the *In-Service Rate*

The *In-Service Rate* was derived using customer surveys to identify how many of the bulbs received had actually been installed. Additional questions were asked to identify the locations in which the bulbs were installed. The population of projects was sufficiently small that DEER building types were ascribed to each via internet research (e.g. using the address and business name). DEER hours of use, Coincident Demand Factor, and interactive factors were then applied based on the project's building type. The Ex Post gross impacts are provided in Table 4-14.

Table 4-5 Gross Impacts for Commercial Green Partners LED/CFL Program

Gross Ex Post Annual Energy Impacts [kWh]	*Gross Ex Post Peak Demand Reductions [kW]*
88,621	23

4.2.3. **Net Impact Methods and Results**

ADM found very low response rates in our survey efforts for commercial customers. It is likely that the significant snowfall and severe winter weather which occurred in concert with this evaluation impacted the customer's willingness to respond to surveys.[17] In light of the low response rate we applied the NTG rates derived in the previous evaluation cycle for the program – 47%.

4.2.4. **Evaluation Findings and Results**

The following represent ADM's key findings for the evaluation of the 2017 Commercial Green Partners LED/CFL program:

- **Program tracking documentation continues to be very good.** Program staff maintained accurate and detailed records of bub counts, model numbers, wattages, etc. for each project in the program.
- **Large Percentage of A19 LED Bulbs.** The evaluation found that while the program has successfully transitioned to primarily distribute LED light bulbs, about 60% of these bulbs are A19 which are the most heavily impacted by both EISA standards and Net-to-Gross considerations.

[15] Per DEER 2013 for appropriate building type

[16] Per DEER 2013 for appropriate building type

[17] Given the record levels of precipitation, many homes and businesses were suffered power outages, significant snow removal burdens, etc.

The evaluation team has the following recommendations to improve program performance in future program cycles:

- **Consider phasing out A19 bulbs in favor of specialty sockets.** As efficient lighting saturates the commercial market (e.g. CFLs and LEDs) the first sockets to reach saturation are A19. Many A19 LED bulbs are replacing either CFLs or pre-existing LEDs at this point which indicates that future free-ridership rates will be significantly higher for this bulb-type.
- **Increase efforts to directly engage local business owners.** Program participants indicated program awareness through direct communication from PUD staff – which is in line with how the program has historically been marketed. As the program has matured, it will become more difficult to reach business which have not already participated in the program and additional penetration will require more creative or concerted marketing.

  One potential opportunity is in the form of a small commercial direct install program in which program staff canvas the town and provide commercial customers with LED light bulbs and a basic energy audit which can funnel into the custom, lighting, or refrigeration programs.

4.3. Commercial - Lighting

Table 4-6 Commercial - Lighting: Summary Table

Project Count:	7
Ex Post Gross Energy Savings [kWh]:	284,486
Ex Post Gross Demand Savings [kW]:	80
Total Resource Cost [$/kWh]:	$0.04
Net-To-Gross Ratio:	0.93
Contribution to Commercial Portfolio:	42%
General EM&V Approach	Site-Specific

The Commercial – Lighting program provides incentives for businesses to replace old linear fluorescent fixtures with reduced wattage T-8 fluorescent or LED fixtures. Other retrofits may qualify for a rebate equivalent to projected first year energy savings.

4.3.1. Sample Design

Only 7 projects received incentives in Cy 2017 which were represented by (4) different participants. The evaluation reviewed a census of projects.

4.3.2. Gross Impact Methods and Results

ADM leveraged a *Site-Specific* savings approach to this program in which we identified the most appropriate IPMVP option for each sampled site. Table 4-23 summarizes the IPMVP Option and savings identified for each site evaluated.

Table 4-7 Summary of Results by Sampled Project (Gross Impacts): Refrigeration

Project #	*IPMVP Option*	*Gross Ex Post Energy Impacts [kWh]*	*Gross Ex Post Peak Reduction [kW]*
1	Option A	0.00	0.00
2	Option A	1,716.50	0.89
3	Option A	60,520.00	14.85
4	Option A	19,314.00	5.43
5	Option A	75,325.00	25.90
6	Option A	19,291.00	4.86
7	Option A	108,319.00	28.15

4.3.3. Net Impact Methods and Results

As discussed in the previous section, ADM found very low response rates in our survey efforts for commercial customers.

4.3.4. Evaluation Findings and Results

The following represent ADM's key findings for the CY 2017 evaluation of the Commercial Lighting program:

- **Program tracking documentation continues to be very good.** Program staff maintained accurate and detailed records of bub counts, model numbers, wattages, etc. for each project in the program.

The evaluation team has the following recommendations to improve program performance in future program cycles:

- **Review incentive levels for the program.** Current incentive levels for this program average at $0.42 per kWh verified which is higher than 'typical' incentive levels for commercial lighting. Given the high NTG rate for this program there may be room to reduce the incentive and improve program cost effectiveness.
- **Consider Emphasizing Controls.** As efficient lighting fixtures are becoming more standard the potential savings is reducing. Lighting controls represent an area of potential savings remaining in commercial lighting.

5. Appendix A: Customer Survey for Res Green Partners Program

Hello, my name is _____ and I'm calling from ADM Associates on behalf of TDPUD. We are conducting a survey regarding household lighting. We are contacting customers that received CFLs/LEDs through the Residential Green Partners program. The survey should only take about 10-15 minutes and your answers will be completely anonymous. Am I speaking to the correct person about this?

Q1. We have it in our records that you received ___ number of bulbs. Is this correct? [MAX BULBS = 24]

- ❑ Yes 01
- ❑ No 02 [SKIP TO Q1A]
- ❑ Don't know 98 [SKIP TO Q2]

Q1a. How many bulbs did you receive?

- ❑ #_____ [RECORD NUMBER, 0 – 24.]
- ❑ Don't recall 98
- ❑ Refused 99

Q2. How many of those CFLs would you estimate you installed?

- ❑ #_____ [RECORD NUMBER. IF RESPONDENT SAYS "100%" or "ALL", THEN SKIP TO Q4]
- ❑ Don't recall 98
- ❑ Refused 99

Q3. Are there any CFL bulbs you received that you have not installed or are saving for a later date?

- ❑ Yes, have some left 01 [GO TO Q3A]
- ❑ None 02 [SKIP TO Q4]
- ❑ Don't know 98 [SKIP TO Q4]
- ❑ Refused 99 [SKIP TO Q4]

Q3a. How many of those CFLs you received did you save to install at a later date? [If respond is unsure, say "Your best estimate is okay."]

