Evaluation of the 2017 Public Service Company of New Mexico Energy Efficiency and Demand Response Programs

Final Report

April 5, 2018

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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 2017 (PY2017).

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 PY2017, the following PNM programs were evaluated:

- Commercial Comprehensive
- Residential Lighting
- Home Works
- 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 UCT. A brief process evaluation was also conducted for the Commercial Comprehensive program.

[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 January 1, 2015 that sets forth the NMPRC's policy and requirements for energy efficiency and load management programs. This Rule can be found online at http://164.64.110.239/nmac/parts/title17/17.007.0002.htm

The remaining programs that were not evaluated in 2017 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 PY2017 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. 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 the lighting elasticity model.

Home Works. The Home Works program provides energy efficient measures to students along with energy saving tips. The measures distributed to students through this program have deemed savings values, which were reviewed as part of the evaluation and compared with the New Mexico TRM.

Power Saver and Peak Saver. PNM had two demand response programs in PY2017. The Power Saver program focuses on single-family, multifamily, 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 PY2017 evaluation methods.

Table 1: Summary of PY2017 Evaluation Methods by Program

Program	Deemed Savings Review	Phone Verification	Engineering Desk Reviews	Elasticity Model	Billing Regression
Commercial Comprehensive	◆	◆	◆	□	□
Residential Lighting	◆	□	□	◆	□
Home Works	◆	□	□		□
Power Saver (Res & Small Commercial)				□	◆
Peak Saver (Large Commercial & Industrial)				□	◆

The results of the PY2017 impact evaluation are shown in Table 2 (kWh) and Table 3 (kW), with the programs evaluated in 2017 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: PY2017 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						
Large Business	371	27,409,027	0.9047	24,797,423	0.6733	16,695,002
Midstream	29	1,746,497	0.9047	1,580,086	0.8400	1,327,272
Quick Saver	272	10,362,321	0.9047	9,374,972	1.0000	9,374,972
New Construction	46	5,441,068	0.9047	4,922,629	0.8400	4,135,008
Multifamily	65	4,059,546	1.0000	4,059,546	0.8360	3,393,780
Residential Lighting	1,274,328	35,032,511	1.0000	35,032,511	0.6400	22,420,807
Home Works	9,530	1,845,130	1.0000	1,845,130	1.0000	1,845,130
Energy Smart	5,101	784,357	1.0000	784,357	1.0000	784,357
Residential Comprehensive						
Home Energy Checkup	3,952	2,451,533	1.0000	2,451,533	0.9917	2,431,159
Refrigerator Recycling	7,689	8,509,836	1.0000	8,509,836	0.6800	5,786,688
Cooling	4,512	6,798,874	1.0000	6,798,874	0.3730	2,535,980
Easy Savings Kit	6,847	2,560,778	1.0000	2,560,778	1.0000	2,560,778
New Homes	398	724,785	1.0000	724,785	0.8000	579,828
Power Saver	42,231	519,097	0.6303	327,198	1.0000	327,198
Peak Saver	105	374,687	0.7638	286,170	1.0000	286,170
Total		**108,620,047**		**104,055,828**		**74,484,131**

Table 3: PY2017 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						
Large Business	371	3,945	0.7499	2,958	0.6733	1,992
Midstream	29	346	0.7499	260	0.8400	218
Quick Saver	272	2,063	0.7499	1,547	1.0000	1,547
New Construction	46	946	0.7499	709	0.8400	596
Multifamily	65	340	1.0000	340	0.8360	284
Residential Lighting	1,274,328	4,577	1.0000	4,577	0.6400	2,929
Home Works	9,530	112	1.0000	112	1.0000	112
Energy Smart	5,101	59	1.0000	59	1.0000	59
Residential Comprehensive						
Home Energy Checkup	3,952	518	1.0000	518	0.9917	514
Refrigerator Recycling	7,689	1,938	1.0000	1,938	0.6800	1,318
Cooling	4,512	5,462	1.0000	5,462	0.3730	2,037
Easy Savings Kit	6,847	93	1.0000	93	1.0000	93
New Homes	398	296	1.0000	296	0.8000	237
Power Saver	42,231	37,943	0.7388	28,033	1.0000	28,033
Peak Saver	105	24,118	0.7762	18,721	1.0000	18,721
Total		**82,756**		**65,623**		**58,690**

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: PY2017 Savings Summary – Lifetime kWh

Program	Expected Gross kWh Lifetime Savings	Realized Gross kWh Lifetime Savings	Realized Net kWh Lifetime Savings
Commercial Comprehensive	454,320,715	414,505,823	314,438,797
Residential Lighting	323,004,876	323,004,876	206,723,121
Home Works	20,598,960	20,598,960	20,598,960
Energy Smart	4,298,992	4,298,992	4,298,992
Residential Comprehensive	167,097,421	167,097,421	96,221,628
Easy Savings Kit	26,487,978	26,487,978	26,487,978
New Homes	12,321,334	12,321,334	9,857,067
Power Saver	519,115	327,198	327,198
Peak Saver	374,666	286,170	286,170
Total	**1,009,024,057**	**968,928,752**	**679,239,910**

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.[2] The evaluation team conducted this test in a manner consistent with the California Energy Efficiency Policy Manual.[3] The results of the UCT are shown below in Table 5. All programs had a UCT of greater than 1.00, and the portfolio overall was found to have a UCT ratio of 1.57.

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

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

Table 5: PY2017 Cost Effectiveness

Program	Utility Cost Test (UCT)
Commercial Comprehensive	1.52
Residential Lighting	3.01
Home Works	1.64
Energy Smart	1.03
Residential Comprehensive	1.40
Easy Savings Kit	2.23
New Homes	1.11
Power Saver	1.04
Peak Saver	1.11
Overall Portfolio	**1.57**

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 projects, deemed savings reviews, an elasticity model for Residential Lighting, and statistical models for Power Saver and Peak Saver—resulted in relatively high realized gross savings. Adjustments to savings based on the Commercial Comprehensive desk reviews were due to three main factors: conflict between the New Mexico TRM and the PNM Workpapers, lack of documentation of custom lighting hours, and savings values that were not adequately documented. The evaluation team has provided a number of recommendations to improve savings values that include consolidation of the PNM Workpapers and the TRM, documenting the source of custom hours of use for lighting projects, documenting calculations of project savings, and other minor consistency improvements. A few recommendations related to data tracking were also made, including the addition of measure quantity and lighting watts in the Multifamily data and original bulb price in the Residential Lighting data.

In terms of cost effectiveness, the UCT test was used and found all PNM programs 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 and Quick Saver participants as well as interviews with Multifamily and New Construction participants, found very high levels of satisfaction across various aspects of the programs. Very few instances of dissatisfaction were reported, and the main recommendations for improvement were to simplify the project application process and increase outreach and marketing to reach more potential participants.

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 2017 (PY2017).

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).[4] 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.

[4] 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 January 1, 2015 that sets forth the NMPRC's policy and requirements for energy efficiency and load management programs. This Rule can be found online at http://164.64.110.239/nmac/parts/title17/17.007.0002.htm

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- Peak Saver

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The remaining programs that were not evaluated in 2017 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 PY2017 evaluation. The *Impact Evaluation Results* chapter follows and presents the energy and demand savings by program. *The Cost Effectiveness Results* are summarized in the next chapter, followed by a chapter presenting the *Process Evaluation Results*. 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 PY2017 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. 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 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 the lighting elasticity model.

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Table 6 summarizes the PY2017 evaluation methods. Additional detail on each of these evaluation methods is included in the remainder of this chapter.

Table 6: Summary of PY2017 Evaluation Methods by Program

Program	Deemed Savings Review	Phone Verification	Engineering Desk Reviews	Elasticity Model	Billing Regression
Commercial Comprehensive	◆	◆	◆	□	□
Residential Lighting	◆	□	□	◆	□
Home Works	◆	□	□		□
Power Saver (Res & Small Commercial)				□	◆
Peak Saver (Large Commercial & Industrial)				□	◆

2.1 Phone Surveys

A participant phone survey was fielded in early 2018 for participants in Retrofit Rebate and Quick Saver sub-programs of the Commercial 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 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 this program, and given the number of participants, we attempted to contact a census of Retrofit Rebate and Quick Saver participants. Ultimately, 113 phone surveys were completed, split about evenly between the Retrofit Rebate (prescriptive and custom projects) and Quick Saver (direct install) sub-programs of the Commercial Comprehensive program. Table 7 shows the distribution of completed surveys.

Table 7: Commercial Comprehensive Phone Survey Summary

Count of Customers with Valid Contact Info	Target # of Completes	Sub-Program	Completed Surveys
248	100	Retrofit Rebate	53
		Quick Saver	60
		Total	**113**

The final survey instrument is included in Appendix A.

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. 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.

In support of the engineering desk reviews, primary data were collected for select projects through engineering in-depth interviews. These interviews involved speaking with project contacts to confirm equipment installation and operational parameters, in order to determine if additional adjustments to the savings calculations were necessary.

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 (EE/LM) programs, to do the following:

1) 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.
2) In its next report of PNM's EE/LM Programs, the independent evaluator shall evaluate actions that might increase participation in PNM's EE/LM programs while maintaining the cost effectiveness of the programs and recommend actions, if advisable.

The evaluation team concludes that in 2017 the LM programs served a capacity resource that avoided the need for additional supply-side peaking capacity. We also discuss at length the impact of the number and duration of LM events on the cost-effectiveness and value of the LM programs and conclude that the value of the program is in its expected level of capacity rather than the number of times it is used. Therefore, the evaluation team does not have specific recommendations regarding increased participation and use of the LM programs.

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 C and Appendix D.

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 (kWh). 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 8 shows the energy and capacity benefits for the two demand response programs in 2017. Energy benefits amounted to 0.3 percent of Utility Cost Test (UCT) benefits, while capacity benefits accounted for 99.7 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.

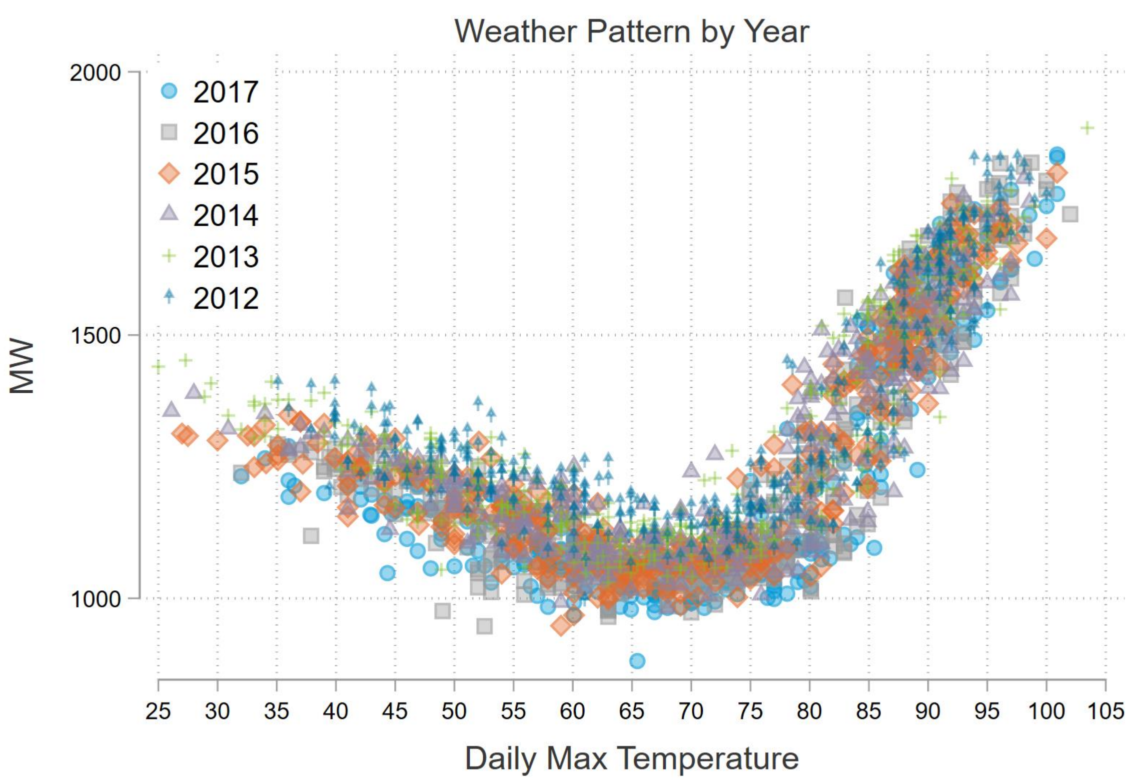
Table 8: 2017 Demand Response Program Benefits

Program	Energy Benefit	Capacity Benefit	Percent Capacity
Power Saver	$10,501	$3,916,406	99.7%
Peak Saver	$9,628	$2,615,455	99.6%
Energy Efficiency Programs	$16,990,436	$15,242,340	47.3%

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 the 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)[5] 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 1 illustrates this relationship using PNM system loads (2012-2017) and weather records from KABQ's weather station in Albuquerque. PNM is clearly a summer-peaking utility with maximum summer loads that are 20-30 percent higher than winter loads each year.

Figure 1: Daily Maximum PNM System Load and Temperature by Year



[5] 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

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, 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 2 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 2 zooms in on the top 100 hours of each year. Even within this very narrow portion of the year (1.1% of the hours in a year), the load duration curve has a very steep slope with as much as a 100 MW difference between the top hour and the 20th hour in some years.

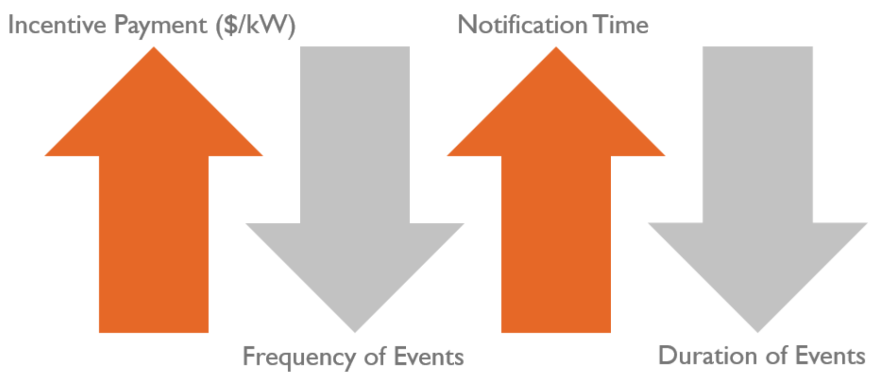
Figure 2: Annual and Top 100 Hour Load Duration Curves 2012-2017

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. In each of the six years examined, the annual peak occurred at hour ending 17 (4:00 p.m. to 5:00 p.m.) Mountain

Daylight time on a weekday. In addition, the reserve margin requirement is above and beyond the forecasted top hour. A supply-side resource like a 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 3 shows the key drivers and the directionality of their effect on demand response program potential.

