Evaluation of the 2018 Public Service Company of New Mexico Energy Efficiency and Demand Response Programs

FINAL Report

April 5, 2019

Table of Contents

Executive Summary

This report presents the independent evaluation results for Public Service Company of New Mexico (PNM) energy efficiency and demand response programs for program year 2018 (PY2018).

The PNM programs and evaluation requirements were first established in 2005 by the New Mexico legislature's passage of the 2005 Efficient Use of Energy Act (EUEA).[1] The EUEA requires public utilities in New Mexico, in collaboration with other parties, to develop cost-effective programs that reduce energy demand and consumption. Utilities are required to submit their proposed portfolio of programs to the New Mexico Public Regulation Commission (NMPRC) for approval. As a part of its approval process, the NMPRC must find that the program portfolio is cost effective based on the Utility Cost Test (UCT).

An additional requirement of the EUEA is that each program must be evaluated at least once every three years. As part of the evaluation requirement, PNM must submit to the NMPRC a comprehensive evaluation report prepared by an independent program evaluator. As part of the reporting process, the evaluator must measure and verify energy and demand savings, determine program cost effectiveness, assess how well the programs are being implemented, and provide recommendations for program improvements as needed.

For PY2018, the following PNM programs were evaluated:

- Commercial Comprehensive
- Residential Lighting
- Energy Smart
- Residential Comprehensive
- New Home Construction
- Large Customer Self Direct
- Power Saver
- Peak Saver

[1] NMSA §§ 62-17-1 *et seq* (SB 644). Per the New Mexico Public Regulation Commission Rule Pursuant to the requirements of the EUEA, the NMPRC issued its most recent *Energy Efficiency Rule* (*17.7.2 NMAC*) effective September 26, 2017, that sets forth the NMPRC's policy and requirements for energy efficiency and load management programs. This Rule can be found online at http://164.64.110.134/parts/title17/17.007.0002.html

For each of the evaluated programs, the evaluation team estimated realized gross and net impacts (kWh and kW) and calculated program cost effectiveness using the UCT.[2] Brief process evaluations were also conducted for the Commercial Comprehensive and Residential Comprehensive programs.

The remaining programs that were not evaluated in 2018 are still summarized in this report. The accomplishments for the non-evaluated programs are reported using the following parameters:

- Gross impacts (kWh, kW) were calculated using PNM's *ex ante* values for annual savings;
- Net impacts were calculated from the gross impacts using the existing *ex ante* net-to-gross (NTG) ratio; and
- Cost effectiveness calculations were calculated using the *ex ante* net impact values and cost data as reported by PNM.

The analysis methods used for the evaluated PY2018 programs are summarized as follows:

Commercial Comprehensive. The measures eligible for the Commercial Comprehensive program are primarily prescriptive in nature, but the program also includes custom projects. Gross impacts were estimated based on a review of the deemed savings values combined with engineering desk reviews of a statistically representative sample of projects covering a range of major measure types in each of the sub-programs. A small number of site visits were also conducted to confirm operating conditions for a select few projects. A phone survey was used to verify installation and to collect information needed for a self-report analysis of free ridership to determine net impacts.

Residential Lighting. Deemed savings values included in PNM's tracking data (and used for the *ex ante* impacts) were compared with the values contained in the New Mexico Technical Reference Manual (TRM). If the values did not match, they were carefully reviewed to determine if the values were reasonable and the source appropriately documented. Net impacts were estimated using a lighting elasticity model.

Energy Smart. A deemed savings review was conducted to determine gross impacts for measures delivered by the Energy Smart program. Because this program serves low-income households, and most measures are directly installed, the NTG ratio is assumed to be 1.

[2] The evaluation team consists of Evergreen Economics, EcoMetric, Demand Side Analytics, and Research & Polling.

Residential Comprehensive. A deemed savings review was conducted for the Home Energy Checkup, Cooling and Pool Pumps, and Refrigerator Recycling sub-programs. Participant phone surveys to verify installation and collect information for the self-report analysis of free ridership were also conducted for the Home Energy Checkup and Cooling and Pool Pumps sub-programs.

New Home Construction. Gross impacts for Performance path projects were determined by engineering desk reviews of a statistically representative sample of projects. For prescriptive measures, gross impacts were evaluated by a deemed savings review. To determine net impacts, interviews were conducted with participating builders to assess whether the *ex ante* NTG ratio is still reasonable.

Large Customer Self Direct. One project in this category was completed in PY2018. Gross impacts were estimated based on an engineering desk review of the project details. The NTG ratio for this project was assumed to be 1.

Power Saver and Peak Saver. PNM had two demand response programs in PY2018. The Power Saver program focuses on single-family, multifamily, and small and medium commercial customers. For all Power Saver customers, the five-minute interval load data were analyzed during event periods and compared to load shapes from a control group. The Peak Saver program is for larger customers that typically have unique load shapes, which makes finding a matched control group difficult. For these customers, savings were estimated based on the differences in load shapes between event and non-event weekdays for the same customer.

Table 1 summarizes the PY2018 evaluation methods.

Table 1: Summary of PY2018 Evaluation Methods by Program

Program	Deemed Savings Review	Phone Verification	Engineering Desk Reviews	Site Visits	Elasticity Model	Billing Regression
Commercial Comprehensive	◆	◆	◆	◆		
Residential Lighting	◆				◆	
Energy Smart	◆					
Residential Comprehensive	◆	◆				
New Home Construction	◆	◆	◆			
Large Customer Self Direct			◆			
Power Saver (Res & Small/Med Commercial)				◆		◆
Peak Saver (Large Commercial & Industrial)						◆

The results of the PY2018 impact evaluation are shown in Table 2 (kWh) and Table 3 (kW), with the programs evaluated in 2018 highlighted in blue. For the non-evaluated programs, the totals are based on the *ex ante* savings and NTG values from the PNM tracking data.

Table 2: PY2018 Savings Summary - kWh

Program	# of Projects	Expected Gross kWh Savings	Engineering Adjustment Factor	Realized Gross kWh Savings	NTG Ratio	Realized Net kWh Savings
Commercial Comprehensive						
Retrofit Rebate	223	24,322,155	0.9853	23,964,257	0.6856	16,429,613
Midstream	19	307,207	0.6654	204,420	0.8400	171,713
Quick Saver	312	10,237,508	1.0486	10,735,347	1.0000	10,735,347
Building Tune-Up	69	2,151,101	0.9426	2,027,711	0.8700	1,764,109
New Construction	54	7,373,633	0.8288	6,111,437	0.8400	5,133,607
Multifamily	35	3,021,834	0.9670	2,922,016	0.8360	2,442,805
Residential Lighting	911,276	26,998,470	1.0017	27,044,554	0.6300	17,038,069
Home Works	9,094	1,761,801	1.0000	1,761,801	1.0000	1,761,801
Energy Smart	223	321,255	1.0000	321,255	1.0000	321,255
Residential Comprehensive						
Home Energy Checkup	1,989	2,333,433	1.0000	2,333,433	0.8977	2,094,670
Refrigerator Recycling	7,047	7,603,123	1.0000	7,603,123	0.6800	5,170,124
Cooling/Pool Pumps	3,887	5,354,353	1.0015	5,362,307	0.5463	2,929,428
Easy Savings Kit	6,211	2,323,535	1.0000	2,323,535	1.0000	2,323,535
New Home Construction	702	1,321,909	1.0338	1,366,545	0.8000	1,093,236
Large Customer Self Direct	1	282,523	1.4294	403,843	1.0000	403,843
Power Saver	44,430	547,000	1.0178	556,737	1.0000	556,737
Peak Saver	110	508,973	1.0000	508,973	1.0000	508,973
Total		**96,769,813**		**95,551,293**		**70,878,864**

Table 3: PY2018 Savings Summary - kW

Program	# of Projects	Expected Gross kW Savings	Engineering Adjustment Factor	Realized Gross kW Savings	NTG Ratio	Realized Net kW Savings
Commercial Comprehensive						
Retrofit Rebate	293	3,716	1.1129	4,135	0.6856	2,835
Midstream	19	25	1.2520	31	0.8400	26
Quick Saver	312	2,395	0.6227	1,492	1.0000	1,492
Building Tune-Up	69	90	0.8198	74	0.8700	64
New Construction	54	1,463	1.0731	1,570	0.8400	1,319
Multifamily	35	202	1.5652	317	0.8360	265
Residential Lighting	911,276	3,358	1.0017	3,364	0.6300	2,119
Home Works	9,094	105	1.0000	105	1.0000	105
Energy Smart	223	36	1.0000	36	1.0000	36
Residential Comprehensive						
Home Energy Checkup	1,989	261	1.0000	261	0.8977	234
Refrigerator Recycling	7,047	1,754	1.0000	1,754	0.6800	1,193
Cooling	3,887	4,203	0.9979	4,194	0.5463	2,291
Easy Savings Kit	6,211	84	1.0000	84	1.0000	84
New Home Construction	702	526	1.0295	542	0.8000	433
Large Customer Self Direct	1	38	1.1762	44	1.0000	44
Power Saver	44,430	41,340	0.6355	26,272	1.0000	26,272
Peak Saver	110	23,103	0.6586	15,216	1.0000	15,216
Total		**82,700**		**59,490**		**54,028**

Lifetime kWh savings are shown in Table 4 by program and for the portfolio overall. This includes expected gross, realized gross, and realized net kWh lifetime savings.

Table 4: PY2018 Savings Summary – Lifetime kWh

Program	Expected Gross kWh Lifetime Savings	Realized Gross kWh Lifetime Savings	Realized Net kWh Lifetime Savings
Commercial Comprehensive	419,248,560	406,451,776	324,058,672
Residential Lighting	229,036,217	229,427,162	144,539,112
Home Works	19,732,175	19,732,175	19,732,175
Energy Smart	4,593,337	4,593,337	4,593,337
Residential Comprehensive	127,847,654	127,951,507	82,192,014
Easy Savings Kit	24,397,119	24,397,119	24,397,119
New Home Construction	19,683,425	20,348,066	16,278,453
Large Customer Self Direct	4,520,368	6,461,493	6,461,493
Power Saver	547,000	556,737	556,737
Peak Saver	508,973	508,973	508,973
Total	**850,114,828**	**840,428,344**	**623,318,084**

Using net realized savings from this evaluation and cost information provided by PNM, the evaluation team calculated the ratio of benefits to costs for each of PNM's programs and for the portfolio overall. The evaluation team calculated cost effectiveness using the UCT, which compares the benefits and costs to the utility or program administrator implementing the program.[3] The evaluation team conducted this test in a manner consistent with the California Energy Efficiency Policy Manual.[4] The results of the UCT are shown below in Table 5. All programs except Power Saver and Peak Saver had a UCT of greater than 1.00, and the portfolio overall was found to have a UCT ratio of 1.71.

[3] The Utility Cost Test is sometimes referred to as the Program Administrator Cost Test, or PACT.

[4] http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy_-_Electricity_and_Natural_Gas/EEPolicyManualV5forPDF.pdf

Table 5: PY2018 Cost Effectiveness

Program	Utility Cost Test (UCT)
Commercial Comprehensive	2.08
Residential Lighting	3.42
Home Works	2.09
Energy Smart	1.03
Residential Comprehensive	1.56
Easy Savings Kit	2.54
New Home Construction	2.26
Power Saver	0.85
Peak Saver	0.94
Overall Portfolio	**1.71**

Based on the data collection and analysis conducted for this evaluation, the evaluation team found that, overall, PNM is operating high-quality programs that are achieving significant energy and demand savings and producing satisfied participants.

The impact evaluation—which included engineering desk reviews for a sample of Commercial Comprehensive and New Home Construction projects, deemed savings reviews, an elasticity model for the Residential Lighting program, and statistical models for the Power Saver and Peak Saver programs—resulted in relatively high realized gross savings. Adjustments to savings based on the Commercial Comprehensive desk reviews were due to three main factors: project-specific calculation inputs documented solely in the processing database, adjustments made by the evaluation team to use available site-specific information, and differences in HVAC baseline parameters. The evaluation team has provided a number of recommendations to improve savings values that include updates to the PNM Workpapers, utilizing project-specific inputs when available, documenting calculations of project savings, and other minor consistency improvements. A few recommendations related to data tracking were also made, including one to improve the accuracy of the Residential Lighting data.

In terms of cost effectiveness, the UCT test was used and found all PNM programs except Power Saver and Peak Saver to be cost effective. The PNM portfolio overall was found to be cost effective. If PNM or the NMPRC desires other cost effectiveness tests to be used in the future, the evaluation team would suggest that PNM track measure costs so that the Total Resource Cost (TRC) test could be calculated in future program years.

The process evaluation activities, which included surveys with Retrofit Rebate, Quick Saver, Home Energy Checkup, and Cooling and Pool Pumps participants, as well as interviews with Multifamily and New Construction participants, found very high levels of satisfaction across various aspects of the programs.

1 Introduction

This report presents the independent evaluation results for Public Service Company of New Mexico (PNM) energy efficiency and demand response programs for program year 2018 (PY2018).

The PNM programs and evaluation requirements were first established in 2005 by the New Mexico legislature's passage of the 2005 Efficient Use of Energy Act (EUEA).[5] The EUEA requires public utilities in New Mexico, in collaboration with other parties, to develop cost-effective programs that reduce energy demand and consumption. Utilities are required to submit their proposed portfolio of programs to the New Mexico Public Regulation Commission (NMPRC) for approval. As a part of its approval process, the NMPRC must find that the program portfolio is cost effective based on the Utility Cost Test.

An additional requirement of the EUEA is that each program must be evaluated at least once every three years. As part of the evaluation requirement, PNM must submit to the NMPRC a comprehensive evaluation report prepared by an independent program evaluator. As part of the reporting process, the evaluator must measure and verify energy and demand savings, determine program cost effectiveness, assess how well the programs are being implemented, and provide recommendations for program improvements as needed.

Within this regulatory framework, the Evergreen evaluation team was chosen to be the independent evaluator for PNM in May 2017, and a project initiation meeting was held with PNM staff on August 28, 2017. The Evergreen evaluation team consisted of the following firms:

- **Evergreen Economics** was the prime contractor and managed all evaluation tasks and deliverables;
- **EcoMetric** provided engineering capabilities and led the review of PNM's savings estimates;
- **Demand Side Analytics** conducted the impact evaluations of the demand response programs; and
- **Research & Polling** fielded all the phone surveys.

[5] NMSA §§ 62-17-1 *et seq* (SB 644). Per the New Mexico Public Regulation Commission Rule Pursuant to the requirements of the EUEA, the NMPRC issued its most recent *Energy Efficiency Rule* (*17.7.2 NMAC*) effective September 26, 2017, that sets forth the NMPRC's policy and requirements for energy efficiency and load management programs. This Rule can be found online at http://164.64.110.134/parts/title17/17.007.0002.html

For PY2018, the following PNM programs were evaluated:

- Commercial Comprehensive
- Residential Lighting
- Energy Smart
- Residential Comprehensive
- New Home Construction
- Large Customer Self Direct
- Power Saver
- Peak Saver

For each of the evaluated programs, the evaluation team estimated realized gross and net impacts (kWh and kW) and calculated program cost effectiveness using the Utility Cost Test (UCT). Brief process evaluations were also conducted for the Commercial Comprehensive and Residential Comprehensive programs.

The remaining programs that were not evaluated in 2018 are still summarized in this report. The accomplishments for the non-evaluated programs are reported using the following parameters:

- Gross impacts (kWh, kW) were calculated using PNM's *ex ante* values for annual savings;
- Net impacts were calculated from the gross impacts using the existing *ex ante* net-to-gross ratio; and
- Cost effectiveness calculations were calculated using the *ex ante* net impact values and cost data as reported by PNM.

The remainder of this report is organized as follows. The *Evaluation Methods* chapter describes the various analysis methods and data collection activities that were conducted for the PY2018 evaluation. Program-specific chapters follow that present the energy and demand savings by program and the process evaluation findings. *The Cost Effectiveness Results* are summarized in the next chapter. The main report concludes with a chapter on evaluation *Conclusions and Recommendations.* Additional technical details on the evaluation methods and results are included in several appendices.

2 Evaluation Methods

The analysis methods used for the evaluated PY2018 programs are summarized as follows:

Commercial Comprehensive. The measures eligible for the Commercial Comprehensive program are primarily prescriptive in nature, but the program also includes custom projects. Gross impacts were estimated based on a review of the deemed savings values combined with engineering desk reviews of a statistically representative sample of projects covering a range of major measure types in each of the sub-programs. A small number of site visits were also conducted to confirm operating conditions for a select few projects. A phone survey was used to verify installation and to collect information needed for a self-report analysis of free ridership to determine net impacts.

Residential Lighting. Deemed savings values included in PNM's tracking data (and used for the *ex ante* impacts) were compared with the values contained in the New Mexico Technical Reference Manual (TRM). If the values did not match, they were carefully reviewed to determine if the values were reasonable and the source appropriately documented. Net impacts were estimated using a lighting elasticity model.

Energy Smart. A deemed savings review was conducted to determine gross impacts for measures delivered by the Energy Smart program. Because this program serves low-income households, and most measures are directly installed, the net-to-gross ratio is assumed to be 1.

Residential Comprehensive. A deemed savings review was conducted for the Home Energy Checkup, Cooling and Pool Pumps, and Refrigerator Recycling sub-programs. Participant phone surveys to verify installation and collect information for the self-report analysis of free ridership were also conducted for the Home Energy Checkup and Cooling and Pool Pumps sub-programs.

New Home Construction. Gross impacts for Performance path projects were determined by engineering desk reviews of a statistically representative sample of projects. For prescriptive measures, gross impacts were evaluated by a deemed savings review. To determine net impacts, interviews were conducted with participating builders to assess whether the *ex ante* net-to-gross ratio is still reasonable.

Large Customer Self Direct. One project in this category was completed in PY2018. Gross impacts were estimated based on an engineering desk review of the project details. The net-to-gross ratio for this project was assumed to be 1.

Power Saver and Peak Saver. PNM had two demand response programs in PY2018. The Power Saver program focuses on single-family, multifamily, and small and medium commercial customers. For all Power Saver customers, the five-minute interval load data were analyzed during event periods and compared to load shapes from a control group. The Peak Saver program is for larger customers that typically have unique load shapes, which makes finding a matched control group difficult. For these customers, savings were estimated based on the differences in load shapes between event and non-event weekdays for the same customer.

Table 6 summarizes the PY2018 evaluation methods. Additional detail on each of these evaluation methods is included in the remainder of this chapter.

Table 6: Summary of PY2018 Evaluation Methods by Program

Program	Deemed Savings Review	Phone Verification	Engineering Desk Reviews	Site Visits	Elasticity Model	Billing Regression
Commercial Comprehensive	◆	◆	◆	◆		
Residential Lighting	◆				◆	
Energy Smart	◆					
Residential Comprehensive	◆	◆				
New Home Construction	◆	◆	◆			
Large Customer Self Direct			◆			
Power Saver (Res & Small/Med Commercial)				◆		◆
Peak Saver (Large Commercial & Industrial)						◆

2.1 Phone Surveys

A participant phone survey was fielded in early 2019 for participants in the Retrofit Rebate and Quick Saver sub-programs of the Commercial Comprehensive program and for participants in the Home Energy Checkup and Cooling and Pool Pumps sub-programs of the Residential Comprehensive program. The surveys averaged about 20 minutes in length and covered the following topics:

- Verification of measures included in PNM's program tracking database;
- Satisfaction with the program experience;
- Survey responses for use in the free ridership calculations;
- Participation drivers and barriers; and

- Customer characteristics.

Additional interviews with Commercial Comprehensive program participants were also conducted by engineers if additional information was needed for the individual project desk reviews.

The original goal was to complete 100 phone surveys for the Commercial Comprehensive program, and given the number of participants, we attempted to contact a census of Retrofit Rebate and Quick Saver sub-program participants. Ultimately, 100 phone surveys were completed, with about one-third completed by Retrofit Rebate (prescriptive and custom projects) sub-program participants and two-thirds completed by Quick Saver (direct install) sub-program participants. The goal for the Residential Comprehensive surveys was to complete 50 for the Home Energy Checkup sub-program (split between low income and non-low income customers) and 50 for the Cooling and Pool Pumps sub-program. Table 7 and Table 8 show the distribution of completed surveys for the Commercial Comprehensive and Residential Comprehensive programs.

Table 7: Commercial Comprehensive Phone Survey Summary

Sub-Program	Count of Customers with Valid Contact Info	Target # of Completes	Completed Surveys
Retrofit Rebate	83	40	34
Quick Saver	157	60	66
Total	**240**	**100**	**100**

Table 8: Residential Comprehensive Phone Survey Summary

Sub-Program	Count of Customers with Valid Contact Info	Target # of Completes	Completed Surveys
Home Energy Checkup	247	50	52
Cooling and Pool Pumps	2,404	50	60
Total	**2,651**	**100**	**112**

The final survey instruments for the Commercial Comprehensive, Home Energy Checkup, and Cooling and Pool Pumps programs are included in Appendices A, C, and D respectively.

2.2 Engineering Desk Reviews

In order to verify gross savings estimates, the evaluation team conducted engineering desk reviews for a sample of the projects in the Commercial Comprehensive program, a sample of Performance projects in the New Home Construction program, and the single Large Customer Self-Direct project conducted in 2018. The goal of the desk reviews was to verify equipment installation, operational parameters, and estimated savings.

Both prescriptive and custom projects received desk reviews that included the following:

- Review of project description, documentation, specifications, and tracking system data;
- Confirmation of installation using invoices and/or post-installation reports; and
- Review of post-installation reports detailing differences between installed equipment and documentation, and subsequent adjustments made by the program implementer.

For projects in the Commercial Comprehensive program that used deemed savings values for prescriptive measures, the engineering desk reviews included the following:

- Review of measures available in the New Mexico TRM and the PNM Workpapers to determine the most appropriate algorithms which apply to the installed measure;
- Recreation of savings calculations using TRM/Workpaper algorithms and inputs as documented by submitted specifications, invoices, and post-installation inspection reports; and
- Review of TRM/Workpaper algorithms to identify candidates for future updates and improvements.

For the custom projects included in the Commercial Comprehensive program, the engineering desk reviews included the following:

- Review of engineering analyses for technical soundness, proper baselines, and appropriate approaches for the specific applications;
- Review of methods of determining demand (capacity) savings to ensure they are consistent with program and/or utility methods for determining peak load/savings;
- Review of input data for appropriate baseline specifications and variables such as weather data, bin hours, and total annual hours to determine if they are consistent with facility operation; and
- Consideration and review for interactive effects between affected systems.

For projects in the Residential New Construction program, the engineering desk reviews included the following:

- Utilization of REM/Rate v15.7.1 to analyze REM/Rate files provided by the program implementer;
- Creation of batch reports comparing the model home and the reference home using the User Defined Reference Home for Albuquerque (compatible with REM/Rate v15.7.1);
- Review of HVAC and furnace ratings/capacity of listed equipment in each home according to Air Conditioning, Heating, and Refrigeration Institute (AHRI) certificates; and
- Review of evaluator-generated Fuel Summary Reports and comparison of the electric and natural gas savings with those listed in the Fuel Summary Reports provided by the program implementer.

For the Large Customer Self-Direct project, the engineering desk review included the following:

- Review of measures available in the New Mexico TRM and the PNM Workpapers to determine the most appropriate algorithms which apply to the installed measure;
- Re-creation of savings calculations using TRM/Workpaper algorithms and inputs as documented by submitted specifications, invoices, and post-installation inspection reports; and
- Verification of operating parameters for lighting projects such as pre- and post-installation wattages and operating schedule.

In support of the engineering desk reviews, primary data were collected for select projects through on-site verification. The evaluation team visited sites to confirm the installation of efficiency measures and operational parameters. Based on participant feedback and visual inspection of equipment and controls, the evaluation team was able to make adjustments to the energy savings calculations to more accurately capture savings. The evaluation team also performed verification by requesting additional project-specific information from PNM and its implementers when clarification was needed and performing internet searches to confirm calculation parameters (e.g., operating hours).

2.3 Demand Response Programs

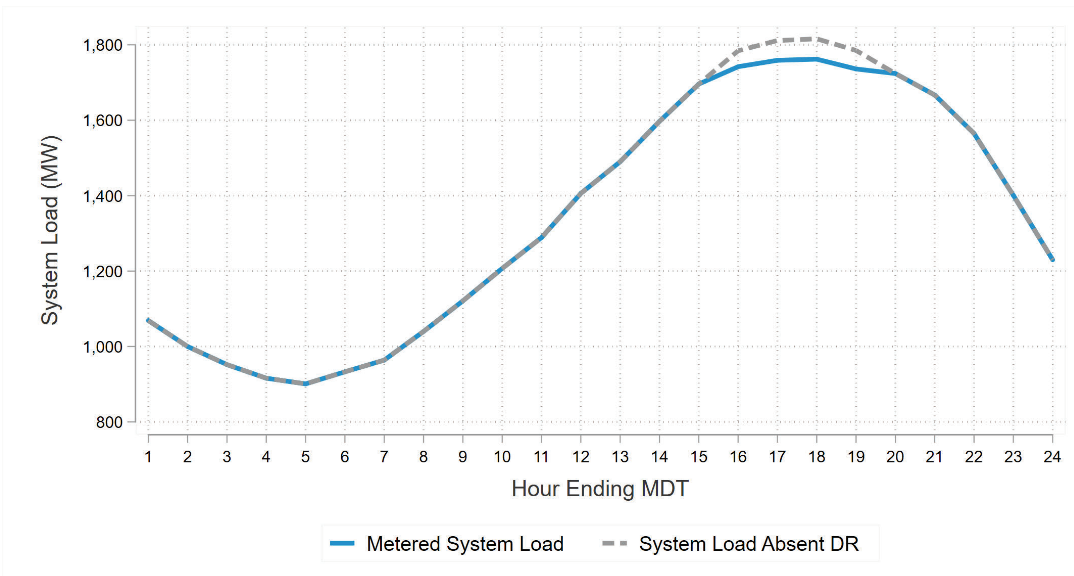
On January 31, 2018, the New Mexico Public Regulation Commission (NMPRC) issued a final order in PNM's 2017 energy efficiency case that directs Evergreen Economics, as independent program evaluator for PNM's energy efficiency and load management (LM) programs, to do the following:

In PNM's future M&V reports, the independent evaluator shall verify that load reductions from deployment of PNM's LM programs avoided or offset the need for or use of additional peaking units or power purchases or shifted demand from peak to off peak period.

The evaluation team concludes that in 2018, the load management programs served a capacity resource that avoided the need for additional supply-side peaking capacity.

Figure 1 illustrates the benefits of the load management programs on system load for a high load day in 2018. Metered retail load on PNM's system peaked at 1,762 MW on June 27, 2018, during hour ending 18:00 (Mountain Daylight Time). If we add back verified estimates of demand response performance, adjusted for line losses, the daily peak would have been 1,816 MW during hour ending 18:00 MDT. The load management programs flatten out system loads toward the top of the afternoon ramp, which reduces the amount of peaking resources needed to balance the supply and demand.

Figure 1: PNM System Load June 27, 2018



The two PNM load management—or demand response—programs relied on similar analysis methods to estimate program impacts. Additional detail on the analysis methods used for both programs is included in Appendix G and Appendix H.

2.3.1 Load Management Programs as a Resource

PNM's demand side management portfolio includes both energy efficiency and demand response programs. While these two categories of programs both fall under the umbrella of demand side management, it is important to understand some key distinctions with respect to the nature of the resource provided. The two primary benefit streams from demand side management programs are:

- **Energy (kWh)** - the generation of electrical power over a fixed period of time. The avoided cost of energy is largely the cost of the fuel not burned in the marginal generating unit.
- **Capacity (kW)** - Capacity is the ability to provide energy when needed and assures that there will be sufficient resources to meet peak loads.

The primary objective of energy efficiency programs is to save energy. To the extent that the affected end-uses operate coincident with the system peak, energy efficiency measures will also provide capacity benefits. Demand response programs like Peak Saver and Power Saver are designed to provide capacity benefits. Their value lies in being able to reduce load quickly to balance the grid if needed. Demand response events typically result in net energy savings because the increased consumption following an event does not totally offset the reduced usage during an event. However, the distribution of benefits across resources is dominated by capacity.

Table 9 shows the energy and capacity benefits for the two demand response programs in 2018. Energy benefits amounted to 0.6 percent of Utility Cost Test (UCT) benefits, while capacity benefits accounted for 99.4 percent of the UCT benefits. This is very different from PNM's energy efficiency programs, where capacity accounts for less than half of UCT benefits.

Table 9: 2018 Demand Response Program Benefits

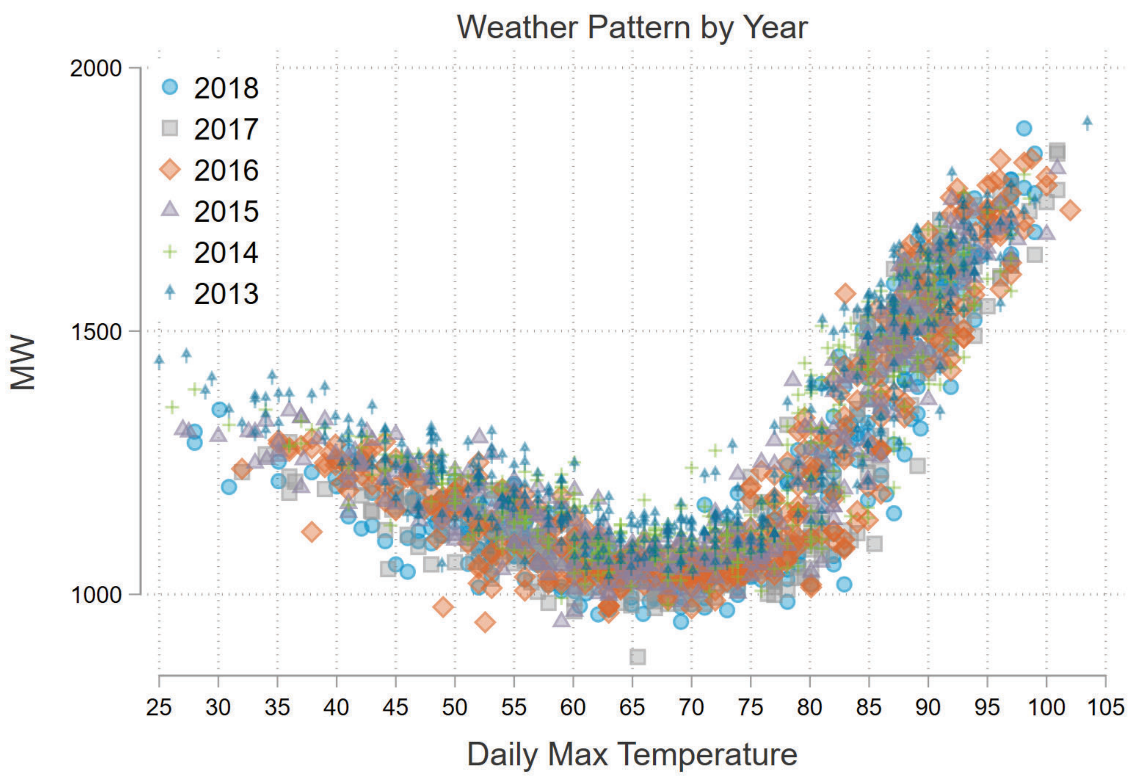
Program	Energy Benefit	Capacity Benefit	Percent Capacity
Power Saver	$17,239	$3,670,322	99.5%
Peak Saver	$15,760	$2,125,697	99.3%
Energy Efficiency Programs	$17,607,832	$16,595,888	48.5%

Another important distinction between energy efficiency and demand response is that demand response is a dispatchable resource and energy efficiency is not. When PNM supports an energy efficiency measure, the demand savings will remain present until the equipment reaches the end of its useful life. Demand response programs like Peak Saver and Power Saver are event-based resources that can be dispatched when needed. A critical thing to understand about dispatchable demand response resources is that they provide capacity benefits even if no events are called in a summer. How often demand response is dispatched and which units in the stack are displaced are energy questions which have almost no material impact on the cost effectiveness of demand response programs. To provide additional context, the evaluation team reviewed PNM's most recent Integrated

Resource Plan (IRP)[6] to summarize how demand side management resources fit into resource planning.

PNM has a summer peak load forecast of approximately 1,900 MW. This does not mean that each summer, peak loads will equal 1,900 MW, because weather plays an important role in electric demand. Figure 2 illustrates this relationship using PNM system loads (2013-2018) and weather records from KABQ's weather station in Albuquerque. PNM is clearly a summer-peaking utility, with maximum summer loads that are 20 to 30 percent higher than winter loads each year.