- ❑ _____ [RECORD NUMBER, 0 – 24]
- ❑ Don't recall 98
- ❑ Refused 99

Q4. Where in your home did you install the bulbs? (Don't read.)
If customer says, "EVERYWHERE", please ask them to clarify/be specific.
AFTER CUSTOMER INDICATES ROOMS, PROMPT ON EACH ROOM: "How many did you install in (room indicated)?

	Room	***# Bulbs***
A	Living room	
B	Kitchen	
C	Family Room / Den	
D	Dining Room	
E	Entry/Hallway	
F	Bedroom	
G	Bathroom	
H	Garage	
I	Outdoors	
J	Closet	
K	Office	
L	Other	

Q5. What type of bulbs did the new CFL bulbs replace? (IF NECESSARY: Did they replace incandescent bulbs? Other CFLs? LEDs?)

- ❑ Replaced incandescent lighting (ask Q5a) 01
- ❑ Replaced CFLs 02
- ❑ Replaced LEDs 03
- ❑ Don' t Know (Don't Read) 98
- ❑ Refused 99

Q5a. (IF THEY REPLACED INCANDESCENT BULBS): Were the incandescent bulbs still operating when you removed them or were they burnt out?

- ❑ Still operating 01
- ❑ Burnt out 02
- ❑ Don't know 98

Q6. How did you become aware of TDPUD's Green Partners Program? [MARK ALL RESPONSES] (Don't read)

- ❑ Bill insert 01
- ❑ Newspaper ad 02
- ❑ Television/radio ad 03
- ❑ Friend/relative/word-of-mouth 04
- ❑ Flyer 05
- ❑ At a giveaway event 06
- ❑ While paying my utility bill 07
- ❑ TDPUD website 08
- ❑ Other (Specify):_____ 09
- ❑ Don't Know 98

Q7. Prior to learning of the program, approximately how many CFL bulbs did you have in your home? [If respond is unsure, say "Your best estimate is okay."]

- ❑ #_____ [RECORD NUMBER, 0 – 97]
- ❑ Don't recall 98
- ❑ Refused 99

Q8. If TDPUD had not given out the CFLs, how likely is it that you would have purchased CFLs anyway?

- ❑ Definitely would have purchased 01
- ❑ Probably would have purchased 02
- ❑ Probably would not have purchased 03
- ❑ Definitely would not have purchased 04

Q9. Have you purchased any incandescent light bulbs in the past year?

- ❑ Yes (ask Q9a, Q9b, and Q9c) 01
- ❑ No 02
- ❑ Don't Know (Don't Read) 98

Q9a. Why did you purchase incandescent bulbs? [RECORD VERBATIM]

_____

Q9b. Have you installed any of the incandescent light bulbs?

- ❑ Yes (ask Q9c) 01
- ❑ No (skip to Q10) 02
- ❑ Don't Know (Don't Read) 98

Q9c. How many of the incandescent light bulbs were installed?

❑ #_____ [RECORD NUMBER, 0 – 97]

❑ Don't recall 98

❑ Refused 99

Q10. After receiving the CFL bulbs from the program, have you since purchased more CFLs or LEDs?

❑ Yes (ask Q10a, Q10b, Q10c, and Q10d) 01
❑ No (skip to Q11) 02
❑ Don't Know (Don't Read) 98

Q10a. If Yes: How many?

CFLs: #_____
LEDs: #_____

Q10b. Did you receive a rebate for any of the purchased bulbs?

❑ Yes 01
❑ No 02
❑ Don't Know (Don't Read) 98

Q10c. Have you installed any of the purchased CFLs or LEDs in your home?

❑ Yes 01
❑ No (skip to Q11) 02
❑ Don't Know (Don't Read) 98

Q10d. How many of the CFLs or LEDs have you installed?

CFLs: #_____
LEDs: #_____

Q11. I'm going to list some factors about the Green Partners program, and I would like you to rate them 1-5, where 1 is "Very Dissatisfied" and 5 is "Very Satisfied". How satisfied were you with:

Element of Program Experience	***Score***	***Don't Know***
The quality of the CFLs		❑
Service provided by TDPUD staff		❑
Savings on your electric bill		❑
Information provided by TDPUD on how to save energy in your home		❑

Overall program experience		❑

For any answer less than 3, ask Q11a.

Q11a: Why did you rate [factor] at [score]? [RECORD VERBATIM]

_____

Q12. Have you participated in any other TDPUD residential programs?

- ❑ Yes (ask Q12a) 01
- ❑ No 02
- ❑ Don't Know (Don't Read) 98

Q12a. IF YES: Which programs? [RECORD VERBATIM]

_____

Household Characteristics / Demographics

Q13. Which of the following best describes your home/residence?

- ❑ Single Family Home, detached 01
- ❑ Single Family Home, factory manufactured/modular 02
- ❑ Single family, mobile home 03
- ❑ Condominium 04
- ❑ Apartment 05
- ❑ Other (specify) 06
- ❑ Don't know 98
- ❑ Refused 99

Q14. Do you own or rent this residence?

- ❑ Own 01
- ❑ Rent 02
- ❑ Don't know 98
- ❑ Refused 99

Q15. Approximately when was your home built? [DO NOT READ]

- ❑ Before 1960 01
- ❑ 1960-1969 02
- ❑ 1970-1979 03
- ❑ 1980-1989 04
- ❑ 1990-1999 05
- ❑ 2000-2010 06
- ❑ 2011 or later 07
- ❑ Don’t know 98
- ❑ Refused 99

Q16. Approximately how many square feet is your home?

- ❑ _____ Record Number [100-99999]
- ❑ Don’t know 98
- ❑ Refused 99

Q17. How many individuals currently live in your home?

- ❑ _____ Record Number [1-97]
- ❑ Don’t know 98
- ❑ Refused 99

Q18. What is your approximate total household income? [PROVIDE BINS]

- ❑ Less than $10,000 01
- ❑ $10,000 to $29,999 02
- ❑ $30,000 to $49,999 03
- ❑ $50,000 to $69,999 04
- ❑ $70,000 to $89,999 05
- ❑ $90,000 to $99,999 06
- ❑ $100,000 to $149,999 07
- ❑ $150,000 or more 08

- ❑ Don’t know 98
- ❑ Refused 99

Q19. Do you have any comments about the Residential Green Partners Program, or any suggestions with regard to how it might be improved?

Thank you very much! Your responses will help TDPUD in improving the program.