Figure 3: Key Drivers of Demand Response Potential



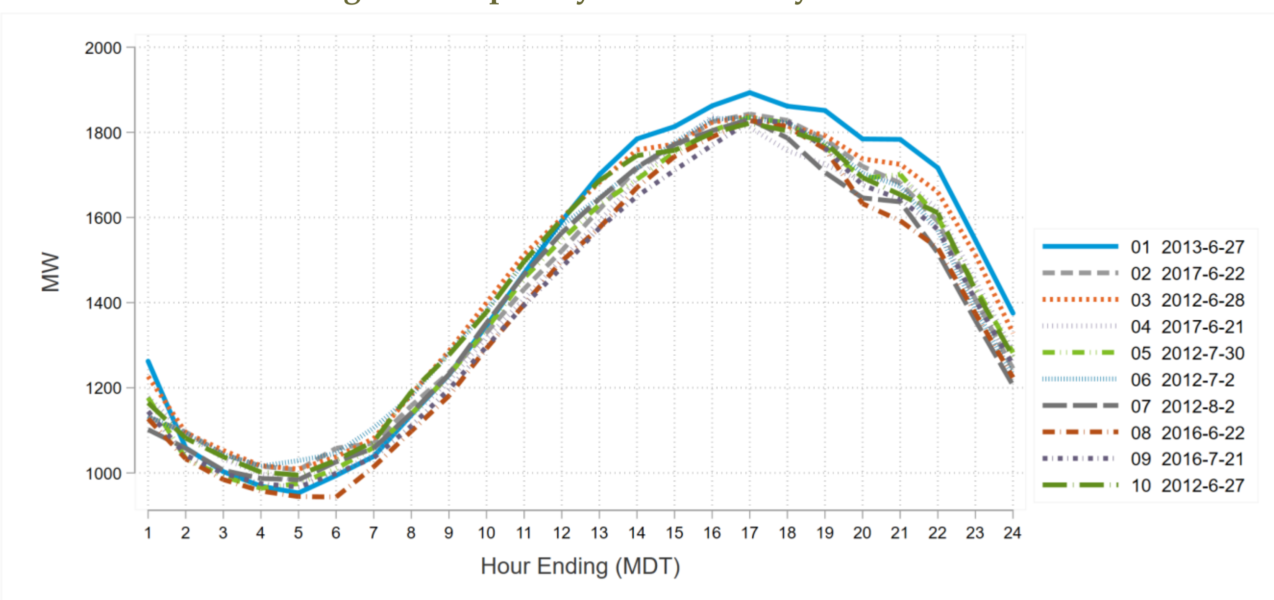
Program participation is not explicitly shown in Figure 3. Rather it is a function of the other drivers. More generous incentives will typically increase participation rates, but at the expense of cost-effectiveness. For programs like Peak Saver and Power Saver, where the costs are mostly volumetric (per-kW committed or per-participant), the cost-effectiveness of the program is largely unaffected by participation levels. Increasing or decreasing participation will affect program costs and benefits in the same proportion. Any change to the UCT ratio would be a function of spreading fixed administrative costs over changing program size.

As indicated by the downward arrows in Figure 3, the more often participants are dispatched and the longer demand response events last, the more participants expect to be compensated for their discomfort or disruption to their businesses. Increasing the number of DR events called would lower the cost-effectiveness of programs because the additional incentives required would not increase the capacity benefits of the program. In the 2016 M&V report, ADM conducted a survey with participants of the Peak Saver program and asked what PNM could do to increase their participation in DR events. The most common response (47%) was "provide higher rebates".

The ideal number of events for a summer is a function of weather conditions and availability of other resources. In an extreme summer, grid operators might need to dispatch Power Saver and Peak Saver on a large number of days. Similarly, if there are unexpected outages at generating stations or transmission constraints, operators might need to rely heavily on demand response programs. In a mild summer, demand response programs might not need to be called at all other than for testing purposes.

Figure 4 shows PNM's top 10 system load days of the last six years. Two of the top five days occurred in 2017. The loads shown are metered, so if demand response events were called, the observed load was reduced by the amount demand reduction provided. Demand response programs were dispatched on June 21, 2017 but not on June 22, 2017, the two top five system load days in 2017 shown in Figure 4.

Figure 4: Top 10 System Load Days 2012-2017



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

- Planning reserves are forecasted generation capacity over and above the amount required to serve the projected peak-hour demand of the year.

- Operating reserves provide the ability to respond to supply and demand imbalances within each hour.[6]

Because the capacity benefits are the dominant benefit stream for demand response programs, the primary research question for EM&V 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 impacts at peaking conditions rather than simple averages of observed impacts during 2017 events. For example, we exclude the voluntary Peak Saver event (June 19) from the capacity estimates because in a situation where grid operators needed the capacity to prevent loss of load, a mandatory event would be called. Similarly, we analyzed the last three summers of Power Saver results to develop a time-temperature matrix and estimate the expected impact from 4:00 p.m. to 5:00 p.m. at 100 degrees (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 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 consistent with our review of system load data and 2017 program performance on event days.

2.3.2 Power Saver

The 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.

There were six Power Saver events during the summer 2017 demand response season, which began June 1st and ended September 30th. Shortly after the conclusion of the summer 2017 season, the program implementer Itron provided the evaluation team with a series of datasets for the evaluation. These files included:

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[6] "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.

- For residential and small commercial sites, five-minute load data from 6/1/2015 to 9/30/2015, from 6/1/2016 to 9/30/2016, and from 6/1/2017 to 9/30/2017;
- 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;
- For medium commercial sites, five-minute load data from 6/1/2017 to 7/31/2017; and
- For medium commercial sites, an M&V list that provided the dates each load control device was active.

The evaluation team also received Itron's Power Saver impact evaluation report, which detailed the methods Itron employed in calculating CBLs for the three different participant classes. 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 impact analysis were to:

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 2017 demand response season.
3. Where possible, leverage additional historical data from 2015 and 2016 to produce *ex ante* estimates of what the per-device impact at peaking conditions 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 150 kW. The program compensates participants for reducing electric load upon dispatch during periods of high system load. There were 106 participating facilities during the summer of 2017.

Shortly after the conclusion of the summer 2017 season, the evaluation team reviewed a series of datasets that captured the program events. These files included:

- Dispatch reports with participant-level and aggregate performance calculations for each event;
- Five-minute load data for each participating facility;

- One-minute load data for the eighth, ninth, and tenth minutes of each event. For the June 21, 2017 event, this dataset also included load measurements for the fourth, fifth, and sixth minutes of the event window.

The dispatch reports contained load impacts calculated using a customer baseline (CBL) method detailed in the contract between PNM and EnerNOC, the program implementer. Load impacts are the difference between the CBL and the metered load during the event. The three key steps in the evaluation process to verify savings were to:

1. Reproduce the performance estimates calculated by EnerNOC using the contractually agreed-upon CBL method.
2. Assess the accuracy of the contract CBL by examining its ability to predict loads on non-event weekdays.
3. Modify the CBL methodology to reduce bias and calculate verified impacts for each event.

The Peak Saver CBL method utilizes a moving average calculation where each five-minute interval of a day's CBL is calculated as follows:

$$\sum_{i=1}^{288} 0.9 * Prior\ Day\ CBL_i + 0.1 * Prior\ Day\ kW_i$$

The calculation is performed separately for each of the 288 five-minute intervals in a given day. The CBL method also includes a 'weather adjustment' component that compares loads for the two hours preceding the event to the unadjusted CBL. If the event day loads are higher than the unadjusted CBL, the average difference is added to the participant's CBL during the event hours. If the average load on the event day during the adjustment window is less than the unadjusted CBL, no weather adjustment is applied. If events are called on consecutive days, the higher of the event day weather adjustment or the prior day's weather adjustment is used to adjust the CBL (provided one adjustment is positive).

The adjusted CBL then is used to calculate a series of performance metrics:

- **Energy Performance** – the difference (in kWh) between the adjusted CBL and the metered load summed over all five-minute intervals of the DR event.
- **10-Minute Capacity Performance** – The difference between the adjusted CBL and the lowest demand measurement in the eighth, ninth, or tenth minute of the event.
- **Average Capacity Performance** – The average difference (in kW) between the adjusted CBL and metered load for each five-minute interval after the five-minute interval comprising the 10-Minute Capacity Performance Measurement.

- **Verified Capacity Performance** – This is a weighted average of the 10-Minute Capacity Performance metric and the Average Capacity Performance metric, calculated as follows: 0.6*(10-Minute Capacity Performance) + 0.4*(Average Capacity Performance).

2.4 Net Impact Analysis

2.4.1 Self-Report Approach

The evaluation team estimated net impacts for most 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).[7] For the PNM programs, questions regarding free ridership were divided into several primary components:

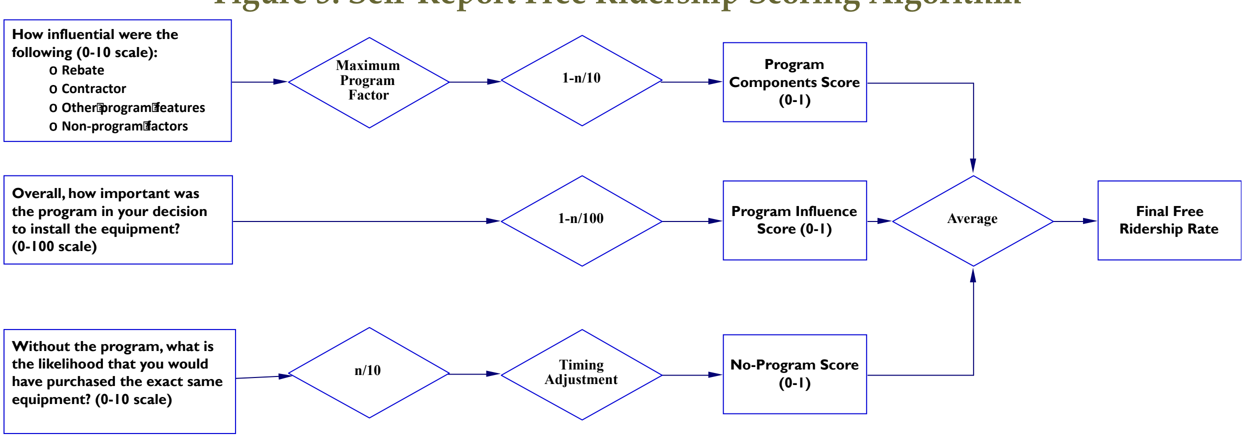
[7] The full Illinois TRM can be found at http://www.ilsag.info/il_trm_version_6.html

- 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;
- 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 5 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 5: 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 5, 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 one question but not important in 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 5. 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 used an elasticity model to estimate free ridership (and ultimately net impacts) for PNM's upstream Residential Lighting program. 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 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 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.

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

$$Bulbs_{i,t,s} = InvoicePeriod_{i,t,s} * e^{(a+b_1 Price_{i,t,s} + b_2 Watts_i + b_3 Char_i + e_{i,t,s})}$$

$$Where:$$

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

$$Price_{i,t,s} = \text{Rebated price for product type i, during period t, at store s}$$

$$Watts_i = \text{Wattage for bulb type i}$$

$$Char_i = \text{Indicator variables describing particular characteristics of bulb type i}$$

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

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 percent 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 were 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)[8] discusses the elasticity model as an appendix to its larger chapter on recommended methods for estimating net impacts.[9]

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

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[8] The UMP is sponsored by the National Renewable Energy Lab 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.

[9] See https://www.nrel.gov/docs/fy17osti/68578.pdf for the full UMP net impacts discussion. The discussion of 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 the National Renewable Energy Laboratory (NREL), October 2017.

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 is 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 CO2 (estimated monetary cost of CO2 per kWh generated);
- Avoided transmission and distribution costs;
- Discount rate;
- Line loss factor;
- Any assumed non-energy benefits; and
- Administrative costs (all non-incentive 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 Easy Savings
  - 100% of Low Income Home Energy Checkup

- 100% of Energy Smart (MFA)
- 40% of Home Works
- 45% of Commercial Comprehensive - Multifamily

- Administrative costs were broken into the following categories:
  - Administration
  - Promotion
  - Measurement & Verification
  - Third-Party Costs

Finally, the incentive and effective useful life values were taken from the final PY2017 tracking data submitted by PNM. The final net energy savings values estimated from the PY2017 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.

3 Impact Evaluation Results

The results of the PY2017 impact evaluation are shown in Table 9 (kWh) and Table 10 (kW), with the programs evaluated in 2017 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 2017, the evaluated programs covered 80 percent of the *ex ante* kWh savings and 90 percent of the *ex ante* kW savings.

Table 9: PY2017 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						
Large Business	371	27,409,027	0.9047	24,797,423	0.6733	16,695,002
Midstream	29	1,746,497	0.9047	1,580,086	0.8400	1,327,272
Quick Saver	272	10,362,321	0.9047	9,374,972	1.0000	9,374,972
New Construction	46	5,441,068	0.9047	4,922,629	0.8400	4,135,008
Multifamily	65	4,059,546	1.0000	4,059,546	0.8360	3,393,780
Residential Lighting	1,274,328	35,032,511	1.0000	35,032,511	0.6400	22,420,807
Home Works	9,530	1,845,130	1.0000	1,845,130	1.0000	1,845,130
Energy Smart	5,101	784,357	1.0000	784,357	1.0000	784,357
Residential Comprehensive						
Home Energy Checkup	3,952	2,451,533	1.0000	2,451,533	0.9917	2,431,159
Refrigerator Recycling	7,689	8,509,836	1.0000	8,509,836	0.6800	5,786,688
Cooling	4,512	6,798,874	1.0000	6,798,874	0.3730	2,535,980
Easy Savings Kit	6,847	2,560,778	1.0000	2,560,778	1.0000	2,560,778
New Homes	398	724,785	1.0000	724,785	0.8000	579,828
Power Saver	42,231	519,097	0.6303	327,198	1.0000	327,198
Peak Saver	105	374,687	0.7638	286,170	1.0000	286,170
Total		**108,620,047**		**104,055,828**		**74,484,131**

Table 10: PY2017 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						
Large Business	371	3,945	0.7499	2,958	0.6733	1,992
Midstream	29	346	0.7499	260	0.8400	218
Quick Saver	272	2,063	0.7499	1,547	1.0000	1,547
New Construction	46	946	0.7499	709	0.8400	596
Multifamily	65	340	1.0000	340	0.8360	284
Residential Lighting	1,274,328	4,577	1.0000	4,577	0.6400	2,929
Home Works	9,530	112	1.0000	112	1.0000	112
Energy Smart	5,101	59	1.0000	59	1.0000	59
Residential Comprehensive						
Home Energy Checkup	3,952	518	1.0000	518	0.9917	514
Refrigerator Recycling	7,689	1,938	1.0000	1,938	0.6800	1,318
Cooling	4,512	5,462	1.0000	5,462	0.3730	2,037
Easy Savings Kit	6,847	93	1.0000	93	1.0000	93
New Homes	398	296	1.0000	296	0.8000	237
Power Saver	42,231	37,943	0.7388	28,033	1.0000	28,033
Peak Saver	105	24,118	0.7762	18,721	1.0000	18,721
Total		**82,756**		**65,623**		**58,690**

Lifetime kWh savings are shown in Table 11 by program and for the portfolio overall. This includes expected gross, realized gross, and realized net kWh lifetime savings.

Table 11: PY2017 Savings Summary – Lifetime kWh

Program	Expected Gross kWh Lifetime Savings	Realized Gross kWh Lifetime Savings	Realized Net kWh Lifetime Savings
Commercial Comprehensive	454,320,715	414,505,823	314,438,797
Residential Lighting	323,004,876	323,004,876	206,723,121
Home Works	20,598,960	20,598,960	20,598,960
Energy Smart	4,298,992	4,298,992	4,298,992
Residential Comprehensive	167,097,421	167,097,421	96,221,628
Easy Savings Kit	26,487,978	26,487,978	26,487,978
New Homes	12,321,334	12,321,334	9,857,067
Power Saver	519,115	327,198	327,198
Peak Saver	374,666	286,170	286,170
Total	**1,009,024,057**	**968,928,752**	**679,239,910**

Details on the individual program impacts are summarized below, with additional details on the analysis methods and results for some programs included as appendices where noted.

3.1 Commercial Comprehensive Program

3.1.1 Commercial Comprehensive Gross Impacts

The *ex ante* 2017 impacts are summarized in Table 12 for each Commercial Comprehensive sub-program, with the Large Business and Quick Saver sub-programs accounting for most of the savings.[10] In total, the Commercial Comprehensive program accounted for 45 percent of energy impacts in PNM's overall portfolio.

[10] Large Business includes both the Retrofit Rebate and Building Tune-Up sub-programs of the Commercial Comprehensive program.

Table 12: Commercial Comprehensive Savings Summary

Sub-Program	# of Projects	Expected Gross kWh Savings	Expected Gross kW Savings
Large Business	371	27,409,027	3,945
Midstream	29	1,746,497	346
Quick Saver	272	10,362,321	2,063
New Construction	46	5,441,068	946
Multifamily	65	4,059,546	340
Total	**783**	**49,018,459**	**7,640**

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 Large Business, Midstream, Quick Saver and New Construction sub-programs. The sample 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 with each measure group. 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 13. The resulting sample achieved a relative precision of 90/7.5 overall, with precision ranging from 90/10 to 90/21 for the individual measure groups. For two measure groups a census was achieved.