Figure 2: Daily Maximum PNM System Load and Temperature by Year



System planners must design the system without knowing what weather conditions will be and ensure reliability even in extreme weather years. In addition to securing resources to meet forecasted demand, PNM planners maintain a reserve margin of resources above and beyond forecasted demand to ensure expected levels of reliability. In the 2017 IRP,

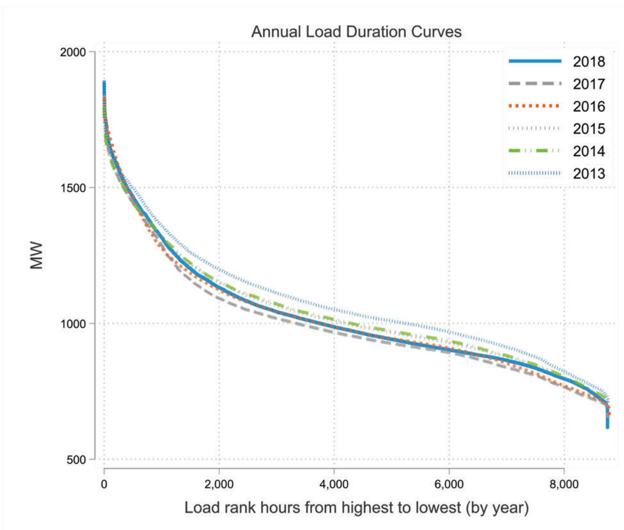
---

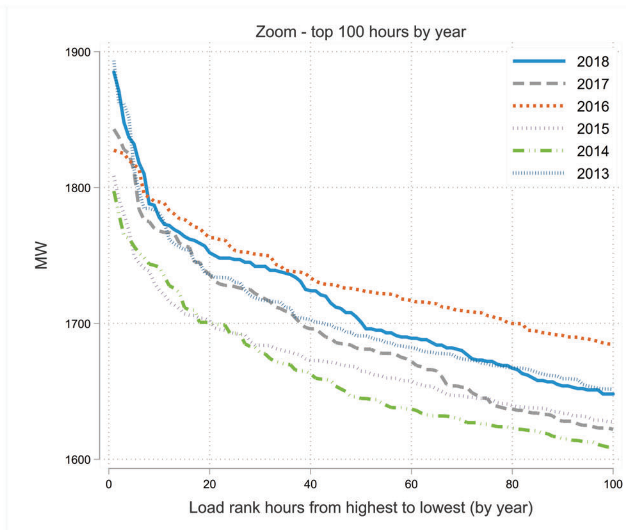
6 PNM 2017-2036 Integrated Resource Plan. July 3, 2017. https://www.pnm.com/documents/396023/396193/PNM+2017+IRP+Final.pdf/eae4efd7-3de5-47b4-b686-1ab37641b4ed

PNM's minimum reserve margin was 13 percent. This means that although peak demand is forecast at 1,900 MW, planners need at least 2,147 MW of capacity to satisfy resource requirements. If the peak load for a summer is actually 1,900 MW and no resources experience outages or other disruptions, this means the 247 MW of capacity could go unused for the year.

Figure 3 provides annual load duration curves for the PNM system over the last six years to illustrate a key point about capacity utilization. Peak load conditions are observed in a very small number of hours. This means some capacity resources need to operate quite intermittently. The right side of Figure 3 zooms in on the top 100 hours of each year. Even within this very narrow portion of the year (1.1 percent of the hours in a year), the load duration curve has a very steep slope. In 2018, there was a 107 MW difference between the top hour and the tenth-highest load hour for the year.

Figure 3: Annual and Top 100 Hour Load Duration Curves 2013-2018





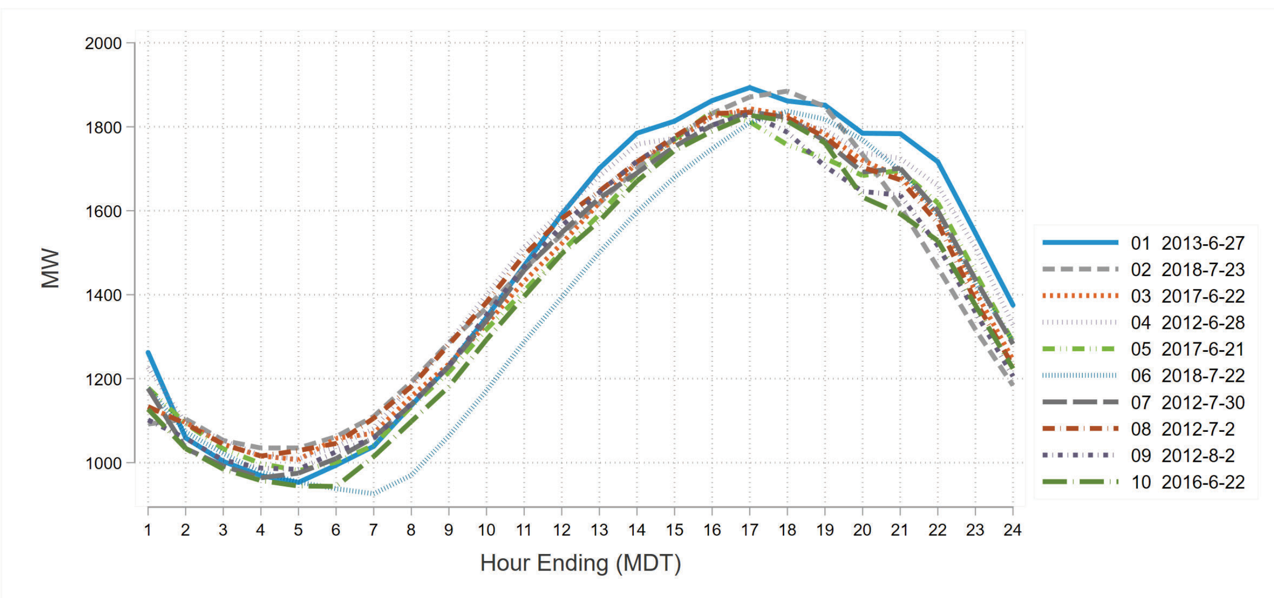
Dispatchable summer capacity resources like Peak Saver and Power Saver (which are only available in the summer) are a good fit for the PNM system because peaks occur exclusively in the summer and are focused on specific hours. From 2012 to 2017 the annual peak occurred at hour ending 17 (4:00 p.m. to 5:00 p.m.) Mountain Daylight Time (MDT) on a weekday. In 2018, the system peaked an hour later at hour ending 18 (5:00 pm to 6:00 pm MDT).

The reserve margin requirement is above and beyond the forecasted top hour. A supply-side resource like a natural gas peaking plant built to satisfy peaks plus reserve margin would operate very infrequently—which is not a cost-effective way to operate a power plant. Demand response resources, on the other hand, work best when dispatched infrequently because it reduces fatigue of participants and limits the financial incentive the utility needs to provide.

Like most vertically integrated utilities, PNM treats energy efficiency and demand response differently in its demand forecast and resource stack. Incremental energy efficiency (because it is not dispatchable) is treated as a top-line adjustment that lowers the forecast. Demand response programs (because they are dispatchable) are listed alongside power plants as resources available to meet demand. Like traditional supply-side resources, demand response programs have a position in the dispatch stack. Although there is no fuel cost associated with demand response programs, there is a definite relationship between how often demand response participants are dispatched and the cost of the resource.

Figure 4 shows PNM's top 10 system load days of the last six years, which includes two days from 2018. July 22, 2018 is noteworthy because it was a Sunday. The PNM system does not generally peak on weekends, and demand response programs are not available on weekends either.

Figure 4: Top 10 System Load Days 2012-2018



The system peak for 2018 was set on July 23rd and was the highest since 2013. Neither the Peak Saver program nor the Power Saver program was dispatched on July 23rd. The Evergreen team probed PNM staff to understand why the load management programs were not dispatched on July 23, 2018, and found out that demand response dispatch has a two-part trigger:

1. If the day-ahead temperature forecast is 96 degrees or higher.

2. A day-of assessment by the Power Operations and Whole Power Marketing departments to assess transmission/capacity constraints or generation issues. These groups also consider participant fatigue and will decide to not dispatch if there are no constraints.

Both the Peak Saver and Power Saver programs were dispatched on July 18, July 19, and July 20. If the load management programs had been dispatched on July 23, it would have been the fourth consecutive weekday with a demand response event. The value in load management programs lies in being able to dispatch the resources *when needed*, and PNM staff are in the best position to determine when the assets are needed from an operational standpoint.

Part of what makes the Peak Saver and Power Saver programs valuable resources for PNM is that they satisfy two types of capacity reserves:

1. Planning reserves are forecasted generation capacity over and above the amount required to serve the projected peak-hour demand of the year.
2. Operating reserves provide the ability to respond to supply and demand imbalances within each hour.[7]

The ability of PNM's load management programs to provide operating reserves was showcased on July 26, 2018. Around 4:00 p.m. MDT, there was an unplanned outage at the Rio Bravo generating station for approximately 90 minutes. Rio Bravo is a 132 MW gas peaking plant. Although July 26th was not an extremely hot or high load day, the loss of a key resource to manage the afternoon ramp and peak created a supply constraint. Peak Saver participants were notified at 3:52 p.m. of a 4:00 p.m. demand response event. Power Saver also responded in a matter of minutes.

Because the capacity benefits are the dominant benefit stream for demand response programs, the primary research question for evaluation is "what kW reduction can each program be expected to provide if dispatched during system peak conditions?" This is why readers will note that the evaluation results in the Power Saver and Peak Saver impact results subchapters focus on inferences about expected, or *ex ante*, impacts at peaking conditions rather than simple averages of observed impacts during 2018 events. We analyzed the last four summers of Power Saver results to develop a time-temperature matrix and estimate the expected impact from 5:00 p.m. to 6:00 p.m. at 100 degrees Fahrenheit (F).

The avoided cost of capacity value used to monetize capacity benefits from demand side management programs is $129/kW-year. This value is consistent with projections the

[7] "PNM's demand response programs help PNM meet operating reserve requirements since they can be dispatched and synced to the grid within 10 minutes." IRP, p. 38.

evaluation team has seen in other jurisdictions of the cost a new combined-cycle natural gas plant would need in order to recover its capital investment and fixed costs, given reasonable expectations about future cost recovery over its economic life. The underlying premise is that the availability of PNM's demand response programs is allowing the utility to defer or avoid the construction or purchase of additional generation capacity. Page 109 of the IRP states: "*Without the demand savings from the programs, 40 MW of additional gas peaking capacity is needed in 2018 and another 41 MW in 2020.*" This statement is remarkably consistent with our verified savings analysis of PNM's load management program performance on 2018 event days. Table 10 shows the Evergreen team's average hourly verified demand savings estimates, by event date, across the two load management programs adjusted by a factor of 1.083 for line losses. The average for the summer is 40.0 MW.

Table 10: Average 2018 Demand Response Impact by Event Date

Event Date	Average MW Impact with Losses
6/7/2018	27.1
6/12/2018	45.9
6/21/2018	44.3
6/22/2018	51.5
6/25/2018	32.6
6/27/2018	49.5
7/18/2018	36.4
7/19/2018	45.1
7/20/2018	46.1
7/25/2018	39.6
7/26/2018	32.5
8/7/2018	29.7
2018 Average	**40.0**

Specific details on both the Power Saver and Peak Saver programs are presented below.

2.3.2 Power Saver

The Power Saver program is a direct load control program offered to PNM's residential, small commercial (< 50 kW), and medium commercial (50 kW – 150 kW) customers. To facilitate load control, participants must have a device attached to the exterior of their air conditioning unit. This device is capable of receiving a radio signal that will turn off the unit's compressor for an interval of time. Such signals are typically sent on the hottest weekday afternoons of the summer, with the goal being to reduce peak demand. Residential and small commercial participants receive an annual $25 incentive for their participation. Medium commercial participants receive an annual incentive of $9 per ton of refrigerated air conditioning.

There were 12 Power Saver events during the summer 2018 demand response season, which began June 1st and ended September 30th. Table 11 provides some information on these 12 2018 events. Note that the event start and end times reflect Mountain Daylight Time (MDT). This is in contrast to how the event times and data were represented by Itron, the program implementer, which reported results in Mountain Standard Time.

Table 11: 2018 Power Saver Event Summary

Date	Day of Week	Start Time (MDT)	End Time (MDT)	Daily High at KABQ (F)
June 7	Thursday	3:00 p.m.	7:00 p.m.	93
June 12	Tuesday	3:00 p.m.	7:00 p.m.	97
June 21	Thursday	3:00 p.m.	7:00 p.m.	94
June 22	Friday	3:00 p.m.	7:00 p.m.	99
June 25	Monday	3:00 p.m.	7:00 p.m.	92
June 27	Wednesday	3:00 p.m.	7:00 p.m.	99
July 18	Wednesday	3:00 p.m.	7:00 p.m.	95
July 19	Thursday	3:00 p.m.	7:00 p.m.	96
July 20	Friday	3:00 p.m.	7:00 p.m.	97
July 25	Wednesday	3:00 p.m.	7:00 p.m.	93
July 26	Thursday	4:00 p.m.	8:00 p.m.	89
August 7	Tuesday	3:00 p.m.	7:00 p.m.	94

Shortly after the conclusion of the summer 2018 season, Itron provided the Evergreen team with a series of datasets for the evaluation. These files included:

- For residential, small commercial, and medium commercial sites, five-minute load data from 6/1/2018 to 9/30/2018;
- For residential and small commercial sites, an M&V list that provided the location type (residential or commercial), the group (control or curtailment), and the dates each load control device was active; and
- For medium commercial sites, an M&V list that provided the dates each load control device was active.

The Evergreen team also received Itron's Power Saver impact evaluation report, which detailed the methods Itron employed in calculating customer baselines (CBLs) for the three different participant classes. A CBL is an estimate of what participant loads would have been absent the demand response event dispatch. By customer class, the report also showed the load impact, which is the difference between the CBL and the metered load, for each five-minute interval of each curtailment day. The key steps in the Evergreen verified savings analysis were:

1. For each customer class, reproduce the performance estimates calculated by Itron using the contractually-agreed upon CBL method.
2. Modify the CBL methodology and produce *ex post* estimates of what the per-device impact was during the 2018 demand response season.
3. Where possible, leverage additional historical data from 2015 - 2017 to produce *ex ante* estimates of what the per-device impact at peaking conditions (3:00 p.m. at 100° F) will be in future summers.

2.3.3 Peak Saver

PNM offers the Peak Saver program to non-residential customers with peak load contributions of at least 50 kW. The program compensates participants for reducing electric load upon dispatch during periods of high system load. Peak Saver was implemented by Enbala, which managed the enrollment, dispatch, and settlement with participating customers. During the summer 2018 demand response season, there were 86 participating facilities and 12 demand response events. These events are summarized in Table 12.

Table 12: 2018 Peak Saver Event Summary

Date	Weekday	Notification Time (MDT)	Start Time (MDT)	End Time (MDT)	Daily High at KABQ (F)
June 7	Thursday	11:34 a.m.	3:00 p.m.	7:00 p.m.	93
June 12	Tuesday	11:20 a.m.	3:00 p.m.	7:00 p.m.	97
June 21	Thursday	2:08 p.m.	3:00 p.m.	7:00 p.m.	94
June 22	Friday	2:01 p.m.	3:00 p.m.	7:00 p.m.	99
June 25	Monday	1:14 p.m.	3:00 p.m.	7:00 p.m.	92
June 27	Wednesday	1:23 p.m.	3:00 p.m.	7:00 p.m.	99
July 18	Wednesday	11:40 a.m.	3:00 p.m.	7:00 p.m.	95
July 19	Thursday	11:52 a.m.	3:00 p.m.	7:00 p.m.	96
July 20	Friday	12:41 p.m.	3:00 p.m.	7:00 p.m.	97
July 25	Wednesday	12:25 p.m.	3:00 p.m.	7:00 p.m.	93
July 26	Thursday	3:52 p.m.	4:00 p.m.	7:00 p.m.	89
August 6	Tuesday	12:07 p.m.	3:00 p.m.	7:00 p.m.	97

After the 2018 demand response season concluded, Enbala provided the Evergreen team with one-minute interval load data for each site in the Peak Saver population, as well as some workbooks with the performance metrics (10-minute capacity, average participant capacity, participant event capacity, and energy delivered) for each site/event combination. The interval data spanned a period from May 29 to August 31. September data was not included simply because no demand response events were dispatched in September. Though May was not part of the demand response season, a few May days were included in the data to facilitate the baseline calculation for the June 7th event.

The one-minute interval load data also included a field with load impacts calculated using a customer baseline (CBL) method detailed in the contract between PNM and Enbala. A CBL is an estimate of what participant loads would have been absent the demand response event dispatch. Load impacts are the difference between the CBL and the metered load during the event. The relevant CBLs were also in the one-minute load data.

With these data sources, the Evergreen team completed our verified savings analysis. The three key steps in the analysis were to:

1. Reproduce the performance estimates calculated by Enbala using the contractually-agreed upon CBL method;

2. Assess the accuracy of the contract CBL method by examining its ability to predict loads on non-event weekdays; and
3. Modify the CBL methodology to reduce bias and calculate verified impacts for each event.

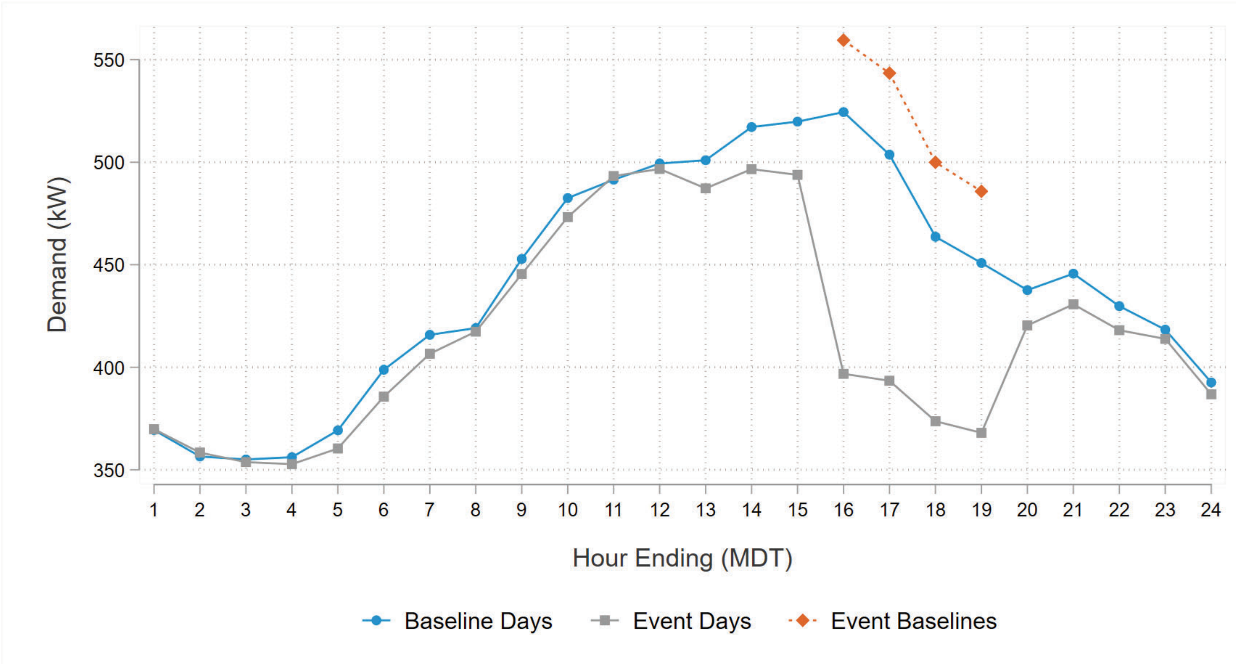
The settlement calculations called for a "high 3-of-5" baseline with an uncapped, asymmetric day-of adjustment. The high 3-of-5 days were determined as follows:

- Collapse the one-minute interval data to 15-minute interval data;
- Select the five non-holiday, non-event weekdays that immediately precede the event; and
- Out of those five days, pick the three days with the highest 15-minute interval read during the hours in which the event occurred.

Note that the three days with the highest 15-minute interval read were not necessarily the days with the highest average event-window load. In the case of a tie, the first of the two days was selected as a baseline day. This tie-breaking procedure was not laid out formally; rather, we discovered it when recreating Enbala's calculations.

For two sites, we discovered that the day-of adjustment had not been applied to the baseline. Our team alerted PNM, which then alerted Enbala. In response, Enbala provided updated results for these two sites. Other than those two sites, the Evergreen team encountered no issues in duplicating Enbala's baselines. Figure 5 shows average hourly event day loads across the full population, average hourly loads on baseline days (again across the full population), and also average hourly baselines. Note that the largest site (in terms of average kW) was not included in the figure, as its size and event day load profile muddied the overall trend. The event on July 26th was not included either, as this was the only event that did not run from 3:00 p.m. until 7:00 p.m.

Figure 5: Peak Saver Loads and Baselines



After verifying that the baselines were calculated correctly, our team moved onto the performance metric calculations. The relevant performance metrics are:

- **10-Minute Participant Capacity Performance** – The difference between the CBL and the lowest actual electrical demand measured by a one-minute interval reading between eight and ten minutes after the start of an event.
- **Average Participant Capacity Performance** – The average difference between the CBL and the participant's actual electric demand beginning ten minutes after the initiation of the event.
- **Participant Event Capacity Performance** – Weighted average of 10-Minute Participant Capacity Performance (40 percent weight) and Average Participant Capacity Performance (60 percent weight).

We ran into one initial issue: the contract that described how the performance metrics would be calculated made no mention of special treatment for negative performances, but we found that they were being zeroed out. PNM relayed our questions about zeroing out negative performances to Enbala, which replied as follows:

> *"Regarding the performance calculations, if the (weighted) Event Capacity Performance is less than 0, it is capped to a minimum of 0 and the 10-minute and Average Performance numbers are also displayed as 0. However, if the Event Capacity Performance is greater than 0, the 10-minute and Average Performance numbers are left untouched and allowed to go negative."*

With this information, our team was able to replicate all performance metrics for each site/event combination.

2.4 Net Impact Analysis

2.4.1 Self-Report Approach

The evaluation team estimated net impacts for some programs using the self-report approach. This method uses responses to a series of carefully constructed survey questions to learn what participants would have done in the absence of the utility's program. The goal is to ask enough questions to paint an adequate picture of the influence of the program activities (rebates and other program assistance) within the confines of what can reasonably be asked during a phone survey.

With the self-report approach, specific questions that are explored include the following:

- What were the circumstances under which the customer decided to implement the project (i.e., new construction, retrofit/early replacement, replace-on-burnout)?
- To what extent did the program accelerate installation of high efficiency measures?
- What were the primary influences on the customer's decision to purchase and install the high efficiency equipment?
- How important was the program rebate on the decision to choose high efficiency equipment?
- How would the project have changed if the rebate had not been available (e.g., would less efficient equipment have been installed, would the project have been delayed, etc.)?
- Were there other program or utility interactions that affected the decision to choose high efficiency equipment (e.g., was there an energy audit done, has the customer participated before, is there an established relationship with a utility account representative, was the installation contractor trained by the program)?

The method used for estimating free ridership (and ultimately the net-to-gross [NTG] ratio) using the self-report approach is based on the 2017 Illinois Statewide Technical Reference Manual (TRM).[8] For the PNM programs, questions regarding free ridership were divided into several primary components:

- A ***Program Component*** series of questions that asked about the influence of specific program activities (rebate, customer account rep, contractor recommendations, other assistance offered) on the decision to install energy efficient equipment;

---

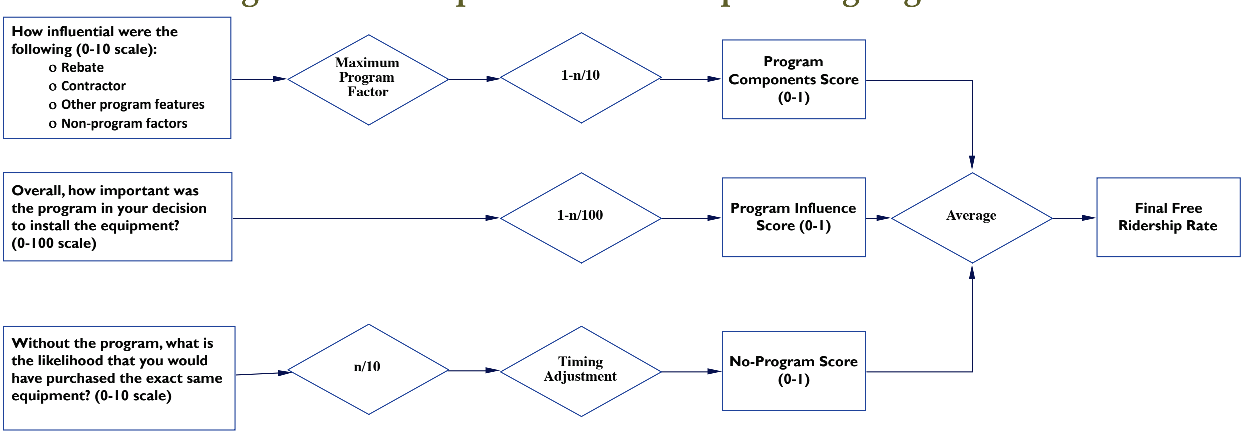
[8] The full Illinois TRM can be found at http://www.ilsag.info/il_trm_version_6.html

- A ***Program Influence*** question, where the respondent was asked directly to provide a rating of how influential the overall program was on their decision to install high efficiency equipment, and
- A ***No-Program Component*** series of questions, based on the participant's intention to carry out the energy-efficient project without program funds or due to influences outside of the program.

Each component was assessed using survey responses that rated the influence of various factors on the respondent's equipment choice. Since opposing biases potentially affect the main components, the *No-Program* component typically indicates higher free ridership than the *Program Component/Influence* questions. Therefore, combining these opposing influences helps mitigate the potential biases. This framework also relies on multiple questions that are crosschecked with other questions for consistency. This prevents any single survey question from having an excessive influence on the overall free ridership score.

Figure 6 provides a simplified version of the scoring algorithm. In some cases, multiple questions were asked to assess the levels of efficiency and purchase timing in absence of the program. For each of the scoring components, the question responses were scored so that they were consistent and resulted in values between 0 and 1. Once this was accomplished, the three question components were averaged to obtain the final free ridership score.

Figure 6: Self-Report Free Ridership Scoring Algorithm



Source: Adapted by Evergreen Economics from the 2017 Illinois TRM.

More detail on each of the three question tracks is provided below.

Program Component Questions

The ***Program Component*** battery of questions was designed to capture the influence of the program on the equipment choice. These questions were also designed to be as comprehensive as possible so that all possible channels through which the program is attempting to reach the customer were included.

The type of questions included in the Program Component question battery included the following:

- How influential were the following on your decision to purchase your energy efficient equipment?
  - Rebate amount
  - Contractor recommendation
  - Utility advertising/promotions
  - Technical assistance from the utility (e.g., energy audit)
  - Recommendation from utility customer representative (or program implementer)
  - Previous participation in a utility efficiency program

As shown at the top of Figure 6, the question with the highest value response (i.e., the program factor that had the greatest influence on the decision to install a high efficiency measure) was the one that was used in the scoring algorithm as the Program Component score.

Program Influence Question

A separate ***Program Influence*** question asked the respondent directly to rate the combined influence of the various program activities on their decision to install energy efficient equipment. This question allowed the respondent to consider the program as a whole and incorporated other forms of assistance (if applicable) in addition to the rebate. Respondents were also asked about potential non-program factors (condition of existing equipment, corporate policies, maintenance schedule, etc.) to put the program in context with other potential influences.

The Program Influence question also provided a consistency check so that the stated importance of various program factors could be compared across questions. If there appeared to be inconsistent answers across questions (rebate was listed as very important in response to one question but not important in response to a different question, for example), then the interviewer asked follow-up questions to confirm responses. The verbatim responses were recorded and were reviewed by the evaluation team as an additional check on the free ridership results.

No-Program Questions

A separate battery of ***No-Program*** component questions was designed to understand what the customer might have done if the PNM rebate program had not been available. With these questions, we attempted to measure how much of the decision to purchase the energy efficient equipment was due to factors that were unrelated to the rebate program or other forms of assistance offered by PNM.

The types of questions asked for the No-Program component included the following:

- If the program had not existed, would you have
    - Purchased the exact same equipment?
    - Chosen the same energy efficiency level?
    - Delayed your equipment purchase?
- Did you become aware of the utility rebate program before or after you chose your energy efficient equipment?

The question regarding the timing of awareness of the rebate was used in conjunction with the importance rating the respondent provided in response to the earlier questions. If the respondent had already selected the high efficiency equipment prior to learning about the rebate **and** said that the rebate was the most important factor, then a downward adjustment was made on the influence of the rebate in calculating the Program Component score.

The responses from the No-Program questions were analyzed and combined with a timing adjustment to calculate the No-Program score, as shown in Figure 6. The timing adjustment was made based on whether or not the respondent would have delayed their equipment purchase if the rebate had not been available. If the purchase would have been delayed by one year or more, then the No-Program score was set to zero, thereby minimizing the level of free ridership for this algorithm component only.

Free Ridership and NTG Calculation

The values from the Program Component score, the Program Influence score, and the No-Program score were averaged in the final free ridership calculation; the averaging helped reduce potential biases from any particular set of responses. The fact that each component relied on multiple questions (instead of a single question) also reduced the risk of response bias. As discussed above, additional survey questions were asked about the relative importance of the program and non-program factors. These responses were used as a consistency check, which further minimized potential bias.

Once the self-report algorithm was used to calculate free ridership, the total NTG ratio was calculated using the following formula:

$$Net\text{-}to\text{-}Gross\ Ratio = (1 - Free\ Ridership\ Rate)$$

2.4.2 Elasticity Model

The evaluation team relied on the results from the elasticity model developed for the 2017 Residential Lighting program to estimate free ridership and a NTG ratio for the 2018 program year.[9] An elasticity model is an econometric model that estimates how a change in price affects the demand for a good or service. Evergreen developed an elasticity model for the 2017 program year evaluation to estimate how rebates offered through PNM's Residential Lighting program affect customer demand for LED bulbs. The results of the elasticity model allowed us to develop estimates of the "price elasticity of demand for LED bulbs," which is simply the percent increase in the number of bulbs purchased by residential customers associated with a 1 percent decrease in the price of LED bulbs due to the rebates offered by PNM.

The elasticity model results from the 2017 program year were applied to LED sales data for the 2018 program year to derive estimates of free ridership (and ultimately net impacts) for PNM's upstream Residential Lighting program for 2018. The elasticity model approach was used for two primary reasons:

1. Customer-specific purchase information is not tracked for the bulbs bought through the program. This is common for upstream programs, where the rebate is provided to the retailer rather than to the customer. To promote sales, ease of use for the customer is emphasized over burdening the customer with requests for additional information.
2. The elasticity model is based on observed market behavior and utilizes all the light bulb sales data from the program. This is in contrast to the alternative net impact methods (either phone surveys or store intercept surveys) that only cover a small portion of program bulb sales. Since all the sales data are used in the model, the results will be more representative. The data also reflect actual market decisions (revealed preferences) rather than the hypothetical purchase scenarios that would be obtained using the surveys (stated preferences).

The purpose of the elasticity model is to estimate how sensitive customers are to price changes for the energy efficient lighting options rebated through the program. By calculating the price elasticity, we create an estimate of how much demand will change

[9] Evergreen attempted to estimate the elasticity model using sales data for the 2018 program year, but due to inconsistencies in the 2018 sales data, ultimately relied on model results of the elasticity model from the 2017 program year to develop estimates of free ridership and NTG for 2018. Fortunately, we believe the data on the number of bulbs sold by merchant type (warehouse stores versus non-warehouse store) and bulb type (standard LED versus specialty LED) were correct, so that we were able to apply the results of the 2017 elasticity model to the accurate bulb counts for 2018.

with a change in price. Once this relationship is established, we can estimate how much the price reduction through the program is influencing overall lighting sales.

A variety of different model specifications were explored, and the final elasticity model is as follows:

$$Bulbs_{i,t,s} = InvoicePeriod_{i,t,s} * e^{(\alpha+\beta_1 \Pr ice_{i,t,s}+\beta_2 Watts_i+\beta_3 Char_i+\varepsilon_{i,t,s})}$$

$Where:$

$Bulbs_{i,t,s} =$ *Number of bulbs sold by product type i, during period t, at store s*

$\Pr ice_{i,t,s} =$ *Rebated price for product type i, during period t, at store s*

$Watts_i =$ *Wattage for bulb type i*

$Char_i =$ *Indicator variables describing particular characteristics of bulb type i*

$InvoicePeriod_{i,t,s} =$ *Number of days each bulb type i was offered for sale during period t at store s*

With this model specification and *Price* as an independent variable, the coefficient estimate on the *Price* variable multiplied by the average price of a rebated bulb is an elasticity. In this case, the elasticity reflects the percentage change in lighting demand due to a 1 percent change in lighting price. A value less than 1.0 indicates that lighting purchases are relatively insensitive to price changes, while a value greater than 1.0 indicates that customers are sensitive to prices, and therefore, the program will have a greater impact in the lighting market (i.e., lower free ridership).

Once the elasticity is estimated, the net program bulb sales are estimated using the following steps:

1. The total number of bulbs sold through the program is totaled from the program sales data (**Gross Program Sales**).
2. The average price per bulb ***without*** the rebate is calculated from the sales data (i.e., the rebate cost is added back to the bulb price).
3. The elasticity value is used to estimate how much bulb sales would decrease if the price was increased by the amount of the rebate (mimicking the sales if the rebate had not been available). The change in bulb sales due to the price increase is the **Net Program Sales,** as this is the amount of total bulb sales that are being driven by the rebate.
4. The **Free Rider Sales** are calculated by subtracting **Net Program Sales** from **Gross Program Sales.**

5. The free ridership rate and final NTG ratio are calculated using the following equation:

$$Free\ Ridership\ Rate = \frac{Free\ Rider\ Sales}{Gross\ Program\ Sales}$$

$$Net\text{-}to\text{-}Gross\ Ratio = (1 - Free\ Ridership\ Rate)$$

There are several important advantages to using the elasticity model rather than a phone survey to estimate net impacts:

- **The elasticity model is based on real world behavior.** The model is estimated based on market data from actual lighting purchases, which is the best indicator of customers' sensitivity to price. This is preferable to a self-report survey where we would first need to locate lighting purchasers in the general population and then ask them what type of lighting purchases they would have made if the price had not been reduced. These hypothetical 'stated preference' data are generally less preferred than actual market data (but sometimes are the only data available).
- **A larger sample size is available at lower cost.** Because the model can be estimated based on data that are already tracked by the program, an additional customer survey is not needed. This reduces the cost of the evaluation significantly. Similarly, because we can use the entire lighting dataset (not just a subset of those customers surveyed), the evaluation has a larger amount of data that should lead to more accurate estimates of net impacts.
- **The elasticity model approach has been applied successfully in other territories.** This approach is gaining wider use in other regions, for the reasons given above. This has allowed the elasticity model to be tested and refined over time.