6. Appendix B: Customer Survey for Refrigerator Recycling Program

Hello. My name is _____ with _____, and I am calling from ___ on behalf of Truckee Donner PUD, your utility service provider. I am conducting a brief survey regarding TDPUD's Refrigerator Recycling Program. Our records show that you recycled a refrigerator or freezer through the program in the past year. We would like to get some feedback from you about the program. May I ask you a few questions?

Q1 Do you recall having one of your old refrigerators or freezers picked up for recycling and receiving a rebate from TDPUD?

- ❑ Yes
- ❑ No [IF NO, THANK RESPONDENT AND TERMINATE INTERVIEW]

Q2 When did you learn about the TDPUD's Refrigerator Recycling program? Was it…

- ❑ Before deciding to recycle the refrigerator/freezer (1)
- ❑ After deciding to recycle the refrigerator/freezer (2)
- ❑ At the same time as deciding to recycle the refrigerator/freezer (3)
- ❑ Don't Know [DON'T READ] (98)

Q3 Was the unit being used as your main refrigerator/freezer, or was it a secondary or spare unit?

- ❑ Main [ASK Q3a] (1)
- ❑ Secondary or Spare [ASK Q3b] (2)
- ❑ Don't Know [DON'T READ. SKIP TO Q4] (98)

Q3a Why did you replace your refrigerator/freezer? [DON'T READ. MARK ALL INDICATED. PROBE FOR MULTIPLE RESPONSES. SKIP TO Q4 AFTER THIS QUESTION ANSWERED]

- ❑ Wanted a better working unit (1)
- ❑ Wanted a newer unit (2)
- ❑ Wanted a more efficient unit (3)
- ❑ Wanted a different size/type (4)

- ❑ Remodeling home (5)
- ❑ Other (Specify) _____ (6)

Q3b Would you say that prior to recycling the refrigerator/freezer, it was… [READ ALL]

- ❑ Unplugged (skip to Q4) (1)
- ❑ Operated for a portion of the year (ask Q3c) (2)
- ❑ Operated year-round (skip to Q4) (3)
- ❑ Don't know

Q3c Approximately how many months out of the year would you estimate that the refrigerator/freezer was used in the past year?

- ❑ _____ Months (1)
- ❑ Don't know (2)

Q4 When the refrigerator/freezer was in use, where in the house was it set up? [PROMPT ONLY IF NECESSARY]

- ❑ Kitchen (1)
- ❑ Den/Lounge (2)
- ❑ Garage (3)
- ❑ Basement (4)
- ❑ Outdoors (5)
- ❑ Other [SPECIFY]_____ (6)

Q5 Did you have specific plans to dispose of the refrigerator/freezer prior to learning about the program?

- ❑ Yes (1)
- ❑ No (2)

Q6 When replacing a major appliance, what do you typically do with the old unit? [DO NOT READ. PROMPT ONLY IF NECESSARY]

- ❑ Keep the unit (1)
- ❑ Sold to a private party (ask Q6a) (2)
- ❑ Sold/gave to a used-appliance dealer (3)
- ❑ Gave to a friend/family/neighbor (4)

- ❑ Donate it (5)
- ❑ Removed by dealer when replacement unit came (6)
- ❑ Dispose or recycle it myself (7)
- ❑ Hire someone to dispose or recycle it for me (8)
- ❑ Other [SPECIFY]_____ (9)

Q6a Are you more likely to sell the appliance in a private party sale, or to sell or trade it in to a used refrigerator dealer?

- ❑ Private Party (1)
- ❑ Used Appliance Dealer (2)
- ❑ Other [SPECIFY]_____ (3)
- ❑ Don't Know (98)

Q7 Did you attempt to sell or donate your refrigerator/freezer prior to participating in the Refrigerator Recycling Program?

- ❑ Yes [ASK Q7a] (1)
- ❑ No [SKIP TO Q8] (2)

Q7a Why did you not follow through with selling or donating the unit? [DON'T READ OPTIONS, CHECK ALL THAT APPLY]

- ❑ Couldn't find an interested buyer at the price I wanted (1)
- ❑ Couldn't find an interested buyer because of the unit's condition (2)
- ❑ Decided recycling the unit was more important than selling it (3)
- ❑ Other [SPECIFY] _____ (4)
- ❑ Don't Know (98)

Q8 What would you have done with your old appliance if you had not recycled it through the program? [DO NOT PROMPT]

- ❑ Continued to use it (1)
- ❑ Sold it (2)
- ❑ Unplugged and stored it (3)

- ❑ Disposed of it (4)
- ❑ Given it away / Donated (5)
- ❑ Other [SPECIFY] _____ (6)

Q9 What condition was the unit in when it was picked up? [READ LIST, INDICATE ONE RESPONSE]

- ❑ It worked well and was in good physical condition (normal wear and tear such as scratches, etc.) (1)
- ❑ It worked but needed minor repairs (like a door seal or handle) (2)
- ❑ It worked but had some problems (like it wouldn't defrost) (3)
- ❑ It didn't work at all (4)
- ❑ Don't Know [DON'T READ] (98)

Q10 How did you first hear about the Refrigerator Recycling Program? [DO NOT PROMPT, CHECK ALL THAT APPLY]

- ❑ Advertisement (print, radio, etc.) (1)
- ❑ TDPUD bill insert, flyer or letter (2)
- ❑ Friend or relative / Word of mouth (3)
- ❑ TDPUD website (4)
- ❑ Email from TDPUD (5)
- ❑ Other website: specify (6)
- ❑ Retailer / in-store [MARK IF REPSONDENT INDICATES IN-STORE SIGNAGE OR FROM RETAIL STAFF, OR MENTIONS A SPECIFIC RETAILER BY NAME] (7)
- ❑ Other [SPECIFY] _____ (8)
- ❑ Don't know (98)

Q11 What factors motivated you to recycle your refrigerator with the program this past year? [DO NOT READ. CHECK ALL THAT APPLY]

- ❑ The rebate (1)
- ❑ Energy cost savings (2)
- ❑ Good for the environment (3)
- ❑ Refrigerator no longer worked properly (4)
- ❑ Purchased new refrigerator or freezer (5)
- ❑ Convenience of free pickup (6)
- ❑ Other [SPECIFY] _____ (7)
- ❑ Don't Know [DON'T READ] (98)

Q12 How important was the rebate in your decision to recycle your refrigerator?

- ❑ Very Important (1)
- ❑ Somewhat Important (2)
- ❑ Slightly Important (3)
- ❑ Not at All Important (4)
- ❑ Don't Know [DON'T READ] (98)

Q13 How important was the free pickup service in your decision to recycle your refrigerator?

