



*A personal commitment  
to New Mexico*

**2008  
Gas Energy Efficiency  
Program  
Annual Report**

*April 1, 2009*

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## ***Introduction***

PNM submits this annual report on the Gas Energy Efficiency Programs for program year 2008. Also submitted is the final report prepared by the independent evaluator, KEMA, Inc. (“KEMA”), entitled “2006-07 MFA Weatherization Program Gas Billing Analysis” (“M&V Report”), which was completed on March 25, 2009.

PNM filed its first set of gas energy efficiency programs in June 2005, which were subsequently approved by the New Mexico Public Regulation Commission (“NMPRC” or “Commission”) on December 20, 2005 in their final order in Case 05-00261-UT. PNM began offering these programs to residential gas customers on January 30, 2006. PNM filed its second set of gas energy efficiency programs, Case No 07-00273-UT, in June 2007, which were approved by the NMPRC on January 24, 2008, and became available to customers in March 2008. PNM sold its gas assets to New Mexico Gas Company (“NMGC”) on January 30, 2009. This report covers all costs incurred in the implementation of the programs and all customer participation in the programs from January 1, 2008 through January 30, 2009. NMGC assumed responsibility for the gas energy efficiency programs as of January 30, 2009.

The following programs are included in this annual report:

- (1) The Residential Insulation and Weatherization program, which provides rebates on qualifying insulation and weatherization measures installed by a Participating Contractor
- (2) The Low Income Weatherization Contract program, which provides additional funding to the existing New Mexico Weatherization Assistance Program (“WAP”) administered by the New Mexico Mortgage Finance Authority (“MFA”)
- (3) The Commercial High Efficiency Water Heater program, which provides rebates on qualifying equipment.
- (4) The Commercial Gas Fryer program, which provides rebates on the purchase and installation of ENERGY STAR<sup>®</sup> gas fryers
- (5) The ENERGY STAR Home program, which provides incentives for homebuilders who build homes to the ENERGY STAR standards

This report begins with an executive summary that presents a high level assessment of program performance in 2008. This is followed by a summary of the findings of the M&V Report and the impacts on the future of the programs. This report also includes specific program information as required in the NMPRC Energy Efficiency Rule (17.7.2 NMAC) (“Rule”), as well as additional program information.

## ***Executive Summary***

This is the third annual report on PNM’s Gas Energy Efficiency Program (“Program”), and it presents the detailed results of two existing programs and three new programs. PNM processed a number of rebate applications in early 2008 for three programs that were discontinued in 2007. This information is also included in the report.

The following table shows the total number of customer participants, the annual energy savings and the total costs for each of the programs for program year 2008.

Programs	Program Participants	Annual Savings (therms)	Total Program Costs
Residential Insulation	1,046	70,082	\$ 469,343
Energy Star Home	66	8,316	\$ 75,631
Low Income Weatherization	321	104,068	\$ 869,364
Commercial Food Service	11	4,433	\$ 57,522
Commercial HE Water Heating	1	606	\$ 54,662
Gas Efficiency Bundle (Discontinued)	54	362	\$ 2,251
Energy Star Thermostat (Discontinued)	76	608	\$ 2,202
Water Heater Wrap (Discontinued)	33	465	\$ 340
<b>Total</b>	<b>1,608</b>	<b>188,940</b>	<b>\$ 1,531,315</b>

The Rule requires that an independent evaluator conduct measurement and verification assessments of all energy efficiency programs. Through a competitive bidding process, PNM selected and hired an independent program evaluator, RLW Analytics, Inc. (“RLW”), to perform evaluation, measurement, and verification of PNM’s Residential Gas Energy Efficiency Programs for program years 2006 and 2007. For program year 2008, PNM and the NMPRC appointed M&V Committee, chose to have RLW perform M&V of the Low Income Weatherization Program for the time period it has been in existence (2006-2008). However, RLW was acquired by KEMA, Inc. (“KEMA”) in January 2009, and the M&V Report was prepared and submitted by KEMA.