The Uniform Methods Project (UMP)[10] discusses the elasticity model as an appendix to its larger chapter on recommended methods for estimating net impacts.[11]

[10] The UMP is sponsored by the National Renewable Energy Laboratory (NREL) and provides documentation of current energy efficiency program evaluation practices. The purpose of the UMP is to promote consistent and straightforward methods for estimating gross and net savings based on current best practices.

[11] See https://www.nrel.gov/docs/fy17osti/68578.pdf for the full UMP net impacts discussion. The discussion of the elasticity model is included in Appendix A. Daniel Voilette and P. Rathbun. "Chapter 21: Estimating Net Savings – Common Practices." *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures.* Prepared for NREL, October 2017.

2.5 Realized Gross and Net Impact Calculation

The final step in the impact evaluation process is to calculate the realized gross and net savings, based on the program-level analysis described above. The **Gross Realized Savings** are calculated by taking the original *ex ante* savings values from the participant tracking databases and adjusting them using an **Installation Adjustment** factor (based on the count of installed measures verified through the phone surveys) and an **Engineering Adjustment** factor (based on the engineering analysis, desk reviews, etc.):

Gross Realized Savings =

(*Ex Ante* Savings)*(Installation Adjustment)*(Engineering Adjustment Factor)

Net Realized Savings are then determined by multiplying the Gross Realized Savings by the net-to-gross ratio:

Net Realized Savings = (Net-to-Gross Ratio)*(Gross Realized Savings)

2.6 Cost Effectiveness

The cost effectiveness of PNM's programs was tested using the Utility Cost Test (UCT). In the UCT, the benefits of a program are considered to be the present value of the net energy saved, and the costs are the present value of the program's administrative costs plus incentives paid to customers. In order to perform the cost effectiveness analysis, the evaluation team obtained the following from PNM:

- Avoided cost of energy (costs per kWh over a 20+ year time horizon);
- Avoided cost of capacity (estimated cost of adding a kW/year of generation, transmission, and distribution to the system);
- Avoided cost of CO_2 (estimated monetary cost of CO_2 per kWh generated);
- Avoided transmission and distribution costs;
- Discount rate;
- Line loss factor; and
- Program costs (all expenditures associated with program delivery).

The following are items to note regarding the data received from PNM:

- PNM does not quantify the avoided cost of transmission and distribution.
- PNM provided a levelized avoided cost of capacity, to which the discount rate was not applied further.

- The NMPRC allows for the benefits of low-income programs to be boosted by 20 percent to account for utility system economic benefits. PNM estimates the following proportions of low-income customers participate in their programs:
  - 100% of Low Income Home Energy Checkup
  - 54% of Commercial Comprehensive - Multifamily
  - 100% of Easy Savings Kit
  - 100% of Energy Smart (MFA)
  - 40% of Home Works
- Program costs were broken into the following categories:
  - Administration
  - Promotion
  - Measurement & Verification
  - Rebates
  - Third-Party Costs
  - Market Transformation

The program weighted average effective useful life values were provided by PNM, calculated by dividing lifetime savings by annual savings. The evaluation team performed a spot check of measure-specific effective useful life values to confirm reasonableness and alignment with the TRM when applicable. The final net energy savings values estimated from the PY2018 impact evaluation were used in the final cost effectiveness calculations.

The evaluation team input the savings and cost data into a cost effectiveness model that calculated the benefits, costs, and benefit-cost ratio for each measure, project, or program entered, and rolled up the data into program-level UCT values.

The evaluation team also tested the cost effectiveness of the one Large Customer Self-Direct project using the UCT. PNM does not claim any administrative costs for self-directed projects, so the project cost paid by the customer, as documented in the submitted project files, was input as the cost for the UCT. Additionally, the evaluation team calculated the simple payback period of the project, as the New Mexico Energy Efficiency Rule requires that self-directed projects have a simple payback period of more than one year but less than seven years.

3 Impact Evaluation Results Summary

The results of the PY2018 impact evaluation are shown in Table 13 (kWh) and Table 14 (kW), with the programs evaluated in 2018 highlighted in blue. For the non-evaluated programs, the totals are based on the *ex ante* savings and net-to-gross (NTG) values from the PNM tracking data.

As noted previously, each program is required to be evaluated a minimum of once every three years. For 2018, the evaluated programs covered 96 percent of the *ex ante* kWh savings and 99 percent of the *ex ante* kW savings.

Table 13: PY2018 Savings Summary - kWh

Program	# of Projects	Expected Gross kWh Savings	Engineering Adjustment Factor	Realized Gross kWh Savings	NTG Ratio	Realized Net kWh Savings
Commercial Comprehensive						
Retrofit Rebate	223	24,322,155	0.9853	23,964,257	0.6856	16,429,613
Midstream	19	307,207	0.6654	204,420	0.8400	171,713
Quick Saver	312	10,237,508	1.0486	10,735,347	1.0000	10,735,347
Building Tune-Up	69	2,151,101	0.9426	2,027,711	0.8700	1,764,109
New Construction	54	7,373,633	0.8288	6,111,437	0.8400	5,133,607
Multifamily	35	3,021,834	0.9670	2,922,016	0.8360	2,442,805
Residential Lighting	911,276	26,998,470	1.0017	27,044,554	0.6300	17,038,069
Home Works	9,094	1,761,801	1.0000	1,761,801	1.0000	1,761,801
Energy Smart	223	321,255	1.0000	321,255	1.0000	321,255
Residential Comprehensive						
Home Energy Checkup	1,989	2,333,433	1.0000	2,333,433	0.8977	2,094,670
Refrigerator Recycling	7,047	7,603,123	1.0000	7,603,123	0.6800	5,170,124
Cooling/Pool Pumps	3,887	5,354,353	1.0015	5,362,307	0.5463	2,929,428
Easy Savings Kit	6,211	2,323,535	1.0000	2,323,535	1.0000	2,323,535
New Home Construction	702	1,321,909	1.0338	1,366,545	0.8000	1,093,236
Large Customer Self Direct	1	282,523	1.4294	403,843	1.0000	403,843
Power Saver	44,430	547,000	1.0178	556,737	1.0000	556,737
Peak Saver	110	508,973	1.0000	508,973	1.0000	508,973
Total		**96,769,813**		**95,551,293**		**70,878,864**

Table 14: PY2018 Savings Summary - kW

Program	# of Projects	Expected Gross kW Savings	Engineering Adjustment Factor	Realized Gross kW Savings	NTG Ratio	Realized Net kW Savings
Commercial Comprehensive						
Retrofit Rebate	223	3,716	1.1129	4,135	0.6856	2,835
Midstream	19	25	1.2520	31	0.8400	26
Quick Saver	312	2,395	0.6227	1,492	1.0000	1,492
Building Tune-Up	69	90	0.8198	74	0.8700	64
New Construction	54	1,463	1.0731	1,570	0.8400	1,319
Multifamily	35	202	1.5652	317	0.8360	265
Residential Lighting	911,276	3,358	1.0017	3,364	0.6300	2,119
Home Works	9,094	105	1.0000	105	1.0000	105
Energy Smart	223	36	1.0000	36	1.0000	36
Residential Comprehensive						
Home Energy Checkup	1,989	261	1.0000	261	0.8977	234
Refrigerator Recycling	7,047	1,754	1.0000	1,754	0.6800	1,193
Cooling	3,887	4,203	0.9979	4,194	0.5463	2,291
Easy Savings Kit	6,211	84	1.0000	84	1.0000	84
New Home Construction	702	526	1.0295	542	0.8000	433
Large Customer Self Direct	1	38	1.1762	44	1.0000	44
Power Saver	44,430	41,340	0.6355	26,272	1.0000	26,272
Peak Saver	110	23,103	0.6586	15,216	1.0000	15,216
Total		**82,700**		**59,490**		**54,028**

Lifetime kWh savings are shown in Table 15 by program and for the portfolio overall. This includes expected gross, realized gross, and realized net kWh lifetime savings.

Table 15: PY2018 Savings Summary – Lifetime kWh

Program	Expected Gross kWh Lifetime Savings	Realized Gross kWh Lifetime Savings	Realized Net kWh Lifetime Savings
Commercial Comprehensive	419,248,560	406,451,776	324,058,672
Residential Lighting	229,036,217	229,427,162	144,539,112
Home Works	19,732,175	19,732,175	19,732,175
Energy Smart	4,593,337	4,593,337	4,593,337
Residential Comprehensive	127,847,654	127,951,507	82,192,014
Easy Savings Kit	24,397,119	24,397,119	24,397,119
New Home Construction	19,683,425	20,348,066	16,278,453
Large Customer Self Direct	4,520,368	6,461,493	6,461,493
Power Saver	547,000	556,737	556,737
Peak Saver	508,973	508,973	508,973
Total	**850,114,828**	**840,428,344**	**623,318,084**

Details on the individual program impacts and process evaluation findings are summarized in the chapters that follow, with additional details on the analysis methods and results for some programs included as appendices where noted.

4 Commercial Comprehensive Program

4.1 Commercial Comprehensive Gross Impacts

The *ex ante* 2018 impacts are summarized in Table 16 for each Commercial Comprehensive sub-program, with the Retrofit Rebate and Quick Saver sub-programs accounting for most of the savings. In total, the Commercial Comprehensive program accounted for 49 percent of energy impacts in PNM's overall portfolio.

Table 16: Commercial Comprehensive Savings Summary

Sub-Program	# of Projects	Expected Gross kWh Savings	Expected Gross kW Savings
Retrofit Rebate	223	24,322,155	3,716
Midstream	19	307,207	25
Quick Saver	312	10,237,508	2,395
Building Tune-Up	69	2,151,101	90
New Construction	54	7,373,633	1,463
Multifamily	35	3,021,834	202
Total	**712**	**47,413,438**	**7,892**

The majority of the gross impact evaluation activities were devoted to engineering desk reviews of a sample of projects. For the desk reviews, the sample frame included projects in the Retrofit Rebate, Midstream, Quick Saver, Building Tune-Up, New Construction, and Multifamily sub-programs. The sample for the Retrofit Rebate sub-program was stratified to cover a range of different measure types so that no single measure (often lighting) would dominate the desk reviews. The sample was also stratified based on total energy savings within each sub-program. In some cases, very large projects were assigned to a "certainty" stratum and were automatically added to the sample (rather than randomly assigned). This allowed for the largest projects to be included in the desk reviews and maximized the amount of savings covered in the sample. Overall, the sampling strategy ensured that a mix of projects in terms of both project size and measure type would be included in the desk reviews.

The final sample design is shown in Table 17. The resulting sample achieved a relative precision of 90/3.7 for the Commercial Comprehensive program overall, with precision ranging from 85/20 to 90/4.2 for the individual sub-programs.

Table 17: Commercial Comprehensive Desk Review Sample

Sub-Program	Measure Group	Stratum	Count	Average kWh	Total kWh Savings	% of Savings	Final Sample
Retrofit Rebate	Custom	Certainty	3	872,251	2,478,748	5.2%	3
		1	16	55,831	893,293	1.9%	12
	HVAC	Certainty	5	146,480	717,019	1.5%	5
		1	6	64,179	385,072	0.8%	5
		2	30	10,204	306,111	0.6%	2
	Lighting	Certainty	2	2,660,041	5,320,082	11.2%	2
		1	12	428,181	5,138,169	10.8%	5
		2	27	177,182	4,783,907	10.0%	5
		3	118	33,564	3,960,602	8.3%	5
	Other	Certainty	4	84,788	339,153	0.7%	4
Quick Saver		1	10	223,882	2,238,820	4.7%	1
		2	29	90,810	2,633,479	5.5%	2
		3	69	41,270	2,847,650	6.0%	3
		4	200	12,273	2,454,571	5.2%	4
Building Tune-Up		Certainty	3	280,703	765,756	1.6%	3
		1	4	110,684	442,734	0.9%	3
		2	7	74,296	520,075	1.1%	1
		3	28	15,091	422,535	0.9%	3
Midstream		Certainty	2	40,459	80,918	0.2%	2
		1	3	27,957	83,872	0.2%	2
		2	4	17,530	70,120	0.1%	3
		3	8	9,037	72,297	0.2%	3

Sub-Program	Measure Group	Stratum	Count	Average kWh	Total kWh Savings	% of Savings	Final Sample
Multifamily		Certainty	3	308,561	925,683	1.9%	3
		1	5	161,614	808,070	1.7%	2
		2	7	111,584	781,087	1.6%	2
		3	20	38,001	760,017	1.6%	2
New Construction		Certainty	4	554,744	2,218,976	4.7%	4
		1	7	271,872	1,903,101	4.0%	2
		2	10	168,977	1,689,774	3.5%	2
		3	33	47,327	1,561,782	3.3%	3
Total			**679**		**47,603,473**	**100.0%**	**102**

As discussed in the *Evaluation Methods* chapter, gross realized impacts for the Commercial Comprehensive program were determined by performing engineering desk reviews on the sample of projects.

For prescriptive projects, the evaluation team found multiple measures that existed in both the New Mexico TRM and the PNM Workpapers, and the savings calculation approaches sometimes differed across sources. In these cases, we examined both sources to determine which approach offered greater detail and accuracy. Some of the other incentivized measures existed only in the PNM Workpapers, and in these cases, the algorithms were reviewed for accuracy and adjusted as necessary to calculate realized energy and demand savings. We also deferred to non-prescriptive values (e.g., custom lighting hours of use) assumed in the project files when possible, checking the values for reasonableness by corroborating with sources such as the TRM and posted business hours.

For custom projects, the *ex ante* savings calculations were recreated when possible (i.e., simple spreadsheet calculations). For more complex analyses (whole building energy simulations), the evaluation team audited the approaches taken and inputs used. When applicable, approaches and assumptions used in custom analyses were compared to those contained in the TRM.

A sub-sample of projects also received on-site verification visits from an engineer. Custom projects, lighting projects with savings of 750,000 kWh or greater, non-lighting projects with savings of 250,000 kWh or greater, and certainty stratum projects were identified as candidates for on-sites. Reviewing engineers contacted selected participants by phone and email to schedule appointments to come on site and confirm installation of incentivized equipment and verify operational parameters integral to the calculation of estimated savings. A total of eight site visits were completed, and no major issues were identified during these visits. During one on-site, the reviewing engineer obtained detailed documentation of the duct leakage per HVAC unit and subsequently modified those values in the *ex ante* custom calculations, resulting in larger savings for that measure. This was the most significant change that was discovered during an on-site inspection. The most common adjustment resulting from the on-sites was adjusting the hours of use for equipment based on either trend data that was obtained from a building automation system (BAS), or interviews conducted with site contacts.

The evaluation team, PNM, and its implementers regularly collaborated to discuss significant issues and questions that arose from the engineering desk reviews that were in progress. The implementers provided additional information, which the evaluation team was able to use to refine the results of the engineering desk reviews, often bringing verified results more in line with reported results.

Table 18 and Table 19 show the results of the desk reviews and site visits and how the resulting engineering adjustments were used to calculated realized savings. For the Commercial Comprehensive program overall, these adjustments resulted in an engineering adjustment factor of 0.9695 for kWh and 0.9654 for kW.

Table 18: PY2018 Commercial Comprehensive Gross kWh Impact Summary

Sub-Program	# of Projects	Expected Gross kWh Savings	Engineering Adjustment Factor	Realized Gross kWh Savings
Retrofit Rebate	223	24,322,155	0.9853	23,964,257
Midstream	19	307,207	0.6654	204,420
Quick Saver	312	10,237,508	1.0486	10,735,347
Building Tune-Up	69	2,151,101	0.9426	2,027,711
New Construction	54	7,373,633	0.8288	6,111,437
Multifamily	35	3,021,834	0.9670	2,922,016
Total	**712**	**47,413,438**	**0.9695**	**45,965,187**

Table 19: PY2018 Commercial Comprehensive Gross kW Impact Summary

Sub-Program	# of Projects	Expected Gross kW Savings	Engineering Adjustment Factor	Realized Gross kW Savings
Retrofit Rebate	223	3,716	1.1129	4,135
Midstream	19	25	1.2520	31
Quick Saver	312	2,395	0.6227	1,492
Building Tune-Up	69	90	0.8198	74
New Construction	54	1,463	1.0731	1,570
Multifamily	35	202	1.5652	317
Total	**712**	**7,892**	**0.9654**	**7,619**

Engineering adjustment factors that varied significantly from 100 percent were predominately caused by three overarching reasons:

1. **Project-specific calculation inputs documented solely in processing database.** For multiple projects, the evaluation team followed the algorithms contained in the PNM Workpapers but arrived at savings that differed from those reported by PNM. Specific algorithm inputs and any project-specific adjustments were not documented in the materials available to the evaluation team for the desk reviews, which prevented the evaluation team from identifying the specific sources of discrepancies for multiple projects.
2. **Adjustments made based on available site-specific information.** The evaluation team adjusted the inputs into the savings algorithms for multiple projects to account for the available site-specific information. Adjustments were made to parameters such as building type (which impacts building-type-specific parameters such as operating hours) and lighting schedule. Site-specific information was gathered through review of the provided project documentation as well as performing online searches, and was only used to adjust savings when the information gathered substantially supported overriding the values used by PNM.
3. **Differences in HVAC baseline parameters.** For certain HVAC equipment types, the evaluation team defined the baseline performance differently than was done in PNM's calculations.
    - For chiller projects, PNM used Integrated Part Load Value (IPLV) ratings to calculate both energy and demand savings for chillers. Since IPLV is a part-load rating, it is appropriate to use for the calculation of energy savings. However, it is more appropriate to use full-load efficiency ratings when calculating peak demand reductions, as chillers can be expected to be

operating near full load during peak conditions. The evaluation team used IPLV ratings to calculate chiller energy savings and full-load efficiency ratings to calculate chiller demand reductions.

- PNM calculated packaged terminal air conditioner and packaged terminal heat pump (PTAC/PTHP) savings using baseline performance corresponding to replacement/non-standard size units. However, the evaluation team found that the units installed were new construction/standard size units, and thus are subject to different minimum performance standards. The evaluation team calculated PTAC/PTHP savings based on the baseline standards for new construction/standard size units. Another item to note is that PNM calculated PTAC/PTHP savings based on IECC 2009 baseline performance instead of the more stringent current federal standards contained in 10 CFR 431.97(c). However, the evaluation team also calculated savings using IECC 2009, as this is consistent with the guidance the evaluation team provided PNM in the evaluation of PY2017, and the impact on overall program savings was minimal.

Additionally, one project installing a high-efficiency chiller, PNM-18-03479, had an engineering adjustment factor significantly lower than 100 percent due to an error the evaluation team identified in how the PNM Workpapers spreadsheet calculates the "bonus" savings beyond the minimum-qualifying chiller efficiency. The bonus demand reduction should be calculated as *the total high-efficiency demand reduction* minus *the minimum-qualifying demand reduction*. However, the workpaper equation is written as *the qualifying efficiency* minus *the total high-efficiency demand reduction*, which leads to an overstatement of bonus savings. The evaluation team created a new analysis for this project that properly accounts for the difference between the baseline chiller efficiency and the installed chiller efficiency, which resulted in estimated savings significantly lower than the reported savings.

A summary of the individual desk review findings for each of the 102 projects is included in Appendix I.

4.2 Commercial Comprehensive Net Impacts

Net impacts for the Commercial Comprehensive program were calculated using NTG ratios from the participant phone survey or *ex ante* values, depending on the sub-program. For the Retrofit Rebate sub-program, the NTG ratio was developed using the self-report method described in the *Evaluation Methods* chapter using participant phone survey data. The resulting NTG ratio for the Retrofit Rebate sub-program is 0.6856. For Midstream sub-program projects, customer contact information was not available, so a participant survey was not conducted. The *ex ante* NTG ratio of 0.84 was applied to the Midstream sub-program projects. For the Quick Saver sub-program, an NTG ratio of 1.00 was applied, due to the direct install design of this sub-program.[12]

For both the New Construction and Multifamily sub-programs, a small number of participant interviews were conducted to collect self-reported data on free ridership. Due to the small sample sizes for these interviews, we did not calculate NTG ratios for these sub-programs based on these data, but do discuss qualitative findings related to free ridership in the *Process Evaluation Results* chapter. Instead, we have applied the *ex ante* NTG ratios for the New Construction and Multifamily sub-programs of 0.84 and 0.836, respectively.

Table 20 and Table 21 summarize the PY2018 net impacts for the Commercial Comprehensive program using the NTG ratios described above. Net realized savings for the program overall are 36,677,193 kWh, and net realized demand savings are 6,001 kW.

Table 20: PY2018 Commercial Comprehensive Net kWh Impact Summary

Sub-Program	# of Projects	Realized Gross kWh Savings	NTG Ratio	Realized Net kWh Savings
Retrofit Rebate	223	23,964,257	0.6856	16,429,613
Midstream	19	204,420	0.8400	171,713
Quick Saver	312	10,735,347	1.0000	10,735,347
Building Tune-Up	69	2,027,711	0.8700	1,764,109
New Construction	54	6,111,437	0.8400	5,133,607
Multifamily	35	2,922,016	0.8360	2,442,805
Total	**712**	**45,965,187**	**0.7979**	**36,677,193**

[12] An *ex ante* NTG ratio of 0.84 for the Quick Saver direct install sub-program was used by the previous evaluator. However, the evaluation team believes that assigning an NTG ratio of 1.00 is appropriate, as the targeted customers are very unlikely to complete these projects on their own. This is analogous to assigning an NTG ratio of 1.00 to low income programs, which is typically done for the same reason.

Table 21: PY2018 Commercial Comprehensive Net kW Impact Summary

Sub-Program	# of Projects	Realized Gross kW Savings	NTG Ratio	Realized Net kW Savings
Retrofit Rebate	223	4,135	0.6856	2,835
Midstream	19	31	0.8400	26
Quick Saver	312	1,492	1.0000	1,492
Building Tune-Up	69	74	0.8700	64
New Construction	54	1,570	0.8400	1,319
Multifamily	35	317	0.8360	265
Total	**712**	**7,619**	**0.7876**	**6,001**

4.3 Quick Saver and Retrofit Rebate Participant Surveys

As part of the process evaluation, the evaluation team conducted telephone surveys with representatives from 100 participating companies that received rebates through the PNM Commercial Comprehensive Quick Saver (direct install) or Retrofit Rebate (prescriptive and custom) sub-programs. The surveys were completed in January 2019 and ranged from 15 to 20 minutes in length.

The participant survey was designed to cover the following topics:

- Verifying the installation of measures included in the program tracking database;
- Collecting information on participants' satisfaction with their program experience;
- Survey responses for use in the free ridership calculations;
- Participant drivers/barriers; and
- Additional process evaluation topics.

PNM provided program data on the Commercial Comprehensive participant projects, which allowed us to select a sample for interviews. The evaluation team randomly selected and recruited program participants based on whether they had valid contact information and received a rebate through the Quick Saver or Retrofit Rebate sub-programs (excluding the Multifamily and New Construction sub-programs, which were covered by separate participant interviews described in Section 4.4 and 4.5).

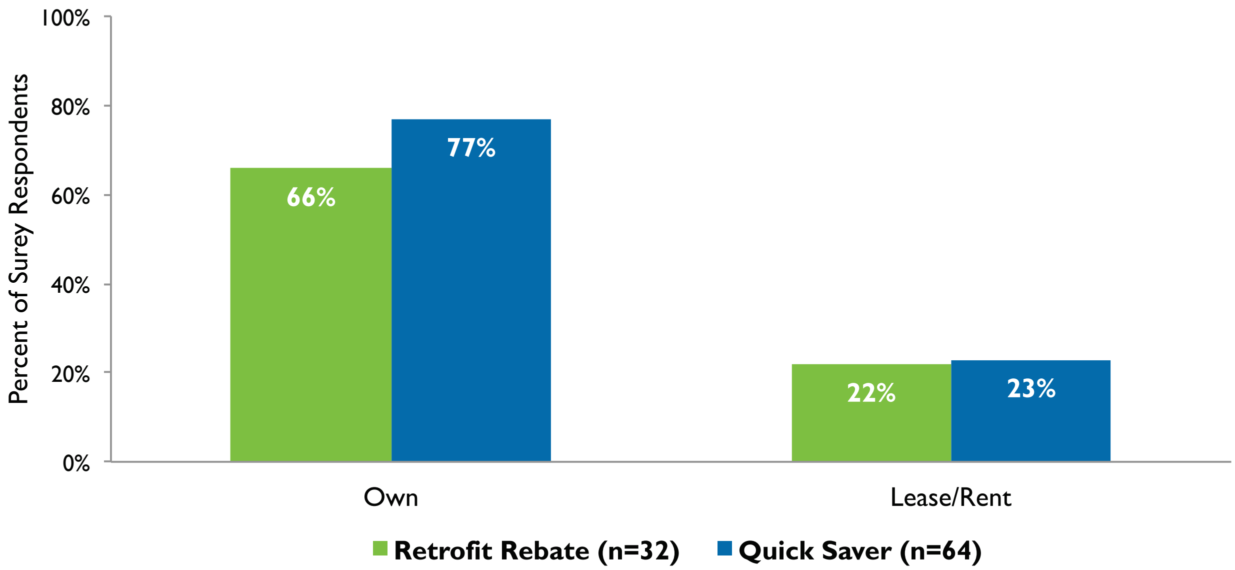
The following subchapters report results on company demographics, sources of program awareness, motivations for participation, and program satisfaction.

Throughout the analysis described here, we present the survey results as weighted percentages based on the proportion of savings represented by survey respondents relative to the total savings of all program participants.

4.3.1 Company Demographics

We asked survey respondents whether their company owns or leases the building where the project was completed. Counterintuitive to what would be expected of Quick Saver sub-program participants, Figure 7 shows that 77 percent of Quick Saver sub-program participants own their building, which is somewhat unexpected as direct install programs typically target customers that rent their spaces. On the other hand, 66 percent of Retrofit Rebate sub-program participants reported they own the building where the measures were installed, which is more in line with what would be expected for this group.

Figure 7: Quick Saver and Retrofit Rebate Participant Own or Rent



The following two exhibits summarize the survey respondents' building and employee size by whether they participated in the Quick Saver or Retrofit Rebate sub-programs. Consistent with program design, Figure 8 and Figure 9 both show that larger customers are more likely to get rebates through the Retrofit Rebate sub-program, with 38 percent occupying buildings of 50,000 square feet or more. Additionally, 24 percent of Retrofit Rebate participants reported having more than 100 full-time employees. Comparatively, mid- to small-sized customers were more commonly participants of the Quick Saver sub-program, with the majority of participant firms (59%) occupying buildings of less than 10,000 square feet. In addition, nearly all Quick Saver participants (96%) reported having less than 100 full-time employees.

Figure 8: Quick Saver and Retrofit Rebate Participant Building Size

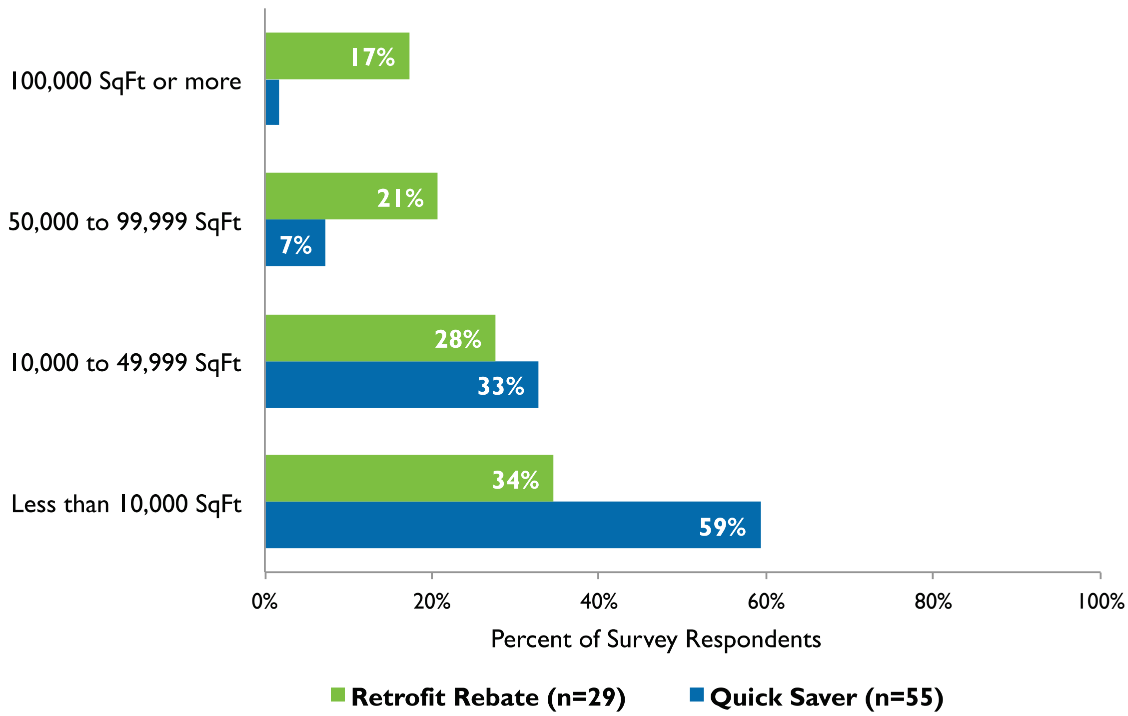


Figure 9: Quick Saver and Retrofit Rebate Participant Number of Employees

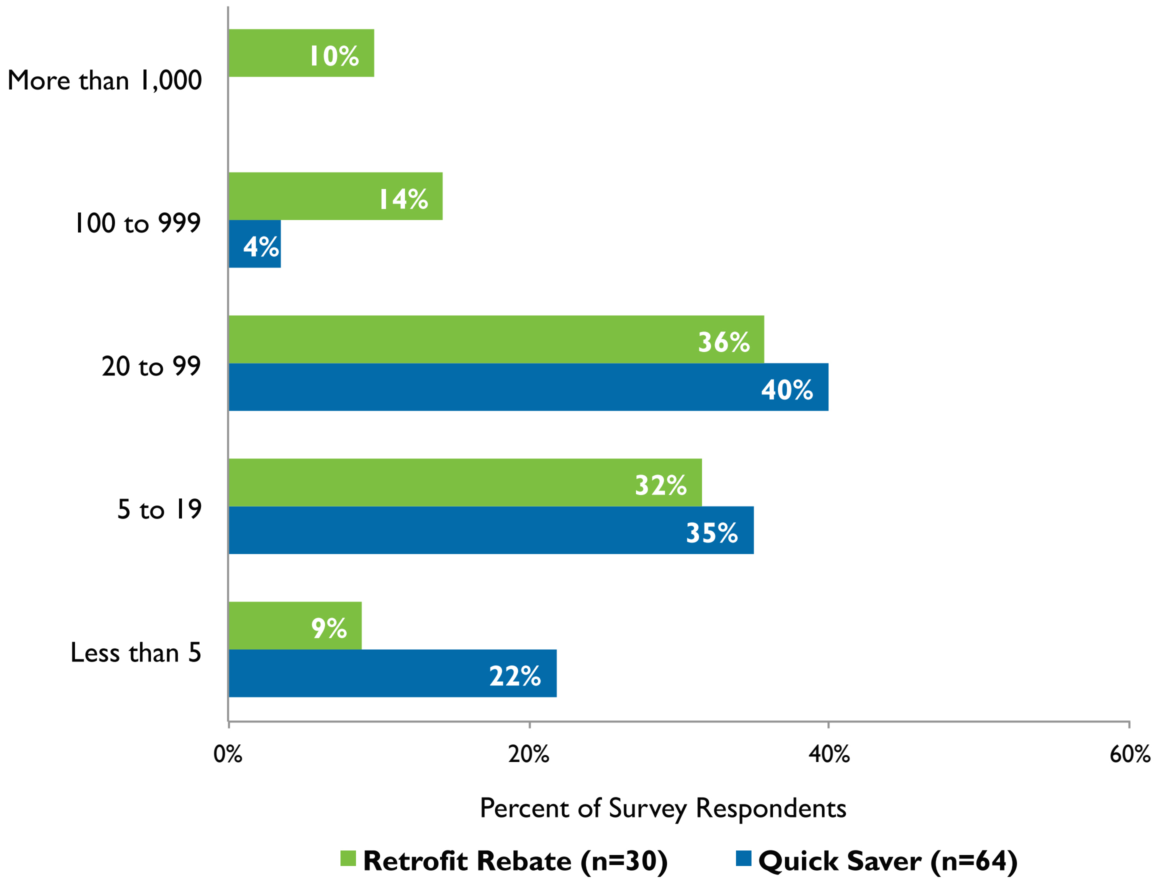
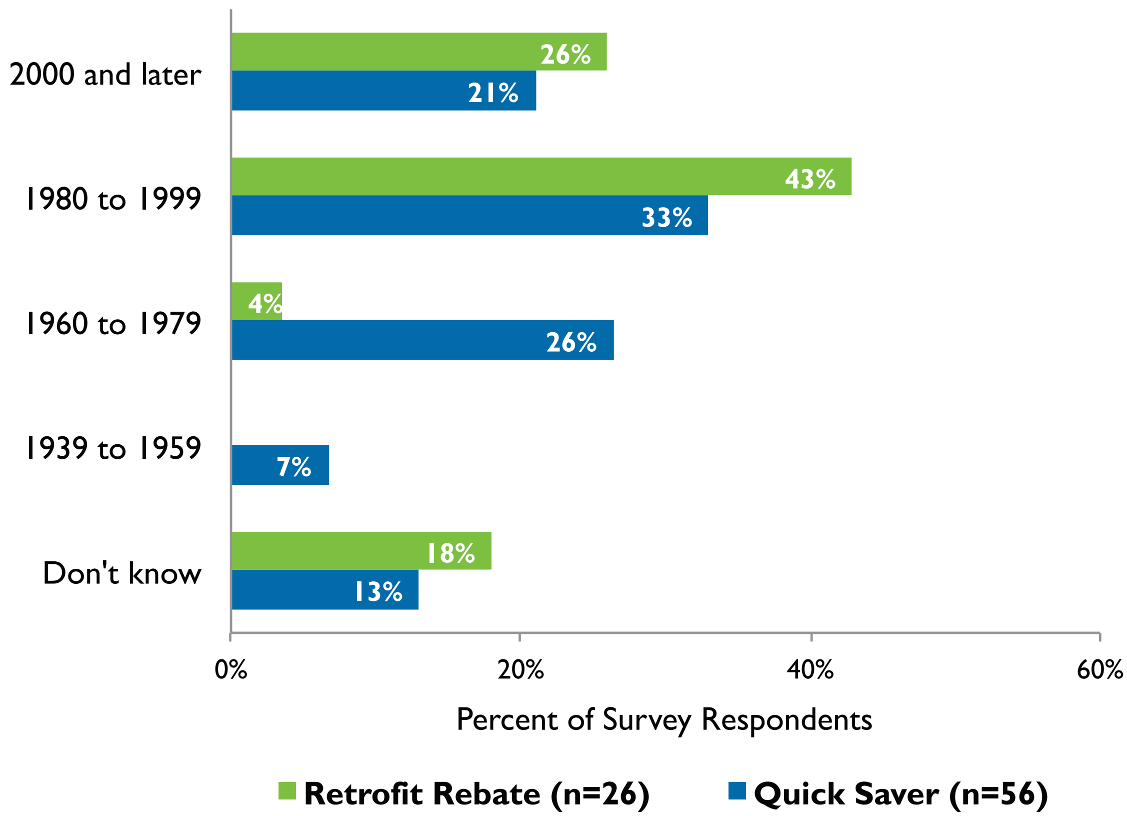


Figure 10 shows that the majority (43%) of Retrofit Rebate participants' buildings were built between 1980 and 1999 compared to 33 percent of Quick Saver participants' buildings. Quick Saver participants generally occupy older buildings on average, with 33 percent reporting that their buildings were built sometime before 1979 compared to just 4 percent of Retrofit Rebate participants' buildings built in the same time frame. This suggests that both sub-programs are doing a good job at targeting older buildings, where the potential for significant energy savings is the greatest.