- ❑ Very Important (1)
- ❑ Somewhat Important (2)
- ❑ Slightly Important (3)
- ❑ Not at All Important (4)
- ❑ Don't Know [DON'T READ] (98)

Q14 How long did it take to receive your rebate? [READ IF NECESSARY]

- ❑ 2 weeks or less (1)
- ❑ 2-4 weeks (2)
- ❑ 4 or more weeks (3)
- ❑ Don't know (98)

Q15 Do you think the wait time to receive the rebate was too long?

- ❑ Yes (1)

- ❑ No (2)
- ❑ Don't know (98)

Q16 On a scale of 1 to 10, with "1" meaning "very dissatisfied" and "10" meaning "very satisfied", how satisfied were you with:

[ASK IN RANDOM ORDER, WITH ITEM (F) ALWAYS LAST]

	Score:	*Don't know or no answer*
A. The scheduling process for recycling		❑
B. The service performed by staff that picked up your refrigerator		❑
C. The wait time between scheduling and pick-up of the refrigerator		❑
D. The wait time to receive the rebate		❑
E. The rebate amount		❑
F. Overall program experience		❑

[IF ANY ITEM <5, ASK Q17. OTHERWISE SKIP TO Q-18]

Q17 Why were you dissatisfied with [COMPONENT SCORED < 5]? [ENTER VERBATIM RESPONSE]

Q18 TDPUD often has a table at local community events where they hand out CFL bulbs to those in attendance. Did you receive any CFL bulbs during any event held throughout the last year?

- ❑ Yes (ask Q19) (1)
- ❑ No (skip to Q23) (2)
- ❑ Don't know (98)

Q19 How many CFL bulbs were you given at the event?

- ❑ Record number _____
- ❑ Don't know (98)

Q20 How many of those CFLs bulbs did you install?

- ❑ Record number _____
- ❑ Don't know/remember (98)

Q21 Where in your home did you install the CFL bulbs?

- ❑ Living room
- ❑ Kitchen
- ❑ Dining room
- ❑ Entry/Hallway
- ❑ Bedroom
- ❑ Bathroom
- ❑ Garage
- ❑ Outdoors
- ❑ Closet
- ❑ Office
- ❑ Other

Q22 Were the CFLs bulbs installed in Truckee or somewhere else?

- ❑ Truckee (1)
- ❑ Other city (2)
- ❑ Don't know (98)

Household Characteristics / Demographics

Q23 Which of the following best describes your home/residence?

- ❑ Single Family Home, detached construction
- ❑ Single Family Home, factory manufactured/modular
- ❑ Single family, mobile home
- ❑ Condominium

- ❑ Apartment
- ❑ Other (specify)
- ❑ Don’t know
- ❑ Refused

Q24 What type of cooling system do you have for your home? Do you have a... [READ LIST, ONE ANSWER ONLY]

- ❑ Central air conditioning system (1)
- ❑ Evaporative cooling system or a swamp cooler (2)
- ❑ Window air conditioner (3)
- ❑ No cooling system [DON’T READ] (4)
- ❑ Don’t Know [DON’T READ] (98)

Q25 Do you own or rent this residence?

- ❑ Own
- ❑ Rent
- ❑ Don’t know
- ❑ Refused

Q26 Approximately when was your home constructed? [DO NOT READ]

- ❑ Before 1960
- ❑ 1960-1969
- ❑ 1970-1979
- ❑ 1980-1989
- ❑ 1990-1999
- ❑ 2000-2010
- ❑ 2011 or later
- ❑ Don’t know
- ❑ Refused

Q27 Approximately how many square feet is your home?

- ❑ _____ Record Number [100-99999]
- ❑ Don’t know
- ❑ Refused

Q28 How many individuals currently live in your home?

- ❑ _____ Record Number [1-97]
- ❑ Don’t know
- ❑ Refused

Q29 What is your approximate total household income? [PROVIDE BINS]

- ❑ Less than $10,000
- ❑ $10,000 to $29,999
- ❑ $30,000 to $49,999
- ❑ $50,000 to $69,999
- ❑ $70,000 to $89,999
- ❑ $90,000 to $99,999
- ❑ $100,000 to $149,999
- ❑ $150,000 or more
- ❑ Don’t know
- ❑ Refused

Q30 Do you have any comments about the Refrigerator Recycling program, or any suggestions with regard to how it might be improved?

Thank you very much! Your responses will help TDPUD in improving the program.

7. Appendix C: Customer Survey for RES/ESP Program

Hello. My name is ___ and I'm calling from ADM Associates on behalf of TDPUD. We are conducting a study of the Residential Energy Survey [Energy Savings Partners] Program, through which you've received an audit and direct install measures for energy and water efficiency improvements. TDPUD will use this information to help them improve the program. The interview will take approximately 15 minutes. May I ask you a few questions?

Customer Name: _____

Date of interview: _____

.....

Q-1 Our records indicate that you received a survey and directly installed fixtures from TDPUD in your home. Is this correct?

- ❑ Yes *(If checked, go to Q-2)*
- ❑ No *(If checked, thank respondent and terminate interview)*
- ❑ Don't know *(If checked, ask to speak with someone in the home who may know)*

Q-2 After the surveyor came to your home, what energy or water fixtures were installed? [CHECK ALL THAT ARE MENTIONED]

❑	CFLs	01
❑	LEDs	02
❑	Low-flow showerhead(s)	03
❑	Faucet aerator(s)	04
❑	Hose spray nozzle	05
❑	Weather stripping	06
❑	Door sweeps	07
❑	Hot water piping insulation	08
❑	Water heater jacket	09
❑	Don't know/unsure	98

Q-2 How did you first hear about the RES/ESP program?

[DO NOT READ. Check all mentioned. Prompt only if necessary. Probe as needed.]

- ❑ At the utility office/from program staff 01
- ❑ Print ad/flyer 02
- ❑ Word-of-mouth 03
- ❑ TV/radio ad 04
- ❑ Bill insert/brochure/message 05
- ❑ TDPUD website 06
- ❑ Community/local event 07
- ❑ Other (*Specify*) 08
- ❑ Don't know 98

Q-3 Why did you participate in the RES/ESP Program?

[DO NOT READ. Check all mentioned. Prompt only if necessary. Probe as needed.]