Table 13: Commercial Comprehensive Desk Review Sample

Measure Group	Stratum	Count	Average kWh	Total kWh Savings	% of Savings	Final Sample
Custom	Certainty	2	417,949	835,898	2.1%	2
Custom	1	3	194,823	584,469	1.4%	3
Custom	2	6	136,633	819,795	2.0%	2
Custom	3	28	20,057	561,596	1.4%	4
HVAC	Certainty	1	862,124	862,124	2.1%	1
HVAC	1	4	290,335	1,161,340	2.9%	4
HVAC	2	13	96,554	1,255,196	3.1%	5
HVAC	3	109	7,318	797,666	2.0%	4
RCx Study	Certainty	4	202,595	810,381	2.0%	4
Refrigeration	Certainty	2	73,869	147,738	0.4%	2
Refrigeration	1	5	33,986	169,928	0.4%	3
Refrigeration	2	16	14,628	234,055	0.6%	2
Refrigeration	3	30	5,936	178,074	0.4%	6
Other	Certainty	5	16,492	65,968	0.2%	5
Lighting	Certainty	3	1,585,539	4,756,616	11.8%	3
Lighting	1	14	532,703	7,457,836	18.5%	8
Lighting	2	32	213,973	6,847,132	16.9%	10
Lighting	3	122	67,495	8,234,348	20.4%	12
Lighting	4	288	16,102	4,637,388	11.5%	9
Total		**687**		**40,417,547**	**100.0%**	**89**

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 defaulted to TRM values in situations where non-prescriptive values (e.g. custom lighting hours of use) were not adequately documented in the project files.

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 an additional in-depth interview from an engineer. Custom projects and projects with high levels of savings were identified as candidates for interviews. Reviewing engineers contacted selected participants by phone and email to confirm installation of incentivized equipment and verify operational parameters integral to the calculation of estimated savings. A total of 12 interviews were completed, and no major issues were identified during these interviews. The most common adjustment resulting from the interviews was adjusting the hours of use for equipment based on more detailed information obtained on specific project applications.

Note that for the Multifamily sub-program, the evaluation was limited to conducting a deemed savings review. The deemed savings review included replicating the per unit savings values reported by PNM based on the New Mexico TRM. Equipment installed in the Multifamily sub-program included lighting, windows, refrigerators, and custom measures.

A key issue in the review of the Multifamily program tracking data was that measure quantities were not correctly shown in the main tracking data file; instead, gross savings values appeared in both the savings field and the quantity field. However, quantities do appear in the individual project files. Additionally, in the review of lighting measure savings, the evaluation team found insufficient information in the tracking data to link the savings back to values in the TRM. The majority of lighting measures in the tracking data did not include installed or replaced watts. This information is included in the more detailed individual project files, but is not consistently recorded in the tracking data. Despite this lack of information in the tracking data, savings values in the data generally appeared to be reasonable for the types of measures installed. As a result, the evaluation team determined that an engineering adjustment factor of 1.00 should be applied for the

2017 program, with a recommendation to improve the tracking data so that savings can be traced back to the TRM or other referenced source of savings.

Table 14 and Table 15 show the results of the desk review and how the resulting engineering adjustments were used to calculated realized savings. For the energy impacts overall, the desk reviews resulted in an engineering adjustment factor of 0.8684 for the subgroups covered by the sample. For projects in the Multifamily sub-program that were not included in the desk reviews, an engineering adjustment factor of 1.00 was assumed. For the Commercial Comprehensive program overall, these adjustments resulted in an engineering adjustment factor of 0.9126 for kWh and 0.7610 for kW.

Table 14: PY2017 Commercial Comprehensive Gross kWh Impact Summary

Sub-Program	# of Projects	Expected Gross kWh Savings	Engineering Adjustment Factor	Realized Gross kWh Savings
Large Business	371	27,409,027	0.9047	24,797,423
Midstream	29	1,746,497	0.9047	1,580,086
Quick Saver	272	10,362,321	0.9047	9,374,972
New Construction	46	5,441,068	0.9047	4,922,629
Multifamily	65	4,059,546	1.0000	4,059,546
Total	**783**	**49,018,459**	**0.9126**	**44,734,656**

Table 15: PY2017 Commercial Comprehensive Gross kW Impact Summary

Sub-Program	# of Projects	Expected Gross kW Savings	Engineering Adjustment Factor	Realized Gross kW Savings
Large Business	371	3,945	0.7499	2,958
Midstream	29	346	0.7499	260
Quick Saver	272	2,063	0.7499	1,547
New Construction	46	946	0.7499	709
Multifamily	65	340	1.0000	340
Total	**783**	**7,640**	**0.7610**	**5,814**

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

- **Conflict between the New Mexico TRM and the PNM Workpapers.** Multiple measures exist in both the New Mexico TRM and the PNM Workpapers, but the calculation methods are not always consistent across these sources. As mentioned above, in cases of conflict the evaluation team determined which source offered greater detail and accuracy. For certain measures and assumptions, we determined that the TRM offered greater detail and accuracy than the PNM Workpapers, which resulted in calculating savings that differed from the *ex ante* values reported by PNM. The most notable measures affected by this were lighting and unitary air conditioners.
- **Lack of documentation of custom lighting hours.** For multiple lighting projects, it appears that custom lighting hours of use (HOU) were used in the savings calculations. However, many of these projects did not include documentation explaining the source and derivation of these hours. Examples of adequate documentation would be light logger data or documented interviews with building owners or managers detailing daily, weekly, and monthly schedules. In the absence of this documentation, the evaluation team defaulted to lighting HOU values from the TRM, treating the TRM as a guidance document with vetted deemed HOU values.
- **Lack of transparency in calculations.** For multiple projects, the evaluation team followed the algorithms contained in the PNM Workpapers to the letter but arrived at savings that differed from those reported by PNM. During a demonstration of PNM's project database, DNV-GL implementation staff mentioned that additional adjustments may be made to deemed savings assumptions to account for project-specific considerations. However, these adjustments were not documented in the materials available to the evaluation for the desk reviews, which prevented the evaluation team from identifying the sources of any discrepancies. In these cases, the evaluation team used our calculated savings rather than the original PNM values. The reviewed measures with the greatest discrepancies were midstream HVAC measures and hot food holding cabinets.

A summary of the individual desk review findings for each of the 89 projects is included in Appendix E.

3.1.2 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 Retrofit Rebate, 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 Retrofit Rebate is 0.6733. For Midstream 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 projects. For Quick Saver, an NTG ratio of 1.00 was applied, due to the direct install design of this sub-program.[11]

For both 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* chapter. Instead, we have applied the *ex ante* NTG ratios for New Construction and Multifamily of 0.84 and 0.836, respectively.

Table 16 and Table 17 summarize the PY2017 net impacts for the Commercial Comprehensive program using the NTG ratios described above. Net realized savings for the program overall are 34,926,035 kWh and net realized demand savings are 4,637 kW.

Table 16: PY2017 Commercial Comprehensive Net kWh Impact Summary

Sub-Program	# of Projects	Realized Gross kWh Savings	NTG Ratio	Realized Net kWh Savings
Large Business	371	24,797,423	0.6733	16,695,002
Midstream	29	1,580,086	0.8400	1,327,272
Quick Saver	272	9,374,972	1.0000	9,374,972
New Construction	46	4,922,629	0.8400	4,135,008
Multifamily	65	4,059,546	0.8360	3,393,780
Total	**783**	**44,734,656**	**0.7807**	**34,926,035**

[11] PNM originally had an *ex ante* NTG ratio of 0.84 for the Quick Saver direct install program. 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 17: PY2017 Commercial Comprehensive Net kW Impact Summary

Sub-Program	# of Projects	Realized Gross kW Savings	NTG Ratio	Realized Net kW Savings
Large Business	371	2,958	0.6733	1,992
Midstream	29	260	0.8400	218
Quick Saver	272	1,547	1.0000	1,547
New Construction	46	709	0.8400	596
Multifamily	65	340	0.8360	284
Total	**783**	**5,814**	**0.7974**	**4,637**

3.2 Residential Lighting

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 18).[12]

Table 18: Sales of Bulbs Through the PNM Residential Lighting Program, March 28, 2016 – December 30, 2017 [13]

Retailer Type	Bulbs Sold	Percent of Total
Warehouse	475,567	37.2%
Non-Warehouse	801,850	62.8%
Total	**1,277,417**	**100%**

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

While 11 retailers participated in the Residential Lighting program over the period analyzed, participation in the program was dominated by just three retailers. Combined, these three retailers accounted for 86 percent of rebated sales through the program. Table

[12] Rebates were also available for CFLs through one retailer in PNM's service territory; however, CFLs accounted for only 0.01 percent of light bulbs rebated through the PNM lighting program.
[13] Bulbs invoiced during PY2017 were sold in stores between March 28, 2016 and December 30, 2017.

19 shows summary statistics for the price per LED bulb before rebate and the rebate amounts.[14] On average, LEDs sold through the PNM Residential Lighting program had a pre-rebate price of $3.17 and a median price of $2.50. Actual prices varied considerably, ranging from $1.80 to $14.00 per bulb.[15] Rebates provided to consumers through the Residential Lighting program ranged from $0.40 to $6.00, with an average and median rebate of $1.62 and $1.50, respectively. These rebates cut the price paid per bulb by between 11 percent and 71 percent of the pre-rebate bulb price. On average, the rebate reduced the price by 51 percent.

Table 19: Summary Statistics on Bulb Prices and Rebates, PNM Residential Lighting*

Statistic	Price Per Bulb Pre-Rebate**	Rebate Per Bulb	Rebate as % of Bulb Price
Mean	$3.17	$1.62	51%
Median	$2.50	$1.50	55%
Minimum	$1.80	$0.40	11%
Maximum	$14.00	$6.00	71%
25th Percentile	$2.16	$1.25	43%
75th Percentile	$3.50	$2.00	60%

* Summary statistics weighted by bulb sales.
** Summary statistics for the 57 most popular bulb types (accounting for more than 80 percent of bulb sales).

3.2.1 Residential Lighting Gross Impacts

For the residential lighting measures, the gross impact analysis consisted of reviewing the per unit savings values used for all the individual lighting measures covered by the program and then comparing these values with those in the New Mexico TRM. The evaluation team found no discrepancies between the *ex ante* savings values with the TRM, nor did we find any per unit values we believed should be revised. Therefore, we are not recommending any changes to the *ex ante* savings values, and the engineering adjustment factor is equal to 1.00.

To facilitate deemed savings reviews of the Residential Lighting program in the future, the evaluation team would recommend that the baseline wattage used to calculate savings be

[14] Bulb price was not included in the program tracking system data provided by PNM. The evaluation team identified the most popular bulbs—defined as those constituting 80 percent of PNM Residential Lighting bulb sales—and pulled bulb prices from retailer contracts provided by PNM. The evaluation team added pre-rebate bulb prices for 57 LED bulbs to the tracking database.
[15] ibid.

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).

3.2.2 Residential Lighting Net Impacts

The Residential Lighting program utilized an elasticity model to determine net impacts. As discussed in the *Evaluation Methods* chapter, the elasticity model estimates the relationship between price and the number of bulbs sold. Once this relationship is established, it can be used to estimate the share of total bulbs sold that should be attributed to the price reductions offered by the program.

The quantity of bulbs sold is inversely related to price, as illustrated by the sales and price data shown in Table 20. Nearly 83 percent of bulbs sold through PNM's Residential Lighting program were $2.00 or less, and another 15 percent were between $2.01 and $4.00. Relatively few bulbs sold through the program had a rebated cost greater than $4.00. This trend was explored in more detail using the elasticity model, described below.

Table 20: Bulb Sales by Rebated Price of Bulb*

Rebated Price of Bulb	Average Pre-Rebate Price Per Bulb	Average Rebated Price Per Bulb	Proportion of Bulbs Sold
$2.00 or less	$2.72	$1.27	82.5%
$2.01 - $4.00	$4.76	$2.96	14.8%
$4.01 - $6.00	$8.02	$5.07	1.4%
$6.01 - $8.00	$11.68	$7.87	0.5%
$8.01 - $10.00	$12.65	$9.10	0.7%
More than $10.00	$12.74	$10.74	0.2%

* Results in table are for the 57 most popular bulb types (accounting for more than 80 percent of bulb sales).

To develop the elasticity model, the evaluation team analyzed 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.[16] 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.

[16] Our analysis focused on bulbs invoiced to PNM during program year 2017, which included bulbs sold between March 28, 2016 and December 30, 2017.

To estimate the impact that price has had on the sale of LED bulbs, we specified and estimated a Poisson regression model.[17] 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 in time period t.

$Bulb\ Char_k$ 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 LED bulb will show any sensitivity to price.

We also estimated separate models for warehouse and non-warehouse retailers. Warehouse and non-warehouse retailers differed significantly with respect to average

[17] 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.

(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 21 shows the estimates of price elasticity of demand for each of the four regression models and for the program as a whole. 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 21 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, the evaluation team estimated the price elasticity of demand for all program LED bulbs to be -1.44. Thus, a 10 percent decrease in the price of LED bulbs will result in a 14.4 percent increase in demand for LED bulbs, holding all else constant.

Table 21: 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
Dollar Type Stores*	N/A	0.95
Residential Lighting Program	**-1.44**	**0.64**

* The evaluation team developed the estimated NTG ratio for bulbs sold at dollar type stores based on the modeling results for standard non-warehouse and standard warehouse LED bulbs.

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[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.

Table 21 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. To take into account the special case of dollar type stores where LED bulbs were not likely to be sold but for 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 PNM Residential Lighting program overall, the evaluation team estimated the NTG ratio to be 0.64.

Figure 6 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 drop, the proportion of purchasers that free ride decreases and the NTG ratio increases. 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 6) 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 6).

Figure 6: Estimated Free Ridership and NTG Ratio by LED Bulb Type and Retailer

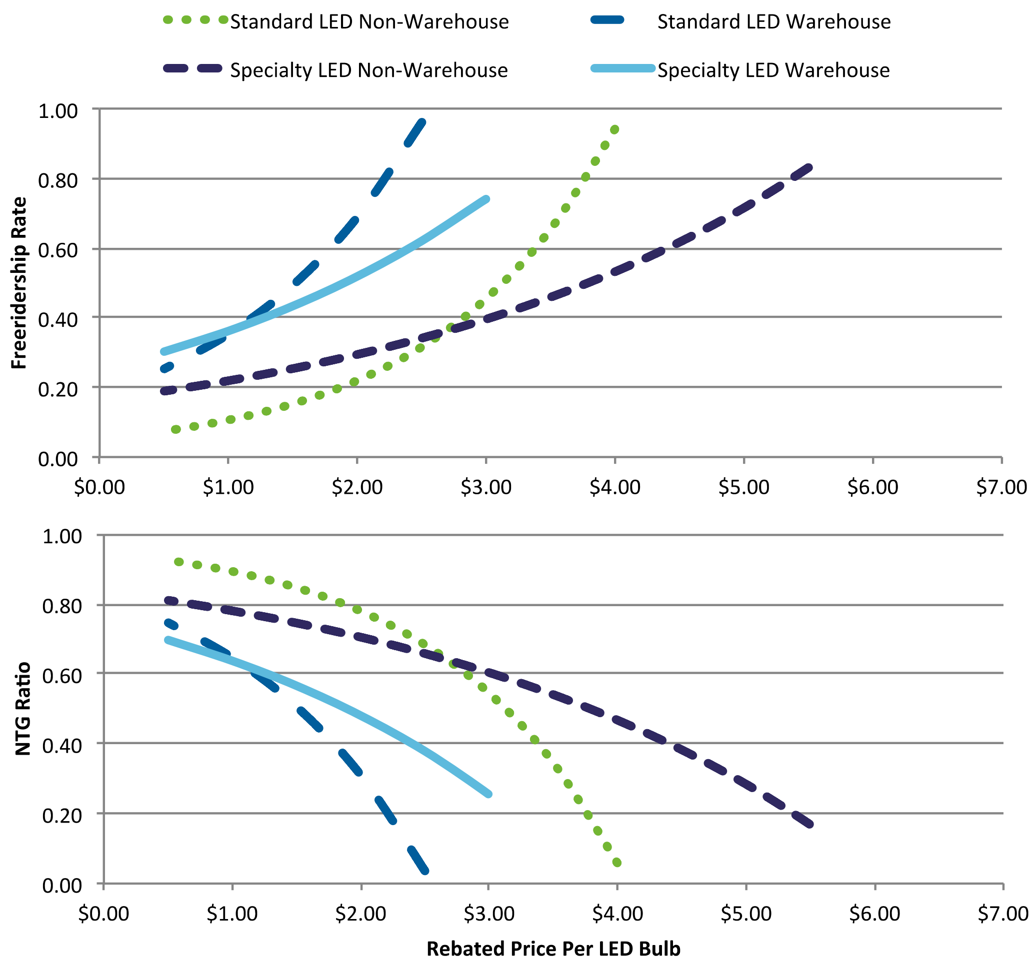


Table 22 summarizes the final gross and net impacts for the Residential Lighting program using the NTG ratio derived from the elasticity model. Using the overall NTG ratio of 0.64, the PY2017 net realized impacts for the Residential Lighting program are 22,420,807 kWh and 2,929 kW.