Figure 10: Quick Saver and Retrofit Rebate Participant Building Age



4.3.2 Sources of Awareness

Both Retrofit Rebate and Quick Saver sub-program participants became aware of the program rebates/assistance through a variety of channels, including contractors/distributors, online web searches, and PNM marketing/outreach. As shown in Figure 11, Retrofit Rebate participants are most commonly learning about program offerings through interactions with contractors and distributors. Additionally, as might be expected for Quick Saver participants, the most frequently reported channels were through word of mouth (39%) and contractors/distributors (34%).

For those who indicated that they learned about the program through multiple sources, the evaluation team asked which source was most useful in their decision to participate. As shown in Figure 12, the most useful source of awareness for both sub-programs were similarly split between contractors and PNM contact, followed closely by the PNM website. Additionally, PNM was reported as being a useful source of awareness, with PNM contacts and previous participation in programs being mentioned by both Retrofit Rebate and Quick Saver participants. This indicates that interactions with PNM (either through direct contact, marketing, and/or previous participation) are significant drivers for both sub-programs.

Figure 11: Initial Source of Awareness

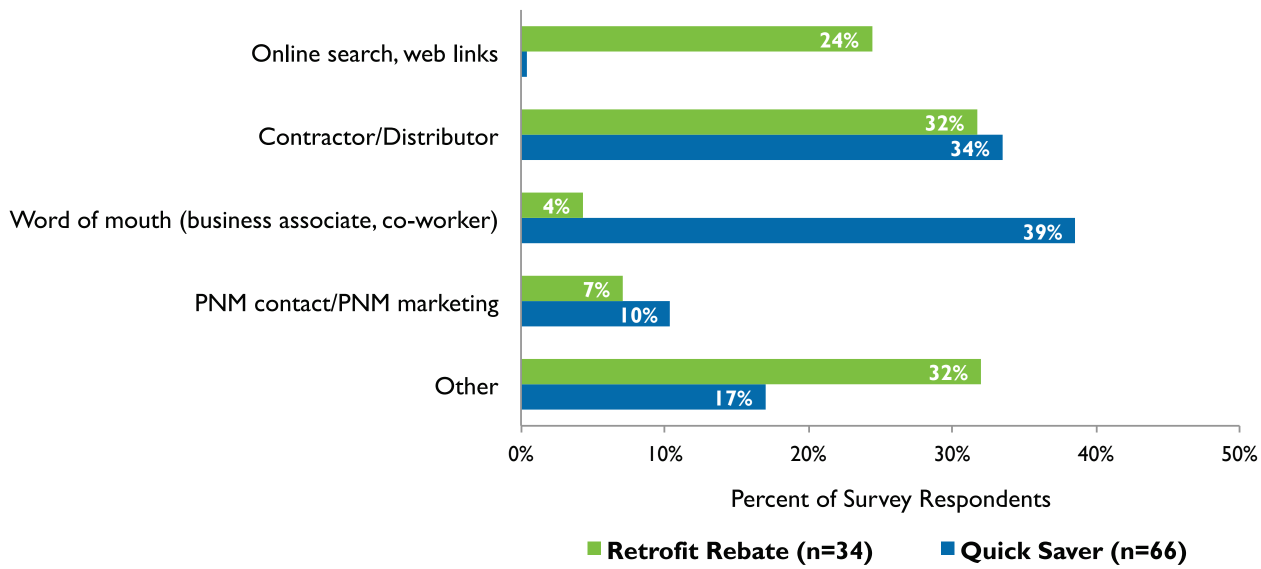
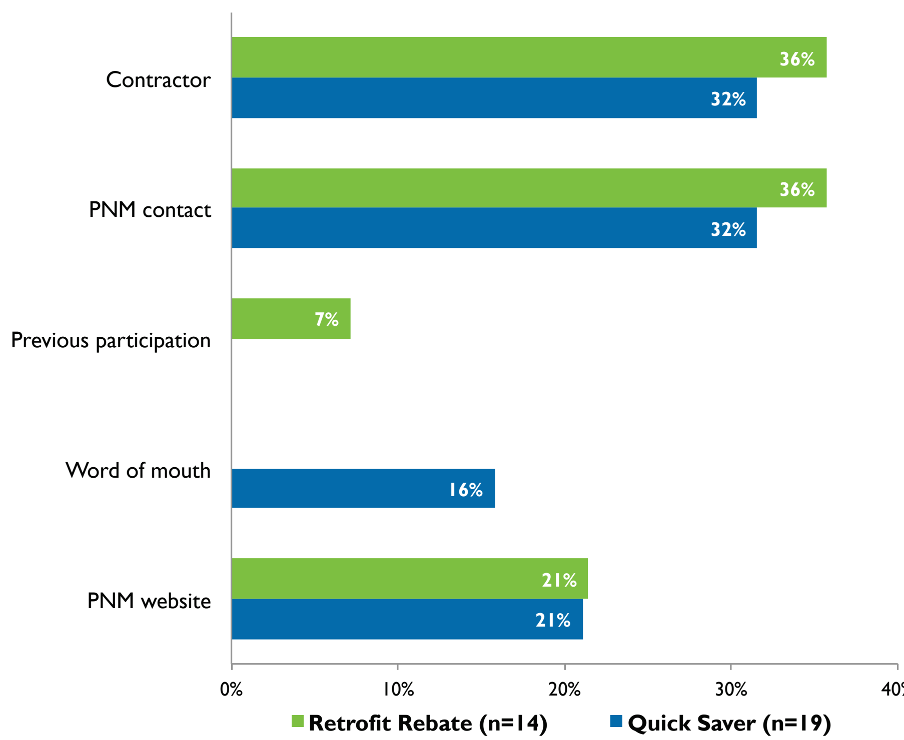


Figure 12: Most Useful Source of Awareness



4.3.3 Motivations for Participation

Figure 13 and Figure 14 show the level of importance placed on a variety of factors that might be influencing participation.

The money the participants expected to save on their energy bill was the most influential factor; 82 percent of Quick Saver and 86 percent of Retrofit Rebate participants reported that these expected savings were extremely important in their decisions to participate in the sub-programs. Other factors Quick Saver participants reported as important included the contractor recommendation and improving comfort. Additionally, receiving the rebate was important among Retrofit Rebate participants, with 70 percent reporting that it was "extremely important."

Environmental concerns were observed to be the least important factor in participation for Quick Saver participants; only 26 percent of Quick Saver participants responded that reducing environmental impact was "extremely important." For Retrofit Rebate participants, improving air quality was the least important factor in deciding to participate, with only 24 percent responding that this was "extremely important" in their decision.

Figure 13: Quick Saver Motivations for Participation (n=66)

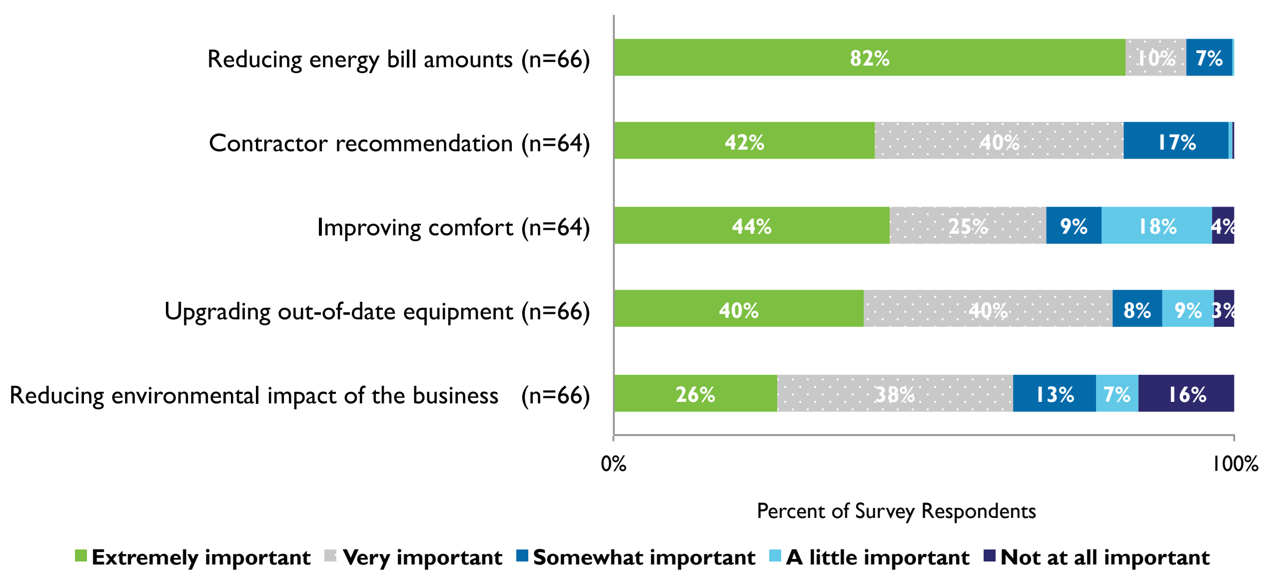
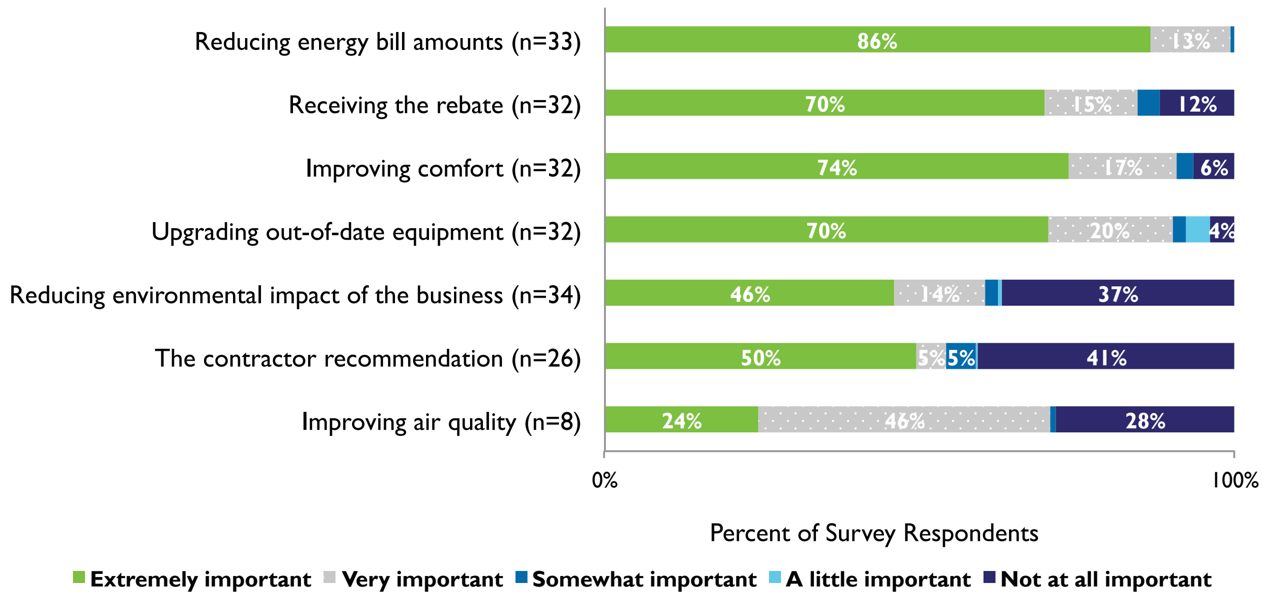


Figure 14: Retrofit Rebate Motivations for Participation (n=34)



In addition to motivations for participating, Retrofit Rebate respondents were given a list of potential program and non-program factors that may have influenced their decision about how energy efficient their equipment would be and were then asked to rate their importance on a 0 to 10 point scale.[13] As shown in Figure 15 below, the majority of Retrofit Rebate participants rated five of the eight program factors as very to extremely important (ratings of 8 to 10) in their decision to determine how energy efficient their project would be. Previous participation in a PNM rebate program was the highest-rated program factor.

[13] On the 0 to 10 point scale, 0 indicated 'not at all important' and 10 indicated 'extremely important'.

Figure 15: Retrofit Rebate Importance of Program Factors (n=34)

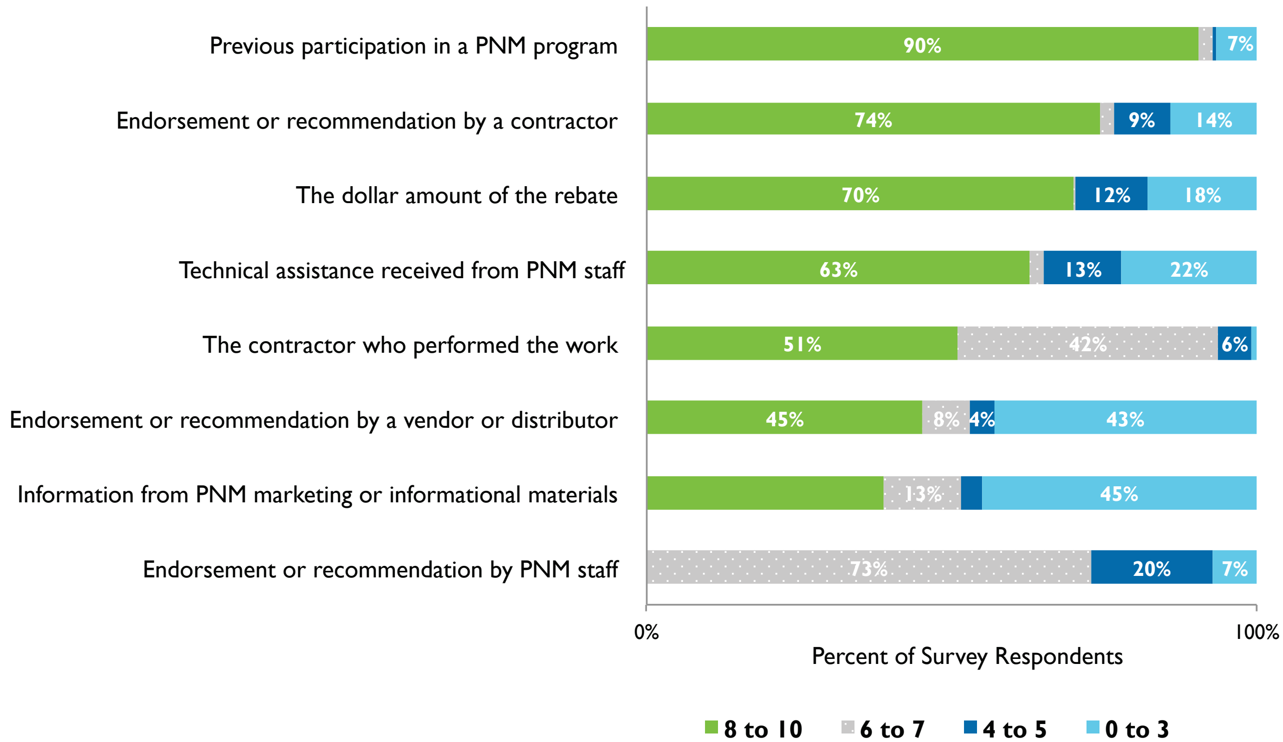
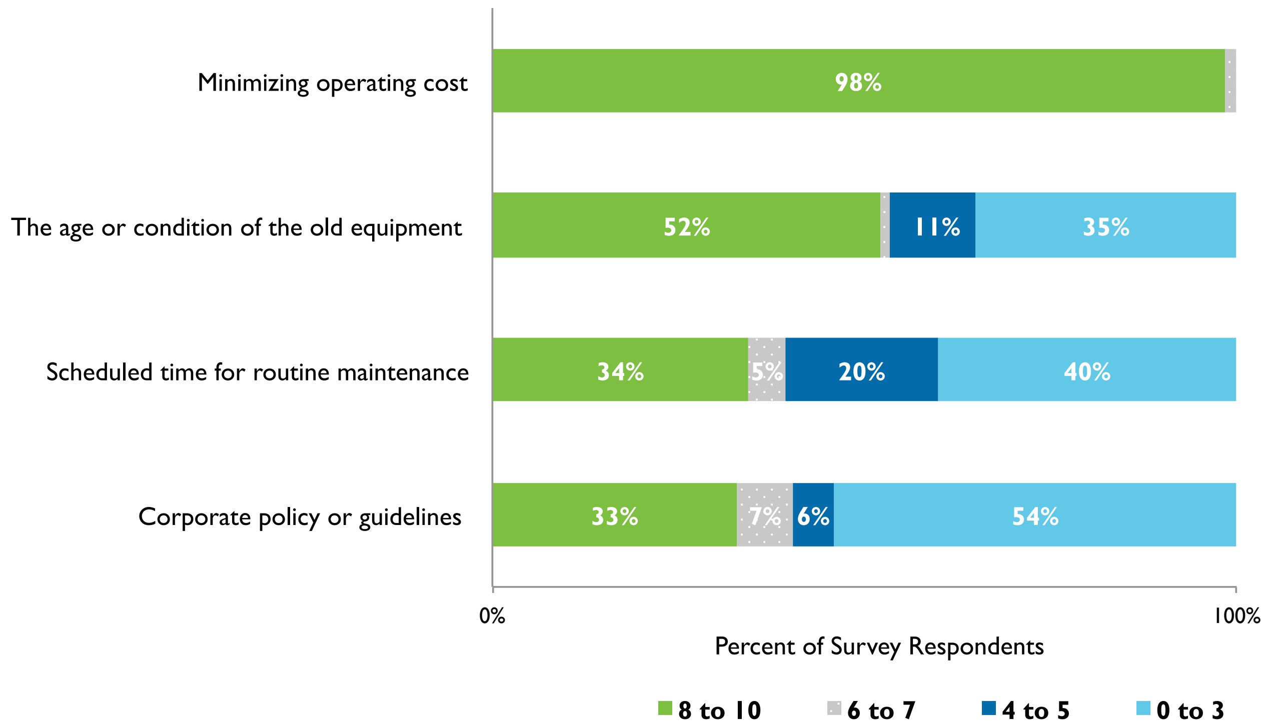


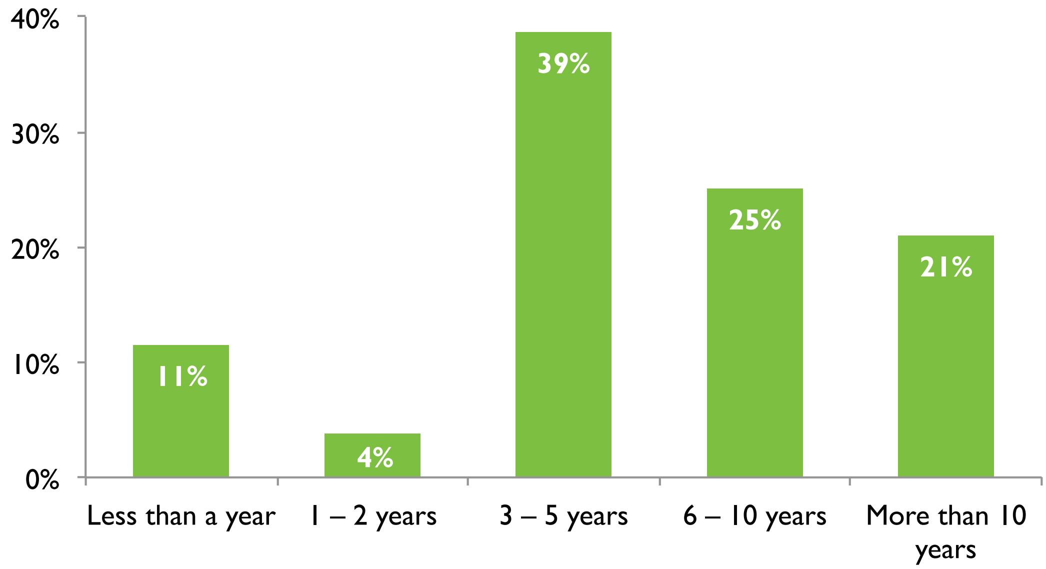
Figure 16 shows the majority of Retrofit Rebate participants rated two of the four non-program factors as very to extremely important (ratings of 8 to 10) on the decision to determine how energy efficient their project would be. Minimizing operating cost was the most influential non-program factor in the decision regarding efficiency level of the equipment. Corporate policy or guidelines was reported as less influential than other non-program factors, with 54 percent of participants reporting that it was a little to not at all important (rating of 0 to 3).

Figure 16: Retrofit Rebate Importance of Non-Program Factors (n=34)



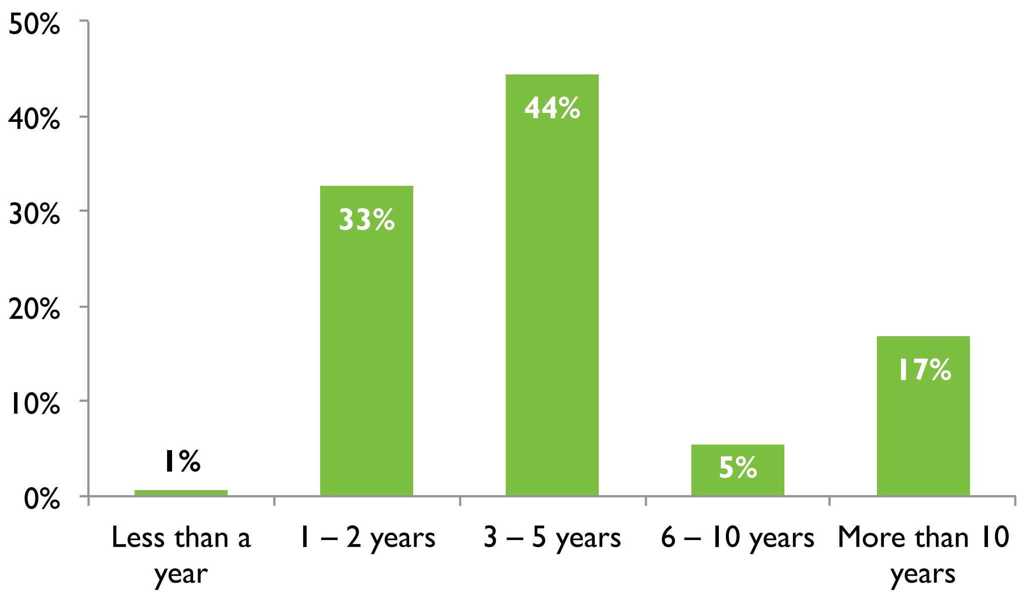
To get a sense of the condition of the existing equipment, respondents were asked approximately how much longer the equipment would have lasted if it had not been replaced. Figure 17 shows that nearly half of Quick Saver participants believed that their equipment would have lasted more than six years. This suggests that the program is doing a good job of targeting customers with functioning equipment, rather than those whose equipment is not working and would need to be replaced anyway (i.e., potential free riders).

Figure 17: Quick Saver Participant Equipment Remaining Life (n=49)



Similarly, Figure 18 shows that the majority of Retrofit Rebate participants reported that their equipment would have lasted more than three years.

Figure 18: Retrofit Rebate Participant Equipment Remaining Life (n=25)



4.3.4 Participant Satisfaction

The participants evaluated their satisfaction with various components of the Quick Saver and Retrofit Rebate sub-programs on the following scale: very satisfied, somewhat satisfied, neither satisfied nor dissatisfied, somewhat dissatisfied, and very dissatisfied.

The individual components that participants were asked to rank their satisfaction with included:

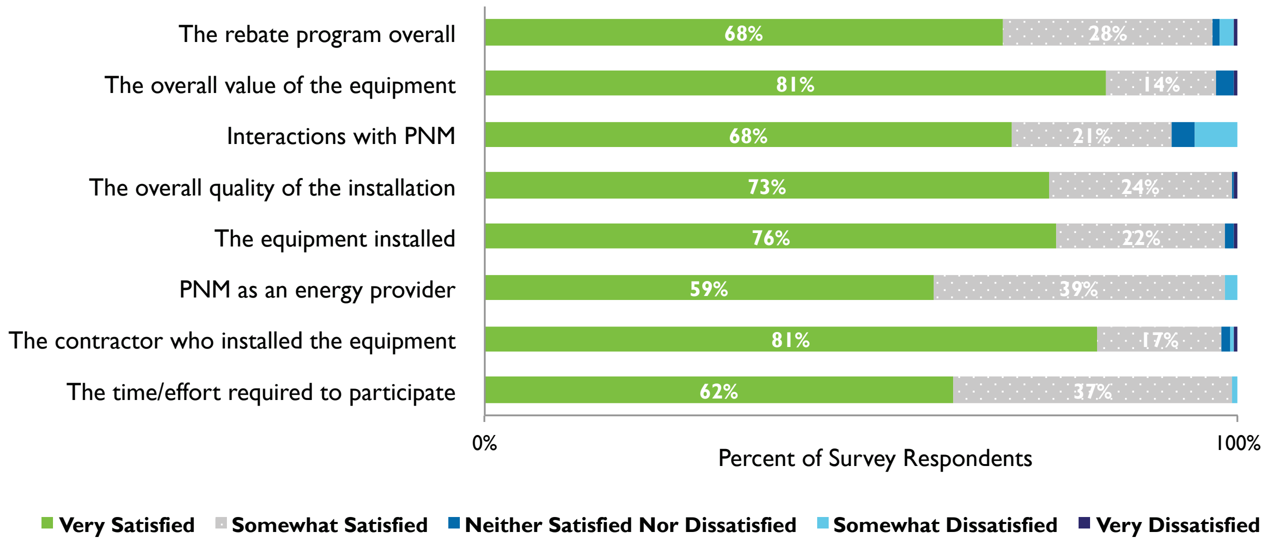
- PNM as an energy provider
- The rebate program overall
- The equipment installed through the program
- The contractor who installed the equipment
- Overall quality of the equipment installation
- The time it took to receive the rebate
- The dollar amount of the rebate
- Interactions with PNM
- The overall value of the equipment for the price they paid
- The time and effort required to participate
- The project application process

Figure 19 and Figure 20 below summarize the satisfaction levels for Quick Saver and Retrofit Rebate participants.

Overall, surveyed program participants expressed high levels of satisfaction with the Quick Saver and Retrofit Rebate sub-program components. As shown in Figure 19, Quick Saver participants expressed high levels of satisfaction across each individual program component, with the majority reporting being "very satisfied." A small percentage of Quick Saver participants reported lower satisfaction ratings.

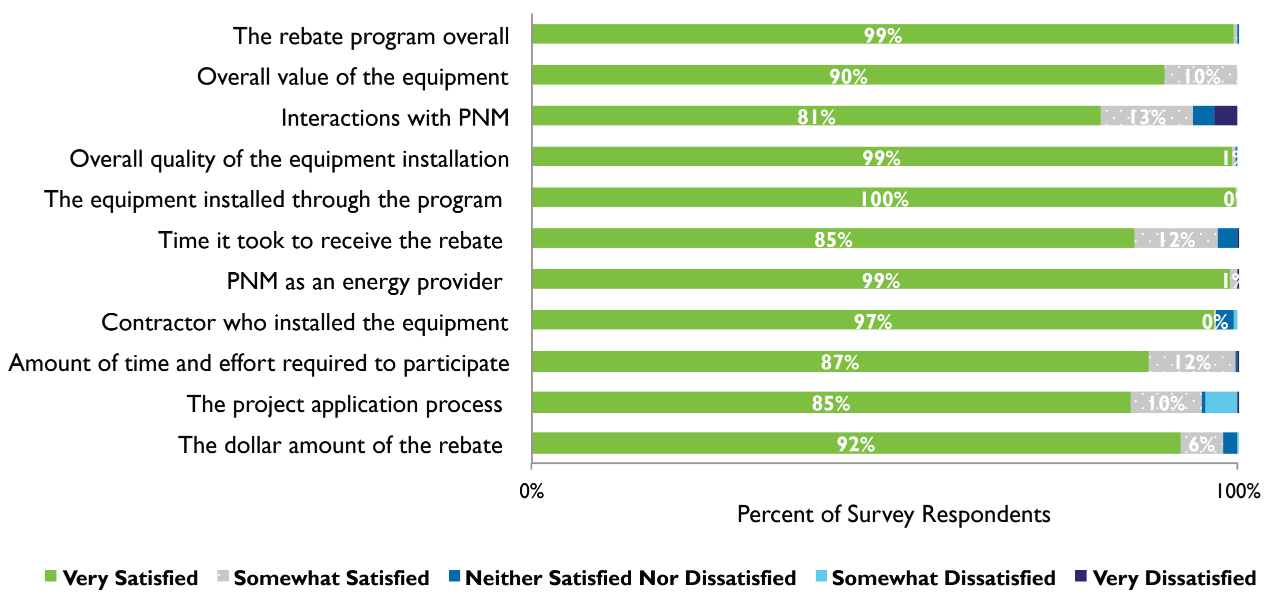
Some of the justifications Quick Saver participants provided for their low satisfaction ratings were that "the rebates have become less and less each year" and "There was a large amount of follow through that I had to do to get the job complete."

Figure 19: Quick Saver Participant Program Satisfaction (n=66)



As shown in Figure 20, Retrofit Rebate participants also expressed high levels of satisfaction, with the majority of participants reporting ratings of "very satisfied" across all but one program component. Ninety-nine percent reported being "very satisfied" with the rebate program overall, and 97 percent were "very satisfied" with the contractor who installed the equipment.

Figure 20: Retrofit Rebate Participant Program Satisfaction (n=34)



4.4 Multifamily Participant Interviews

The evaluation team completed three in-depth interviews with 2018 PNM Multifamily sub-program participants. The interviewees represented projects completed in both low income and market rate multifamily dwellings, representing approximately 30 percent of 2018 program electric savings (kWh).

The interviews were completed in February of 2019 and focused on the following topics:

- Project context
- Role and influence of PNM in the completed project
- Program satisfaction

4.4.1 Project Context

Interviewees had varying levels of interaction with the PNM Multifamily sub-program directly; however, they were all familiar with the recorded project and played a role in the decision to participate in the sub-program. Projects were in multifamily complexes ranging from 50 units to 120 units, and all completed LED lighting upgrades. All of the multifamily buildings were part of complexes where the tenant paid for the energy usage in the individual dwelling and property management paid for the common area energy usage. The completed projects all utilized an installation contractor or trade ally for the rebated equipment. Two of the three interviewees first learned about the PNM Multifamily sub-program through a contractor or trade ally, while the remaining interviewee learned about the sub-program through independent online research.

4.4.2 Program Influence

The evaluation team asked the Multifamily sub-program interviewees a series of questions about how influential various factors—both internal to the sub-program and independent of PNM—were in their decision to install energy efficient equipment. The interviewees assessed the program influence both in a general sense and in a more quantifiable approach that targeted the level of importance various program and non-program factors had on their decision to complete the efficiency upgrade using a scale from 0 to 10, where 0 was "not at all important" and 10 was "very important".

Overall, all three interviewees acknowledged that they wanted to complete some type of efficiency upgrade for their multifamily property regardless of the program rebates. Two of the three added that the program and the contractors they worked with helped direct them toward the types of efficiency upgrades they decided to install and helped explain how the PNM rebate process worked. In comparing the program and non-program factors, two interviewees said the non-program factors—highlighted by the ongoing operational savings and their internal efficiency goals—were more influential than the program factors in their decision to install the energy efficient equipment. All three said they most likely would have completed a similar efficiency project without the program, although two said they may have delayed the installation somewhat without the PNM rebate.