- ❑ To save energy 01
- ❑ To reduce our utility bill 02
- ❑ Because services were free of charge 03
- ❑ Good for the environment 04
- ❑ Because you had trouble paying your utility bill 05
- ❑ Indoor air quality/health issues 06
- ❑ Property manager wanted you to 07
- ❑ Recommendation of a friend/relative 08
- ❑ Other (*Specify*) 09
- ❑ Don't know 98

Q-3A Of the things you mentioned, which was the most important?

- ❑ To save energy 01
- ❑ To reduce our utility bill 02
- ❑ Because services were free of charge 03

- ❑ Good for the environment 04
- ❑ Because you had trouble paying your utility bill 05
- ❑ Indoor air quality/health issues 06
- ❑ Property manager wanted you to 07
- ❑ Recommendation of a friend/relative 08
- ❑ Other (*Specify*) 09
- ❑ Don't know 98

DIRECT INSTALL COMPONENTS

Now I'm going to ask you some questions about the energy and/or water fixtures that were installed in your home.

[CFLs]

[ASK IF Q2 = 01 IS CHECKED]

Q-4 How many CFLs were installed in your home? [MAX COMBO = 24 bulbs]

- ❑ #____
- ❑ Don't know [DON'T READ] 98

Q-5 Are there any CFLs that have not been installed?

- ❑ Yes (ask Q-5A) 01
- ❑ No 02
- ❑ Don't know 98

Q-5A How many of those CFLs have not been installed?

- ❑ #____
- ❑ Don't know [DON'T READ] 98

Q-6 Of those CFLs that were installed in your home, did the surveyor install the CFLs or did you install them yourself?

- ❑ The surveyor installed them (ask Q-7) 01

- ❑ I installed them (skip to Q-8) 02
- ❑ The surveyor installed some and I installed some 03
- ❑ Unsure/Don't know 98

[IF SURVEYOR INSTALLED]

Q-7 On a scale of 1-5, where 1 means "not at all satisfied" and 5 means "very satisfied", how satisfied were you with the installation of the CFLs by the surveyor?

- ❑ #____
- ❑ Don't know [DON'T READ] 98

Q-8 On a scale of 1-5, where 1 means "not at all satisfied" and 5 means "very satisfied", how satisfied were you with the CFLs?

- ❑ #____
- ❑ Don't know [DON'T READ] 98

Q-9 Do you think the CFLs are higher quality, the same quality, or lower quality than what you had before?

- ❑ Higher 01
- ❑ Same 02
- ❑ Lower (ask Q9a) 03
- ❑ Don't know 98

Q-9a Could you clarify why you thought the CFLs were lower quality? [RECORD VERBATIM]

_____

Q-10 Have you removed any of the CFLs?

- ❑ Yes (ask Q-10a and Q11) 01
- ❑ No 02
- ❑ Don't know 98

Q10a How many CFLs did you remove?

- ❑ #____
- ❑ Don't know [DON'T READ] 98

Q-11 Why did you remove them? [DON'T READ. CHECK ALL INDICATED]

- ❑ They were not bright enough 01
- ❑ I didn't like the color 02
- ❑ I didn't like them 03
- ❑ Wanted something else 04
- ❑ Stopped working 05
- ❑ Other (specify) 06
- ❑ Don't know 98

[LEDs]

[ASK IF Q2 = 02 IS CHECKED]

Q-12 How many LEDs were installed in your home? [MAX = 2 bulbs]

- ❑ #____
- ❑ Don't know [DON'T READ]

Q-13 Are there any LEDs that have not been installed?

- ❑ Yes (ask Q-13A) 01
- ❑ No 02
- ❑ Don't know 98

Q-13A How many of those LEDs have not been installed?

- ❑ #____
- ❑ Don't know [DON'T READ] 98

Q-14 Of those LEDs that were installed, did the surveyor install the LEDs or did you install them yourself?

- ❑ The surveyor installed (ask Q-15) 01
- ❑ I installed (skip to Q-16) 02
- ❑ Don't know 98

[IF SURVEYOR INSTALLED]

Q-15 On a scale of 1-5, where 1 means “not at all satisfied” and 5 means “very satisfied”, how satisfied were you with the installation of the LEDs by the surveyor?

- ❑ #____
- ❑ Don't know [DON’T READ] 98

Q-16 On a scale of 1-5, where 1 means “not at all satisfied” and 5 means “very satisfied”, how satisfied were you with the LEDs?

- ❑ #____
- ❑ Don't know [DON’T READ] 98

Q-17 Do you think the LEDs are higher quality, the same quality, or lower quality than what you had before?

- ❑ Higher 01
- ❑ Same 02
- ❑ Lower (ask Q17a) 03
- ❑ Don't know 98

Q-17a Could you clarify why you thought the LEDs were lower quality? [RECORD VERBATIM]

_____

Q-18 Have you removed any of the LEDs?

- ❑ Yes (ask Q-19) 01
- ❑ No 02
- ❑ Don't know 98

Q-19 Why did you remove them? [DON’T READ. CHECK ALL INDICATED]

- ❑ They were not bright enough 01
- ❑ I didn’t like the color 02
- ❑ I didn’t like them 03
- ❑ Wanted something else 04

- ❑ Stopped working 05
- ❑ Other (specify) 06
- ❑ Don’t know/Refused to answer 98

[LOW-FLOW SHOWERHEADS]

[ASK IF Q2 = 03 IS CHECKED]

Q-20 How many low-flow showerheads were installed in your home?

- ❑ #____ [MAX = 2]
- ❑ Don't know [DON’T READ] 98

Q-21 Did the surveyor install the showerheads or did you install them yourself?

- ❑ The surveyor installed them (ask Q-21a) 01
- ❑ I installed them (skip to Q-22) 02
- ❑ Unsure/Don’t know 98

Q-21a On a scale of 1-5, where 1 means “not at all satisfied” and 5 means “very satisfied”, how satisfied were you with the installation of the showerhead(s)?

- ❑ #____
- ❑ Don't know [DON’T READ] 98

Q-22 On a scale of 1-5, where 1 means “not at all satisfied” and 5 means “very satisfied”, how satisfied were you with the showerhead(s)?

- ❑ #____
- ❑ Don't know [DON’T READ] 98

Q-23 Have you removed any of them?

- ❑ Yes (Q-23a and Q24) 01
- ❑ No 02
- ❑ Don't know 98

Q-24 Why did you remove them? [DON’T READ. CHECK ALL INDICATED]

- ❑ Not enough flow 01
- ❑ Didn’t like the spray 02

- ❑ Wanted one with a hose 03
- ❑ Didn’t like the look 04
- ❑ Stopped working 05
- ❑ Other (specify) 06
- ❑ Don’t know/Refused to answer 98

[FAUCET AERATORS]

[ASK IF Q2 = 04 IS CHECKED]

Q-25 How many faucet aerators were installed in your home?