The M&V Report contains important findings and recommendations. A more complete summary of these findings and recommendations along with PNM’s comments are provided in the next section. These findings include the following:

- The savings determined through the billing analysis were significantly lower than were predicted by PNM and by the energy auditing software used by MFA.
- However, further analysis is recommended, specifically, comparing the results to a control group of non-participant low income customers

### Tariff Collections

Beginning March 30, 2006, tariff Rider 15 was implemented on all residential gas bills. The Rider recovered costs of the Program at a rate of \$0.0075/therm. With the Commission’s decision in Case No. 07-00273-UT, cost recovery changed from a cents/therm basis to a percentage of bill basis. Beginning with the first billing cycle of March 2008, the Rider began recovering costs at a rate of 0.369% of eligible customers’ bills as approved in Case No. 07-00273-UT. The total costs recovered through the Rider from January 1, 2008 through January 30, 2009 totaled \$2,073,829. Total expenses for the same period were \$1,531,315 which results in an over collection of \$542,514. This balance was transferred to NMGC on January 30, 2009.

## **Regulatory Proceedings**

On June 27, 2008 PNM filed Case No 08-00220-UT, which included application for a new residential water heater wrap program, the discontinuation of the Insulation and Weatherization Program, and the continuation of the Commercial Water Heating Program, Commercial ENERGY STAR Gas Fryer Program, and the ENERGY STAR Home Program.

On January 30, 2009, PNM closed the sale of its gas assets to New Mexico Gas Company. After this date all implementation and management of all gas energy efficiency programs became the responsibility of NMGC.

## **Summary of M&V Report Findings**

### **Background and Purpose of Independent Evaluation**

Through a competitive bidding process, PNM selected RLW to perform independent evaluation, measurement, and verification of PNM's Residential Gas Energy Efficiency Programs for program years 2006 and 2007. PNM worked closely with RLW to provide them with the data necessary to complete the 2007 M&V Report. This included providing rebate processing files, budget data by program, program files from MFA, and avoided cost information. PNM also approved the research plan that RLW proposed to complete the evaluation.

The primary purpose of the independent evaluation is to assess the cost effectiveness of the programs using the TRC Test. A second purpose of the evaluation is to perform a basic process evaluation of the program to determine customer satisfaction with how the programs operated.

Since this was the third year that independent M&V would be completed on PNM's gas programs, it was decided in consultation with the NMPRC appointed M&V Committee, that the report for program year 2008 would focus on the Low-Income Weatherization Program. Specifically, KEMA was to conduct a billing analysis of past participants in the program.

### 2008 Work Plan

The 2008 program year evaluation consists of an analysis of past participants in the Low Income Weatherization program in order to verify annual natural gas savings per customer. PNM provided KEMA with the billing history of customers that participated in the program in 2006 and 2007. KEMA performed analysis of the billing data comparing the energy consumption before and after the completion of energy efficiency measures. The analysis includes a correction or normalization of data that accounts for changes in weather between the years. The analysis also includes a statistically adjusted engineering analysis which incorporates the energy savings estimates done on the homes before the retrofits were completed. (Please see Appendix B for the complete RLW (KEMA) Work Plan)

### **Summary of Findings and PNM Comments**

PNM believes that RLW has conducted a professional billing analysis assessment of the Low Income Weatherization program. Unfortunately, PNM also agrees with KEMA that the findings are inconclusive and that additional analysis will be required before a determination of savings

can be made. Below is a summary of their findings and recommendations along with PNM's comments.

- 1) The observed savings in annual gas consumption following weatherization did not reflect the savings predicted from tracking data. In all but a couple of premises annual consumption was predicted to drop following weatherization program installation. The observed annual consumption following the program installation, however, only dropped slightly overall over the year prior to installation and in close to half of the premises the consumption actually increased.**

*PNM RESPONSE:*

PNM has no reason to dispute the accuracy of the analysis showing that little change in annual gas usage was observed. However, it should be noted that the billing analysis did not attempt to adjust for any changes that might have occurred at the premises examined or for the significant fluctuation in natural gas prices over the period. For example, changes made to the premises, additions of appliances, changes in the number of occupants or changes in ownership or tenants could have a significant impact on consumption.

- 2) The statistically adjusted engineering (SAE) adjustments could not be applied in the most accurate manner because a large sample of non-participant data was not available.**

*PNM RESPONSE:*

The request for non-participant data was not made to PNM at the time the billing files were delivered to KEMA. PNM received the request for 500 non-participant billing records on March 17, 2009 which was too late for PNM to respond in time to meet the April 1 deadline for submitting the annual report.