4.4.3 Program Satisfaction

The evaluation team asked PNM interviewees to evaluate their overall level of satisfaction with the Multifamily sub-program using a scale from 1 to 5, where 1 meant "very dissatisfied" and 5 meant "very satisfied". Across all sub-program categories, including PNM as an energy provider, the rebate quantity, the eligible equipment, the participation process and timing, and the overall rebate program, interviewees said they were either "satisfied" or "very satisfied".

Given the high levels of satisfaction, interviewees did not have many direct recommendations for improving the Multifamily sub-program. However, one interviewee acknowledged that the program application "took some time to fully understand" and that other utility programs they had engaged with previously had easier application processes. Another interviewee suggested that it is important for PNM to continue to identify new eligible measures that help promote energy efficiency in multifamily settings.

4.5 New Construction Participant Interviews

The evaluation team completed six in-depth interviews with 2018 PNM New Construction sub-program participants. The interviewees represented projects across multiple business types including universities and colleges (n=4), K-12 schools (n=1), and retail (n=1). The interviewees represented approximately 30 percent of the total New Construction projects completed in 2018 and 37 percent of the 2018 program electric savings (kWh).

The interviews were completed in February of 2019 and focused on the following topics:

- Project context
- Role and influence of PNM in completed projects
- Program satisfaction

4.5.1 Project Context

Interviewees had different involvement levels with the completed efficiency upgrades and the PNM rebate processes. Interviewees included building maintenance managers (n=3), property managers (n=2), and a sustainability manager (n=1). All six of the projects utilized an installation contractor and included lighting upgrades, while only two included HVAC upgrades. Three of the projects received an incentive for the whole building design of 20 percent or more energy savings. All of the interviewees noted that overall, the installed equipment has worked well and met their expectations, with only minor replacements or swaps required.

4.5.2 Program Influence

The evaluation team asked the New Construction sub-program interviewees a series of questions about how influential various factors—both internal to the program and independent of PNM—were in their decision to install energy efficient equipment. The interviewees assessed the program influence both in a general sense and in a more quantifiable approach that targeted the level of importance various program and non-program factors had on their decision to complete the efficiency upgrade using a scale from 0 to 10, where 0 was "not at all important" and 10 was "very important".

Overall, five out of six interviewees said the non-program factors such as the financial benefits of the efficiency upgrades and internal energy policies contributed more to their decisions to complete the efficiency upgrade. However, five out of six interviewees said the PNM rebate was important in their decision despite not being the primary influence. Five out of six interviewees also said they were very to extremely likely to complete the exact same efficiency project in the absence of the PNM New Construction sub-program.

4.5.3 Program Satisfaction

The evaluation team asked PNM interviewees to evaluate their overall level of satisfaction with the New Construction sub-program using a scale from 1 to 5, where 1 meant "very dissatisfied" and 5 meant "very satisfied". Across all program categories, including PNM as an energy provider, the rebate quantity, the eligible equipment, the participation process and timing, and the overall rebate program, interviewees said they were either "satisfied" or "very satisfied".

Given the high levels of satisfaction, interviewees did not have many direct recommendations for improving the New Construction sub-program. However, three of the interviewees suggested that additional trainings for maintenance staff to help explain the application processes and eligible equipment would be beneficial. Two of the interviewees added that additional customer support and outreach could help increase program awareness.

4.6 Commercial Comprehensive Contractor Interviews

The evaluation team completed five interviews with contractors who participated in the 2018 Commercial Comprehensive program. For this evaluation round, the team concentrated on commercial retrofit rebates. The interviews focused on the following topics:

- Contractor background and program involvement;
- Program satisfaction; and
- Role and influence of the PNM program in the market.

Due to the low number of interviews and the depth of discussion, this section presents results in a qualitative fashion to show the range of perceptions and responses.

4.6.1 Contractor Background and Program Involvement

The interviewed contractors varied greatly in the scope of their work and geographic reach of their businesses. They included large companies with wide-ranging services that span multiple PNM programs, as well as more narrowly-focused contractors that specialize in such end uses as lighting. Some appear to focus on New Mexico, while others are regional or national in nature. One contractor specifically focuses on helping companies direct their energy efficiency efforts on the best opportunities.

The contractors' pre-existing understanding of utility energy efficiency programs and their sophistication in making use of the programs mirrors their diverse nature. Some contractors are very used to utility efficiency programs, know the program PNM implementation contractor from work they do in other states, and understand how to make use of the programs. Others who are more locally focused tend to learn about the programs from PNM or its local implementation contractor and face a steeper learning curve in understanding utility efficiency offerings and how to best engage with the programs. While all contractors handle the required rebate applications for their customers, the smaller, more locally-focused contractors appear to find the program process (such as approval processes and application forms) more cumbersome and challenging.

The diversity of contractor backgrounds and prior experience with utility efficiency programs suggests an opportunity to better meet contractor needs with tiered program information, outreach, and engagement that distinguishes between large, regional market actors and more locally-focused smaller businesses.

4.6.2 Program Satisfaction

Contractors tended to rate the comprehensive programs relatively highly, although some did identify room for improvement. Interviewed contractors rated the program a 3 (one response), 4 (one response), or 5 (three responses) on a 5-point scale.[14]

Regardless of the ranking they provided, contractors did identify areas of potential improvement or ideas they wish PNM would consider. These included:

- ***Simplifying the paperwork or project approval process***—Two contractors expressed a desire for a simpler approval and application process or more assistance with it.

[14] The evaluation team asked contractors to rate the comprehensive program overall on a 5-point scale that ranged from 1 ('very dissatisfied') to 5 ('very satisfied'). A 3 was defined as 'neither satisfied or dissatisfied', while a 4 indicated the contractor was 'somewhat satisfied'.

- ***Co-branding***—One contractor expressed a desire for co-branding with PNM, while another wished PNM did more advertising outside the Albuquerque area on behalf of the program so the outreach is not all up to the contractors. In one of these contractors' words, *"We'd love to be co-branded. We have to go out and find our own work and it's nice to say we're trade allies with PNM. .... PNM could add more assistance to finding qualified customers."*[15]

Several contractors also expressed a desire for higher rebate amounts and feel that reductions in some past rebates have affected customer interest. However, they did express an understanding that the utility needs to calibrate the incentives to business considerations.

In comments that extended into other program areas, one contractor said he thought there were substantial opportunities for HVAC measures in multifamily buildings that are not currently covered by programs, and he wished PNM could help firms like his offer efficiency in schools.

4.6.3 PNM Program Influence

To better understand the program influence on the market, the evaluation team explored how and when contractors communicate about the PNM rebates with customers and what role they play in the contractors' and customers' ultimate choices. Responses varied, sometimes reflecting the diversity of contractor engagement with efficiency programs and pointing to multiple types of market impacts that vary by program and by contractor.

Generally, the interviewed contractors believe they are the ones who inform customers of the efficiency opportunities and the PNM rebates, but with the PNM program providing additional credibility for these options. Thereby, the PNM rebates increase consideration of efficient options through participating trade allies.

Some contractors specify efficient measures almost exclusively and bring up the PNM rebate as part of their bid. They tend to believe that the program makes the efficient technologies easier for customers to choose because their net costs are reduced, but the program does not substantially affect the choices the contractor offers to the customer. In these cases, the ultimate program impact is on customer selections when weighing competing bids.

Other contractors say the rebates apply for only a subset of their customers and that they will include the efficient option with the rebate in their bids in those cases. It is plausible that the rebates affect these contractors' offers and recommendations to customers, thereby influencing the supply chain's offers and recommendations.

[15] PNM does not currently allow co-branding with contractors.

These results are based on a small number of interviews, however, and should be seen as informing the utility's understanding of *how* the program influences the market and not *how much*. It would take more research to determine how widespread these dynamics are or to measure market effect quantitatively.

5 Residential Lighting Program

The residential lighting market in the U.S. has experienced significant change over the past decade as the Energy Independence and Security Act of 2007 (EISA) has led to the phase-out of incandescent bulbs, consumers have become more aware of LEDs, and the purchase price of LEDs has become increasingly affordable. PNM’s Residential Lighting program promotes adoption of LED lighting by providing incentives to customers to replace less efficient light bulbs with LED bulbs through in-store rebates and coupons at participating retailers in PNM's service territory and rebated online sales for rural or homebound customers (shown in Table 22).

Table 22: Sales of Bulbs Through the PNM Residential Lighting Program, 2018 Program Year

Retailer Type	Bulbs Sold	Percent of Total
Warehouse	315,851	34.7%
Non-Warehouse	595,425	65.3%
Total	**911,276**	**100%**

Source: Analysis by Evergreen Economics of data provided by PNM.

While 12 retailers participated in the Residential Lighting program over the period analyzed, three participating retailers dominated bulb sales. These three retailers each fit a different retail channel (mass merchant, warehouse, and DIY) and serve an array of customer income demographics. Combined, these three retailers accounted for 91 percent of rebated sales through the program.

5.1 Residential Lighting Gross Impacts

For the Residential Lighting program measures, the gross impact analysis consisted of reviewing the calculations of per-unit savings values used for all the individual lighting measures covered by the program and then comparing those calculations to the algorithms and assumptions in the New Mexico TRM. In general, the evaluation team found that the formula used to calculate bulb savings was correct. One minor error was found in the lookup of baseline wattages for specialty bulbs with 1,500 lumens, which was corrected by the evaluation team and resulted in slightly higher verified kWh and kW savings for the Residential Lighting program. The resulting engineering adjustment factor for both kWh and kW savings is 1.0017.

To facilitate deemed savings reviews of the Residential Lighting program in the future, the evaluation team recommends that the baseline wattage used to calculate savings be included in the tracking data, as well as a field denoting the source of the baseline wattage used (i.e., the table name from the TRM).

5.2 Residential Lighting Net Impacts

The Residential Lighting program utilized the elasticity model developed using 2017 program year data to determine net impacts for the 2018 program year. As discussed in the *Evaluation Methods* chapter, due to errors in the collection of sales data for the 2018 program year, Evergreen found that it was not possible to develop the econometric-based elasticity model specifically for the 2018 program year. Instead, we relied on the results from the 2017 elasticity model to develop estimates for the 2018 program year based on the count of bulbs sold in 2018.

Evergreen developed the 2017 elasticity model based on sales data for PNM's Residential Lighting program beginning on March 28, 2016, and extending through December 30, 2017, to understand the impact that direct (in-store) rebates have had on the sale of residential LED lighting. Since the customer receives the rebate at the time of purchase (as opposed to a mail-in rebate or a rebate on a future purchase), it acts to immediately lower the purchase price of the LED lighting.

To estimate the impact that price has had on the sale of LED bulbs, we specified and estimated a Poisson regression model.[16] The Poisson model is preferable to standard ordinary least squares (OLS) regression because the response variable (i.e., bulb sales) only takes on non-negative (or positive) values. The OLS regression model is generally not an appropriate choice because it fails to account for the limited possible values of the response variable. While there are other models that account for limitations of count data (e.g., negative binomial), the Poisson model is the most often-used approach.

The generalized log-linear Poisson model is specified as:

$$Ln(\mu_i) = x_i'\beta$$

Where μ_i is the mean of the individual bulb sales across retailers and sales periods. The empirical model the evaluation team estimated for the PNM Residential Lighting program is specified as:

$$Ln(Bulb\ Sales_{kit}) = \beta_0 + \beta_1(Rebated\ Price_{kit}) + \beta_k(Bulb\ Char_k)$$

Where,

$Ln(Bulb\ Sales_{kit})$ is the natural logarithm of the quantity of bulb type k sold by retailer i in time period t.

$Rebated\ Price_{kit}$ is the price after rebate for bulb type k sold by retailer i at time t.

---

[16] The evaluation team did examine two alternative modeling approaches: fixed-effects and random-effects Poisson models. Results varied little between these models and the (standard) Poisson model.

$Bulb\ Char_k$ is an array of characteristics of the LED bulb, such as lumens and watts.

We estimated separate models for standard and specialty LED bulbs and for warehouse and non-warehouse retailers (four models in total). Our *a priori* assumption was that consumers are more sensitive to price when purchasing standard LED bulbs, which are applicable to a greater range of residential lighting fixtures and for which consumers may have a greater number of alternative lighting options (e.g., efficient incandescent, halogen, CFL). In comparison, as the name implies, there is a wide range of specialty LED bulbs available in the market, but not every specialty LED bulb is demanded by every consumer and, therefore, only those consumers who have a use for a specific specialty bulb—regardless of lighting option—will show any sensitivity to the price of the LED option.

We also estimated separate models for warehouse and non-warehouse retailers. Warehouse and non-warehouse retailers differed significantly with respect to average (before rebate) price per bulb—$3.18 for warehouse versus $4.70 for non-warehouse (48 percent higher price per bulb sold through non-warehouse retailers). Warehouse retailers also typically sold bulbs in larger packs than non-warehouse retailers, but carried a narrower selection of bulbs.

Table 23 shows the estimates of price elasticity of demand for each of the four regression models based on 2017 program year data and for the program as a whole.[17] The price elasticity of demand is a measure of the change in the demand for a good or service when the price of that good or service increases by a small amount (generally 1 percent). Price elasticities are assumed to be negative—that is, as price goes up, demand for the good or service goes down; it is the magnitude of the elasticity (the "responsiveness") that is of primary interest.[18]

As Table 23 shows, the evaluation team found that the demand for LED bulbs is highly elastic for both standard and specialty bulbs sold through non-warehouse retailers (price elasticity of demand of -1.78 and -1.61, respectively). Comparatively, the evaluation team found that the demand for standard LED bulbs from warehouse retailers is unit elastic (the estimated elasticity of -0.96 is not statistically significantly different from 1.0) and that demand for specialty LED bulbs from warehouse retailers is price inelastic (the estimated elasticity of -0.73 is statistically significantly less than 1.0). Overall, when weighting by LED bulb sales from all retailers for the 2018 program year, the evaluation team estimated the price elasticity of demand for all program LED bulbs to be -1.46. Thus, a 10 percent

[17] The program level estimates of price elasticity and NTG account for the distribution of bulb sales during the 2018 program year.

[18] If the price elasticity for a good is greater than 1.0 in absolute value, demand for that good is referred to as elastic (more responsive). Similarly, when the price elasticity is less than 1.0 in absolute value, demand for that product is referred to as inelastic.

decrease in the price of LED bulbs will result in a 14.6 percent increase in demand for LED bulbs, holding all else constant.

Table 23: Estimates of Price Elasticity and NTG Ratio

LED Bulb Type and Retailer	Elasticity at Mean Rebated Price	NTG Ratio at Mean Rebated Price
Standard Non-Warehouse	-1.78	0.69
Standard Warehouse	-0.96	0.53
Specialty Non-Warehouse	-1.61	0.63
Specialty Warehouse	-0.73	0.50
Residential Lighting Program	**-1.46**	**0.63**

Table 23 also shows estimates of the NTG ratio for PNM's Residential Lighting program using the elasticity model. The estimates of the NTG ratio also vary across the four combinations of bulb type and retailer. The highest NTG ratio estimate was for standard bulbs sold by non-warehouse retailers (0.69), and the lowest estimated NTG ratio was for specialty bulbs sold at warehouse stores.[19]

To take into account the special case of dollar-type stores where LED bulbs were not likely to be sold without the influence of the program, the evaluation team computed the weighted average NTG ratio for standard non-warehouse and standard warehouse LED bulbs assuming a rebated price of $0.01. The estimated NTG ratio of 0.95 seems reasonable and indicates that approximately 5 percent of customers who purchased LED bulbs at a dollar-type store would have purchased the bulbs elsewhere had they not been available at that store because of the program. For the 2018 PNM Residential Lighting program overall, the evaluation team estimated the NTG ratio to be 0.63.

Figure 21 shows how expected rates of free ridership and NTG ratios vary by rebated bulb for each of the four combinations of bulb type and retailer. As the rebated price of LEDs drops, the proportion of purchasers that free ride decreases and the NTG ratio increases.

[19] The difference in NTG between warehouses and non-warehouses may be due to differences between warehouse and non-warehouse retailers in pricing and product packaging, as well as due to differences among customers who frequent these two retail channels. Bulbs sold at warehouse stores are, on average, less expensive on a per-bulb basis compared to non-warehouse retailers, but the number of bulbs per package is typically greater. The additional incentive of the PNM in-store rebate is likely welcomed by customers of warehouse stores but may not be sufficient to entice them to purchase additional packages of bulbs given the relatively large number of bulbs per package. Likewise, it may also be that in-store rebates when offered at a non-warehouse store lead to greater impulse purchases than the same or similar rebate at a warehouse retailer.

The trajectories differ for each combination of bulb type and retailer because the types and prices of bulbs differ. In addition, it is likely that the characteristics of buyers differ between those who shop at warehouse and non-warehouse retailers.

It is important to note that the free ridership chart (upper panel of Figure 21) does not show the expected number of bulbs sold by rebated price, but rather the proportion of bulbs sold by rebated price that would have sold even without the rebate. As the rebated price decreases (moving from right to left along the horizontal axis), more and more consumers—who otherwise would not purchase LED bulbs—are motivated to purchase bulbs, resulting in a decreasing proportion of purchasers that are free riders.

The purpose of the rebates is to encourage those consumers who would not otherwise purchase an LED to make the purchase. However, since the rebate is available to all purchasers of the LED bulbs, even those who would have purchased the bulbs without the rebate receive the rebate. The larger the rebate, the greater the number of consumers who will purchase LED bulbs, leading to a lower rate of free ridership and a higher NTG ratio (lower panel of Figure 21).

Figure 21: Estimated Free Ridership and NTG Ratio by LED Bulb Type and Retailer

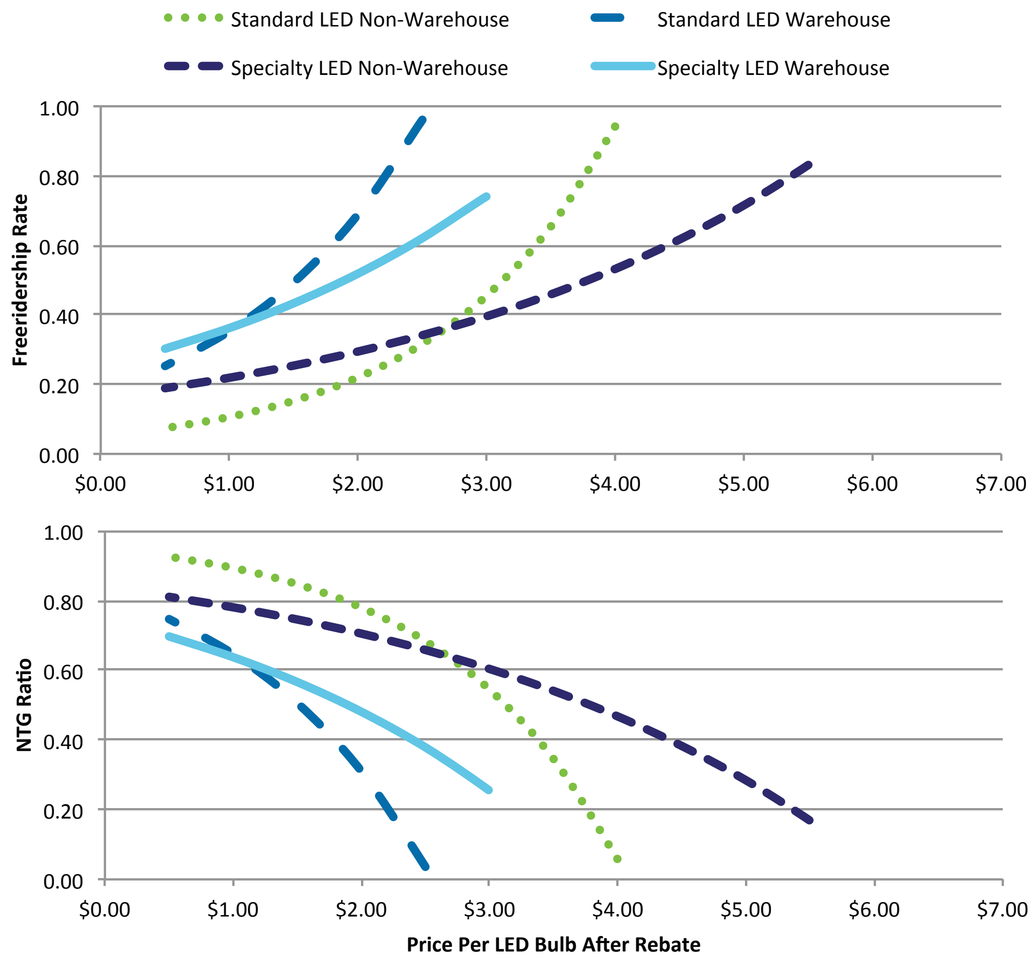


Table 24 summarizes the final gross and net impacts for the Residential Lighting program using the NTG ratio derived from the elasticity model. Using the overall NTG ratio of 0.63, the PY2018 net realized impacts for the Residential Lighting program are 17,038,069 kWh and 2,119 kW.

Table 24: Residential Lighting PY2018 Impact Summary

Residential Lighting	# of bulbs	Expected Gross Savings	Engineering Adjustment Factor	Realized Gross Savings	NTG Ratio	Realized Net Savings
kWh Savings	911,276	26,998,470	1.0017	27,044,554	0.6300	17,038,069
kW Savings	911,276	3,358	1.0017	3,364	0.6300	2,119

6 Energy Smart Program

PNM's Energy Smart program provides weatherization services and other efficiency upgrades to low-income households in PNM territory. Measures are prescriptive in nature and include insulation, duct sealing, water heater tank and pipe insulation, low-flow showerheads and aerators, and efficient lighting. To evaluate the impacts of the Energy Smart program, the evaluation team conducted a deemed savings review of the energy saving measures provided by the program.

In the deemed savings review, we attempted to confirm the source of savings cited by PNM and/or replicate the per-unit savings values if savings were based on an algorithm from the New Mexico TRM. During the review of per-unit kW savings, we found that the kW savings shown in the tracking data were not the final kW savings claimed by PNM. PNM confirmed the alternate source of kW savings used for the Energy Smart program, and we were able to confirm the source of those savings. However, we suggest that PNM track the claimed kW savings in the program tracking data, as is done for kWh savings, in order to keep all program savings in one location. Ultimately, we were able to confirm the source of savings or replicate savings for all measures, and found these values to be reasonable. Therefore, the engineering adjustment factor for the Energy Smart program was 1.00.

The NTG ratio for the Energy Smart program is stipulated at 1, and as a result, the net realized savings are equal to the gross verified savings of 321,255 kWh and 36 kW.

7 Residential Comprehensive Program

7.1 Residential Comprehensive Gross Impacts

The *ex ante* 2018 impacts are summarized in Table 25 for each Residential Comprehensive sub-program. In total, the Residential Comprehensive program accounted for 16 percent of energy impacts in PNM's overall portfolio.

Table 25: Residential Comprehensive Savings Summary

Sub-Program	# of Projects	Expected Gross kWh Savings	Expected Gross kW Savings
Home Energy Checkup	1,989	2,333,433	261
Refrigerator Recycling	7,047	7,603,123	1,754
Cooling and Pool Pumps	3,887	5,354,353	4,203
Total	**12,923**	**15,290,909**	**6,218**

The gross impact evaluation of the Residential Comprehensive program consisted of a deemed savings review of per-unit savings values for each of the three sub-programs. We compared PNM documentation on the source, calculations, and input assumptions of savings values to determine whether they were correct and appropriate.

For the Home Energy Checkup sub-program, we were able to confirm the source of savings, calculations, and input assumptions for the majority of measures. For measures where we did not have enough information on the input assumptions to replicate the calculations, we confirmed that the per-unit values were within a reasonable range for the type of measure. In the future, we recommend that PNM clearly and consistently document the source of deemed savings, formulas used to calculate deemed savings, and all input assumptions for those calculations in order to facilitate evaluator review of savings values. The engineering adjustment factor for the Home Energy Checkup program was 1.00.

For the Refrigerator Recycling sub-program, we confirmed the source of deemed savings values and found the per-unit values to be reasonable for the refrigerator and freezer recycling measures. As a result, the engineering adjustment factor for the Refrigerator Recycling sub-program was 1.00.

For the Cooling and Pool Pumps sub-program, the savings calculations were confirmed to be accurate with a few exceptions. For kW savings for the room AC and window evaporative cooler measures, the residential HVAC coincidence factor of 0.87 was not applied as is recommended in the New Mexico TRM. For smart thermostats, the kWh savings were determined using the algorithm from the New Mexico TRM, but did not include the duct efficiency factor of 0.8 or the correct cooling adjustment (0.07 was used instead of 0.08 per the TRM). With these modifications to savings, the engineering adjustment factors for the Cooling and Pool Pumps sub-program were 1.0015 for kWh and 0.9979 for kW.

Table 26 and Table 27 show the results of the deemed savings reviews and how the resulting engineering adjustments were used to calculated realized savings. For the Residential Comprehensive program overall, these adjustments resulted in an engineering adjustment factor of 1.0005 for kWh and 0.9986 for kW.

Table 26: PY2018 Residential Comprehensive Gross kWh Impact Summary

Sub-Program	# of Projects	Expected Gross kWh Savings	Engineering Adjustment Factor	Realized Gross kWh Savings
Home Energy Checkup	1,989	2,333,433	1.0000	2,333,433
Refrigerator Recycling	7,047	7,603,123	1.0000	7,603,123
Cooling and Pool Pumps	3,887	5,354,353	1.0015	5,362,307
Total	**12,923**	**15,290,909**	**1.0005**	**15,298,862**

Table 27: PY2018 Residential Comprehensive Gross kW Impact Summary

Sub-Program	# of Projects	Expected Gross kW Savings	Engineering Adjustment Factor	Realized Gross kW Savings
Home Energy Checkup	1,989	261	1.0000	261
Refrigerator Recycling	7,047	1,754	1.0000	1,754
Cooling and Pool Pumps	3,887	4,203	0.9979	4,194
Total	**12,923**	**6,218**	**0.9986**	**6,209**

7.2 Residential Comprehensive Net Impacts

Net impacts for the Residential Comprehensive program were calculated using NTG ratios from the participant phone survey or *ex ante* values, depending on the sub-program. For non-low income and non-direct install measures for the Home Energy Checkup sub-program, the NTG ratio was developed using the self-report method described in the *Evaluation Methods* chapter using participant phone survey data. The resulting NTG ratio for this portion of the Home Energy Checkup sub-program is 0.5788. For low income or direct install measures in the Home Energy Checkup sub-program, an NTG ratio of 1 was applied. As a result, the overall NTG ratio for the Home Energy Checkup sub-program was 0.8977. For the Cooling and Pool Pumps sub-program, the NTG ratio was developed using the self-report method with participant phone survey data. The resulting NTG ratio for this sub-program was 0.5463. For the Refrigerator Recycling sub-program, a participant phone survey was not conducted this year, so the *ex ante* NTG ratio of 0.68 was applied to this sub-program.

Table 28 and Table 29 summarize the PY2018 net impacts for the Residential Comprehensive program using the NTG ratios described above. Net realized savings for the program overall are 10,194,222 kWh, and net realized demand savings are 3,718 kW.

Table 28: PY2018 Residential Comprehensive Net kWh Impact Summary

Sub-Program	# of Projects	Realized Gross kWh Savings	NTG Ratio	Realized Net kWh Savings
Home Energy Checkup	1,989	2,333,433	0.8977	2,094,670
Refrigerator Recycling	7,047	7,603,123	0.6800	5,170,124
Cooling and Pool Pumps	3,887	5,362,307	0.5463	2,929,428
Total	**12,923**	**15,298,862**	**0.6663**	**10,194,222**

Table 29: PY2018 Residential Comprehensive Net kW Impact Summary

Sub-Program	# of Projects	Realized Gross kW Savings	NTG Ratio	Realized Net kW Savings
Home Energy Checkup	1,989	261	0.8977	234
Refrigerator Recycling	7,047	1,754	0.6800	1,193
Cooling and Pool Pumps	3,887	4,194	0.5463	2,291
Total	**12,923**	**6,209**	**0.5988**	**3,718**

7.3 Home Energy Checkup Participant Surveys

The evaluation team conducted telephone surveys with representatives from 52 residential customers that received rebates through the PNM Home Energy Checkup sub-program of the Residential Comprehensive program. The surveys were completed in February 2019 and ranged from 15 to 20 minutes in length.

The participant survey was designed to cover the following topics:

- Verifying the installation of measures included in the program tracking database;
- Collecting information on participants' satisfaction with their program experience;
- Survey responses for use in the free ridership calculations;
- Baseline data on energy use and/or equipment holdings;
- Participant drivers/barriers; and
- Additional process evaluation topics.

PNM provided program participation data on the Home Energy Checkup projects, which were used to select a sample of residential customers who had valid contact information and received a rebate through the Home Energy Checkup sub-program.

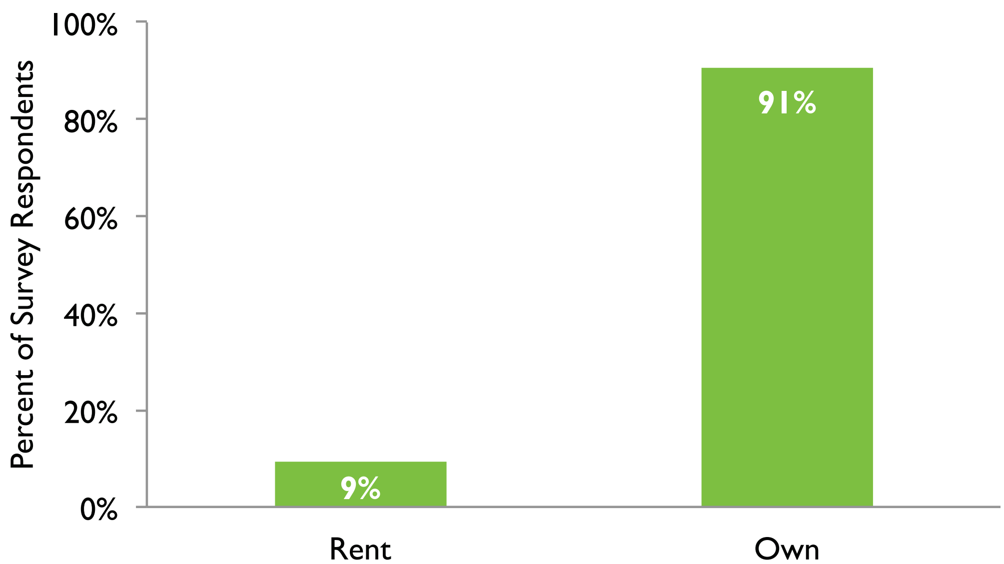
The following subchapters include data covering demographics, sources of program awareness, motivations for participation, and program satisfaction among survey participants.

Throughout the analysis described here, we present the survey results as weighted percentages based on the proportion of savings represented by survey respondents relative to the total savings of all program participants.

7.3.1 Household Demographics

The majority of survey respondents (91%) own their home (Figure 22).

Figure 22: Participant Own or Rent (n=42)



The following two figures summarize the survey respondents' home and household size. Home size was generally above 1,500 square feet among survey respondents, with the majority (53%) residing in a home between 2,000 and 2,999 square feet. Additionally, as shown in Figure 24, the majority (54%) of respondents have two to three full-time residents living in the home where the project was completed.