- ❑ #____
- ❑ Don't know [DON’T READ] 98

Q-26 Did the surveyor install the faucet aerators or did you install them yourself?

- ❑ The surveyor installed them (ask Q-26a) 01
- ❑ I installed them (skip to Q-27) 02
- ❑ Unsure/Don’t know 98

Q-26a On a scale of 1-5, where 1 means “not at all satisfied” and 5 means “very satisfied”, how satisfied were you with the installation of the faucet aerator(s)?

- ❑ #____
- ❑ Don't know [DON’T READ] 98

Q-27 On a scale of 1-10, where 1 means “not at all satisfied” and 10 means “very satisfied”, how satisfied were you with the faucet aerator(s)?

- ❑ #____
- ❑ Don't know [DON’T READ] 98

Q-28 Have you removed any of them?

- ❑ Yes (Q-29) 01
- ❑ No 02
- ❑ Don't know 98

Q-29 Why did you remove them? [DON’T READ. CHECK ALL INDICATED]

- ❑ Not enough flow 01
- ❑ Didn’t like the spray 02
- ❑ Didn’t like the look 03
- ❑ Stopped working 04
- ❑ Other (specify) 05
- ❑ Don’t know/Refused to answer 98

[WEATHER STRIPPING]

[ASK IF Q2 = 05 IS CHECKED]

Q-30 Did you have weather stripping installed in your home?

- ❑ Yes 01
- ❑ No 02
- ❑ Don't know 98

Q-31 Did the surveyor install the weather stripping or did you install it yourself?

- ❑ The surveyor installed them (ask Q-31a) 01
- ❑ I installed them (skip to Q-32) 02
- ❑ Unsure/Don’t know 98

Q-31a On a scale of 1-5, where 1 means “not at all satisfied” and 5 means “very satisfied”, how satisfied were you with the installation of the weather stripping?

- ❑ #____
- ❑ Don't know [DON’T READ] 98

Q-32 On a scale of 1-5, where 1 means “not at all satisfied” and 5 means “very satisfied”, how satisfied were you with the weather stripping?

- ❑ #____
- ❑ Don't know [DON’T READ] 98

Q-33 Have you removed it?

- ❑ Yes (Q-34) 01
- ❑ No 02

- ❑ Don't know 98

Q-34 Why did you remove it?

- ❑ RECORD VERBATIM
- ❑ Don’t know/Refused to answer 98

[DOOR SWEEP]

[ASK IF Q2 = 06 IS CHECKED]

Q-35 Did you have a door sweep installed in your home?

- ❑ Yes 01
- ❑ No 02
- ❑ Don't know 98

Q-36 Did the surveyor install it or did you install it yourself?

- ❑ The surveyor installed them (ask Q-36a) 01
- ❑ I installed them (skip to Q-37) 02
- ❑ Unsure/Don’t know 98

Q-37a On a scale of 1-5, where 1 means “not at all satisfied” and 5 means “very satisfied”, how satisfied were you with the installation of the door sweep?

- ❑ #____
- ❑ Don't know [DON’T READ] 98

Q-38 On a scale of 1-10, where 1 means “not at all satisfied” and 5 means “very satisfied”, how satisfied were you with the door sweep?

- ❑ #____
- ❑ Don't know [DON’T READ] 98

Q-39 Have you removed it?

- ❑ Yes (Q-40) 01
- ❑ No (skip to Q41) 02
- ❑ Don't know 98

Q-40 Why did you remove it?

- ❑ RECORD VERBATIM
- ❑ Don’t know/Refused to answer 98

[HOT WATER PIPING INSULATION]

[ASK IF Q2 = 07 IS CHECKED]

Q-41 Did you have hot water piping insulation installed in your home?

- ❑ Yes 01
- ❑ No 02
- ❑ Don't know 98

Q-42 Did the surveyor install it or did you install it yourself?

- ❑ The surveyor installed them (ask Q-42a) 01
- ❑ I installed them (skip to Q-43) 02
- ❑ Unsure/Don’t know 98

Q-42a On a scale of 1-5, where 1 means “not at all satisfied” and 5 means “very satisfied”, how satisfied were you with the installation of the hot water piping insulation?

- ❑ #____
- ❑ Don't know [DON’T READ] 98

Q-43 On a scale of 1-10, where 1 means “not at all satisfied” and 5 means “very satisfied”, how satisfied were you with the hot water piping insulation?

- ❑ #____
- ❑ Don't know [DON’T READ] 98

Q-44 Have you removed it?

- ❑ Yes (ask Q45) 01
- ❑ No (skip to Q46) 02
- ❑ Don't know 98

Q-45 Why did you remove it?

- ❑ RECORD VERBATIM
- ❑ Don’t know/Refused to answer 98

EXPERIENCE WITH SURVEYOR

Q-46 Was your surveyor professional and knowledgeable?

- ❑ Yes 01
- ❑ No 02
- ❑ Don't know 98

Q-47 Using the 1-5 scale, where 1 means “strongly disagree” and 5 means “strongly agree”, please rate your experience with the installation work done on your home by the surveyor.

#____

- ❑ Don't know [DON’T READ] 98

Q-48 Have you noticed a decrease in your utility electric and/or water bill since participating in the program?

- ❑ Yes – electric 01
- ❑ Yes – water 02
- ❑ Yes – both 03
- ❑ No 04
- ❑ Don't know 98

Q-49 Did you have plans to make these improvements to your home prior to learning about the program?

- ❑ Yes 01
- ❑ No 02
- ❑ Don't know 98

Q-50 Would you have been financially able to make these home improvements without the incentive from the utility?

- ❑ Yes 01

- ❑ No 02
- ❑ Don't know 98

Q-51 If the services from the RES/ESP program were not available, how likely would you have been to install the same home improvements? [READ, MARK ONE]

- ❑ Definitely would have installed 01
- ❑ Probably would have installed 02
- ❑ Probably would not have installed 03
- ❑ Definitely would not have installed 04
- ❑ Don't know (*don't read*) 98

Q-52 On a scale of 0 to 5, where "5"; is very satisfied , "0" is very dissatisfied, how would you rate the following? [RANDOMIZE. ASK "OVERALL PROGRAM EXPERIENCE" LAST]

Element of Program Experience	***Score***	***Don't Know***
A. Information provided by the surveyor		❑
B. The quality of installation work by the surveyor [SKIP IF SELF-INSTALLED]		❑
C. The savings on your monthly bill		❑
D. The service provided by utility staff		❑
E. Information provided by TDPUD on how to reduce your utility bill		❑
F. Improvement in home comfort after receiving the home improvements		❑
G. Overall program experience		❑

[FOR ANY PROGRAM ELEMENT SCORED < 3]

Q-52a Why were you dissatisfied with [Program Element]?