Table 22: Residential Lighting PY2017 Impact Summary

Residential Lighting	# of Projects	Expected Gross Savings	Engineering Adjustment Factor	Realized Gross Savings	NTG Ratio	Realized Net Savings
kWh Savings	1,274,328	35,032,511	1.0000	35,032,511	0.6400	22,420,807
kW Savings	1,274,328	4,577	1.0000	4,577	0.6400	2,929

3.3 Home Works

PNM's Home Works program provides energy efficiency education and kits of easy-to-install energy efficiency and water saving measures such as LEDs, faucet aerators, and low-flow showerheads to elementary and high school students. In 2017, 9,530 kits were distributed, with a total of 1,845,130 kWh and 112 kW gross savings claimed. To evaluate the impacts of the Home Works program, the evaluation team conducted a deemed savings review of the energy saving measures included in the school kits.

In the deemed savings review, we attempted to replicate the per unit savings values used by PNM based on the assumptions in the New Mexico TRM. For all school kit measures with deemed savings in the TRM, we found that PNM was applying the correct value from the TRM. The only measure that did not appear in the TRM is the five-minute shower timer. For that measure, PNM calculated savings based on assumptions in the TRM for the showerhead measure and assumed a five-minute shower with the timer, which we were able to replicate and found to be appropriate in the absence of a deemed TRM value. Therefore, the engineering adjustment factor for the Home Works program was 1.00.

The NTG ratio for the Home Works program is stipulated at 1, and as a result, the net realized savings are equal to the gross verified savings of 1,845,130 kWh and 112 kW.

3.4 Power Saver

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, which is approximately $25 per kW reduction.

There were six Power Saver events during the summer 2017 demand response season, which began June 1st and ended September 30th. Table 23 summarizes the conditions on these six 2017 demand response events.

Table 23: 2017 Power Saver Event Summary

Date	Day of Week	Start Time (MDT)	End Time (MDT)	Daily High at KABQ (F)
June 19	Monday	4:00 p.m.	8:15 p.m.	99
June 20	Tuesday	2:00 p.m.	6:00 p.m.	101
June 21	Wednesday	4:20 p.m.	7:50 p.m.	102
July 3	Monday	2:00 p.m.	6:00 p.m.	96
July 10	Monday	2:00 p.m.	6:00 p.m.	94
July 26	Wednesday	4:00 p.m.	8:00 p.m.	95

Shortly after the conclusion of the summer 2017 season, Itron provided the evaluation team with a series of datasets for the evaluation. These files included:

- For residential and small commercial sites, five-minute load data from 6/1/2015 to 9/30/2015, from 6/1/2016 to 9/30/2016, and from 6/1/2017 to 9/30/2017.
- 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.
- For medium commercial sites, five-minute load data from 6/1/2017 to 7/31/2017.
- For medium commercial sites, an M&V list that provided the dates each load control device was active.

The evaluation team also received Itron's Power Saver impact evaluation report, which detailed the methods Itron used in calculating customer baselines (CBLs) for the three different participant classes to reflect 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.

Using this information, the key steps the evaluation team used in the verified savings analysis were:

1. For each customer class, reproduced the performance estimates calculated by Itron using the contractually agreed-upon CBL method.
2. Modified the CBL methodology and produced *ex post* estimates of what the per-device impact was during the 2017 demand response season.

3. Where possible, leveraged additional historical data from 2015 and 2016 to produce *ex ante* estimates of what the per-device impact at peaking conditions will be in future summers.
4. Used the CBL methodology developed in (2) to estimate the net energy savings associated with each demand response event. In estimating energy savings, the evaluation team looked at net energy impacts from the beginning of each event through the end of the event day.

Table 24 summarizes the evaluation results. The main driver in the difference between Itron's and the evaluation team's load reduction estimates is that Itron commonly summarized impacts with the maximum (e.g., the largest of the twelve 15-minute rolling averages[19] in a one-hour interval is the impact for that interval), whereas the evaluation team summarized impacts with an average over the same period.

Multiplying our per-device reduction estimates by the number of devices in each class (shown in Table 24) leads to an average total estimated load reduction of approximately 24.7 MW, 1.7 MW, and 2.2 MW in the Residential, Small Commercial, and Medium Commercial customer classes, respectively. In aggregate, the average total estimated load reduction capability is 28.6 MW. This is approximately 62 percent of Itron's estimate (46.2 MW).

The energy savings estimates shown in Table 24 represent the sum of the kWh savings (per device) from the onset of each event through the end of each event day across the six events. Dividing the values in that row by six would yield an average kWh savings estimate per device per event day. In aggregate, the total estimated kWh savings were 327,198 kWh.

Table 24: Power Saver Impact Results

Customer Class	Number of Devices Installed	Itron Load Reduction Estimate (kW/device)	Evaluation Load Reduction Estimate (kW/device)	Evaluation Energy Savings Estimate (kWh/device)
Residential	35,291	1.02	0.70	8.07
Small Commercial	3,720	1.90	0.47	8.86
Medium Commercial	3,220	0.93	0.67	2.94

[19] A separate 15-minute rolling average is calculated for each 5-minute interval.

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

3.5 Peak Saver

PNM offers the Peak Saver program to non-residential customers with peak load contributions of at least 150 kW. The program compensates participants for reducing electric load upon dispatch during periods of high system load. In 2017, Peak Saver was implemented by EnerNOC, which managed the enrollment, dispatch, and settlement with participating customers. There were 106 participating facilities during the summer of 2017. The committed load reductions vary by participant, with the largest being 6,600 kW and 22 participants committing just 5 kW each. Two-thirds of the committed reductions came from three participants.

There were five Peak Saver events during the summer 2017 demand response season, which began on June 1st and ended on September 30th. Table 25 summarizes the 2017 events.

Table 25: 2017 Peak Saver Event Summary

Event Date	Weekday	Event Type	Nomination (MW)	Start Time (MDT)	End Time (MDT)	Daily High at KABQ (F)
June 19	Monday	Voluntary	15.8	3:55 p.m.	7:55 p.m.	99
June 20	Tuesday	Mandatory	15.8	2:00 p.m.	6:00 p.m.	101
June 21	Wednesday	Mandatory	15.8	4:32 p.m.	7:00 p.m.	102
July 3	Monday	Mandatory	16.8	2:00 p.m.	6:00 p.m.	96
July 10	Monday	Mandatory	16.8	2:00 p.m.	6:00 p.m.	94

Shortly after the conclusion of the summer 2017 season, EnerNOC provided the evaluation team with a series of datasets for the evaluation. These files included:

- Dispatch reports with participant-level and aggregate performance calculations for each event.
- Five-minute load data for each participating facility.
- One-minute load data for the eighth, ninth, and tenth minutes of each event. For the 6/21 event, this dataset also included load measurements for the fourth, fifth, and sixth minutes of the event window.

The dispatch reports contained load impacts calculated using a CBL method detailed in the contract between PNM and EnerNOC. The three key steps the evaluation team used to verify savings analysis included:

1. Reproducing the performance estimates calculated by EnerNOC using the contractually agreed-upon CBL method;
2. Assessing the accuracy of the contract CBL by examining its ability to predict loads on non-event weekdays; and
3. Modifying the CBL methodology to reduce bias and calculate verified impacts for each event.

Table 26 shows the results of our evaluation of the 2017 Peak Saver demand response events. On average, the evaluated verified capacity performance estimates are 76 percent of the totals reported by EnerNOC. The two main drivers of the lower estimates are the use of a symmetric weather adjustment and the fact that the evaluation did not zero out negative performance estimates. In cases where a site's weather adjustment resulted in a negative CBL, the evaluation team assigned a floor of zero kW.

Table 26: 2017 Peak Saver Evaluated Performance Summary by Event

Event Date	Nomination (kW)	10-Minute Capacity Performance (kW)	Average Capacity Performance (kW)	Verified Capacity Performance (kW)	Energy Performance (kWh)
June 19	15,800	2,733	9,977	5,630	38,113
June 20	15,800	20,887	19,164	20,198	76,656
June 21	15,800	21,064	16,622	19,287	41,386
July 3	16,800	15,430	11,707	13,941	47,142
July 10	16,800	21,824	20,913	21,459	82,873
2017 Average	**16,200**	**16,387**	**15,677**	**16,103**	**57,234**
Mandatory Event Average	**16,300**	**19,801**	**17,101**	**18,721**	**62,014**

The number of participants with negative verified capacity performance ranged from 16 (July 10) to 50 (June 19). One participant showed negative performance for all five events despite a 70 kW nomination. Seven participants showed negative performance for four events.

Table 26 also includes a summary row that excludes the June 19 voluntary event. Because we believe that demand response dispatch would be mandatory rather than voluntary in the event of true emergency grid conditions, the four mandatory events are the appropriate measurement of the capacity resource the Peak Saver program represents. Although the evaluated impacts are lower than the values reported in the dispatch reports, the 2017 Peak Saver program performance exceeded participant nominations on mandatory event days.

Independence Day Adjustment

In 2017, Independence Day fell on a Tuesday, which made Monday, July 3, an unusual day for a demand response event. While technically a non-holiday weekday, some businesses and workers elected to enjoy a four-day weekday or operate a reduced schedule on July 3. Table 26 shows that the evaluated impacts were down for all capacity metrics for the July 3 event. As can be seen in Figure 7, closer inspection of the load data revealed that the number of participants with an average adjusted CBL that was less than their nominated kW value was unusually high on July 3.

Figure 7: Number of Sites with CBL Less Than Nominated kW by Event

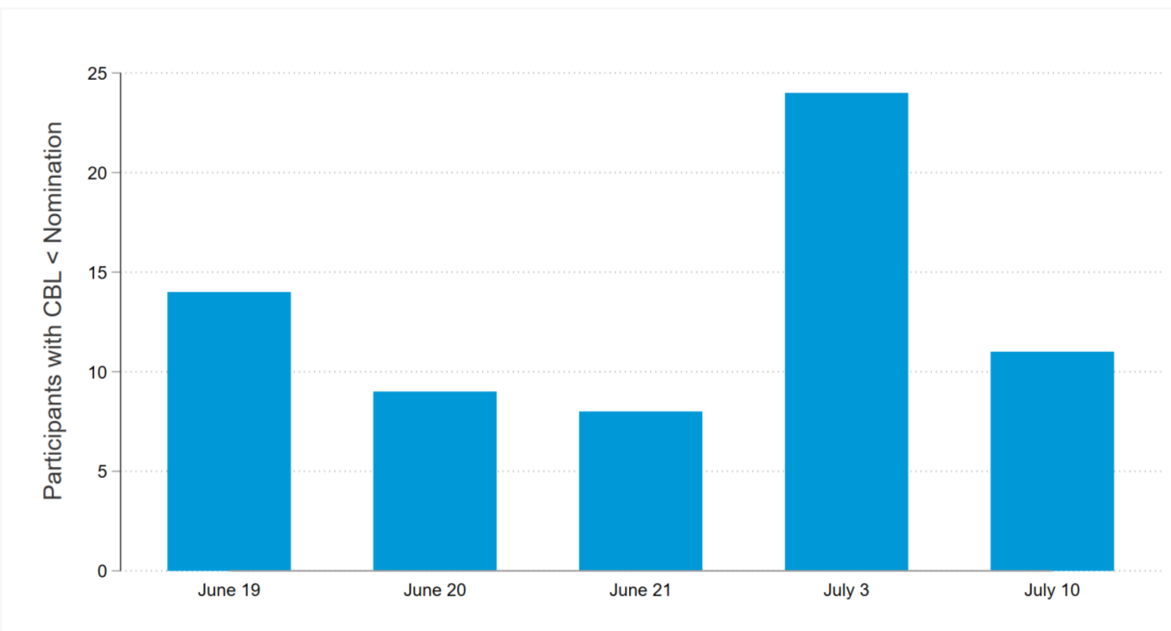
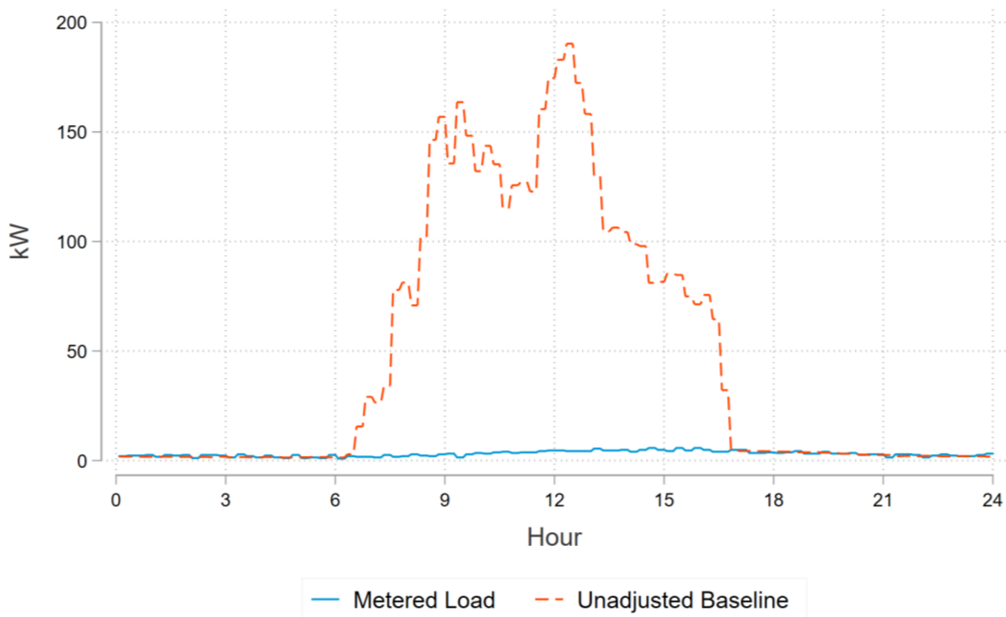


Figure 8 provides a visual example for a specific participant (PNM35811). This participant has a nominated kW value of 190 kW for each 2017 event. The unadjusted baseline trend for the day indicates what the typical recent load pattern for the site is—the site opens around 6:00 a.m. and operates until about 5:00 p.m. most weekdays, with peak loads approaching 200 kW. However, on July 3, the site never records a five-minute demand measurement over 6 kW. The business is clearly closed for the day. A symmetric adjustment picks up this closure and reduces the CBL to near zero.

Figure 8: Metered Load vs. Baseline for Closed Site – July 3, 2017



This highlights an interesting policy issue. If a site commits to reduce load upon request and nominates a kW value, that nomination will generally assume that they are operating and can turn off certain non-essential processes. On a day when the facility is already closed, there are two perspectives:

1. **Down-From** – The site has no load and therefore cannot provide any load reduction to the system.
2. **Down-To** – The nomination value is a pledge to use less electricity during demand response events. If the facility happens to be closed during the event, their load is down (unrelated to dispatch). If the processes are already off, there is no way to reduce load further.

The settlement rules of Peak Saver are indicative of a 'down-from' program approach. In a 'down-to' program, the utility would ask customers to commit to reducing load to a certain level when dispatched and the load reduction would be measured against some historical average demand level. For example, if a site with a typical monthly peak demand of 500 kW commits to reducing their load to 100 kW when dispatched, that commitment would be considered a 400 kW capacity resource.