Figure 23: Home Energy Checkup Participant Home Size

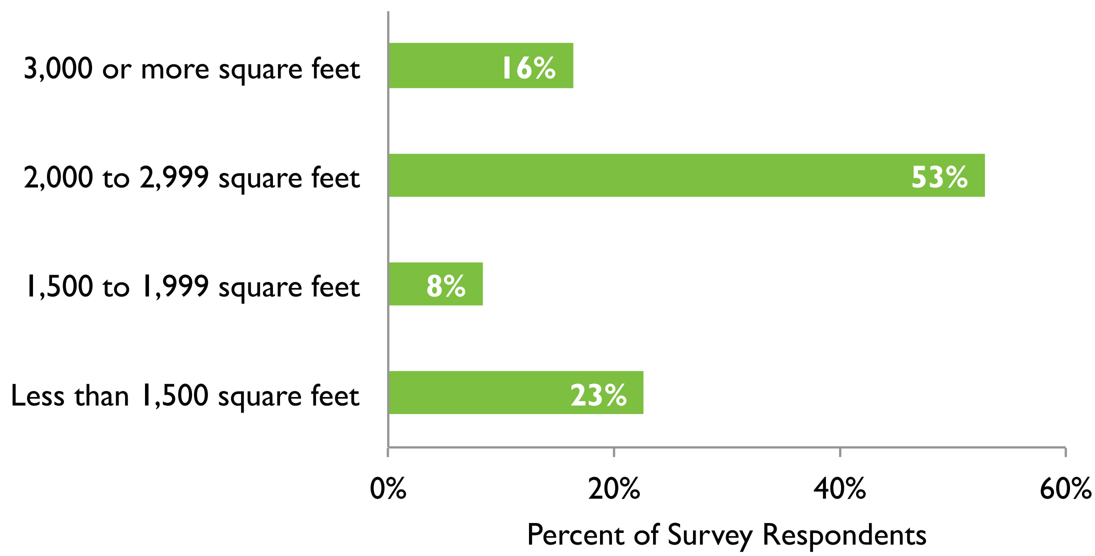
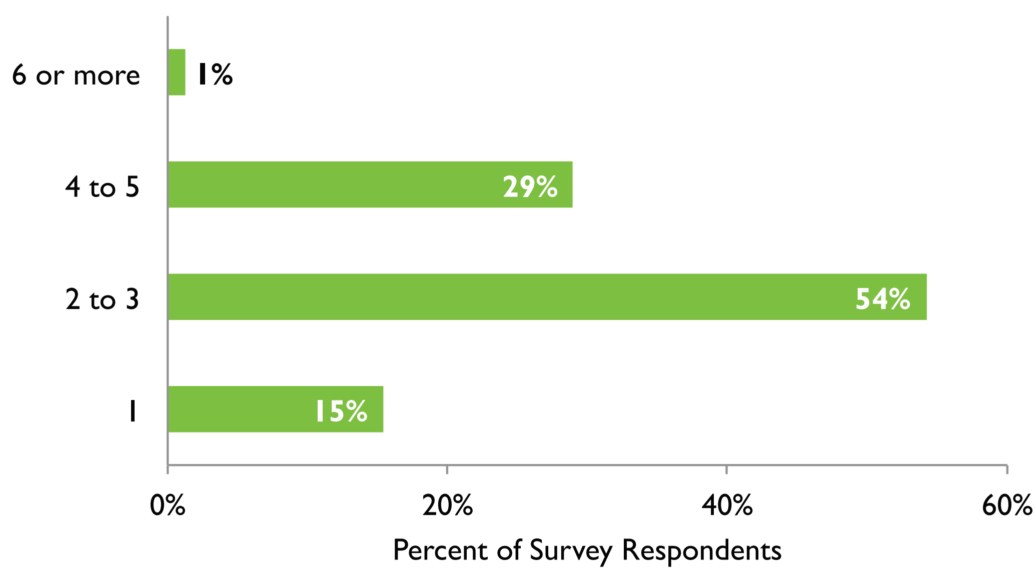
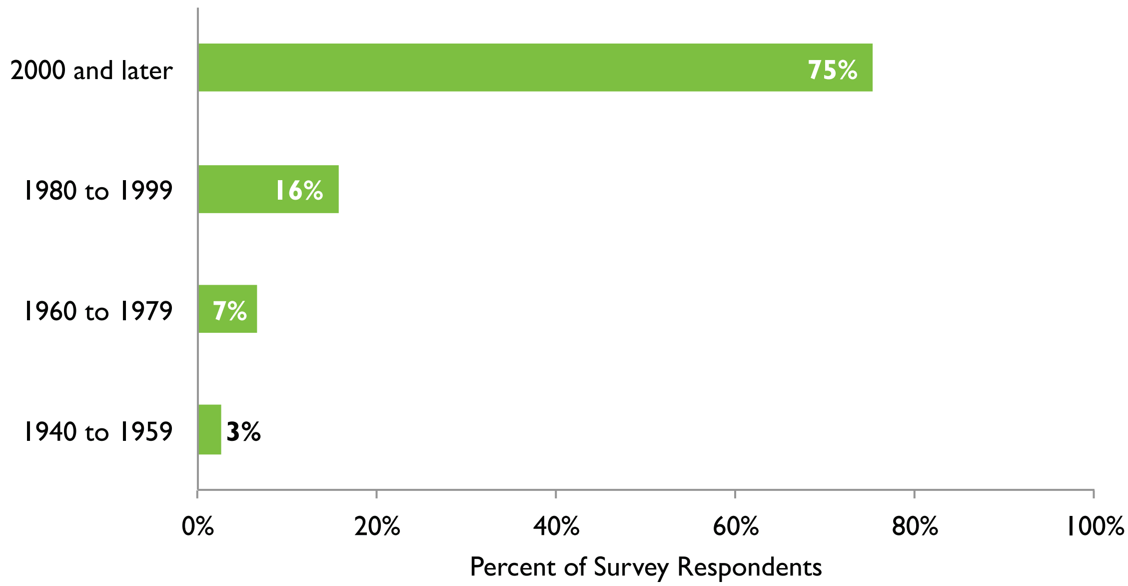


Figure 24: Home Energy Checkup Participant Household Size



As shown in Figure 25, the vast majority (75%) of Home Energy Checkup participants reported that their homes were built sometime after the year 2000. This suggests that in future years, the program should focus on targeting older homes where the potential for significant energy savings is the greatest.

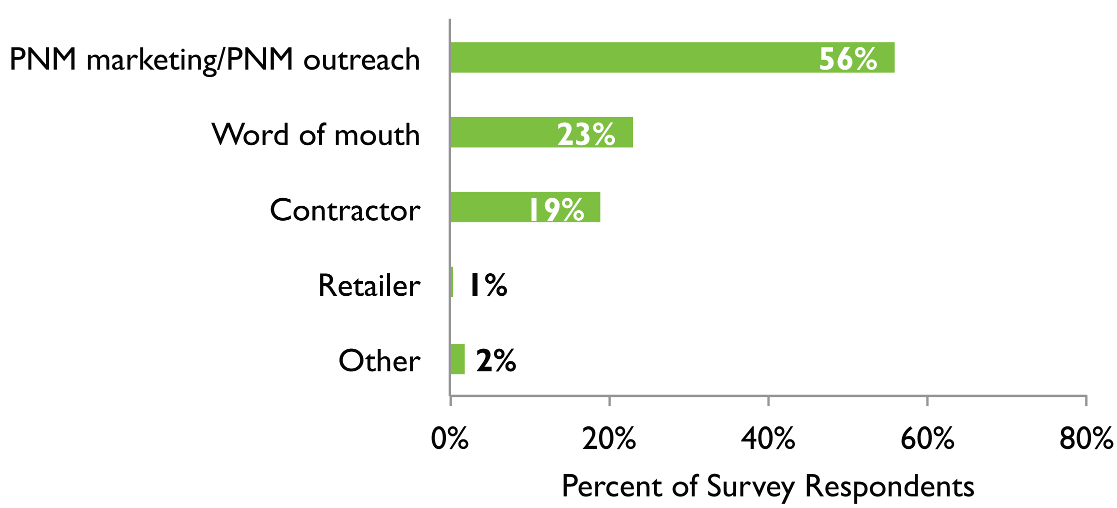
Figure 25: Home Energy Checkup Home Age



7.3.2 Source of Awareness

Survey respondents became aware of the program rebates/assistance through a variety of channels, including PNM marketing/outreach, word of mouth, contractors, and retailers. As shown in Figure 26, interactions with PNM (either through direct contact or marketing) were significant sources of awareness for survey respondents.

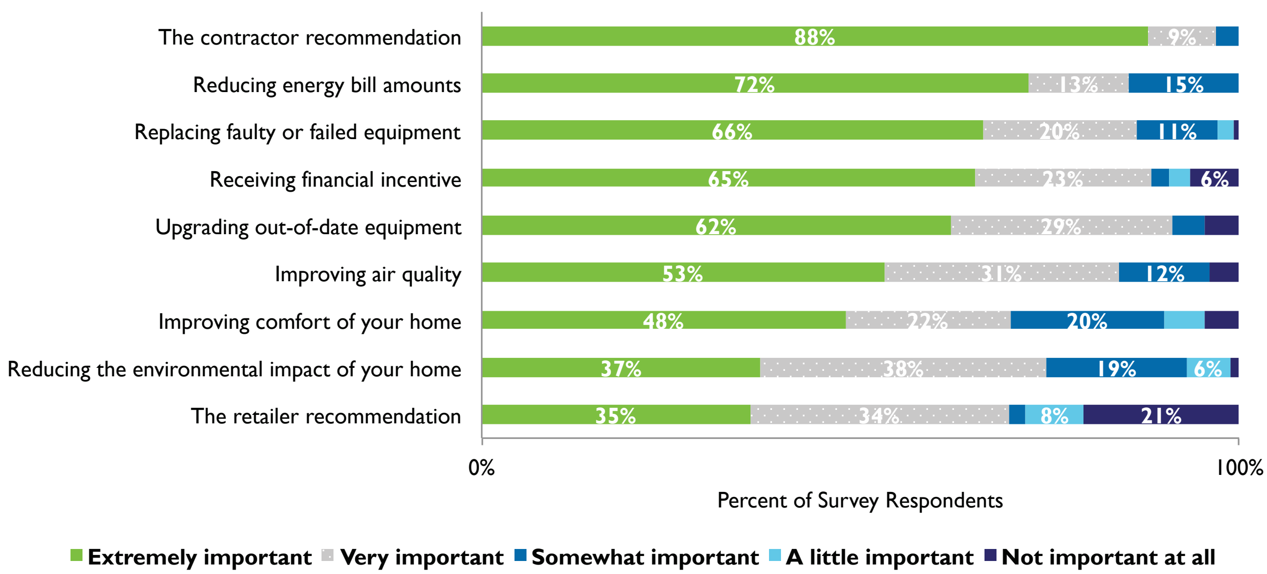
Figure 26: Home Energy Checkup Participants Source of Awareness



7.3.3 Motivations for Participation

Respondents were asked to rate the importance of a variety of factors that might have influenced their decision to participate in the incentive program. Among Home Energy Checkup survey respondents, the contractor recommendation was the most important factor, with 88 percent of respondents reporting it as "extremely important" in their decision to participate in the program (Figure 27). Other important factors included reducing energy bill amounts, replacing faulty or failed equipment, receiving financial incentive, upgrading out-of-date equipment, and improving air quality.

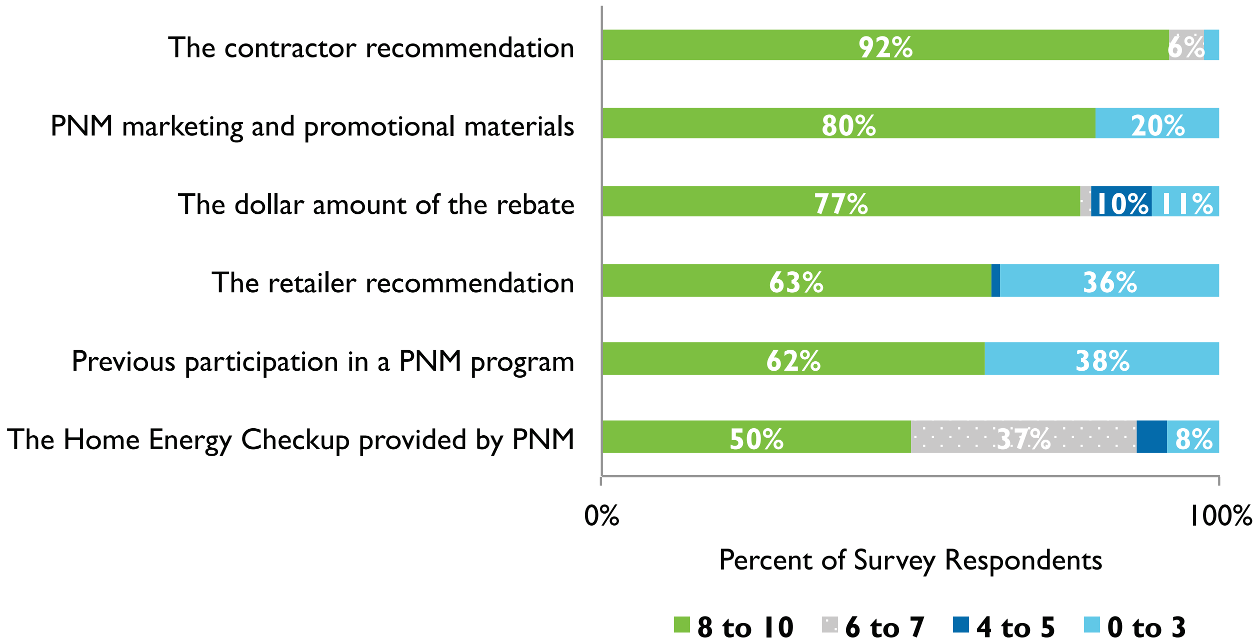
Figure 27: Home Energy Checkup Motivations for Participation (n=42)



In addition to motivations for participating, survey respondents were given a list of potential program factors that may have influenced their decision to participate in the rebate program and were then asked to rate the influence of those factors on a 0 to 10 scale.[20] Consistent with what is shown in Figure 27, Figure 28 shows that the contractor recommendation was influential in the survey respondents' decision to participate in the program. The Home Energy Checkup provided by PNM was the least influential in respondents' decisions to participate in the program, though 50 percent of respondents reported it as extremely influential (ratings of 8 to 10).

[20] On the 0 to 10 point scale, 0 indicated 'not at all influential' and 10 indicated 'extremely influential'.

Figure 28: Home Energy Checkup Influence of Program Factors (n=42)



7.3.4 Participant Satisfaction

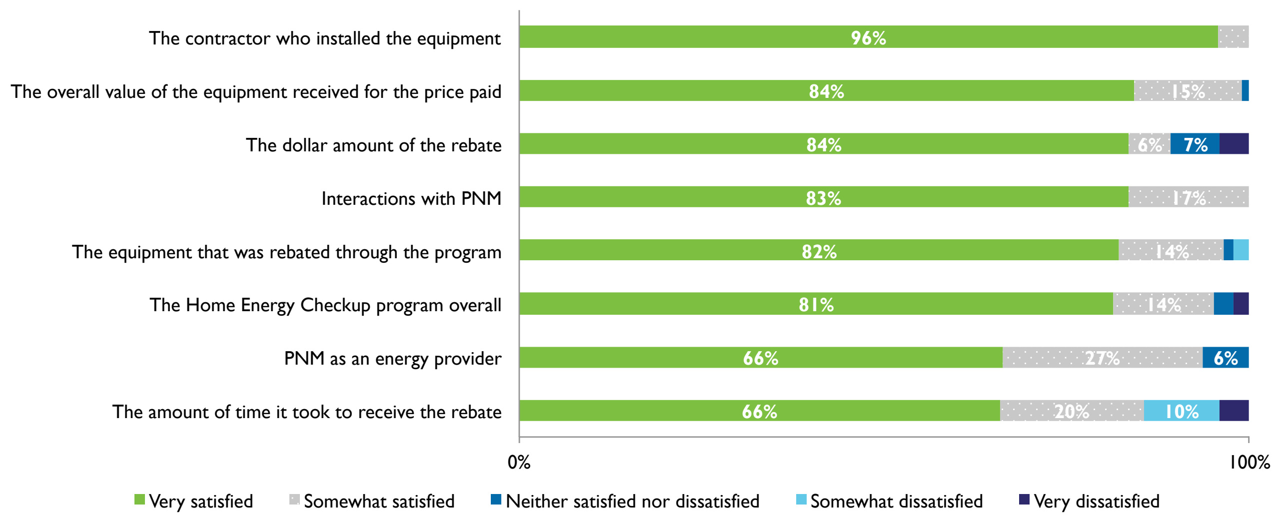
Survey respondents evaluated their satisfaction with various components of the Home Energy Checkup sub-program on the following scale: very satisfied, somewhat satisfied, neither satisfied nor dissatisfied, somewhat dissatisfied, and very dissatisfied. The individual components that participants were asked to rank their satisfaction with included:

- PNM as an energy provider
- The Home Energy Checkup sub-program overall
- The rebated equipment
- The installation contractor
- The time it took to receive the rebate
- The dollar amount of the rebate
- Interactions with PNM
- The overall value of the equipment for the price they paid

Figure 29 below summarizes the satisfaction levels for Home Energy Checkup participants.

Overall, surveyed participants expressed high levels of satisfaction across each program component (Figure 29). The majority of respondents reported being "very satisfied," with the highest satisfaction ratings for the contractor who installed the equipment. A small percentage of Home Energy Checkup respondents reported lower satisfaction ratings, primarily with the time it took to receive the rebate and PNM as an energy provider.

Figure 29: Home Energy Checkup Program Satisfaction (n=42)



7.4 Cooling and Pool Pumps Participant Surveys

As part of the process evaluation, the evaluation team conducted telephone surveys with 60 residential customers that received rebates through the PNM Residential Comprehensive Cooling and Pool Pumps sub-program. The surveys were completed in January 2019 and ranged from 15 to 20 minutes in length.

The participant survey was designed to cover the following topics:

- Verifying the installation of measures included in the program tracking database;
- Collecting information on participants' satisfaction with their program experience;
- Survey responses for use in the free ridership calculations;
- Baseline data on energy use and/or equipment holdings;
- Participant drivers/barriers; and
- Additional process evaluation topics.

PNM provided program participation data on the Residential Comprehensive participant projects, which allowed us to select a sample for surveys. The evaluation team randomly selected and recruited program participants based on whether they had valid contact information and received a rebate through the Cooling and Pool Pumps sub-program.

The following subchapters include data covering demographics, sources of program awareness, motivations for participation, and program satisfaction amongst survey participants.

Throughout the analysis described here, we present the survey results as weighted percentages based on the proportion of savings represented by survey respondents relative to the total savings of all program participants.

7.4.1 Participant Demographics

The following two figures summarize the survey respondents' home and household size by whether they installed cooling or pool pump measures. Home size was generally larger among survey respondents who received pool pumps compared to those who received cooling (Figure 30), though home occupancy was not significantly different between survey participants with cooling and pool pumps.

Figure 30: Cooling and Pool Pumps Participant Home Size

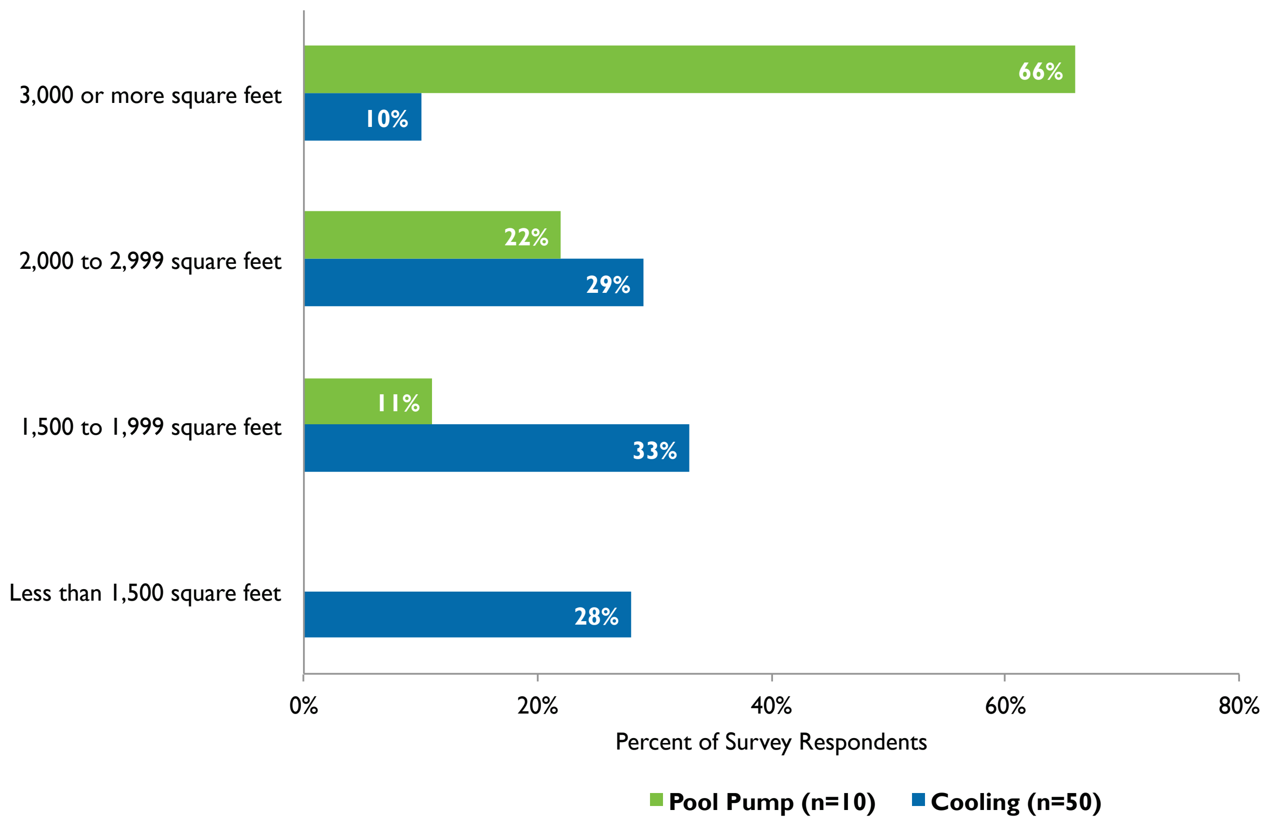
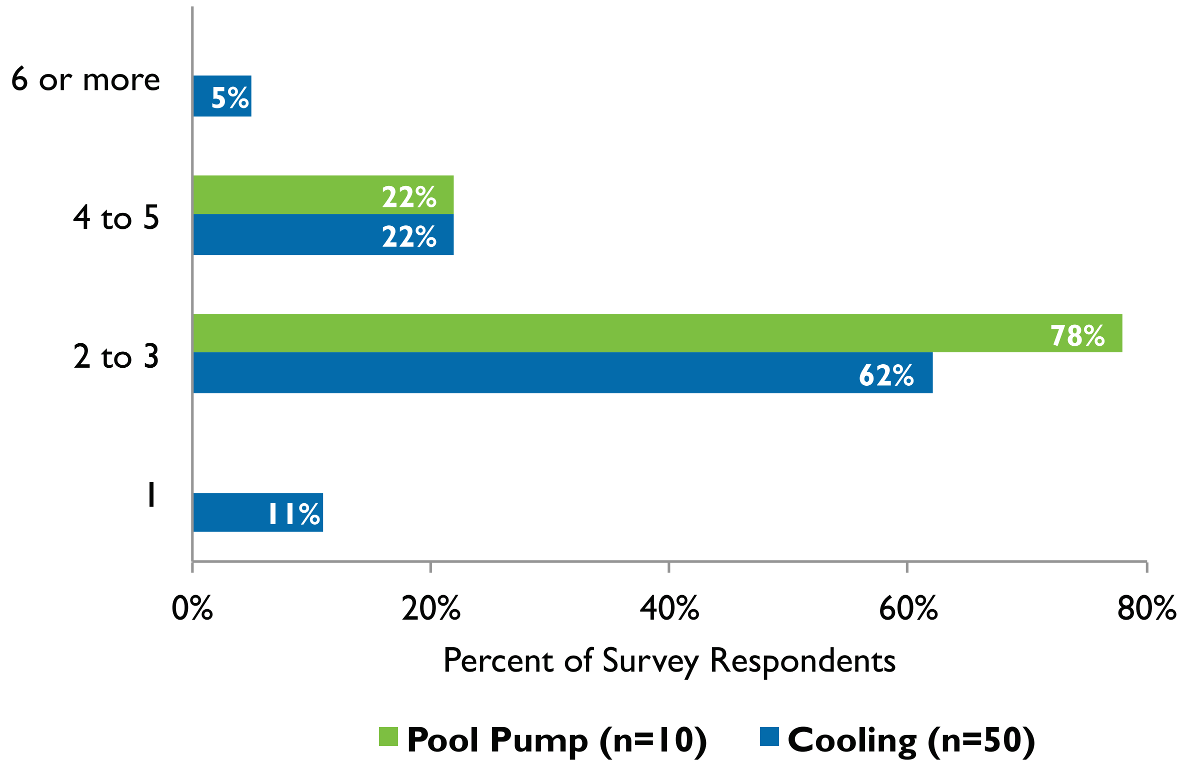
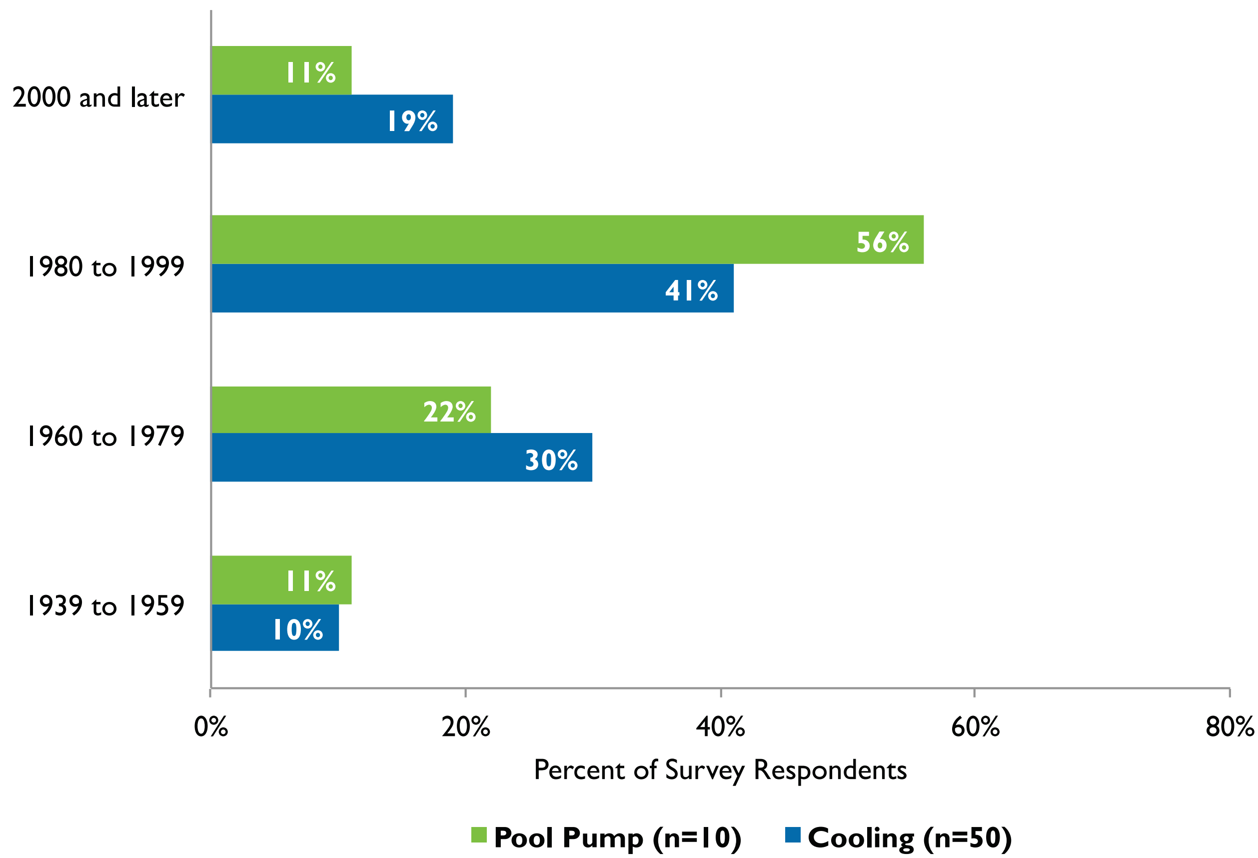


Figure 31: Cooling and Pool Pumps Participant Household Size



As shown in Figure 32, large portion of sub-program participants who received pool pumps (33%) and cooling measures (40%) reported that their homes were built sometime before 1979. This suggests that the programs are doing a good job at targeting older homes, where the potential for significant energy savings is the greatest.

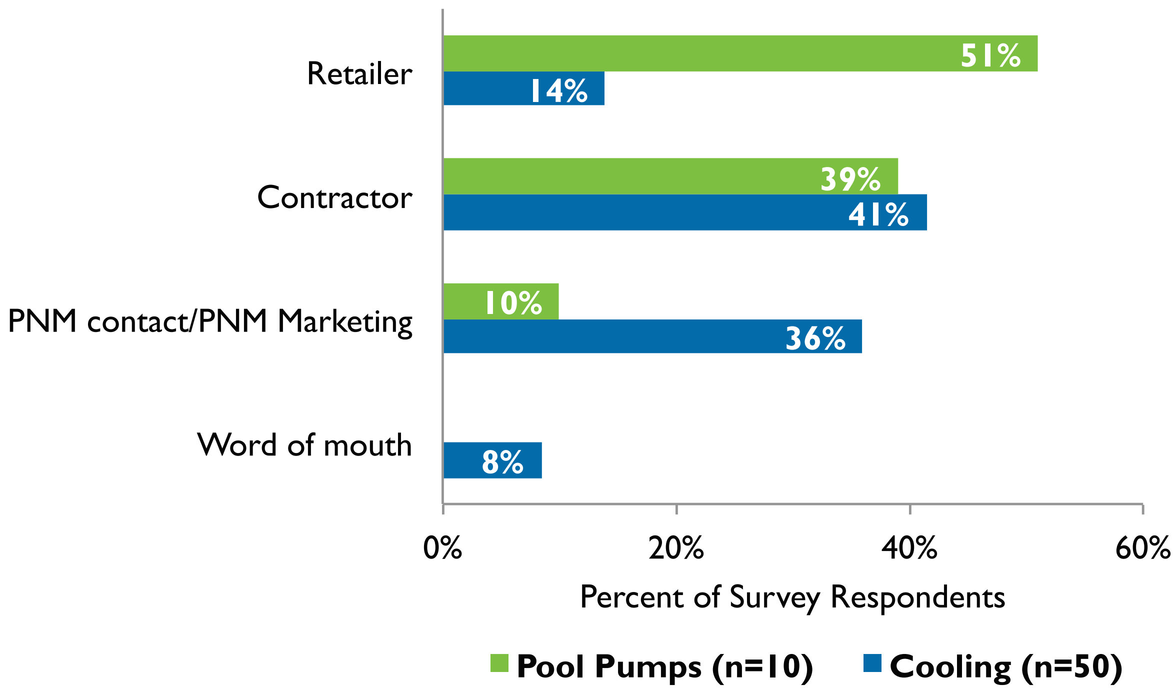
Figure 32: Cooling and Pool Pumps Participant Home Age



7.4.2 Source of Awareness

Cooling and Pool Pumps sub-program participants became aware of the program rebates/assistance through a variety of channels, including retailers, contractors, PNM marketing/outreach, and word of mouth. As shown in Figure 33, just over half of survey respondents who installed pool pumps learned about the program offerings through retailers. For pool pump survey respondents, contractors and interactions with PNM (either through direct contact or marketing) were significant sources of awareness.

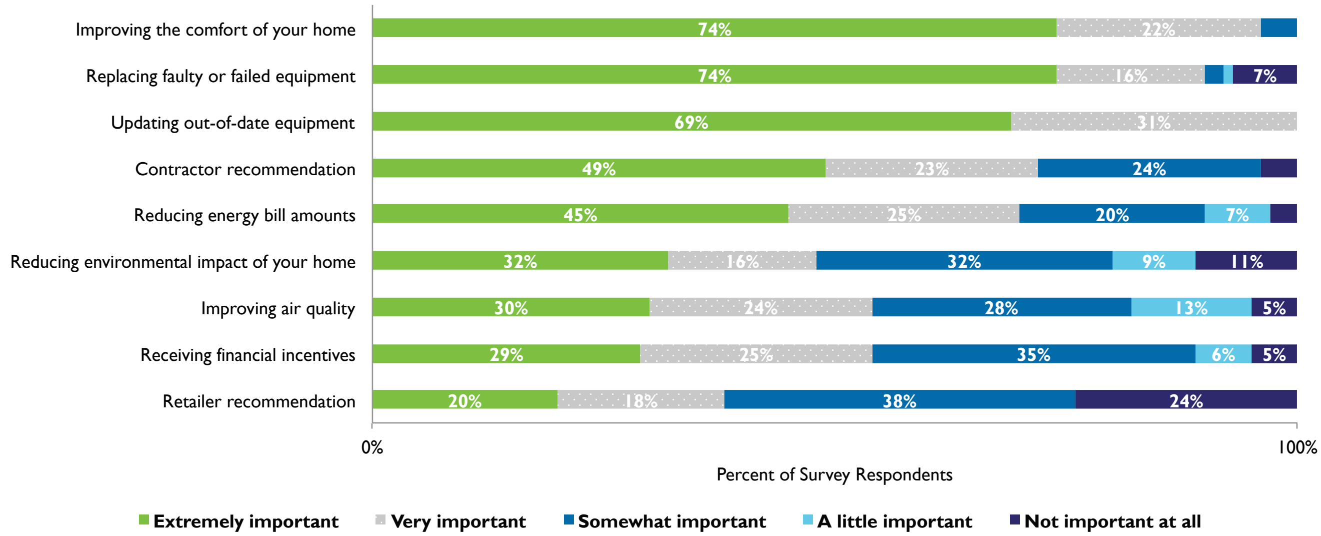
Figure 33: Cooling and Pool Pumps Participants Source of Awareness



7.4.3 Motivations for Participation

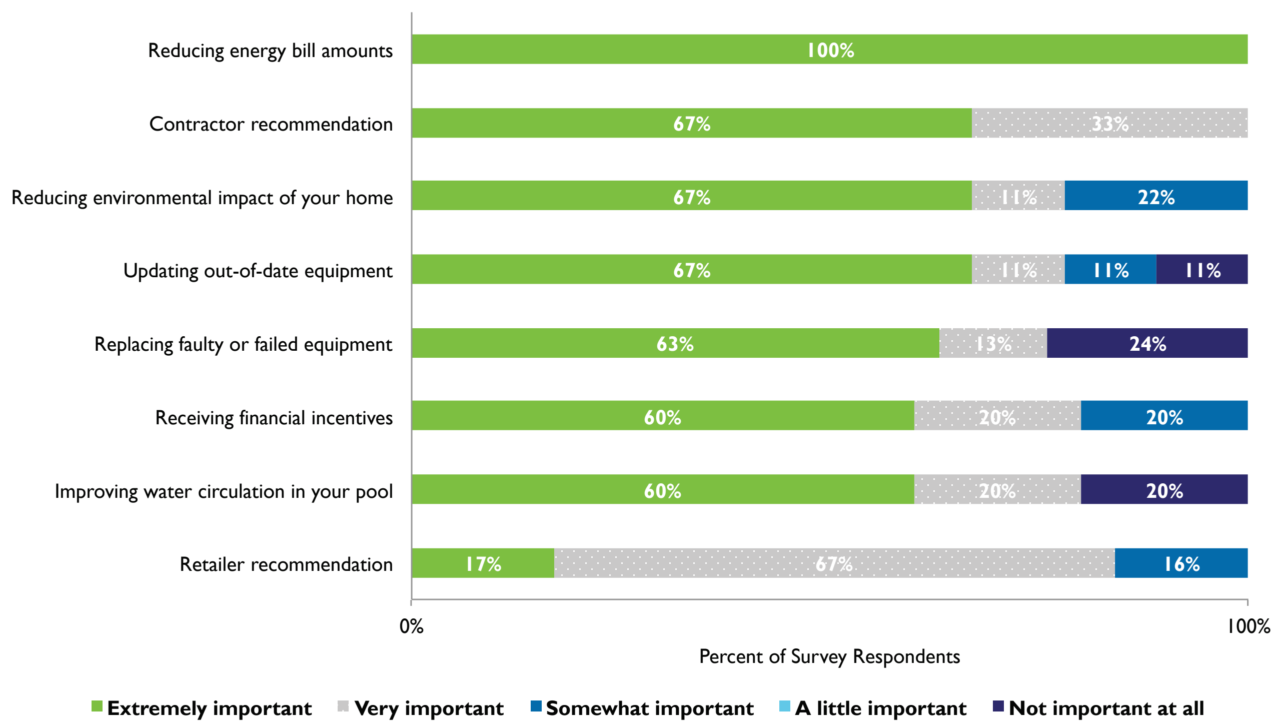
Respondents were asked to rate a variety of factors that might have influenced their decision to participate in the incentive program. Among sub-program participants who received cooling measures, improving comfort of the home and replacing faulty or failed equipment were the two most important factors, with 74 percent of respondents reporting that both of these factors were extremely important in their decisions to participate in the program (Figure 34). Upgrading out-of-date equipment was also important among cooling survey respondents, with 69 percent reporting that it was "extremely important."