Q53 Which of the following best describes your home/residence?

❑ Single Family Home, detached construction	01
❑ Single Family Home, factory manufactured/modular	02
❑ Single family, mobile home	03
❑ Condominium	04
❑ Apartment	05
❑ Other (specify)	06
❑ Don’t know	98
❑ Refused	99

Q54 Do you own or rent this residence?

❑ Own	01
❑ Rent	02
❑ Don’t know	98
❑ Refused	99

Q-55 Approximately when was your home built? [IF RESPONDENT DOES NOT GIVE VERBATIM ANSWER, READ OFF YEAR RANGES UNTIL RESPONDENT INDICATES ONE]

❑ Before 1960	01
❑ 1960-1969	02
❑ 1970-1979	03
❑ 1980-1989	04
❑ 1990-1999	05
❑ 2000-2010	06
❑ 2011 or later	07

- ❑ Don’t know 98
- ❑ Refused 99

Q56 Approximately how many square feet is your home?

- ❑ _____ Record Number [100-99999]
- ❑ Don’t know 98
- ❑ Refused 99

Q57. How many individuals currently live in your home?

- ❑ _____ Record Number [1-97]
- ❑ Don’t know 98
- ❑ Refused 99

Q-58 Do you have any comments about the RES/ESP Program, or any suggestions with regard to how it might be improved?

Thank you very much! Your responses will help TDPUD in improving the program.

8. Appendix D: Customer Survey for Residential Lighting Rebate Program

Hello, my name is _____ and I'm calling from ADM Associates on behalf of TDPUD. We are conducting a survey regarding household lighting. I am calling to ask a few brief questions about any light bulbs you've purchased for your home. The survey should only take about 10-15 minutes and your answers will be completely anonymous. May I please speak with the person who is responsible for purchasing the light bulbs for your home?

- ❑ Yes, I purchased lights [GO TO Q1]
- ❑ Someone else does it [ASK TO SPEAK WITH PERSON, REPEAT INTRODUCTION THEN GO TO Q1]
- ❑ No [TRY TO RESCHEDULE, AND THEN TERMINATE]

Recent Light Bulb Purchases

Q1. I'd like to ask you a few questions about your light bulb purchases during the past year. Have you purchased any light bulbs?

- ❑ Yes 01
- ❑ No 02 [SKIP TO Q2]
- ❑ Don't know 98 [SKIP TO Q2]
- ❑ Refused 99 [SKIP TO Q2]

Q2. During the past six months, how many light bulbs would you say you have purchased? [If respondent unsure, say "Your best estimate is OK."] [READ ANSWERS]

- ❑ 0-5
- ❑ 6-10
- ❑ 11-15
- ❑ 16-20
- ❑ 21-25
- ❑ 25-30
- ❑ Other (specify) _____
- ❑ Don't know/Unsure
- ❑ Refused

Q3. Have you purchased any CFLs (compact fluorescent bulbs) during the past year?

- ❑ Yes [ask Q3a]
- ❑ No
- ❑ Don't know
- ❑ Refused

Q3a How many?

- ❑ #_____

Q4. Have you purchased any LEDs (light emitting diode bulbs) during the past year?

- ❑ Yes [ask Q4a]
- ❑ No [skip to Q5]
- ❑ Don't know
- ❑ Refused

Q4a How many?

- ❑ #_____

In-Service Rate

Q5A. How many of those CFLs would you estimate you installed?

- ❑ _____ [RECORD NUMBER. IF RESPONDENT SAYS "100%" or "ALL", THEN SKIP TO Q6A]
- ❑ Don't recall
- ❑ Refused

Q5B. How many of those LEDs would you estimate you installed?

- ❑ _____ [RECORD NUMBER. IF RESPONDENT SAYS "100%" or "ALL", THEN SKIP TO Q6B]

- ❑ Don’t recall
- ❑ Refused

Q6A. Are there any CFL bulbs you purchased in the past six months that you have not installed or are saving for a later date?

- ❑ Yes, have some left [GO TO Q7A]
- ❑ None [GO TO Q8]
- ❑ Don’t know [GO TO Q8]
- ❑ Refused [GO TO Q8]

Q6B. Are there any LED bulbs you purchased in the past six months that you have not installed or are saving for a later date?

- ❑ Yes, have some left [GO TO Q7B]
- ❑ None [GO TO Q8]
- ❑ Don’t know [GO TO Q8]
- ❑ Refused [GO TO Q8]

Q7A. How many of those CFLs purchased did you save to install at a later date? [If respond is unsure, say “Your best estimate is okay.”]

- ❑ _____ [RECORD NUMBER, 0 – 97.]
- ❑ Don’t recall
- ❑ Refused

Q7B. How many of those LEDs purchased did you save to install at a later date? [If respond is unsure, say “Your best estimate is okay.”]

- ❑ _____ [RECORD NUMBER, 0 – 97.]
- ❑ Don’t recall
- ❑ Refused

Purchase Reasoning

Q8. Why did you purchase the CFLs?

[DO NOT READ RESPONSES. RECORD ALL RESPONSES. IF respondent says “I needed bulbs” or similar, PROMPT for more detailed explanation.]

- ❑ Replaced burned out bulbs
- ❑ Replace working bulbs, wanted to lower energy usage
- ❑ Installed in a new light fixture or lamp socket
- ❑ Improve lighting quality/brighten a room
- ❑ Replaced burned out bulbs & working bulbs at same time
- ❑ Stock up on bulbs
- ❑ Good deal prompted purchase
- ❑ Other (describe)_____
- ❑ Don’t recall
- ❑ Refused

Q8a. [ASK IF Q3 = 01] Why did you decide to purchase CFL bulbs instead of another type of bulb, such as an LED bulb?

- ❑ CFLs were the cheapest option
- ❑ CFLs were the only bulb type available at the store
- ❑ CFLs were the closest match to the bulb I was replacing
- ❑ I saw the CFLs first
- ❑ I prefer the lighting quality of CFLs
- ❑ I prefer the features associated with CFLs, such as dimming, instant on, color change, smart controls, etc.
- ❑ CFLs last longer than other bulbs
- ❑ Other (describe)_____
- ❑ Don’t recall
- ❑ Refused

Q9. Why did you purchase the LEDs?