Weather conditions were not particularly extreme on July 3 in PNM's service territory. System load peaked for the day at 1,604 MW, which was only about 85% of the peak load for the summer (1,893 MW), so we recommend excluding the July 3 event from estimates of the size of the Peak Saver resource.

Table 27 summarizes performance across the other three mandatory events. Based on the 2017 results, the Peak Saver program appears to be an approximately 20 MW capacity resource.

Table 27: 2017 Peak Saver Impact Results

Event Date	Nomination (kW)	10-Minute Capacity Performance (kW)	Average Capacity Performance (kW)	Verified Capacity Performance (kW)	Energy Performance (kWh)
June 20	15,800	20,887	19,164	20,198	76,656
June 21	15,800	21,064	16,622	19,287	41,386
July 10	16,800	21,824	20,913	21,459	82,873
Average	**16,133**	**21,258**	**18,900**	**20,315**	**66,972**

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

4 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.[20] The evaluation team conducted these tests in a manner consistent with the California Energy Efficiency Policy Manual.[21]

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 28.

Table 28: 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 29. All programs had a UCT of greater than 1.00, and the portfolio overall was found to have a UCT ratio of 1.57.

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

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

Table 29: PY2017 Cost Effectiveness

Program	Utility Cost Test (UCT)
Commercial Comprehensive	1.52
Residential Lighting	3.01
Home Works	1.64
Energy Smart	1.03
Residential Comprehensive	1.40
Easy Savings Kit	2.23
New Homes	1.11
Power Saver	1.04
Peak Saver	1.11
Overall Portfolio	**1.57**

5 Process Evaluation Results

This chapter summarizes key methods and findings from the PY2017 process evaluation of the PNM Commercial Comprehensive Quick Saver, Retrofit Rebate, New Construction, and Multifamily sub-programs. These findings, along with findings from the impact evaluation, informed the conclusions and recommendations presented in the following chapter.

5.1 Quick Saver and Retrofit Rebate Participant Surveys

As part of the process evaluation, the evaluation team conducted telephone surveys with representatives from 113 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 2018 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 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 the following subchapters).

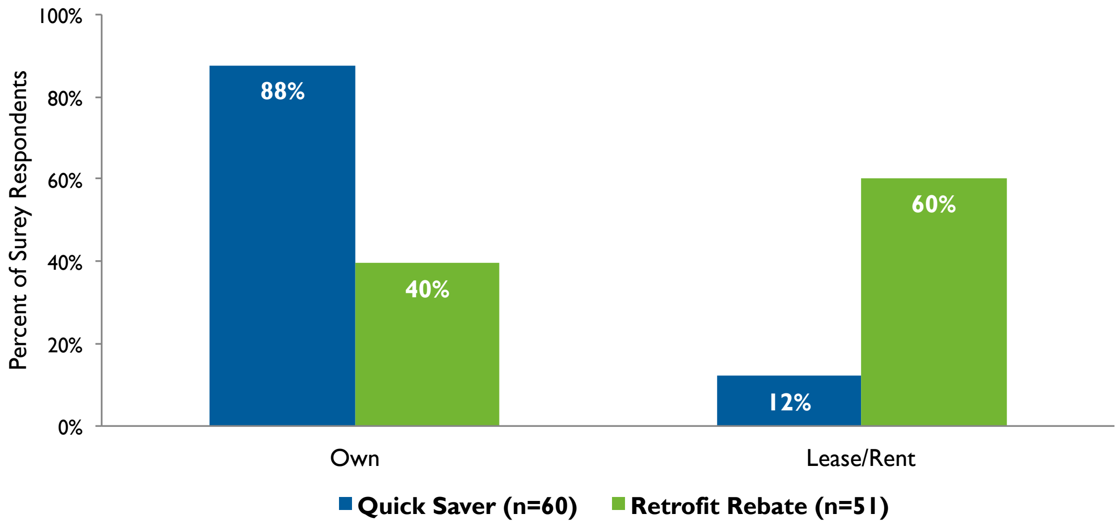
The following subchapters report results on company demographics, sources of program awareness, motivations for participation, and program satisfaction.

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.

5.1.1 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 program participants, Figure 9 shows that 88 percent of Quick Saver program participants own their building, which is somewhat unexpected as direct install programs typically target customers that rent their spaces. In contrast, 60 percent of Retrofit Rebate participants reported they lease or rent the building where the measures were installed.

Figure 9: 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 programs. Consistent with program design, Figure 10 and Figure 11 both show that the majority of larger customers get rebates through the Retrofit Rebate program with 62 percent occupying buildings of 100,000 square feet or more. Additionally, 63 percent of Retrofit Rebate participants reported having more than 1,000 full-time employees, all within the healthcare sector. Comparatively, mid- to small-sized customers were more commonly participants of the Quick Saver program, with most participant firms occupying buildings of less than 50,000 square feet. In addition, the majority of Quick Saver participants reported having less than 100 full-time employees and represented multiple sectors, including hotel/motel, light industry, office/retail, and schools.

Figure 10: Quick Saver and Retrofit Rebate Participant Building Size

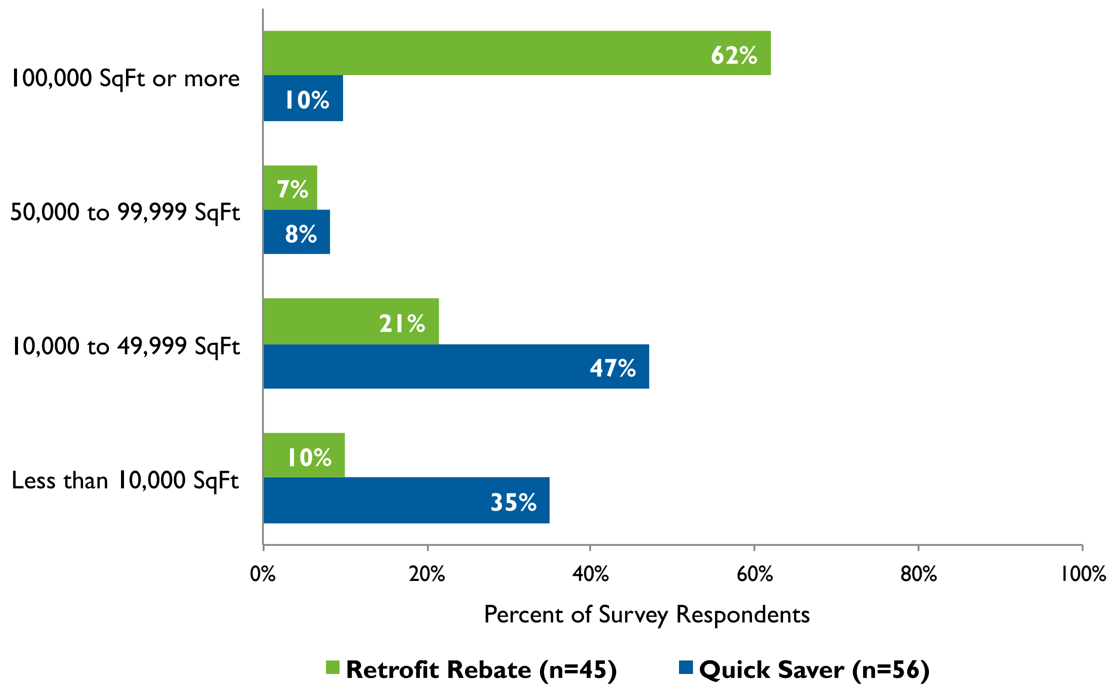
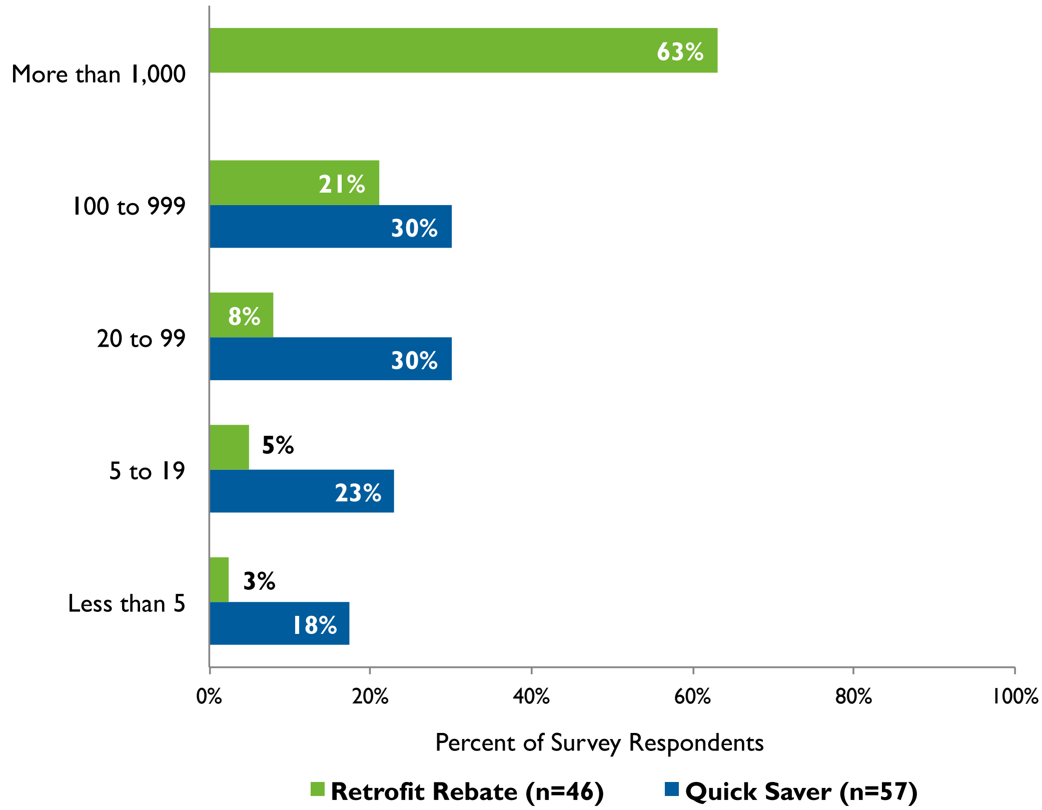
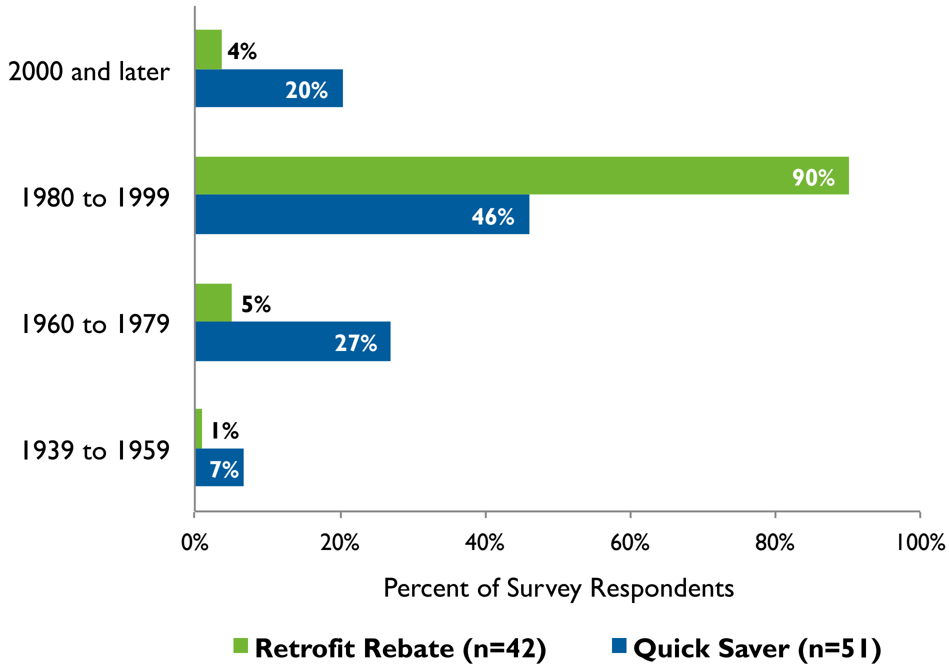


Figure 11: Quick Saver and Retrofit Rebate Participant Number of Employees



Additionally, Figure 12 shows that the vast majority (90%) of Retrofit Rebate participants' buildings were built between 1980 and 1999 compared to 46 percent of Quick Saver participants' buildings. Quick Saver participants generally occupy older buildings on average, with 34 percent reporting that their buildings were built sometime before 1979 compared to just 6 percent of Retrofit Rebate participants' buildings built in the same time frame. This suggests that both programs are doing a good job at targeting older buildings, where the potential for significant energy savings is the greatest.

Figure 12: Quick Saver and Retrofit Rebate Participant Building Age



5.1.2 Sources of Awareness

Both Retrofit Rebate and Quick Saver 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 13, the majority (62%) of Retrofit Rebate participants are learning about program offerings through their own online research. Additionally, as expected for Quick Saver participants, the most frequently reported channel was through contractors/distributors (40%) and word of mouth (40%).

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 14, the most frequently reported useful source of awareness for both programs was the contractor. 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 programs.

Figure 13: Initial Source of Awareness

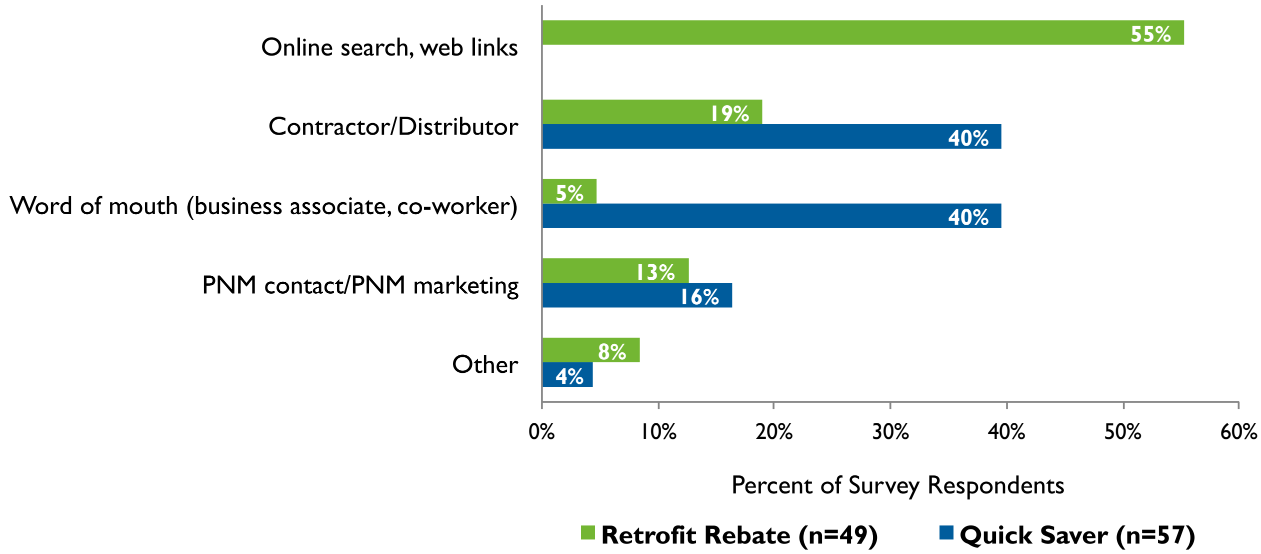
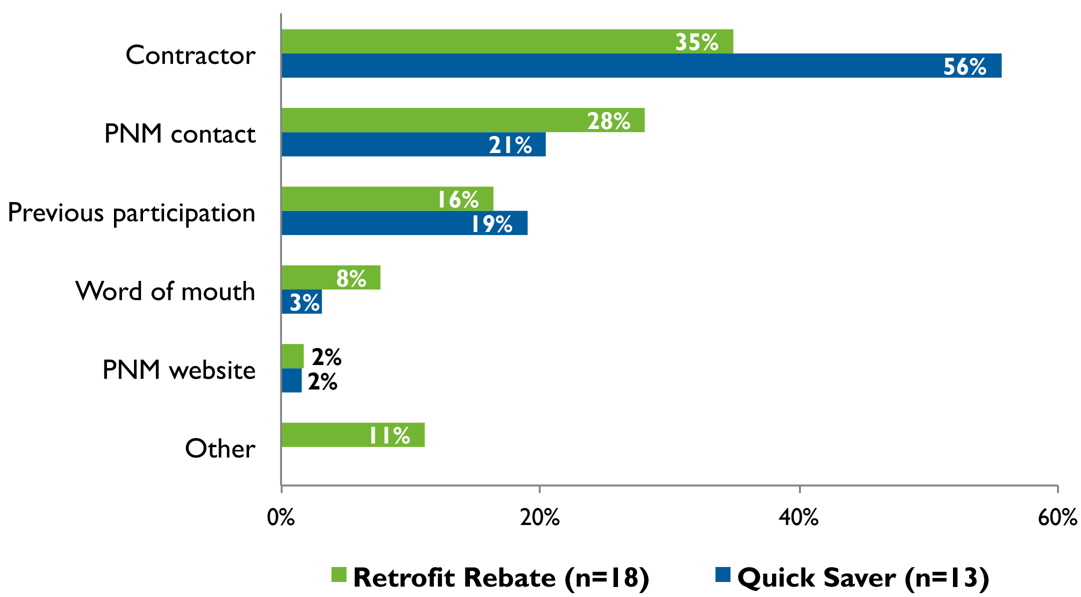


Figure 14: Most Useful Source of Awareness



5.1.3 Motivations for Participation

Figure 15 and Figure 16 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; 61 percent of Quick Saver and 76 percent of Retrofit Rebate participants reported that these expected savings were extremely important in their decisions to participate in the 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 74 percent reporting that it was "extremely important." Consistent with what is shown in Figure 14, the contractor recommendation was more important in the Quick Saver participants' decision to participate in the program, with 59 percent reporting it as "extremely important," compared to 10 percent of Retrofit Rebate participants. This is not surprising given the heavy reliance on the contractor for a direct install program.