Figure 34: Cooling Participants Motivations for Participation (n=50)



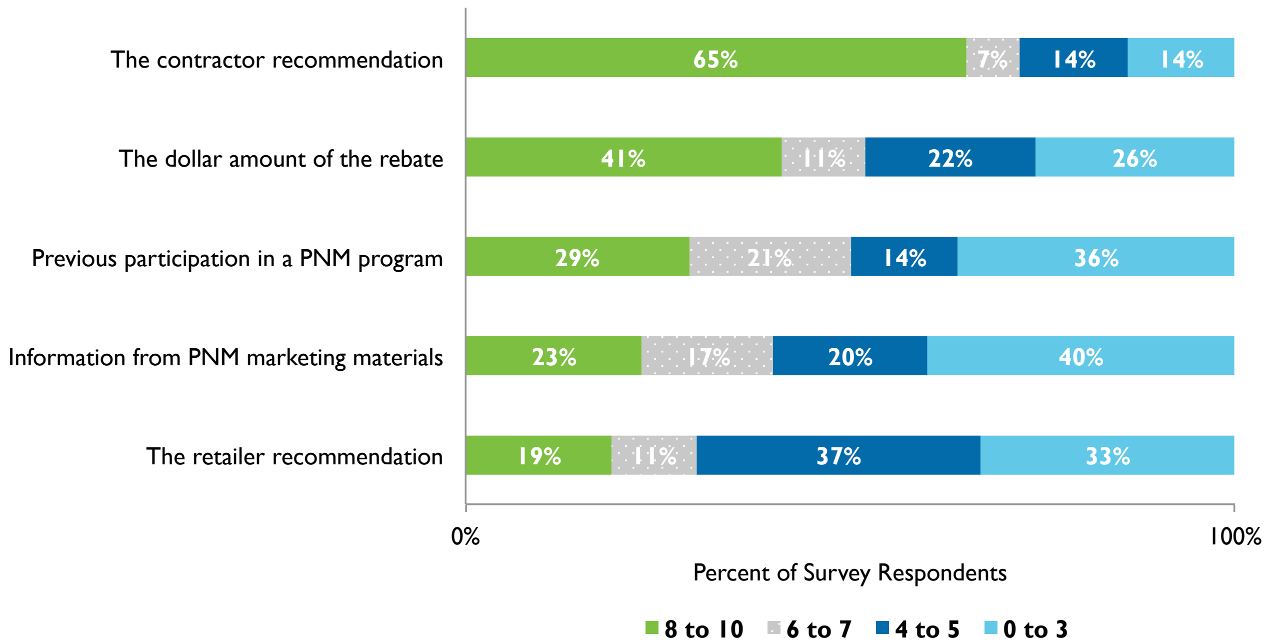
Among survey respondents who received a pool pump, reducing their energy bill was the most important factor with all 10 survey respondents reporting that it was "extremely important" in their decision to participate in the program (Figure 35). The motivating factor with the fewest responses of "extremely important" was the retailer recommendation, likely because it was not a large source of awareness about the program.

Figure 35: Pool Pump Participants Motivations for Participation (n=10)



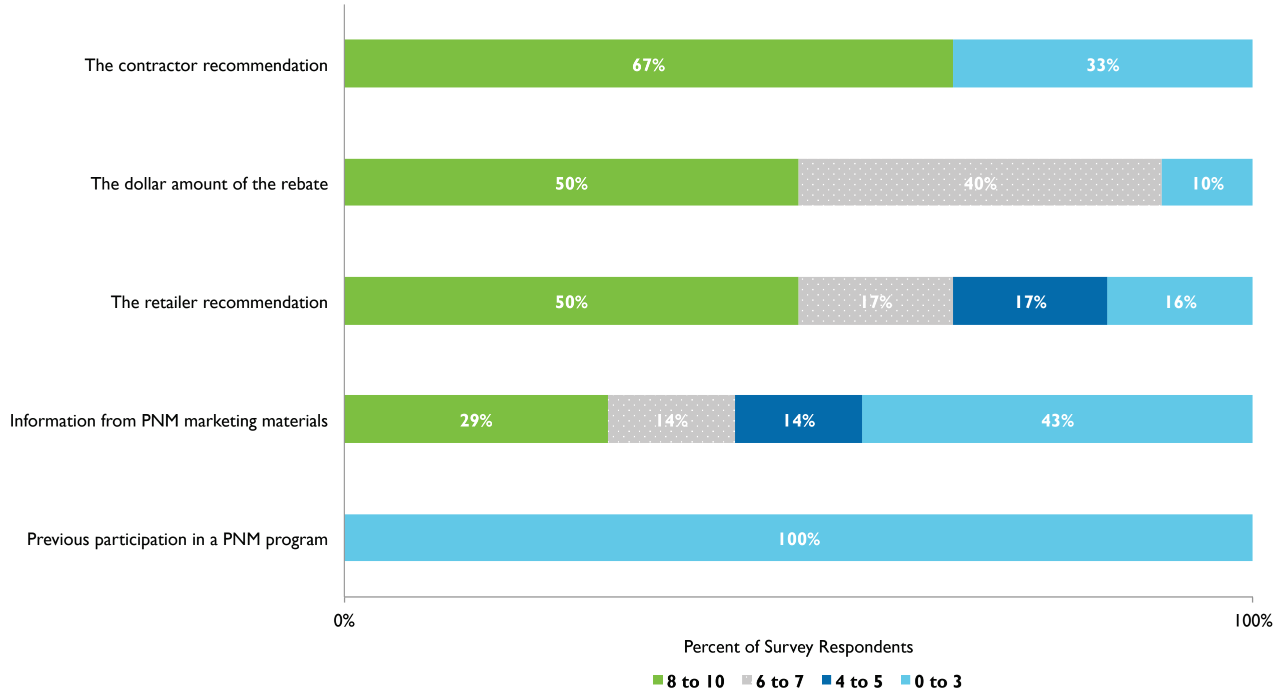
In addition to motivations for participating, survey respondents were given a list of potential program factors that may have influenced their decision about how energy efficient their equipment would be and were then asked to rate their influence on a 0 to 10 scale.[21] As shown in Figure 36 and Figure 37, the majority of both cooling (65%) and pool pump (67%) participants rated the contractor recommendation as "extremely important" (ratings of 8 to 10) in their decision to make the efficiency upgrade. Consistent with what is shown in Figure 35, the financial incentive and the retailer recommendation was more influential in the pool pumps participants' decision about how energy efficient their equipment would be.

Figure 36: Cooling Participants Influence of Program Factors (n=49)



[21] On the 0 to 10 point scale, 0 indicated 'not at all influential' and 10 indicated 'extremely influential'.

Figure 37: Pool Pump Participants Influence of Program Factors (n=10)



7.4.4 Participant Satisfaction

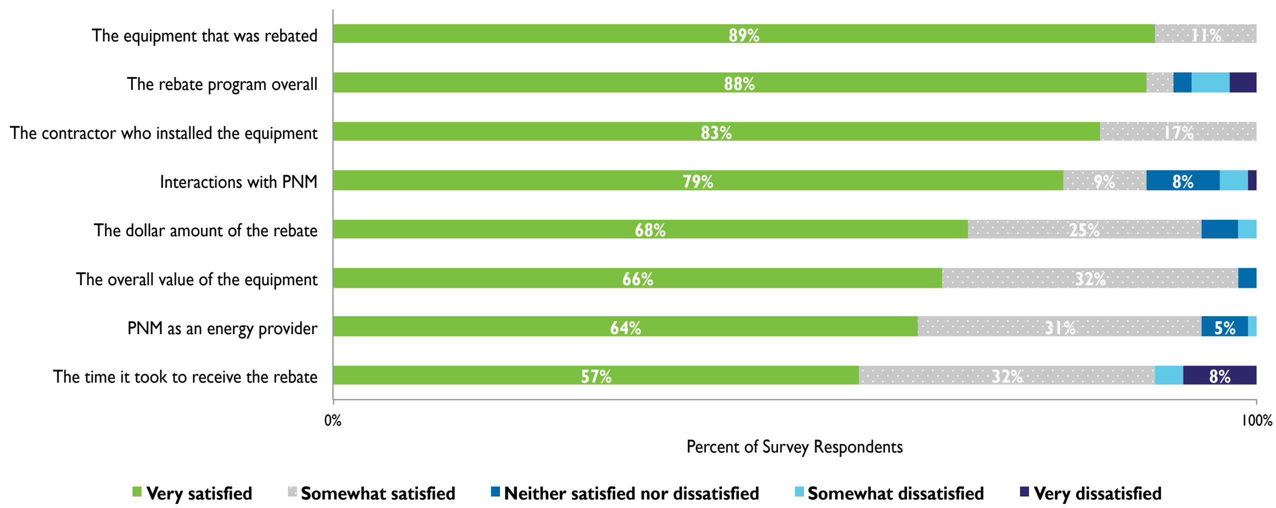
Survey respondents evaluated their satisfaction with various components of the Cooling and Pool Pumps sub-program, and more broadly PNM as an energy provider, on the following scale: very satisfied, somewhat satisfied, neither satisfied nor dissatisfied, somewhat dissatisfied, and very dissatisfied. The individual components that participants were asked to rank their satisfaction with included:

- PNM as an energy provider
- The rebate program overall
- The rebated equipment
- The installation contractor
- The time it took to receive the rebate
- The dollar amount of the rebate
- Interactions with PNM
- The overall value of the equipment for the price they paid

Figure 38 and Figure 39 below summarize the satisfaction levels for Cooling and Pool Pumps participants.

Overall, surveyed program participants' expressed high levels of satisfaction with the Cooling and Pool Pumps sub-program components. As shown in Figure 38, survey respondents that installed cooling equipment expressed high levels of satisfaction across each individual program component, with the majority reporting being "very satisfied." A small percentage of cooling participants reported lower satisfaction ratings, primarily with the time it took to receive the rebate.

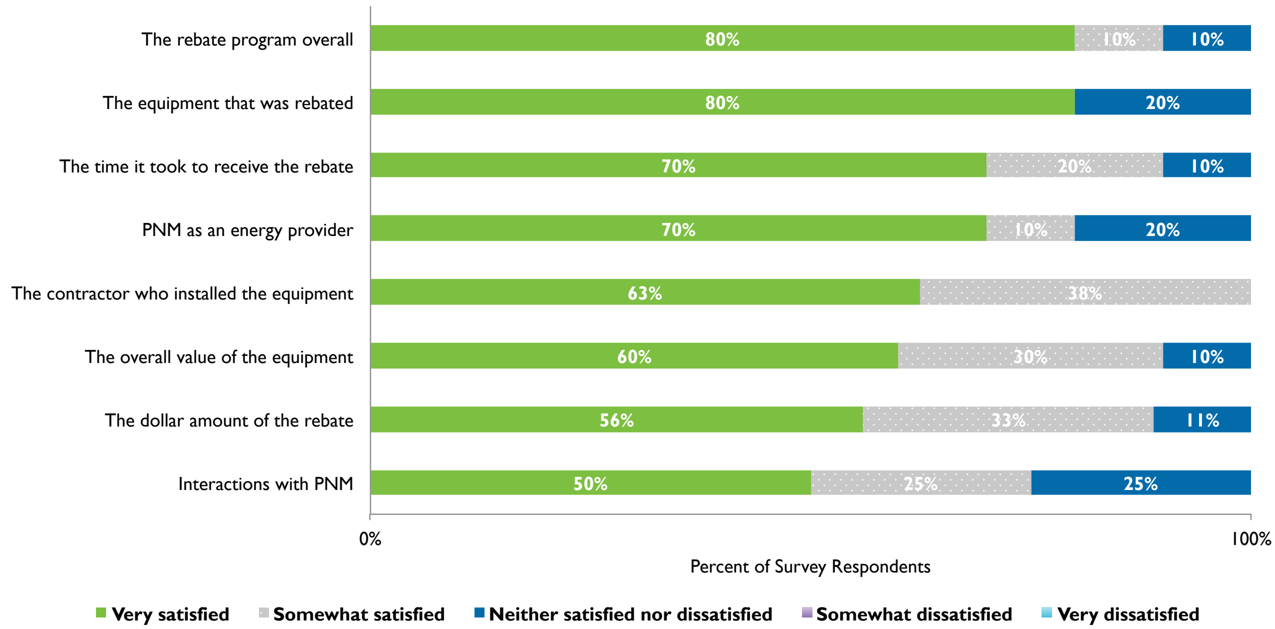
Figure 38: Cooling Participant Program Satisfaction (n=50)



As shown in Figure 39, participants that installed pool pumps also expressed high levels of satisfaction, with the majority of participants reporting ratings of "very satisfied" across all but one program component. Eighty percent of participants reported being "very satisfied" with the rebate program overall and with the equipment that was rebated. Interactions with PNM received the lowest satisfaction rating (but still satisfied), with 75 percent reporting they were "very satisfied" or "somewhat satisfied."

Some of the justifications pool pump participants provided for their low satisfaction ratings were related to not yet receiving their rebates.

Figure 39: Pool Pump Participant Program Satisfaction (n=10)



7.5 Cooling and Pool Pumps Contractor Interviews

The evaluation team completed five interviews with contractors who installed equipment in the 2018 Residential Comprehensive program. For this evaluation round, the team concentrated on the residential Cooling and Pool Pumps sub-program. The interviews focused on the following topics:

- Contractor background and program involvement;
- Program satisfaction; and
- Role and influence of the PNM program in the market.

Due to the low number of interviews and the depth of discussion, this section presents results in a qualitative fashion to show the range of perceptions and responses.

7.5.1 Contractor Background and Program Involvement

The interviewed contractors appeared to be mostly mid-sized businesses with a local or regional focus and work in both the residential and commercial sectors. They learned of the PNM program from the utility (and in one case from a customer). All seek to complete required rebate paperwork to make participation as easy as possible for their customers, but have not had much need for contact with PNM or the program implementation contractor.

Participating residential contractors' cross-sector work offers opportunities for cross-program promotion of PNM's offers for commercial customers to residential contractors if such promotion is not already offered.

7.5.2 Program Satisfaction

All interviewed contractors expressed high satisfaction with the Cooling and Pool Pumps sub-program, unilaterally rating it a 5 on a 1 to 5-point scale.[22]

Contractors felt that the program information was clear and the rebate process worked well (or was easy enough to get used to). Nevertheless, contractors did identify areas of potential improvement or ideas they wish PNM would consider. These included:

- ***Providing more advance notice before making program changes***—Two contractors spoke of having been negatively affected by a sudden change in program offers that they were counting on and communicating to customers.
- ***More marketing by PNM to customers***— Contractors appear to be the conduit through which customers find out about rebates; one contractor commented that it would be helpful if PNM did more marketing on its end to help drive interest and offered somewhat more outreach and program information to contractors. (Along similar lines, a contractor commented that the briefing at the Central New Mexico Community College Workforce Training Center was good, and he would definitely attend again.)[23]

7.5.3 PNM Program Influence

To better understand the program influence on the market, the evaluation team explored how and when contractors communicate about the PNM rebates with customers and what role they play in the contractors' and customers' ultimate choices.

The interviewed contractors generally do feature efficient equipment that qualifies for the rebate more prominently in offers and quotes to customers, thereby increasing customer exposure. However, the contractors expressed varied opinions about the degree to which the rebates affect customer choices and efficiency levels being installed. Two contractors expressed confidence that the rebates help push customers to higher efficiency levels (for one) or avoid low-end equipment with poor efficiency (for the other). Two others talked generally about the sales benefit of being able to offer rebates. A fifth contractor called the

[22] The 1 to 5-point scale defined a 5 as "very satisfied."

[23] CLEAResult, the program implementer, noted that they held over a dozen "Lunch & Learn" events for contractors, but this event at the Central New Mexico Community College Workforce Training Center was not one of them. The contractor that mentioned this event may have been thinking of a different program they are involved in.

rebates “free money.” All contractors agreed that the rebates increase customer satisfaction in the process.

These results are based on a small number of interviews, however, and should be seen as informing the utility’s understanding of *how* the program influences the market and not *how much*. It would take more research to determine how widespread these dynamics are or to measure market effect quantitatively.

8 New Home Construction Program

8.1 New Home Construction Gross Impacts

The *ex ante* 2018 impacts are summarized in Table 30 for the New Home Construction program. In total, the New Home Construction program accounted for 1.4 percent of energy impacts in PNM's overall portfolio.

Table 30: New Home Construction Savings Summary

Program	# of Projects	Expected Gross kWh Savings	Expected Gross kW Savings
New Home Construction	702	1,321,909	526

The gross impact evaluation activities included engineering desk reviews of a sample of Performance projects and a deemed savings review of prescriptive projects. For the desk reviews, the sample was stratified based on total energy savings for each Performance project. The final sample design is shown in Table 31. The resulting sample achieved a relative precision of 90/2 overall for Performance New Home Construction projects.

Table 31: New Home Construction Desk Review Sample

Project Type	Stratum	Count	Average kWh	Total kWh Savings	% of Savings	Final Sample
Performance	1	100	3,110	310,956	26.05%	5
Performance	2	134	2,194	293,951	24.62%	5
Performance	3	158	1,864	294,466	24.66%	5
Performance	4	204	1,444	294,497	24.67%	5
Total		**596**		**1,193,870**	**100%**	**20**

As discussed in the *Evaluation Methods* chapter, gross realized impacts for the New Home Construction program were determined by performing engineering desk reviews on the sample of Performance projects and a deemed savings review for prescriptive projects.

For Performance projects, the project savings were verified using the REM/Rate Fuel Summary Reports. Modeled HVAC equipment was checked against provided AHRI certificates. However, other aspects of the model (e.g., walls, windows, insulation) were not documented, and so were assumed to be consistent with the installed equipment. We recommend that PNM include pictures of installed HVAC equipment model numbers and specifications/cutsheets for insulation to help confirm model accuracy.

For Performance projects, engineering adjustment factors that varied from 100 percent were mainly the result of adjustments the evaluation team made to the modeled heating and cooling equipment capacities. For multiple projects, the evaluation team modified the modeled heating and cooling capacities to match the unit-specific information shown on the AHRI certificates that PNM provided for each project. Making these adjustments and re-running the models resulted in increased savings estimates and decreased savings estimates for projects.

For prescriptive projects, we were able confirm the source of savings, calculations, and input assumptions for the majority of measures. For measures where we did not have enough information on the input assumptions to replicate the calculations, we confirmed that the per-unit values were within a reasonable range for the type of measure. As a result, we did not make any adjustments to savings for prescriptive projects. In the future, we recommend that PNM clearly and consistently document the source of deemed savings, formulas used to calculate deemed savings, and all input assumptions for those calculations in order to facilitate evaluator review of savings values.

Table 32 and Table 33 show the summary results of the desk reviews and deemed savings review and how the resulting engineering adjustments were used to calculated realized savings. For the New Home Construction program overall, these adjustments resulted in an engineering adjustment factor of 1.0338 for kWh and 1.0295 for kW.

Table 32: PY2018 New Home Construction Gross kWh Impact Summary

Program	# of Projects	Expected Gross kWh Savings	Engineering Adjustment Factor	Realized Gross kWh Savings
New Home Construction	702	1,321,909	1.0338	1,366,545

Table 33: PY2018 New Home Construction Gross kW Impact Summary

Program	# of Projects	Expected Gross kW Savings	Engineering Adjustment Factor	Realized Gross kW Savings
New Home Construction	702	526	1.0295	542

A summary of the individual desk review findings for each of the 20 projects is included in Appendix J.

8.2 New Home Construction Net Impacts

Net impacts for the New Home Construction program were calculated using the *ex ante* NTG ratio. The evaluation team conducted interviews with participating homebuilders, and asked them a series of questions to determine how the program has influenced their home building practices and decisions to include efficient equipment and envelope for those homes. The responses from these interviews generally indicated that the rebates offered by PNM are influential in the decision to build energy efficient homes, but that some builders would be making some of these upgrades anyway. We believe the *ex ante* NTG ratio of 0.80 is still a reasonable estimate of the impacts of the program on builders' decisions to incorporate efficient options into their homes.

Table 34 and Table 35 summarize the PY2018 net impacts for the Commercial Comprehensive program using the NTG ratios described above. Net realized savings for the program overall are 1,093,236 kWh, and net realized demand savings are 433 kW.

Table 34: PY2018 New Home Construction Net kWh Impact Summary

Program	# of Projects	Realized Gross kWh Savings	NTG Ratio	Realized Net kWh Savings
New Home Construction	702	1,366,545	0.8000	1,093,236

Table 35: PY2018 New Home Construction Net kW Impact Summary

Program	# of Projects	Realized Gross kW Savings	NTG Ratio	Realized Net kW Savings
New Home Construction	702	542	0.8000	433

8.3 New Home Construction Builder Interviews

The evaluation team completed a total of 11 interviews with home builder participants of the New Homes programs across the three New Mexico utilities that offer a New Homes program: PNM, El Paso Electric, and New Mexico Gas Company. Of these 11 home builders, seven had received rebates from PNM for efficiency upgrades through the New Home Construction program. The interviews focused on the following topics:

- Project context and background;
- Role and influence of the PNM New Home Construction program; and
- Program satisfaction.

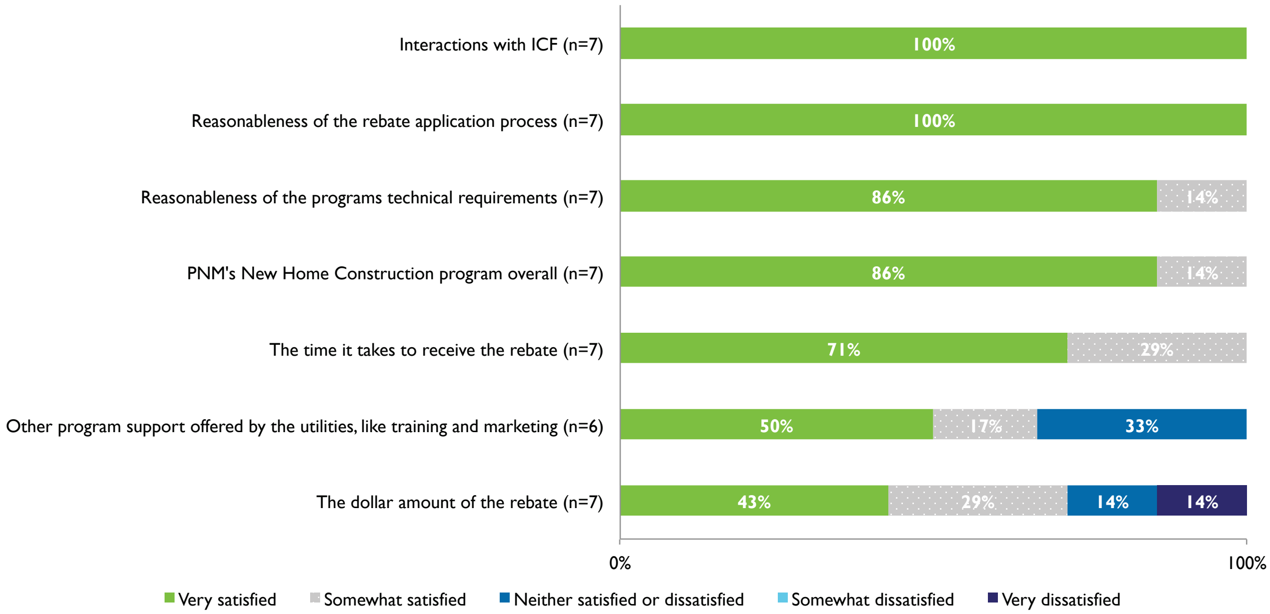
Participants were categorized into three groups based on of the number of projects completed through all of the New Mexico utilities' New Homes programs in 2018: lightly active (1 to 12 projects), moderately active (13 to 100 projects), and highly active (more than 100 projects). The evaluation team interviewed six moderately active firms and five lightly active firms. Six of the seven PNM respondents had completed more than one project through the New Home Construction program, including two builders with experience across more than 50 completed projects. While respondents had varying levels of interaction with the New Home Construction program directly, all seven were familiar with the eligible projects and played a significant role in their business's participation in the program.

8.3.1 Program Satisfaction

New Home Construction interviewees were asked a series of questions to quantify their level of satisfaction with various components of the program using a 1 to 5 point scale, where 1 meant "very dissatisfied" and 5 meant "very satisfied".

Satisfaction with the New Home Construction program was high, but one participant commented on the dollar amount of the rebate being low. As shown in Figure 40 below, all seven PNM builder interviewees said they were "very satisfied" with their interactions with ICF and the reasonableness of the rebate application process. The lowest satisfaction ratings, on average, were for the program support offered, including training and marketing, and the dollar amount of the rebate. However, the two interviewees that gave a rating of "neither satisfied or dissatisfied" for training and marketing reported that it was due to their firm not utilizing what the program offered. For the low satisfaction ratings related to the rebate amount, interviewees said this was because they believe the rebate amounts were too low, which is not an uncommon response to this question.

Figure 40: New Home Construction Program Builder Satisfaction



Participating builders described the New Home Construction program as being moderately influential on the scope of the energy efficiency level to which they built their homes, although some degree of upgrade would likely have happened for each of these builders even in the absence of the program offerings. The degree of program influence varied:

- For four of the seven builders, the New Home Construction program rebates were extremely important in determining the Home Energy Rating (HER) levels they built to overall or on the HVAC equipment, lighting, refrigeration, and insulation they included in the homes they built.
- Interviewees from the other firms claimed they would have built to similar, if not the exact same, energy efficiency levels in the absence of the program. However, the majority of interviewees reported that the rebates provided through the program were a great add-on to what they were already doing.

9 Large Customer Self-Direct Program

To evaluate the impacts of the Large Customer Self-Direct program, the evaluation team conducted an engineering desk review of the savings documentation for the one self-direct project that was completed in 2018. The gross claimed savings for this program in PY2018 were 282,523 kWh and 38 kW. The supporting documentation for the self-direct project was an engineering study completed by the participant. The study included a brief project description, calculation of savings, invoices, and specification documents of the lighting fixtures installed. The study did not provide sufficient documentation of the assumed lighting hours of use in the pre- and post-installation periods. The evaluation team deferred to the New Mexico TRM for lighting hours of use, resulting in increased savings. As a result, the engineering adjustment factors were 1.4294 for kWh and 1.1762 for kW.

We recommend that Large Customer Self-Direct participants provide documentation of hours of use for lighting projects, including a daily lighting schedule that can be used to calculate peak coincident demand savings.

The net impacts for this program were calculated using an NTG ratio of 1, since the savings from this program already reflect the net program influence. As a result, the net realized savings for the Large Customer Self-Direct program are 403,843 kWh and 44 kW.

Additionally, the evaluation team calculated the simple payback period of the project, as the New Mexico Energy Efficiency Rule requires that self-directed projects have a simple payback period of more than one year but less than seven years. We found that the Large Customer Self-Direct project had a simple payback period of 4.0 years, which meets the NMPRC requirement.

10 Power Saver Program

PNM's Power Saver program is a direct load control program offered to residential, small commercial (under 50 kW), and medium commercial (50 kW to 150 kW) customers. To facilitate load control, participants must have a device attached to the exterior of their air conditioning unit; this device is capable of receiving a radio signal that will turn off the unit's compressor for an interval of time. Such signals are typically sent on the hottest weekday afternoons of the summer, with the goal being to reduce peak demand. Residential and small commercial participants receive an annual $25 incentive for their participation. Medium commercial participants receive an annual incentive of $9 per ton of refrigerated air conditioning.

There were twelve Power Saver events during the summer 2018 demand response season, which began June 1st and ended September 30th. Table 36 summarizes the results of the Power Saver impact analysis, with a detailed discussion of the analysis methods and results included in Appendix G.

The main driver in the difference between Itron's and the Evergreen evaluation team's load reduction estimates is that Itron commonly summarized impacts with the maximum impact within a time period (i.e., the largest 5-minute impact in a one-hour interval is the impact for that hour), whereas the evaluation team summarized impacts with an average. Multiplying our per-device reduction estimates by the number of devices in each class (shown in Table 36) leads to a 2018 average total estimated load reduction of approximately 24.8 MW, 3.0 MW, and 1.0 MW in the residential, small commercial, and medium commercial customer classes respectively. In aggregate, the average total estimated load reduction capability is 28.7 MW. This is approximately 66 percent of Itron's estimate (43.3 MW). With an 85 percent adjustment for residential operability, the aggregate evaluation-calculated impacts are 25.0 MW.

The evaluation team used Power Saver results from 2015-2018 to estimate the load relief capability under extreme conditions. We estimate the program is capable of delivering 30.3 MW of load reduction under planning conditions of 100° F between 5:00 p.m. and 6:00 p.m. MDT, of which 27.1 MW comes from the residential class and 1.9 MW and 1.3 MW come from small and medium commercial customers, respectively. Factoring in the operability adjustment, the aggregate program can provide 26.3 MW of load relief.

Table 36: High Level Results

		Unit	Residential Measured	Residential Operability Adjusted	Small Comm.	Medium Comm.
Number of Devices Installed		#	37,131	37,131	3,705	2,887
Itron	5-year Rolling Average kW Factor	kW per device	0.89[24]		1.29	0.96
		MW Aggregate	33.05		4.78	2.77
	2018 Load Reduction Estimate	kW per device	0.93	0.79	1.88	0.61
		MW Aggregate	34.53	29.33	6.97	1.76[25]
Evergreen	2018 Load Reduction Estimate	kW per device	0.67	0.57	0.80	0.33
		MW Aggregate	24.75	21.04	2.96	0.96
	Ex Ante Load Reduction Estimate[26]	kW per device	0.73	0.62	0.52	0.45
		MW Aggregate	27.11	23.04	1.93	1.30
	2018 Energy Savings	kWh per device	14.73	12.52	12.27	16.07
		MWh Aggregate	546.94	464.90	45.46	46.39

A detailed discussion of the impact estimation methods and results for each Power Saver customer class group is included in Appendix G.

[24] The adjustment for operability was only added for Itron's 2018 study. The 2018 kW factor includes a rolling average per-device result for 2014-2018, including an 85 percent adjustment for the 2018 value.

[25] To convert between a per-facility and per-device impact for the medium commercial customers, Itron applied an average of the event day ratios between the number of active facilities and the active number of devices for each day, This is why the per device impact, scaled up by the average number of devices per facility and the Itron-reported per-facility impact do not match. That is, Itron reports a per-facility impact of 5.61kW, but 2,887 devices across 416 facilities yields a per-facility impact of (2,887/416) x 0.61 = 4.23kW. This difference is simply due to the changing ratio of devices to facilities across the summer.

[26] *Ex ante* program capability is reported in the 5:00 p.m.- 6:00 p.m. MDT hour at 100°F. PNM's system peaked during that hour on July 23, 2018.

11 Peak Saver Program

Our estimates of the Peak Saver impacts and the achievements relative to the performance metrics are discussed below. Based on our review of the customer baseline (CBL) methodology used to generate Enbala's baselines and impact estimates, we calculated these values (and the performance metrics they feed into) using an adjusted CBL methodology:

- The adjustment factor is symmetric, meaning it can increase or decrease baselines, rather than only serving to increase baselines;
- The adjustment factor is capped at 20 percent rather than uncapped;
- The adjustment factor is only applied to sites that (1) have weather sensitive loads, (2) do not have solar power, and (3) do not pre-pump prior to demand response events; and
- The 3-of-5 baseline days are selected based on average load during the event window rather than a maximum 15-minute kW reading.

Regarding weather sensitive loads, the Evergreen team estimated weather sensitivity at each site by assessing the relationship between daytime load and temperature. Sites were considered to be weather sensitive if (1) temperature was found to be a statistically significant predictor of load, and (2) temperature could explain at least 10 percent of the variation in load. Only 20 of the 87 sites met these criteria.

11.1 Performance Metrics

After calculating adjusted baselines and adjusted impacts, the Evergreen team calculated participant performance metrics in a manner identical to the manner in which Enbala did so, with one exception: we did not zero out negative performances. The number of participants with negative verified capacity performance ranged from 13 (July 19th) to 23 (June 22nd).

The results of the Evergreen team's 2018 Peak Saver Demand Response evaluation are shown in Table 37. Our findings indicate the Peak Saver program is approximately a 15 to 18 MW capacity resource. On average, the verified capacity performance estimates using the Evergreen methodology are 59 percent of the values calculated by Enbala using the settlement CBL.