[DO NOT READ RESPONSES. RECORD ALL RESPONSES. IF respondent says “I needed bulbs” or similar, PROMPT for more detailed explanation.]

- ❑ Replaced burned out bulbs
- ❑ Replace working bulbs, wanted to lower energy usage
- ❑ Installed in a new light fixture or lamp socket
- ❑ Improve lighting quality/brighten a room
- ❑ Replaced burned out bulbs & working bulbs at same time
- ❑ Stock up on bulbs
- ❑ Good deal prompted purchase
- ❑ Other (describe)_____
- ❑ Don’t recall
- ❑ Refused

Q9a. [ASK IF Q4 = 01] Why did you decide to purchase LEDs instead of another type of bulb, such as a CFL bulb?

- ❑ LEDs were the cheapest option
- ❑ LEDs were the only bulb type available at the store
- ❑ LEDs were the closest match to the bulb I was replacing
- ❑ I saw the LEDs first
- ❑ I prefer the lighting quality of LEDs
- ❑ I prefer the features associated with LEDs, such as dimming, instant on, color change, smart controls, etc.
- ❑ LEDs last longer than other bulbs
- ❑ Other (describe)_____
- ❑ Don’t recall
- ❑ Refused

Bulb Types Replaced

Q10. [ASK IF Q3 = 01] Now I would like you to think about the types of bulbs the CFLs replaced. Did they replace typical incandescent light bulbs, old CFL light bulbs, some other type of existing bulb, or a combination of old bulb types?

- ❑ Incandescent
- ❑ Existing CFLs
- ❑ LEDs
- ❑ Other :_____ [VERBATIM]
- ❑ Mixture:_____ [VERBATIM]
- ❑ Don't know
- ❑ Refused

Q11. [ASK IF Q4 = 01] Now I would like you to think about the types of bulbs the LEDs replaced. Did they replace typical incandescent light bulbs, old LED light bulbs, some other type of existing bulb, or a combination of old bulb types?

- ❑ Incandescent
- ❑ CFLs
- ❑ Existing LEDs
- ❑ Other :_____ [VERBATIM]
- ❑ Mixture:_____ [VERBATIM]
- ❑ Don't know

Refused

Q12. When purchasing light bulbs, what is the most important characteristic you consider when selecting a particular style, brand, or package to buy?

[DO NOT READ RESPONSES. RECORD ALL RESPONSES GIVEN. PROMPT IF NECESSARY.]

- ❑ Cost
- ❑ Energy efficiency

- ❑ Color/style of light
- ❑ Brightness of the bulb
- ❑ Brand
- ❑ How long the bulb lasts before replacement
- ❑ Other (specify)_____
- ❑ Don't recall
- ❑ Refused

Q12A. [If more than one reason listed] Of all the reasons you listed, which is the most important?

- ❑ Cost
- ❑ Energy efficiency
- ❑ Color/style of light
- ❑ Brightness of the bulb
- ❑ Brand
- ❑ How long the bulb lasts before replacement
- ❑ Other (specify)_____
- ❑ Don't recall
- ❑ Refused

Q13. On a scale of one to five, where one is "not important at all" and five is "very important," how important is energy efficiency to you when you select light bulbs for purchase?

- ❑ _____ [Record number, 1-5]
- ❑ Don't know
- ❑ Refused

Awareness of Discounts

Q14. How did you become aware of the TDPUD lighting discounts? [MARK ALL THAT APPLY]

- ❑ In-store promotional event representative
- ❑ In-store signage/marketing materials
- ❑ Store salesperson
- ❑ TDPUD website
- ❑ TDPUD program staff
- ❑ Word of mouth
- ❑ Other:_____ (describe)
- ❑ Don't know
- ❑ Refused

Q15. When purchasing CFL or LED light bulbs in the past six months, do you recall any of the products being discounted from their normal pricing?

❑ Yes (ask Q15a)	01
❑ No	02
❑ Don't know	98
❑ Refused	99

Q15a. Do you recall who the discounts were offered by?

❑ Yes (ask Q15b)	01
❑ No	02
❑ Don't know	98
❑ Refused	99

Q15b. Please specify: _____

Q16. Would you have been financially able to purchase the bulbs without the discount?

- ❑ Yes
- ❑ No
- ❑ Don't know

Q17. If the rebate incentives were not available, how likely would you have been to purchase the CFLs or LEDs bulbs? [READ, MARK ONE]

- ❑ Definitely would have purchased
- ❑ Probably would have purchased
- ❑ Probably would not have purchased
- ❑ Definitely would not have purchased
- ❑ Don’t know (don’t read)

Q18. On a scale of 1 to 5, where 1 is “not important at all” and 5 is “very important,” how important was the TDPUD lighting discount to your decision to purchase those specific light bulbs?

- ❑ _____ [Record number, 1-5]
- ❑ Don’t recall
- ❑ Refused

Household Characteristics / Demographics

Q19. Which of the following best describes your home/residence?

- ❑ Single Family Home
- ❑ Single family, mobile home
- ❑ Condominium
- ❑ Apartment
- ❑ Other (specify)
- ❑ Don’t know
- ❑ Refused

Q20. Do you own or rent this residence?

- ❑ Own
- ❑ Rent
- ❑ Don’t know
- ❑ Refused

Q21. Approximately when was your home constructed? [DO NOT READ]

- ❑ Before 1960
- ❑ 1960-1969
- ❑ 1970-1979
- ❑ 1980-1989
- ❑ 1990-1999
- ❑ 2000-2010
- ❑ 2011 or later
- ❑ Don’t know
- ❑ Refused

Q22. Approximately how many square feet is your home?

- ❑ _____ Record Number [100-99999]
- ❑ Don’t know
- ❑ Refused

Q23. How many individuals currently live in your home?

- ❑ _____ Record Number [1-97]
- ❑ Don’t know
- ❑ Refused

Q24. What is your approximate total household income? [PROVIDE BINS]

- ❑ Less than $10,000
- ❑ $10,000 to $29,999
- ❑ $30,000 to $49,999
- ❑ $50,000 to $69,999
- ❑ $70,000 to $89,999
- ❑ $90,000 to $99,999
- ❑ $100,000 to $149,999
- ❑ $150,000 or more
- ❑ Don’t know
- ❑ Refused

Q25. Do you have any comments about the Residential Lighting Rebate program, or any suggestions with regard to how it might be improved?

Thank you very much! Your responses will help TDPUD in improving the program.