Interestingly, improving air quality was the least important factor in participants' decision to participate in the Retrofit Rebate program, with 15 percent saying it was "very important" and the majority reporting it was only "somewhat" or "a little important" in their decision to participate.

Figure 15: Quick Saver Motivations for Participation (n=54)

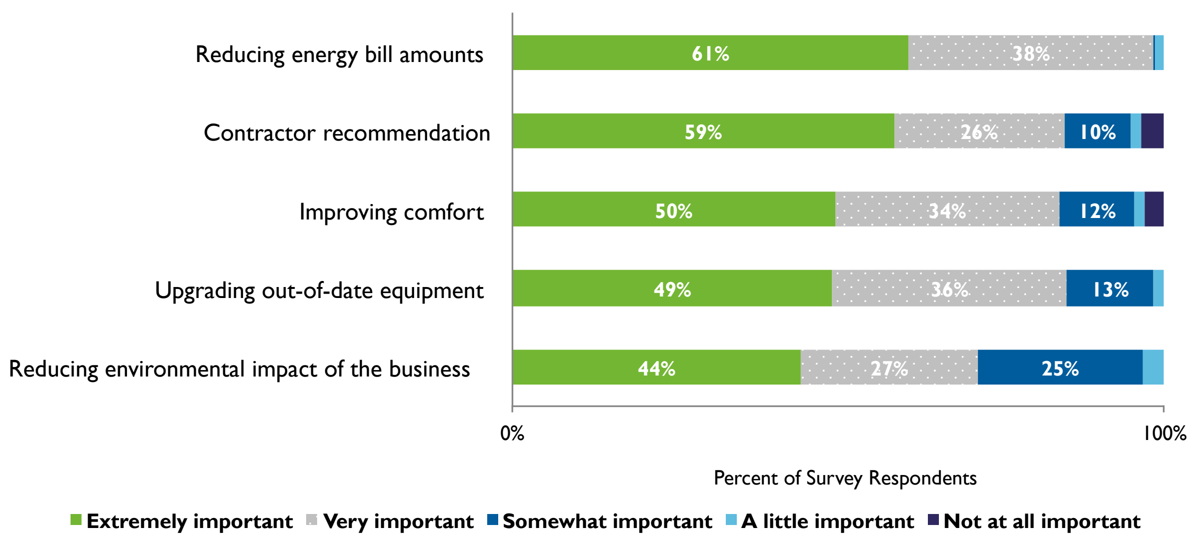
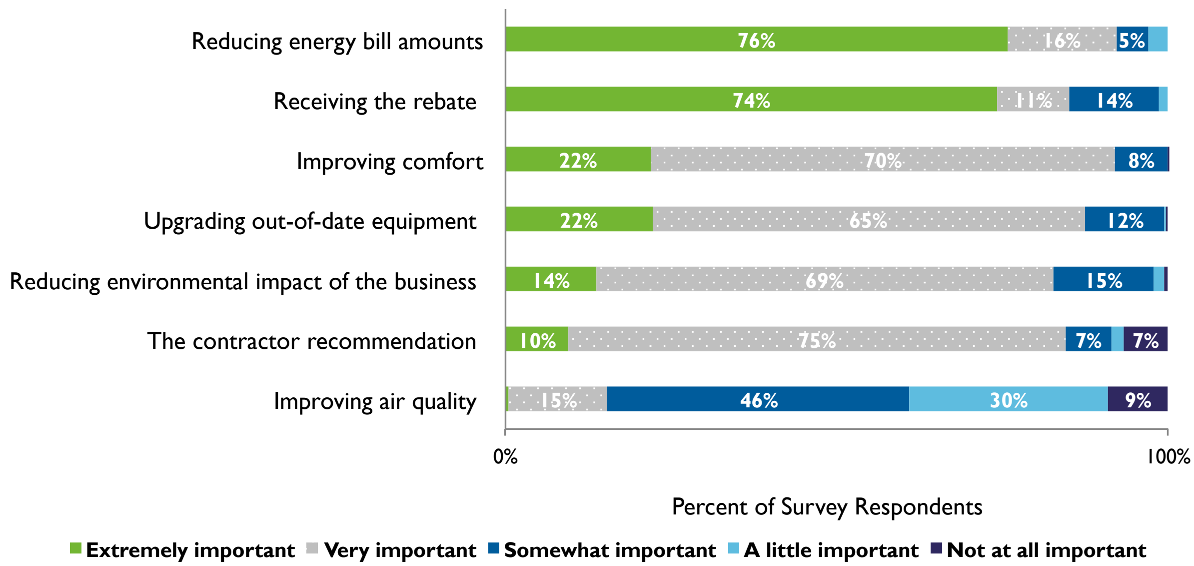


Figure 16: Retrofit Rebate Motivations for Participation (n=53)



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.[22] As shown in Figure 17 below, the majority of Retrofit Rebate participants rated all of the program factors as very to extremely important (8-10) in their decision to determine how energy efficient their project would be.

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

Figure 17: Retrofit Rebate Importance of Program Factors (n=53)

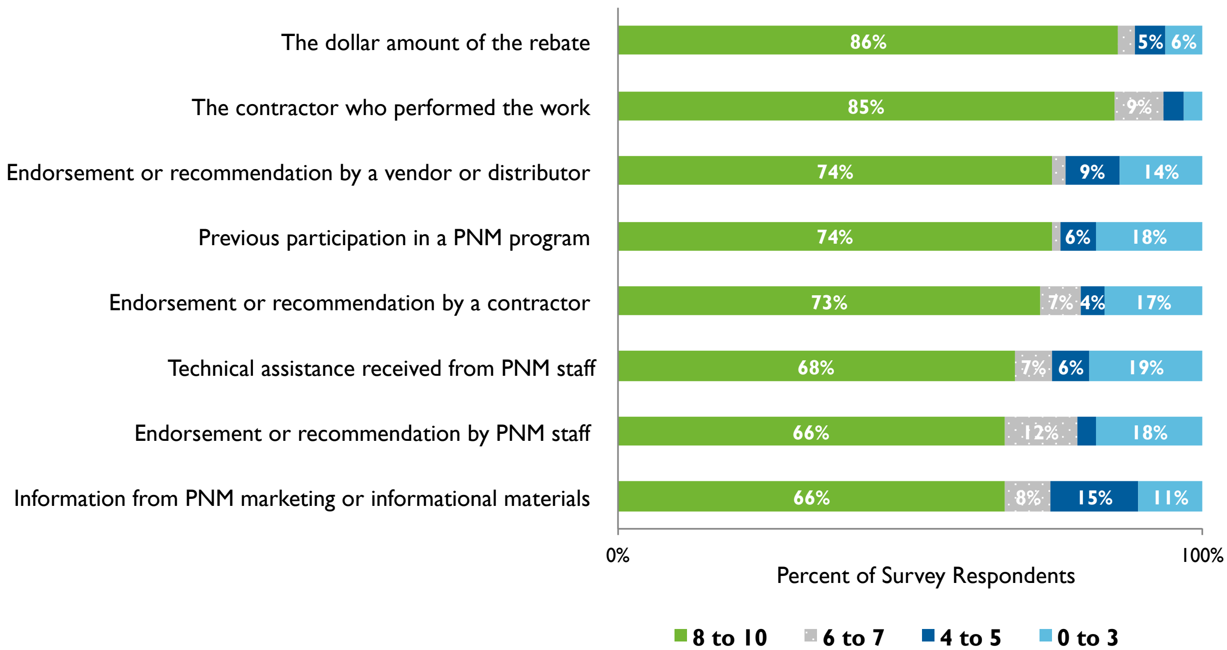
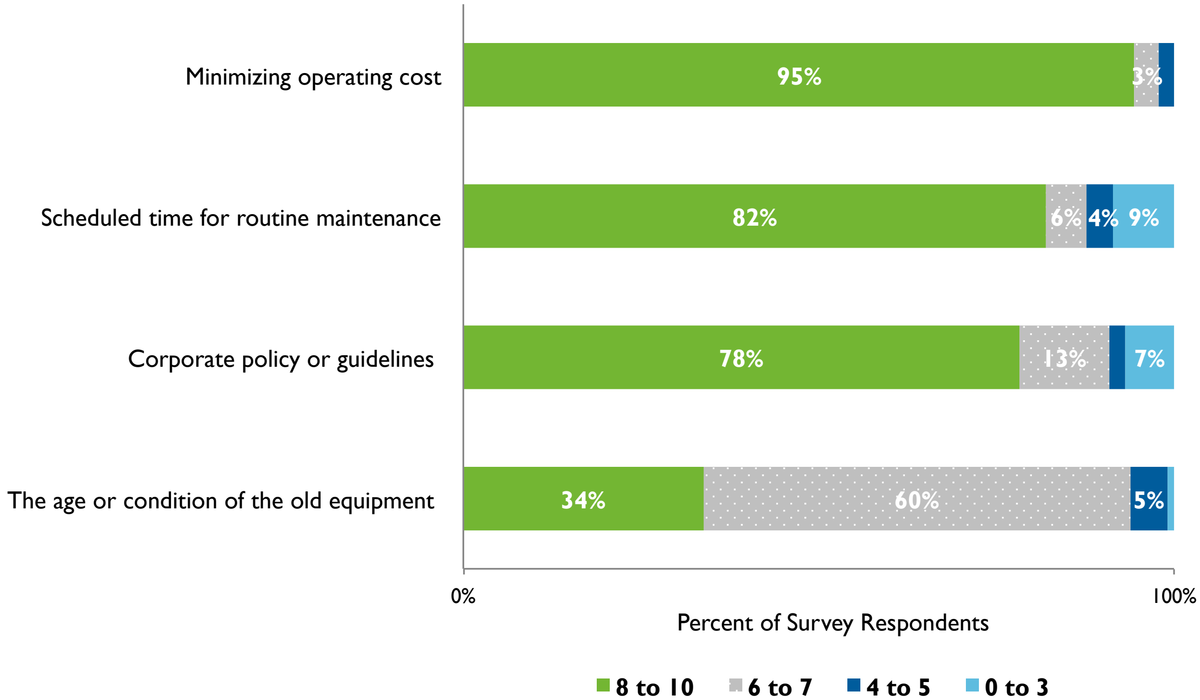


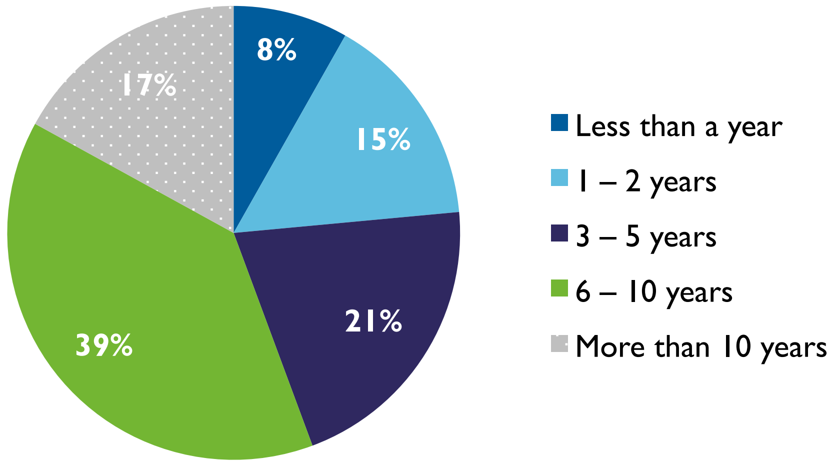
Figure 18 shows the majority of Retrofit Rebate participants rated all but one of the non-program factors as very to extremely important (8-10) on the decision to determine how energy efficient their project would be. Minimizing operating cost was the most influential non-program factor in the decision regarding efficiency level of the equipment. The age or condition of the old equipment was reported as less influential (but still important) than other non-program factors, with 60 percent of participants reporting that it was somewhat important (rating of 6 or 7).

Figure 18: Retrofit Rebate Importance of Non-Program Factors (n=53)



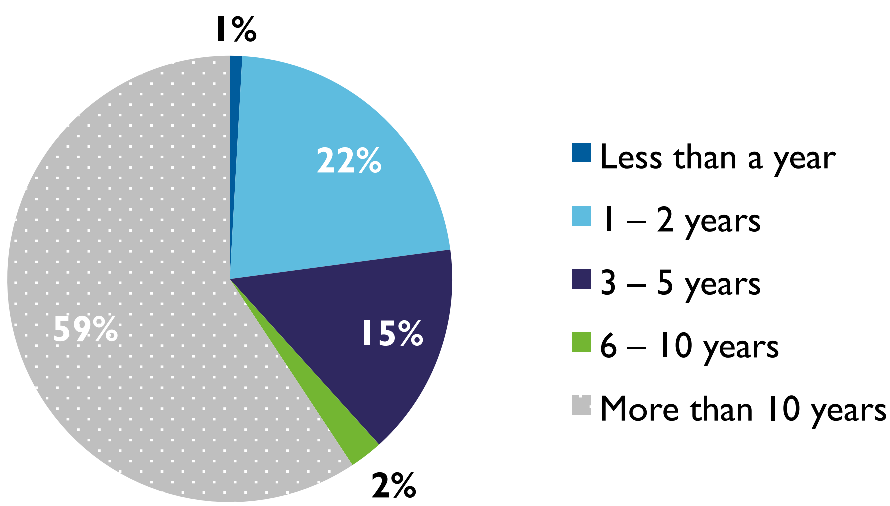
To get a sense of the condition of the existing equipment, respondents were asked approximately how much longer would the equipment have lasted if it had not been replaced. Figure 19 below shows that the majority of Quick Saver participants believed that their equipment would have lasted more than six 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 19: Quick Saver Participant Equipment Remaining Life (n=43)



Similarly, Figure 20 shows the majority of Retrofit Rebate participants reported that their equipment would have lasted more than ten years. This indicates that Retrofit Rebate participants were prompted to replace their equipment even earlier than Quick Saver participants.