The final column of Table 37 presents the daily energy savings. This is the aggregate difference between energy use on an event day and the baseline for all post-notification hours including the event. Comparing the capacity performance, energy savings during the event, and the daily energy savings helps illustrate the extent to which event load was shifted to other hours. On average, aggregate energy use decreased by 42.4 MWh on event days (though the hours outside the event saw a 15 MWh increase relative to the average non-event day).

Table 37: Evaluated Performance Summary by Event

Event Date	10-Minute Capacity Performance (kW)	Average Capacity Performance (kW)	Verified Capacity Performance (kW)	Energy Performance (kWh)	Daily Energy Savings (kWh)
6/7/2018	17,487	10,018	13,006	42,844	57,422
6/12/2018	14,721	12,538	13,411	61,006	424
6/21/2018	22,376	18,588	20,103	75,038	81,909
6/22/2018	17,530	17,559	17,547	71,094	70,090
6/25/2018	17,142	10,020	12,869	50,307	8,189
6/27/2018	19,531	16,529	17,729	67,048	66,197
7/18/2018	15,552	11,517	13,131	51,536	17,108
7/19/2018	22,283	17,409	19,358	71,695	45,640
7/20/2018	20,183	19,391	19,708	78,864	85,748
7/25/2018	21,680	12,663	16,270	52,087	38,601
7/26/2018	12,247	12,028	12,115	37,766	62,113
8/7/2018	9,960	5,599	7,343	29,166	-24,468
Average	**17,558**	**13,655**	**15,216**	**57,371**	**42,414**

11.2 Comparing Performance and Commitments

After calculating verified performance metrics, the Evergreen team compared verified performance with the kW commitments (or "nominations") from each participant. Figure 41 shows a histogram of percent differences. These percent differences were calculated as follows:

$$Percent\ Difference = 100 * \frac{(Verified\ Reduction - Nominated\ Reduction)}{Nominated\ Reduction}$$

Thus, instances where actual reductions do not exceed nominated reductions result in negative percent differences, and vice-versa. The majority of the distribution falls below zero, implying that most sites did not achieve their nominated load reduction on most event days.

Figure 41: Distribution of Percent Differences

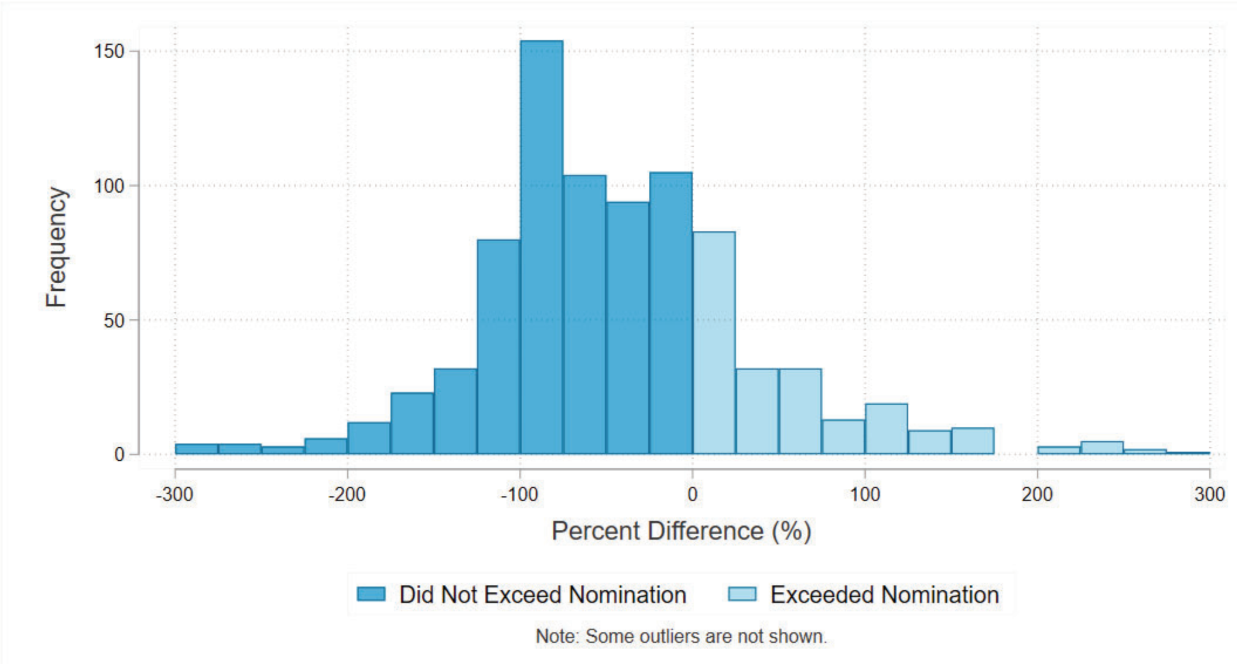


Figure 42 shows, on average, what percentage of their nomination each site achieved. Only 15 sites had an average verified performance that exceeded their average nomination. Eight others averaged negative performances (load actually exceeded baseline) on all 12 events. These eight sites were mostly schools with solar PV. It is possible that they did actually reduce demand, but the program metering configuration, which does not record exports, cannot capture increased exports—and only records zero utility-supplied load. The eight sites that averaged negative performances are not included in the figure. A reference line is drawn at 100 percent; sites below this line did not meet their nomination, on average. The four largest sites (in terms of nomination and average load) fell below the 100 percent reference line. These sites are denoted in the figure with gray bars rather than blue. These four sites drive overall program results since they make up 72 percent of the total demand response nominations.

Figure 42: Average Performance by Site

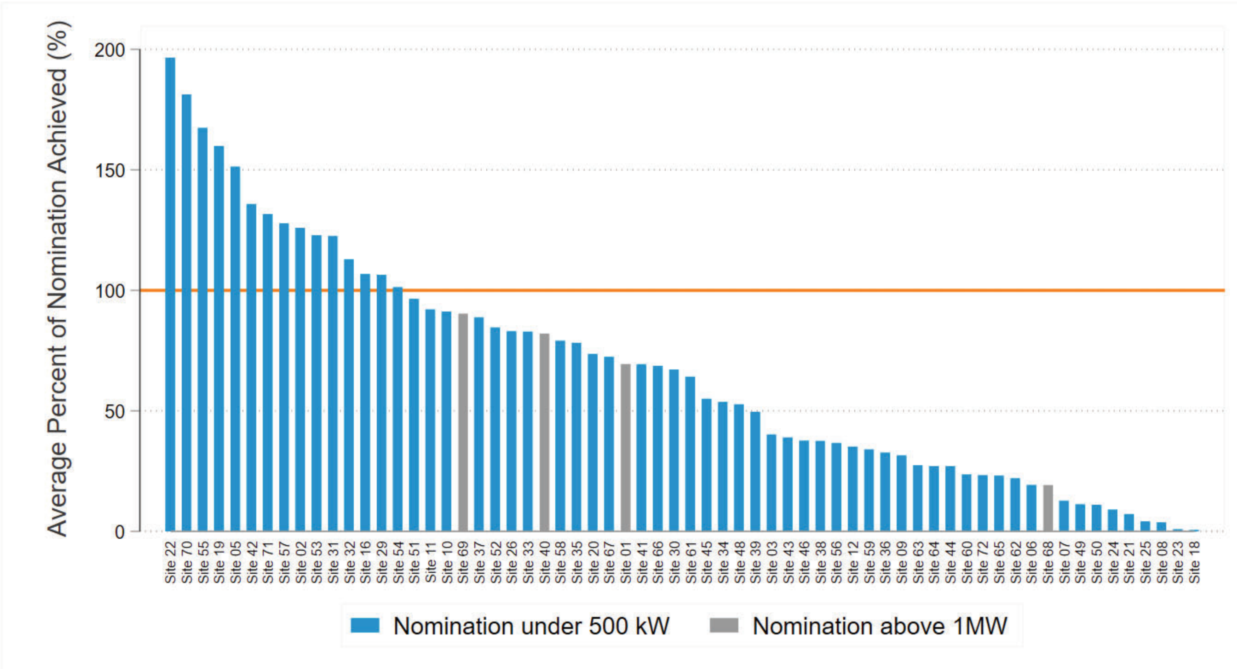
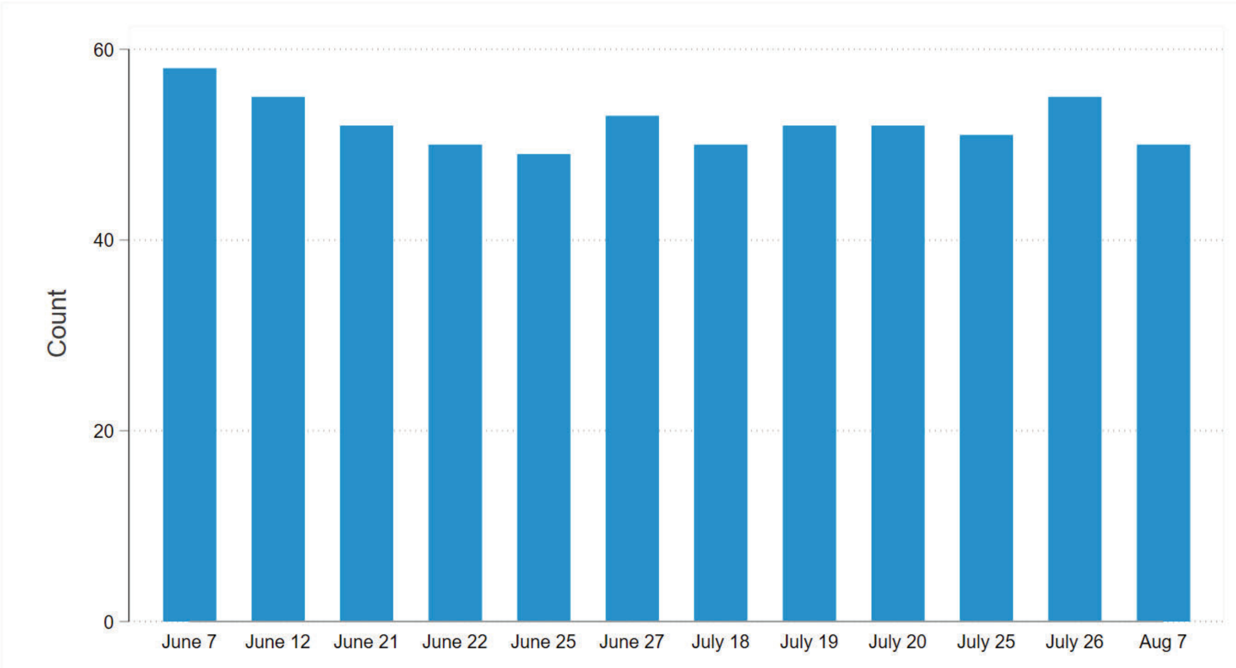


Figure 43 shows the number of sites failing to achieve their nomination by event day. On aggregate, average per-event nominations exceeded 22 MW (22.4 MW for June events, 22.7 MW for July events, and 17 MW for the single August event). Across event days, aggregate reductions fell short of nominated reductions for an average of 52 out of the 73 sites.[27] The greatest number of sites achieved their nomination on June 25th, but even then, 49 sites still failed to do so. On June 7th, 58 sites failed to meet their nomination, making it the worst day in terms of achieving nominations.

[27] Elsewhere, the number of participants was listed as 86. At some sites, nominations are aggregated across multiple locations.

Figure 43: Participants That Did Not Exceed Nomination, by Event Date



Additional detail on the impact estimation methods and results for the Peak Saver program are included in Appendix H.

12 Cost Effectiveness Results

The evaluation team calculated cost effectiveness using the Utility Cost Test (UCT) for each individual PNM energy efficiency and demand response program, as well as the cost effectiveness of the entire portfolio of programs.[28] The evaluation team conducted these tests in a manner consistent with the California Energy Efficiency Policy Manual.[29]

Cost effectiveness tests compare relative benefits and costs from different perspectives. The specific cost effectiveness test used in this evaluation, the UCT, compares the benefits and costs to the utility or program administrator implementing the program. The UCT explicitly accounts for the benefits and costs shown in Table 38.

Table 38: Utility Cost Test Benefits and Costs

Benefits	Costs
• Utility avoided energy-related costs • Utility avoided capacity-related costs, including generation, transmission, and distribution	• Program overhead/administrative costs • Utility incentive costs • Utility installation costs

Using net realized savings from this evaluation and cost information provided by PNM, the evaluation team calculated the ratio of benefits to costs for each of PNM's programs and for the portfolio overall. The results of the UCT are shown below in Table 39. All programs except Power Saver and Peak Saver had a UCT of greater than 1.00, and the portfolio overall was found to have a UCT ratio of 1.71.

[28] The Utility Cost Test is sometimes referred to as the Program Administrator Cost Test, or PACT.

[29] http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy_-_Electricity_and_Natural_Gas/EEPolicyManualV5forPDF.pdf

Table 39: PY2018 Cost Effectiveness

Program	Utility Cost Test (UCT)
Commercial Comprehensive	2.08
Residential Lighting	3.42
Home Works	2.09
Energy Smart	1.03
Residential Comprehensive	1.56
Easy Savings Kit	2.54
New Home Construction	2.26
Power Saver	0.85
Peak Saver	0.94
Overall Portfolio	**1.71**

13 Conclusions and Recommendations

Based on the results from the data collection and analysis methods described in the previous chapters, the evaluation team has developed a number of conclusions and associated recommendations to improve PNM's programs. These are organized below by program.

13.1 Commercial Comprehensive

Impact evaluation activities for the Commercial Comprehensive program included engineering desk reviews for a sample of the Retrofit Rebate, Quick Saver, Building Tune-Up, Midstream, Multifamily, and New Construction sub-programs. A subset of sampled projects also received a site visit by an evaluation engineer. Based on these desk reviews and site visits, an engineering adjustment factor of 0.9695 was found for kWh savings, and 0.9654 was found for kW savings. Conclusions and recommendations resulting from these reviews are discussed below:

- Project-specific *ex ante* calculation steps for prescriptive projects were not documented in the files available for the evaluation team's review.
    - Using inputs from the provided project documents and algorithms from the PNM Workpapers resulted in savings different (both higher and lower) than those reported by PNM for multiple projects.
    - Without additional documentation of the project-specific calculations performed by PNM, the reasons for differences between reported and verified savings were not always clear to the evaluation team.
    - **Recommendation 1:** Provide documentation of calculation steps made for each project, ensuring that submitted project documentation can be followed to reproduce the reported savings estimates.
- Information gathered through the evaluation team's on-site verification was used to adjust the *ex ante* calculations. Parameters that were adjusted include duct leakage rates, light fixture wattages, and proportions of common areas versus dwelling units used to determine weighted average hours of use.
    - **Recommendation 2:** Site-specific information should be used whenever possible to determine inputs for savings algorithms. Key parameters should be verified through M&V when possible and adjusted accordingly.
- The evaluation team adjusted the lighting hours of use for multiple projects.
    - PNM calculated annual lighting hours for Quick Saver projects by multiplying the estimated weekly hours by 52. The evaluation team refined these estimates by multiplying the weekly hours by 365/7, leading to a slight increase in annual hours, and thus annual savings.

- For exterior light fixtures that operate from dusk to dawn, the evaluation team updated the annual hours of use to 4,192 hours per dusk-to-dawn calculations created by the evaluation team based on New Mexico-specific daylight data. This value is higher than the 4,100 hours listed in the PNM Workpapers, which is based on the 2016 version of the New Mexico TRM and is lower than the value of 84 hours per week used for multiple Quick Saver projects.
    - **Recommendation 3:** Refine the calculation of lighting hours by accounting for the actual number of weeks in a year.
    - **Recommendation 4:** Use 4,192 hours per year for lights that operate on a dusk-to-dawn schedule.
- The evaluation team verified installed light fixture wattages using DesignLights Consortium (DLC) certificates when possible. For some fixtures, the wattage used in the *ex ante* calculations did not match the wattage shown on the DLC certificate. In these cases, the evaluation team deferred to the value shown on the DLC certificate.
    - **Recommendation 5:** Verify fixture wattages using DLC certificates when possible and defer to DLC certificate values over manufacturer-provided values.
- The evaluation team found projects that claimed peak demand savings for light fixtures that operate on a dusk-to-dawn schedule. As these fixtures are not on during the afternoon peak demand period, the evaluation team set the demand savings for these fixtures as zero.
    - **Recommendation 6:** Zero out peak demand savings for light fixtures that operate on a dusk-to-dawn schedule.
- HVAC interactive factors for lighting projects are dependent on the project location. The evaluation team found lighting projects with calculated savings using the HVAC interactive factors for Albuquerque but that were located closer to Santa Fe. The evaluation team adjusted the HVAC interactive factors accordingly to use the values for Santa Fe.
    - **Recommendation 7:** Reference the New Mexico TRM to determine the appropriate representative climate city for different counties and use HVAC interactive factors corresponding to the appropriate reference city.
- For certain projects, based on the available information, the evaluation team judged the appropriate building type classification to differ from the building type assumed in the *ex ante* calculations. The evaluation team updated key parameters, such as lighting hours of use and HVAC interactive factors, based on the revised building type.

- **Recommendation 8:** Ensure that all building type options are considered and that the most appropriate option is selected for each project based on all available project information.

- The evaluation team adjusted the savings calculations for chiller projects.
  - Per the PNM Workpapers, PNM used Integrated Part Load Value (IPLV) ratings to calculate both energy and demand savings for chillers. However, it is more appropriate to use full-load efficiency ratings when calculating peak demand reductions. The evaluation team used full-load efficiency ratings to calculate chiller demand reductions.
  - The evaluation team identified an error in how the PNM Workpaper spreadsheet calculates the "bonus" savings beyond the minimum-qualifying chiller efficiency. The bonus demand reduction should be calculated as the *total high-efficiency demand reduction* minus *the minimum-qualifying demand reduction*. However, the Workpaper equation is written as *the qualifying efficiency* minus *the total high-efficiency demand reduction*, which leads to an overstatement of bonus savings. This error most significantly affected project PNM-18-03479.
  - **Recommendation 9:** Use IPLV ratings to calculate energy savings, and full-load efficiency ratings to calculate demand reductions.
  - **Recommendation 10:** Correct the PNM Workpaper spreadsheet to calculate bonus savings by taking the difference of the total high-efficiency demand reduction and the minimum-qualifying demand reduction.
- The evaluation team adjusted the savings calculations for packaged terminal air conditioner and packaged terminal heat pump (PTAC/PTHP) projects.
  - Per the PNM Workpapers, PNM calculated PTAC/PTHP savings using baseline performance corresponding to replacement/non-standard size units. However, the units installed were new construction/standard size units, and thus are subject to different minimum performance standards. The evaluation team calculated PTAC/PTHP savings based on the baseline standards for new construction/standard size units.
  - Another item to note is that PNM calculated PTAC/PTHP savings based on IECC 2009 baseline performance instead of the more stringent current federal standards contained in 10 CFR 431.97(c). This is consistent with the guidance the evaluation team provided PNM in the evaluation of PY2017. However, savings for future PTAC/PTHP installations should calculate savings based on 10 CFR 431.97(c), as the federal standards are more stringent than the state energy code.
  - **Recommendation 11:** Confirm whether installed PTAC/PTHP units are new construction/standard size or replacement/non-standard size as defined by IECC 2009 and determine the baseline efficiency accordingly. The evaluation

team expects the vast majority of units to be new construction/standard size and recommends using this as a default assumption, which will result in conservative savings estimates for replacement/non-standard size units.

  - **Recommendation 12:** Moving forward, calculate PTAC/PTHP savings based on baseline performance as defined by federal standards as long as federal standards are more stringent than the state energy code.

- The evaluation team adjusted the savings claimed for midstream snack machine controls, reach-in cooler controls, and beverage machine controls.
  - PNM claimed savings of 343 kWh for snack machine controls and 1,210 kWh for cooler controls. However, the PNM Workpapers list savings of 387 kWh for snack machine controls and 1,086 kWh for reach-in cooler controls. The evaluation team adjusted these savings further per the following bullet point.
  - The snack machine control, reach-in cooler control, and beverage machine control measures in the PNM Workpapers are based on Database for Energy Efficient Resources (DEER) 2005. The evaluation team performed new analyses of these measures based on the latest version of the DEER measures, which the evaluation team considers more accurate than the DEER 2005 versions. The evaluation team determined savings based on specific building type and assumed the controls were installed on Class B vending machines manufactured before 2019. The evaluation team's analyses resulted in lower kWh savings and higher kW reductions (PNM did not claim any demand reductions for these measures).
  - **Recommendation 13:** Update the snack machine control, reach-in cooler control, and beverage machine control measures in the PNM Workpapers in accordance with the latest versions of these measures in DEER. Updated analyses for these measures will be provided in the updated New Mexico TRM for reference.
  - **Recommendation 14:** Ensure consistency between reported savings and deemed savings values listed in the PNM Workpapers.
- The evaluation team adjusted the savings claimed for anti-sweat heater controls (ASHC).
  - The deemed savings values for ASHC listed in the PNM Workpapers do not match those listed in the New Mexico TRM. The New Mexico TRM lists kWh savings higher than what was claimed by PNM and kW reductions lower than what was claimed by PNM. PNM's implementer DNV-GL stated that the Workpapers would be updated to match the TRM values.
  - PNM claimed demand reductions for ASHC; however, the text of the PNM Workpapers states that the coincident demand factor for this measure is zero. The evaluation team calculated demand reductions for this measure according to the TRM, which has lower demand reductions than what was

claimed but higher demand reductions than zero as is stated in the PNM Workpapers text.

  - **Recommendation 15:** Update the PNM Workpapers to claim savings for ASHC in line with the New Mexico TRM.
  - **Recommendation 16:** Ensure consistency between reported savings and deemed savings values listed in the PNM Workpapers.

- Project PNM-17-03014 is a retro-commissioning project for which PNM calculated savings by comparing pre-retrofit and post-retrofit billing data. The evaluation team found that the *ex ante* analysis did not account for differences in weather conditions between the pre-retrofit and post-retrofit periods. In order to create a fair comparison of billing data, the evaluation team adjusted the data to account for the differences in weather conditions.
  - **Recommendation 17:** Adjust billing data for weather-dependent measures to account for differences in pre-retrofit and post-retrofit weather in order to create a fair comparison of metered usage.
- The evaluation team published an updated version of the New Mexico TRM, which is effective as of January 1, 2019 and will be referenced in the evaluation of PNM's PY2019 programs.
  - **Recommendation 18:** Update program assumptions and Workpapers as needed based on the updated version of the New Mexico TRM.

13.2 Residential Lighting

The deemed savings review to determine gross impacts for the Residential Lighting program found that the formula used to calculate bulb savings was correct. One minor error was found in the lookup of baseline wattages for specialty bulbs with 1,500 lumens, which was corrected by the evaluation team and resulted in slightly higher verified kWh and kW savings for the Residential Lighting program. The resulting engineering adjustment factor for both kWh and kW savings is 1.0017.

- **Recommendation 19:** Include the baseline wattage used to calculate savings in the tracking data, as well as a field denoting the source of the baseline wattage used (i.e., the table name from the TRM or other source).

Due to inconsistencies in the collection of bulb sales data for the 2018 program year, the evaluation team found that it was not possible to develop the econometric-based elasticity model specifically for the 2018 program year to determine net impacts. Instead, we relied on the results from the 2017 elasticity model to develop estimates for the 2018 program year based on the count of bulbs sold in 2018. A net-to-gross (NTG) ratio of 0.63 was calculated for the Residential Lighting program based on application of the PY2017 model results to the PY2018 bulb sales.

- **Recommendation 20:** Accurately track and record original bulb sales price (i.e., the pre-rebated cost) in program tracking data, along with accurate counts of the total quantity of bulbs (i.e., pack size and number of packs) and rebate amounts.

13.3 Energy Smart

To evaluate the impacts of the Energy Smart program, the evaluation team conducted a deemed savings review of the energy saving measures provided by the program. In the deemed savings review, we attempted to confirm the source of savings cited by PNM and/or replicate the per-unit savings values if savings were based on an algorithm from the New Mexico TRM. During the review of per-unit kW savings, we found that the kW savings shown in the tracking data were not the final kW savings claimed by PNM. However, PNM confirmed the alternate source of kW savings used for the Energy Smart program.

- **Recommendation 21:** PNM should report the claimed kW savings in the program tracking data, as is done for kWh savings, in order to keep all program savings in one location and facilitate third-party review of savings claims.

13.4 Residential Comprehensive

The gross impact evaluation of the Residential Comprehensive program consisted of a deemed savings review of per-unit savings values for each of the three sub-programs. We compared PNM documentation on the source, calculations, and input assumptions of savings values to determine whether they were correct and appropriate.

For the Home Energy Checkup sub-program, we were able to confirm the source of savings, calculations, and input assumptions for the majority of measures. For measures where we did not have enough information on the input assumptions to replicate the calculations, we confirmed that the per-unit values were within a reasonable range for the type of measure. However, specific details on the calculations or exact source of savings would be preferred.

- **Recommendation 22:** PNM should clearly and consistently document the source of deemed savings, formulas used to calculate deemed savings, and all input assumptions for those calculations in order to facilitate evaluator review of savings values.

For the Refrigerator Recycling sub-program, we confirmed the source of deemed savings values and found the per-unit values to be within a reasonable range for the refrigerator and freezer recycling measures.

For the Cooling and Pool Pumps sub-program, the savings calculations were confirmed to be accurate with a few exceptions. For kW savings for the room AC and window evaporative cooler measures, the residential HVAC coincidence factor of 0.87 was not applied as is recommended in the New Mexico TRM. For smart thermostats, the kWh savings were determined using the algorithm from the New Mexico TRM, but did not include the duct efficiency factor of 0.8 or the correct cooling adjustment (0.07 was used instead of 0.08 per the TRM). With these modifications to savings, the engineering adjustment factors for the Cooling and Pool Pumps sub-program were 1.0015 for kWh and 0.9979 for kW.

- **Recommendation 23:** In calculating kW savings for residential cooling measures, PNM should utilize the HVAC coincidence factor of 0.87 for residences per the New Mexico TRM.
- **Recommendation 24:** For kWh savings for smart thermostats, PNM should include the duct efficiency factor of 0.8 and the cooling adjustment of 0.08 per the New Mexico TRM.

13.5 New Home Construction

The gross impact evaluation activities for the New Home Construction program included engineering desk reviews of a sample of Performance projects and a deemed savings review of prescriptive projects. Savings for Performance projects were verified using the REM/Rate Fuel Summary Reports. Modeled HVAC equipment was checked against provided AHRI certificates. However, other aspects of the model (e.g., walls, windows, insulation) were not documented, and so were assumed to be consistent with the installed equipment.

- **Recommendation 25:** Include pictures of installed HVAC equipment model numbers and specifications/cutsheets for insulation to help confirm model accuracy.

For prescriptive projects, the evaluation team was able confirm the source of savings, calculations, and input assumptions for the majority of measures. For measures where we did not have enough information on the input assumptions to replicate the calculations, we confirmed that the per-unit values were within a reasonable range for the type of measure.

- **Recommendation 26:** PNM should clearly and consistently document the source of deemed savings, formulas used to calculate deemed savings, and all input assumptions for those calculations in order to facilitate evaluator review of savings values.

13.6 Large Customer Self-Direct

To evaluate the impacts of the Large Customer Self-Direct program, the evaluation team conducted an engineering desk review of the savings documentation for the one self-direct project that was completed in 2018. The gross claimed savings for this program in PY2018 were 282,523 kWh and 38 kW. The supporting documentation for this project was an engineering study completed by the participant. The study included a brief project description, calculation of savings, and invoices and specification documents of the lighting fixtures installed. The study did not provide sufficient documentation of the assumed lighting hours of use in the pre- and post-installation periods. The evaluation team deferred to the New Mexico TRM for lighting hours of use, resulting in increased savings. The resulting engineering adjustment factors were 1.4294 for kWh and 1.1762 for kW.

- **Recommendation 27:** Provide documentation of hours of use for lighting projects, including a daily lighting schedule that can be used to calculate peak coincident demand savings.

13.7 Power Saver

Evaluated energy savings for the Power Saver program were found to be 556,737 kWh (102% of claimed savings) and evaluated demand savings were found to be 26.3 MW (64% of claimed savings). The main driver in the difference between the expected and the evaluation load reduction estimates was that the implementer commonly summarized impacts with the maximum impact in a time period (e.g., the largest impact in a one-hour interval is the impact for that interval), whereas the evaluation team summarized impacts with an average over the same period. Conclusions and recommendations resulting from the evaluation of the Power Saver program are as follows:

- *Ex post* impacts provide a helpful look at program performance, but for planning purposes, a consistent, weather-normalized value should be used.
  - **Recommendation 28:** *Ex ante* program impacts from 5:00 p.m. to 6:00 p.m. MDT at 100ºF, de-rated for operability, should be used for reporting, cost-effectiveness, and planning.
- The Itron contract definition of capacity performance is upwardly biased by capturing favorable noise along with the program impact.
  - **Recommendation 29:** If there is a chance to review the terms, we recommend collapsing to the hourly mean rather than the maximum.
- While the alternating treatment design (A/B) was very successful for residential, it did not provide value for small commercial customers due to very small sample sizes. Several other methods may offer improved accuracy for evaluation.
  - **Recommendation 30:** Use the baseline method laid out for medium commercial customers. This may work best if the small commercial customers are less weather sensitive and have reliable occupancy patterns.
  - **Recommendation 31:** Use a weather-matching baseline. These methods rely on picking similar non-event days by weather, rather than by load. This

works well for weather-sensitive customers but is still relatively simple to understand and compute.
    - **Recommendation 32:** Use a regression method as described in the detailed findings of the Power Saver evaluation in Appendix G, Section 1.3. This method was more accurate than the top 3/5 baseline method tested for these customers, but has the drawback that it relies on the whole summer's worth of data and requires some statistical knowledge to implement the model and explain the results.

13.8 Peak Saver

Twelve total demand response events were called for the Peak Saver program in 2018, and the evaluation team determined that the Peak Saver program appears to be approximately a 15 to 18 MW capacity resource. Conclusions and recommendations resulting from the evaluation of the Peak Saver program are as follows:

- **Recommendation 33:** Consider alternative baseline adjustment methods. The current contract baseline methodology uses pre-event day **loads** to adjust customer baselines. These loads are subject to variation in solar output and pre-loading by customers, and thus may not be indicative of non-event day loads. Using event day **temperature** as an adjustment factor mitigates these problems. For example, the Weather Sensitive Adjustment (WSA) used in PJM adjusts the hourly customer baseline (CBL) up or down based on average hourly temperature differences between event and baseline days. Each site receives a WSA factor, which indicates the kW change in load for each degree (F) of temperature change at that site. The CBL adjustment is obtained by multiplying the WSA factor by the temperature difference between the event hour and the average baseline day temperature in the corresponding hour. The result is added to (or subtracted from) the CBL. This addresses the issues described herein from solar, pre-loading, symmetric adjustments, using uncapped multiplicative adjustments.
- **Recommendation 34:** Alternatively, if the current customer baseline framework is maintained, there are several changes that can mitigate the bias introduced by using pre-event day loads as the basis for baseline adjustments:
    - Make the multiplicative adjustment symmetric rather than asymmetric. As per the assessment of CBL accuracy presented in Appendix H, using an asymmetric adjustment results in an upward bias in the baseline. Biasing the baseline inherently biases the performance metrics.
    - Add a cap to the multiplicative adjustment factor. Otherwise, baselines are apt to approach unrealistic levels. In the example provided in Table 28 of Appendix H, the baseline for one site was more than eight times greater than the peak load observed at that site (between June and early August). This size of the adjustment factor (20.58) in this instance was largely due to solar PV.

- Examine load data for solar patterns or pre-pumping on event days. Pre-loading on event days is fine, but sites that do so should not receive the adjustment factor (or the adjustment factor should be based on weather rather than load). For sites with solar, consider using a smaller adjustment factor cap (or consider removing the adjustment factor altogether).
- PNM should also consider collecting all meter channels for sites with solar PV. This would allow the CBL to fully capture the load shape of sites that are net exporters during key times of day. There were eight sites in the 2018 program that averaged negative performance across all events. It is possible that these sites reduced load and thus became larger exporters than they would have been on a non-event day, but the available data do not allow for a measurement. Also, an additive adjustment may work better than a multiplicative one for sites whose load can cross zero during the event period or adjustment window.
- Customer loads are volatile and baselines are not perfect. When metered load is higher than the baseline, performance estimates should be recorded as negative values and not zeroed out.

13.9 Cost Effectiveness

Cost effectiveness was calculated using the Utility Cost Test (UCT) for each individual program, as well as the entire portfolio of PNM programs.

13.9.1 Conclusions

- PNM does not use the Total Resource Cost (TRC) test, and instead relies solely on the UCT to determine program and portfolio cost effectiveness.
- A 20 percent benefit adder is included in the UCT calculation for low-income projects to account for utility system economic benefits.
- The UCT revealed that all but two programs were cost effective (i.e., had a UCT ratio of greater than 1.00). The two programs found to not be cost effective were Power Saver (UCT ratio of 0.85) and Peak Saver (UCT ratio of 0.94). The PNM portfolio overall had a UCT ratio of 1.71.
- The Large Customer Self-Direct project had a simple payback period of 4.0 years, which meets the NMPRC requirement that self-directed projects have a simple payback period of more than one year but less than seven years.

13.9.2 Recommendations

- **Recommendation 35:** If there is a desire or need to calculate cost effectiveness using the TRC test by either PNM or the New Mexico Public Regulation Commission (PRC), PNM should track measure costs for all programs so that the TRC test can be used in future program years.