Figure 20: Retrofit Rebate Participant Equipment Remaining Life (n=41)



5.1.4 Participant Satisfaction

The participants evaluated their satisfaction with various components of the Quick Saver and Retrofit Rebate 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:

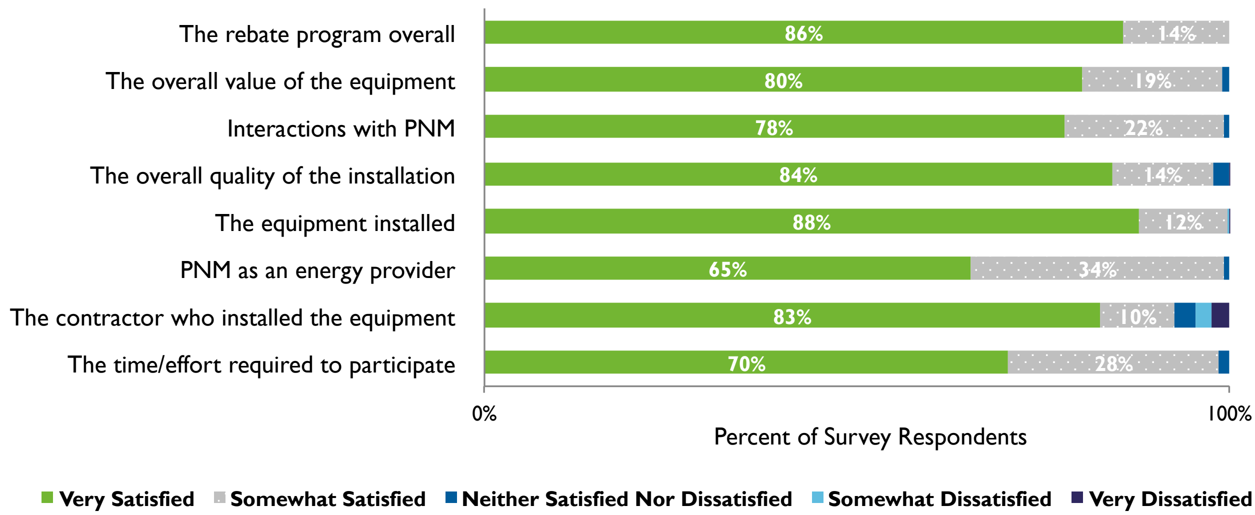
- PNM as an energy provider
- The rebate program overall
- The equipment installed through the program
- The contractor who installed the equipment
- Overall quality of the equipment installation
- The time it took to receive the rebate
- The dollar amount of the rebate
- Interactions with PNM
- The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

Figure 21 and Figure 22 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 program components. As shown in Figure 21, Quick Saver participants expressed high levels of satisfaction across each individual program component, with the majority reporting being "very satisfied" or "somewhat satisfied." A small percentage of Quick Saver participants reported lower satisfaction ratings, primarily with the contractor that did the installation.

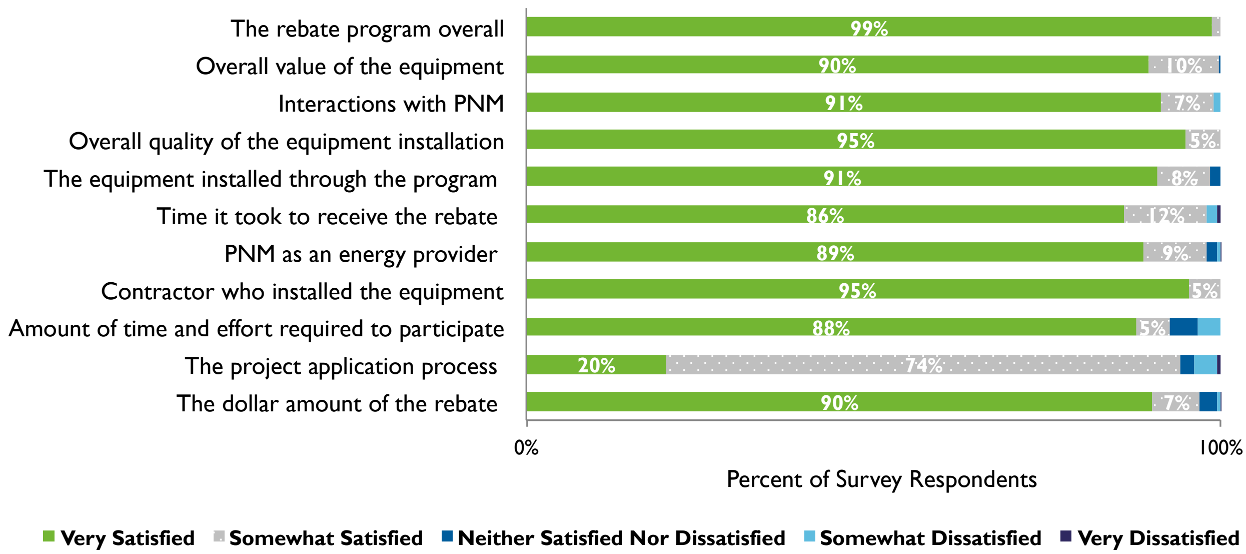
Some of the justifications Quick Saver participants provided for their low satisfaction ratings were that "some equipment was not working properly" and "the contractor was unresponsive when coordinating the time they would be there to install or replace the existing equipment."

Figure 21: Quick Saver Participant Program Satisfaction (n=60)



As shown in Figure 22, 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 95 percent were "very satisfied" with the contractor who installed the equipment. Contrarily, the majority of Retrofit Rebate participants reported being just "somewhat satisfied" with the project application process, with some reasons being that "the paperwork was tedious and it was difficult to find the information needed to complete the forms" and "the forms were too complicated and there were too many pages to fill out."

Figure 22: Retrofit Rebate Participant Program Satisfaction (n=53)



5.2 Multifamily Participant Interviews

The evaluation team interviewed five property managers of multifamily facilities that participated in PNM's Multifamily sub-program of the Commercial Comprehensive program in the latter half of 2017. The interviews focused on the following topics:

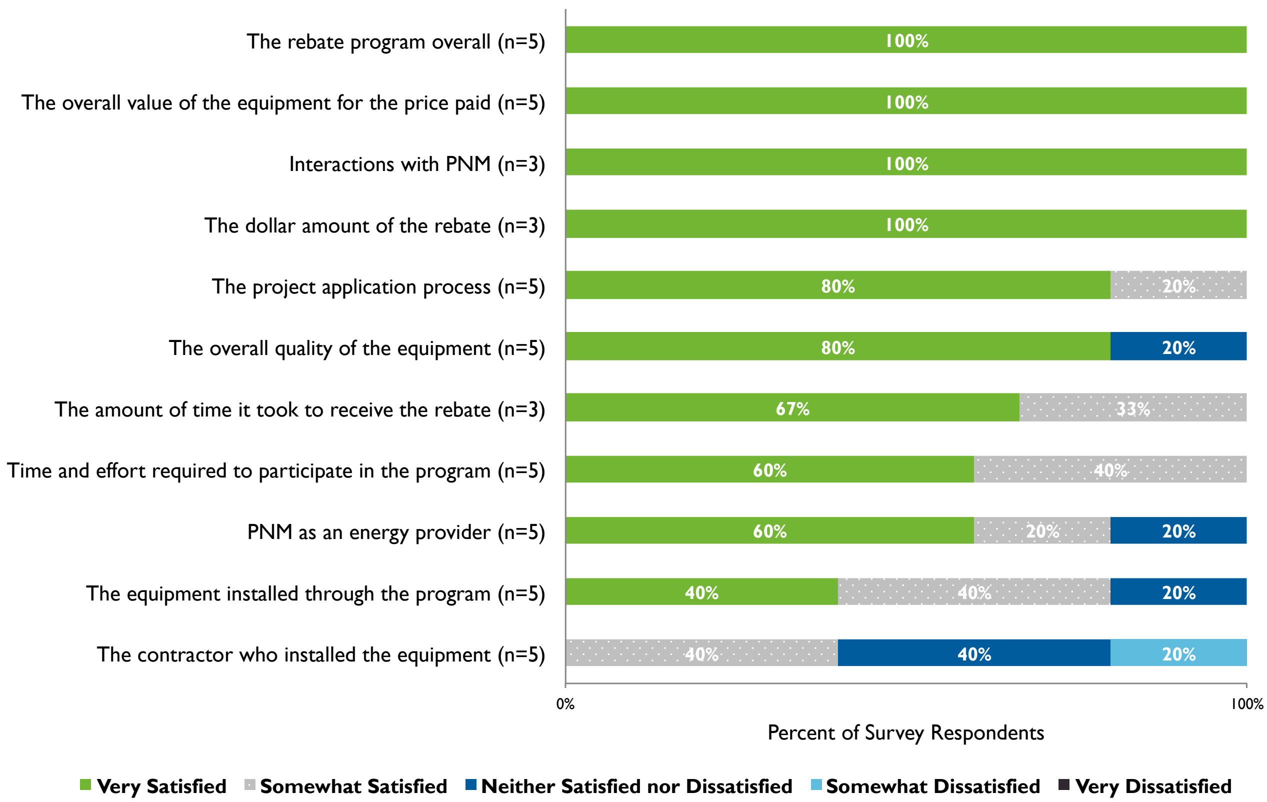
- Project context and background;
- Role and influence of the PNM Multifamily program; and
- Program satisfaction.

The sampled properties included two facilities that qualified as affordable and three market rate complexes. They ranged in size from 50 to 410 units; most were built in the 1970s. All of the sampled properties received lighting upgrades in tenant spaces, common areas, and exterior spaces; one was part of a portfolio-wide upgrade that included non-lighting measures at other buildings.

Satisfaction with PNM's program was high, but three participants commented on issues involving the contractor who approached them about the program and installed some of the upgrades. As shown in Figure 23 below, all five interviewees said they were "very satisfied" with the program overall on a 1 to 5 point scale, where 1 meant very dissatisfied and 5 meant very satisfied. They expressed satisfaction with the incentives, the value of the program and products received, and the processes involved in participating. However, three interviewees offered critical comments involving the program contractor and recommended that PNM work more closely with their contractor(s) to ensure clear communications and high levels of customer service. Specifically:

- One believed that the contractor promised more fixtures than the complex received, noting that they received bulbs when they thought they were receiving fixtures;
- One felt that the contractor did not communicate well about the timing of the upgrade and then rushed the installation work, which the interviewee blamed for several failures of outdoor fixtures installed as part of the program; and
- One commented that the contractor seemed unclear about the PNM program offering, and the interviewee ultimately was not able to recoup costs as expected.

Figure 23: Multifamily Participant Program Satisfaction



Program participants described the PNM Multifamily program as having influenced the scope and timing of their upgrades, although some degree of upgrade would likely have happened for each of these properties even in the absence of the PNM offering. The degree of program influence varied:

- For three of the five properties, the PNM Multifamily program expanded the scope of the lighting upgrade that was underway or being considered, or the program caused the upgrades to happen earlier by at least a couple of years. Each of these interviewees suggested that PNM's Multifamily program was responsible for about 80 percent of their decision to upgrade their efficiency to the level that they did.

- Interviewees from the other two properties claimed to be doing similar upgrades already and commented that the PNM Multifamily program made the upgrade less expensive; in one of these cases, the program allowed the low-income property manager to stretch their dollars further, increasing the scale of a larger upgrade effort by 5 to 10 percent. These two interviewees suggested PNM's Multifamily program was responsible for 20 to 50 percent of the upgrades they completed.

When asked about the degree of influence that various program and non-program factors had on their decision to upgrade to the efficiency levels they did, interviewees ranked the financial benefits of reduced operating cost and the PNM rebate as the most influential factors, on average. Other important factors were the contractor they used and company policy or goals that prioritize efficiency. In general, a mix of program and non-program factors played a role in the decision of these customers to upgrade to efficient equipment.

All of the interviewees were first-time participants in PNM's Multifamily program. One commented that awareness of the program is probably very low among multifamily property managers, and he recommended that PNM market the program in addition to the outreach conducted by the program contractor.

5.3 New Construction Participant Interviews

The evaluation team completed six interviews with participants of the 2017 New Construction sub-program of Commercial Comprehensive; these participants had a range of experience with the program. The interviews focused on the following topics:

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

5.3.1 Project Background

Three of the participants had completed more than one project through the New Construction program, including one participant with experience across four completed projects. While participants had varying levels of interaction with the New Construction program directly, all six were familiar with the eligible project and played a significant role in their business's participation in the program.

The types of projects varied across the participants both in terms of business types and installed measures. Business types included elementary schools (n=2), healthcare offices and facilities (n=2), a parking garage (n=1), and a large office building with classroom and child care facilities (n=1). All six participants completed some type of lighting measure in their New Construction projects, while five of the six also included HVAC measures including air source heat pumps (n=3), unitary and split air conditioning systems (n=3), and variable refrigerant flow (VRF) heat pumps (n=1). All six participants—across the 11 total projects their companies completed—stated they used one or more contractors and electricians to complete their project that was rebated through the New Construction program.

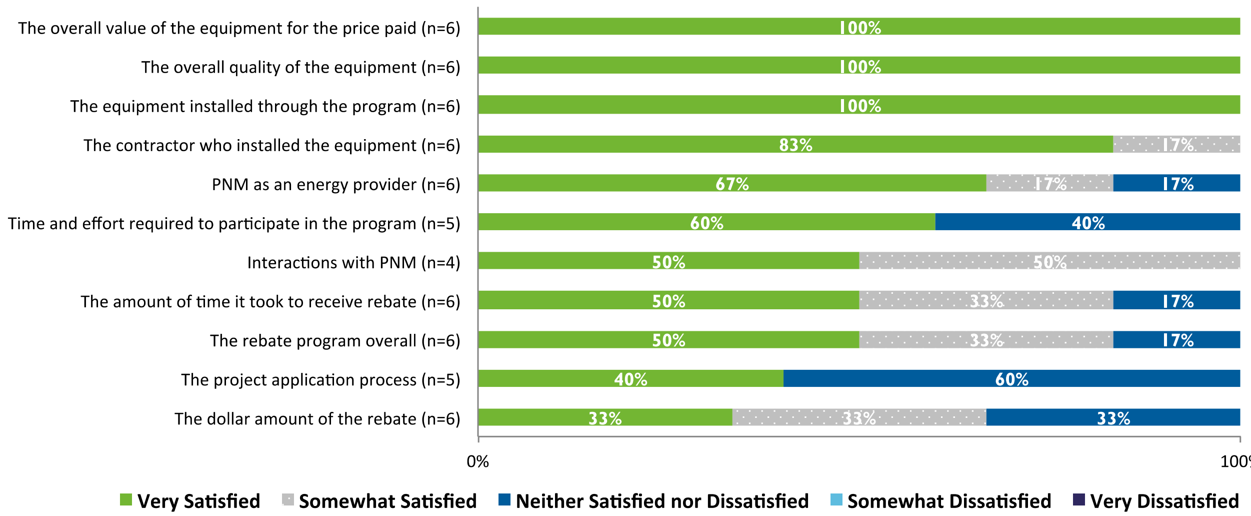
5.3.2 Program Satisfaction

New 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. 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
- The overall quality of the equipment
- The amount of time it took to receive rebate
- The dollar amount of the rebate
- Interactions with PNM
- The overall value of the equipment received for the price paid
- The amount of time and effort required to participate in the program
- The project application process

Overall, as shown in Figure 24 below, participants expressed a high level of overall satisfaction, especially with the overall value and quality of the equipment they installed (mean score of 5). Participants were less satisfied with the project application process (3.8), the dollar amount of the rebate (4), and the amount of time and effort required to participate in the program (4), although none of the six participants said they were dissatisfied with any of those components. However, two of the participants noted the participation process—including the application form and receiving the rebate—seemed to be overly time consuming, while one noted they ended up receiving a smaller rebate than they expected.

Figure 24: New Construction Participant Program Satisfaction



Given the relatively high level of satisfaction, participants did not share many direct suggestions for improving the New Construction program. However, two participants noted that an increase in outreach efforts would be helpful for businesses to learn about the available rebates earlier in the planning process, prior to working with contractors or other market actors that are familiar with the program. As one interviewee noted:

> *A lot of the rebate work was mostly after the fact. It would have been helpful to know ahead of time what was required and what was eligible for a rebate when picking out what equipment to install.*

Additionally, one participant that has completed multiple projects through the New Construction program, as well as dozens of other new construction projects, said they have encountered issues with the New Construction program because certain pieces of equipment they anticipated to get rebates on were not eligible because they had already been incentivized through a distributor midstream program. As the participant noted:

> *The program as it's set up doesn't seem to know how big projects work. We put out big competitive bids and everyone wants these jobs so contractors go get prices from supply houses…and the lowest price wins the day. But when the rebate is applied at the supply shop, and then we go out and send an application and find out the equipment installed is not eligible for a rebate because it was supposedly already given at the supply house and we never knew that when we bought the package from the contractor…I'd love for PNM to figure out a way, honestly, to do away with some of the midstream incentives and make sure distributors and contractors don't try to take reduced price from PNM for bid projects they put out.*

5.3.3 PNM Program Influence

In an effort to gauge the level of influence the New Construction program had on the efficiency level of participants' projects, the evaluation team asked participants 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.

To gauge the influence of the program specifically, interviewees were asked how influential program factors such as the rebate, any technical assistance, recommendations or information from the utility, and their prior participation in PNM rebate programs were in their efficiency upgrades. In evaluating the influence of non-program factors, the evaluation team asked participants how factors such as the financial benefits of the efficiency upgrade through reduced operating costs and pre-existing corporate energy efficiency targets contributed to their efficiency upgrade.

Overall, all six interviewees noted that the non-program factors played a more significant role in their decision to upgrade their efficiency than the program factors did. As a result, four out of the six said it was extremely likely they would have reached the same building energy efficiency level had the New Construction program not existed, while the other two noted it was somewhat or very likely. Generally, participants stated that the rebate was a helpful contribution to their project but was not a primary motivator in their final decision, either because it was a small percentage of their project budget or because they did not know about the rebate until after starting their project. As one participant noted:

> *It [the rebate] was certainly not a primary factor but it is an influence. The whole energy department here has a desire to save energy so we have a bigger commitment to that than getting any particular rebate. The rebate can be a driver sometimes, though; it certainly doesn't mean it's not important to us. But would we try to be energy efficient without it? Absolutely.*

6 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 evaluation component (impact evaluation, cost effectiveness, and process evaluation) and program.

6.1 Impact Evaluation

Impact evaluation activities for the 2017 programs included engineering desk reviews for a sample of the Large Business, Midstream, Quick Saver and New Construction sub-programs of the Commercial Comprehensive program. In addition, the evaluation team conducted deemed savings reviews for the Home Works and Multifamily programs. Net impacts for the Residential Lighting program were estimated with an elasticity model using program tracking data of bulb sales. Impacts from the two demand response programs, Power Saver and Peak Saver, were estimated using billing regression models.

6.1.1 Commercial Comprehensive

For the Commercial Comprehensive sub-programs evaluated by desk reviews (Large Business, Midstream, Quick Saver and New Construction), an engineering adjustment factor of 0.9047 was found for kWh savings and 0.7499 was found for kW savings. This was primarily due to three main factors:

1. The New Mexico Technical Reference Manual (TRM) and the PNM Workpapers conflict with each other.
    - Some measures are contained in both documents, creating conflict, and some measures are available in only one document, creating inconsistent options.
    - Of significant impact, the packaged air conditioner measure has the following conflicts between the TRM and the Workpapers:
        - Baseline efficiencies in Table 43 of the Workpaper do not match those in Table 26 of the TRM.
        - The Workpapers base kW savings for units 65 kBtu/h or less on their SEER rating, while the TRM bases kW savings for these units on their EER rating.
    - The documents have inconsistent references:
        - The New Mexico TRM refers to International Energy Conservation Code (IECC) 2009.
        - The PNM Workpapers refer to IECC 2006.

- There is also a potential issue with changing ENERGY STAR standards if document updates are not on the same schedule.
- The documents have inconsistent peak demand period definitions:
    - The New Mexico TRM defines the peak demand period as the period from 3:00 p.m. to 6:00 p.m. on the hottest summer weekdays.
    - The PNM Workpapers define the peak demand period as being from 8:00 a.m. to 8:00 p.m. on weekdays from June through August.
- **Recommendation 1:** Ensure that the PNM Workpapers are consistent with the New Mexico TRM, as is appropriate. In cases where the Workpapers are in direct conflict with the TRM, indicate the reasoning and justification for deviating from the TRM.

2. Custom lighting hours of use (HOU) are being used in savings calculations but are not being adequately documented. PNM implementation staff noted that lighting HOU are often modified based on site-specific findings. However, in the project files submitted to the evaluation team, custom lighting HOU were often not clearly documented. In these cases, the evaluation team deferred to the New Mexico TRM, as the TRM serves as a guidance document for savings calculations. Deviations from the TRM are allowed, but they must be adequately documented. Without adequate documentation of what custom lighting HOU were used and how they were derived, the evaluation team relied on the TRM HOU values.
    - **Recommendation 2:** Clearly document custom lighting HOU values, indicating the values used and how they were derived.
3. Specific *ex ante* calculation steps and adjustments for prescriptive projects are unclear.
    - There is no documentation of the specific steps taken for individual projects between application submission and final reported savings.
    - Using inputs from project documents and following algorithms from the PNM Workpapers to the letter resulted in savings different than those reported by PNM for multiple projects.
    - PNM implementation staff mentioned that adjustments are made on a case-by-case basis to deviate from the Workpapers' assumptions when appropriate, but these adjustments aren't documented.
    - Without adjustments being documented, it is unclear what adjustments are made, and the reported savings cannot be verified or recreated using the information available.
    - **Recommendation 3:** Clearly document calculation steps and adjustments made for each project, ensuring that submitted project documentation can be followed to reproduce the reported savings estimates.

Additional findings from the desk reviews affected Commercial Comprehensive savings in smaller ways:

- Average values (capacity, wattage, etc.) are used for many measures even when project/unit specific values are available, resulting in inconsistent engineering adjustment factors when savings are based on actual installed equipment.
    - **Recommendation 4:** For Appliances, calculate savings using specific performance characteristics of installed equipment, instead of using average values for all equipment of the same type.
    - **Recommendation 5:** For Lighting Retrofits, calculate savings using baseline and proposed wattages specific to installed bulbs/fixtures instead of average values for all bulbs/fixtures of the same type.
    - **Recommendation 6:** For Lighting Retrofits, provide guidance to implementers and contractors for selecting baseline values when the proposed bulbs/fixtures do not have an exact match in the TRM and Workpapers. For example, a customer may install a 20W A-line LED replacing a CFL. Table 23 in the Workpapers has baseline options corresponding to 13.5W and 22W LEDs. Guidance may be provided directing users to select the baseline option corresponding to the next highest efficient case wattage listed in the table (in this example, the 22W LED).

- For variable refrigerant flow (VRF) systems, the savings values listed in the PNM Workpapers did not produce the savings reported for projects installing these systems. After raising this issue, the implementer provided the evaluation team with VRF savings values that are not contained in the Workpapers. The evaluation team revised our reviews of these projects, producing VRF savings much closer to the reported values.
    - **Recommendation 7:** Update the PNM Workpapers with all current measure assumptions and algorithms so that the savings calculation methodologies for all measures available in the program are clearly documented.

- Packaged Terminal Air Conditioner (PTAC) and Packaged Terminal Heat Pump (PTHP) algorithms in the PNM Workpapers do not account for all measure variations and do not align completely with code.
    - Baseline efficiencies are calculated using the code equations for retrofit units. Code (per Table 503.2.3(3) of the 2009 IECC) includes different equations for new construction units, which are not accounted for in the Workpapers.
    - Baseline efficiencies are calculated using the code equations for PTACs. Code (per Table 503.2.3(3) of the 2009 IECC) includes different equations for PTHPs, which are not accounted for in the Workpapers.

- The code baseline equations use a minimum capacity of 7,000 Btu/h, and a maximum capacity of 15,000 Btu/h (per Table 503.2.3(3), footnote b of the 2009 IECC). These bounds are not accounted for in the Workpapers.
- **Recommendation 8:** Revise the PTAC/PTHP algorithms to account for all equations and capacity bounds set forth in the code. See Table 503.2.3(3) of the 2009 IECC, which has separate equations for PTACs, PTHPs, replacement units, and new construction units.

- There are inconsistencies in qualifying efficiencies between some project applications and the PNM Workpapers.
  - Unitary HVAC has the following inconsistencies:
    - Air Conditioners:
      - 20-63 Tons:
        - The application specifies an Energy Efficiency Ratio (EER) of 10.6
        - The Workpapers specify an EER of 10.8
    - Air-Source Heat Pumps
      - 5.4-11.25 Tons:
        - The application specifies an EER of 11.1
        - The Workpapers specify an EER of 12
      - 11.25-20 Tons:
        - The application specifies an EER of 10.7
        - The Workpapers specify an EER of 12
      - 20-63 Tons:
        - The application specifies an EER of 10.1
        - The Workpapers specify an EER of 10.8
      - >63 Tons:
        - The application specifies an EER of 10.0
        - The Workpapers specify an EER of 10.2
  - Table 81 in the PNM Workpapers listing motor efficiencies does not match the motor efficiency table in the application.
  - **Recommendation 9:** Update documents as needed to ensure consistency between project application and the PNM Workpapers.
  - **Recommendation 10:** Review deemed savings assumptions to verify savings are based on the correct baseline and qualifying efficiencies.

- The efficient motor measure does not account for potential motor redundancy, resulting in over-claiming of savings for projects that install redundant motors.
    - **Recommendation 11:** Include language and procedures to ensure that motor savings are only based on motors that are regularly in use and exclude redundant and/or backup motors.
- Two projects installed ENERGY STAR hot food holding cabinets. The evaluation team followed the PNM Workpaper algorithms for this measure to the letter, but the resulting savings did not align with the reported savings. Additionally, the evaluation team tried to reproduce the savings using the ENERGY STAR foodservice equipment calculator, but no reasonable variation of inputs resulted in the reported savings.
    - **Recommendation 12:** Review the algorithms programmed into the savings database for hot food holding cabinets. If algorithms are correct, provide increased documentation in the future indicating calculation steps taken and reasons why reported savings differ from those calculated using the algorithms from the PNM Workpapers.
- Two projects received incentives for electric foodservice equipment, but actually installed gas foodservice equipment according to project documentation. The invoices included in the project files show that the purchased units use natural gas, and the site visit photographs do not provide any evidence indicating that the installed units are electric and not gas. Therefore there is no documentation to contradict the information on the invoices that show the installed units are gas units.
    - **Recommendation 13:** Review full model numbers to verify if installed equipment is the gas or electric version of the equipment to ensure that only electric foodservice equipment is incentivized.
- PNM assumes exterior lighting hours based on twelve hours per day. This is a simplification of dusk-to-dawn hours, which vary depending on geographic location. The evaluation team used the TRM value of 4,100 hours for exterior lighting as this is deemed a more reasonable estimate that accounts for variations in hours of darkness.
    - **Recommendation 14:** Unless detailed site-specific exterior lighting hours are documented, defer to the TRM value of 4,100 hours for exterior lighting.

The Commercial Comprehensive Multifamily sub-program deemed savings review found insufficient information in the tracking data to trace per-unit savings values back to the TRM. In particular, quantity was not properly tracked in the data, and lighting projects did not always include the installed or replaced watts. Despite this lack of information in the tracking data, savings values generally appeared to be reasonable for the types of measures installed. As a result, the evaluation team determined that an engineering adjustment factor of 1.00 should be applied for the Multifamily sub-program.

- **Recommendation 15:** Correctly track quantity in the tracking data to facilitate verification of savings values.
- **Recommendation 16:** Track watts replaced and installed for lighting measures whenever possible to facilitate verification of savings values.

6.1.2 Home Works

The Home Works deemed savings values were easily traced back to the New Mexico TRM, with the only exception being the shower timer measure which is not included in the TRM. For this measure, PNM staff calculated savings based on the showerhead measure in the TRM and assuming a five-minute shower length with the timer. The evaluation team considered this an acceptable approach and applied an engineering adjustment factor of 1.00 for the Home Works program.

- **Recommendation 17:** The shower timer measure should be added to the TRM, and the evaluation team will include this on our list of measures when TRM updates are made in 2018.

6.1.3 Residential Lighting

Original bulb price was not included in the Residential Lighting program tracking data, but was provided by PNM in retailer contract documents. These data were then used in the lighting elasticity model that was used to estimate net impacts. A net-to-gross (NTG) ratio of 0.64 was calculated for the Residential Lighting program based on model results.

- **Recommendation 18:** Record original bulb sales price (i.e. the pre-rebated cost) in program tracking data.

The deemed savings review of per-unit values in the tracking data could be facilitated by the addition of information regarding the baseline wattage used in the savings calculations.

- **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).

6.1.4 Power Saver

Estimated kWh savings for Power Saver were found to be 63.03 percent of expected savings and estimated kW savings were 73.88 percent of expected 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 (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.

- **Recommendation 20:** Calculate savings using the average over a given interval rather than the maximum in order to more accurately determine expected savings.

6.1.5 Peak Saver

Five total events were called for Peak Saver in 2017, which included one voluntary event and an event on July 3rd, which was an atypical day for businesses given the July 4th holiday and that July 3rd was not a particularly extreme weather day. Taking this into account and using the remaining three mandatory events to determine impacts, the evaluation team found that the Peak Saver program appears to be approximately a 20 MW capacity resource.

- **Recommendation 21:** Calculate demand reductions based on mandatory events.

6.2 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.

6.2.1 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 programs were cost effective (i.e., had a UCT ratio of greater than 1.00) and the PNM portfolio overall had a UCT ratio of 1.57.

6.2.2 Recommendations

- **Recommendation 22:** 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.

6.3 Process Evaluation

The process evaluation component of the 2017 PNM evaluation included surveys with Retrofit Rebate and Quick Saver participants, as well as interviews with participants of the Multifamily and New Construction sub-programs of Commercial Comprehensive. The subchapters below summarize the evaluation team's conclusions and recommendations resulting from this research.

6.3.1 Retrofit Rebate and Quick Saver

Retrofit Rebate participants were motivated primarily by the monetary aspects of reduced bill amounts and the rebate in their decision to participate, but also rated contractors as highly important in their decision to install equipment with the level of efficiency that they did. These participants were very satisfied with their experience with the Retrofit Rebate program in general, although the majority were just "somewhat satisfied" with the project application process. Some elaborated that the application paperwork was tedious, complicated, or too lengthy.

- **Recommendation 23:** Consider ways that the project application process may be simplified for participants, whether that is encouraging contractors to help fill out application forms more often or exploring ways that the process could be streamlined.

Quick Saver participants heard about the program primarily through contractors or word of mouth from a business associate or co-worker and additionally cited contractors as the most useful source of program information. To add to this, Quick Saver participants rated the contractor recommendation as one of the top two motivations for participating in the program. Contractors are clearly a key component of program awareness and are a driver of participation for the Quick Saver program.

- **Recommendation 24:** Continue to promote the Quick Saver program through contractors, as they have been a key source of awareness and a primary driver of participation for customers.

6.3.2 Multifamily

Satisfaction with the Multifamily sub-program was high among the five participants the evaluation team interviewed, but three mentioned issues with the contractor they used while participating in the program. The issues varied, but generally stemmed from miscommunications either between the customer and contractor or the contractor and PNM.

- **Recommendation 25:** Work more closely with contractors who implement Multifamily projects to ensure there is clear communication between PNM, contractors, and the participant to help foster good customer service.

All Multifamily participants interviewed were first-time participants in PNM's program. One commented that awareness of the program is probably very low among multifamily property managers, and he recommended that PNM market the program in addition to the outreach conducted by the program contractor.

- **Recommendation 26:** Consider increasing outreach and marketing to multifamily property owners/managers to increase awareness and potentially participation in the program.

6.3.3 New Construction

New Construction participants reported being very satisfied with their experience with the program, especially with the quality of the equipment installed and the value of the equipment for the price they paid. None of the six interviewees gave ratings indicating dissatisfaction with any aspect of the program, but two did note that it would be helpful for businesses to know about the available rebates earlier in the planning process for new construction projects. These respondents noted that the first source of program information is often a contractor that comes in once they have already picked out equipment.

- **Recommendation 27:** Consider increasing outreach and marketing to bring awareness to businesses and building owners ahead of the construction planning phase.