- 3) If, however, non-participant billing data from similar low-income New Mexico households was available to make up a control group, there would have been the potential to see a different story after fitting the SAE model. . . . it must be conceded that whatever the real story is, it will not be discovered without control group data input to the SAE model along with the program participant data.**

*PNM RESPONSE:*

PNM agrees that further analysis should be done on the billing data, including comparison to a control group of non-participants. However, it should be noted that the non-participant group will not control for potentially significant changes at each premise that may have occurred during the analysis period.

- 4) The straight ratio of total observed savings to the total tracking savings was about 4 percent. The SAE model had to be fit without an intercept, which leads to problems interpreting parameter estimates. Because of this, it is recommended that the 4**

**percent savings ratio and the 3,327 therms total sample savings and 7,709 total program savings be used.**

*PNM RESPONSE:*

PNM does not believe that the average savings per home in the Low Income Weatherization program should be assumed to be 4% of annual usage. PNM believes further study and refinement of the analysis should be pursued.

**Energy Efficiency Rule Reporting Requirements**

This section of the annual report follows the reporting requirements and section headings as specified in the NMPRC Energy Efficiency Rule Section 17.7.2.13.C

**C. (1) Independent Measurement and Verification Report**

PNM contracted with KEMA to conduct the independent evaluation of the gas energy efficiency programs. Their report titled “2008 Evaluation, Measurement and Verification of PNM’s Gas Energy Efficiency Programs” is submitted with this report, and includes an analysis of the energy savings realized by the Low Income Weatherization Program.

**C. (2) Program Expenditures Not Included in the M&V Report**

The M&V Report for program year 2008 contains only a billing analysis of one program: the Low Income Weatherization Program. The expenditures for all programs for program year 2008 as of January 30, 2009 were \$1,531,315. These expenditures include all expenses incurred by PNM to develop and implement the programs.

**C. (3) Budgeted Funds Not Spent in 2007**

The annual program budget as approved by the NMPRC in Case No. 07-00273-UT was \$1,773,515. Total expenses as of January 30, 2009 were \$1,531,315. Therefore, \$242,200 of the approved budget was not spent during the 2008 program year. The following table shows the budgeted amounts, the actual expenditures in 2008 and the variances.

<b>Cost Category</b>	<b>Approved Budget</b>	<b>Program Year 2008 Actual</b>	<b>Variance</b>
<b>Internal Administration</b>	\$ 184,777	\$ 96,577	\$ 88,200
<b>Promotion</b>	\$ 207,711	\$ 142,244	\$ 65,467
<b>M&amp;V</b>	\$ 68,212	\$ 8,512	\$ 59,700
<b>Incentives</b>	\$ 441,850	\$ 427,085	\$ 14,765
<b>NMMFA - Weatherization Contract</b>	\$ 823,453	\$ 812,038	\$ 11,415
<b>Development</b>	\$ 47,512	\$ 44,860	\$ 2,653
<b>Total</b>	\$ 1,773,515	\$ 1,531,315	\$ 242,200

**C. (4) Material Variances in Program Costs**

Total program costs for program year 2008 were below the approved program budget for several reasons. First, administration costs were less than the original projections because the same staff also worked on electric programs in 2008. Second, M&V costs were lower than projected

because the analysis work on the Low Income Weatherization program had not yet been completed at the time PNM closed on the sale of its gas assets to NMGC. Promotional expenses were also lower than originally budgeted due to cost sharing with the electric programs.

### C. (5) Tariff Reconciliation

Tariff Rider 15 was applied to all PNM residential gas bills throughout 2008. Rider 15 recovered costs of the Program at a rate of \$0.0075/therm through February 2008. With the Commission’s decision in Case No. 07-00273-UT, cost recovery changed from a cents/therm basis to a percentage of bill basis. Beginning with the first billing cycle of March 2008, the Rider began recovering costs at a rate of 0.369% of eligible customers’ bills as approved in Case No. 07-00273-UT. The total costs recovered through the Rider from January 1, 2008 through January 30, 2009 totaled \$2,073,829. Total expenses for the same period were \$1,531,315 which results in an over collection of \$542,514. This balance was transferred to NMGC on January 30, 2009.

### C. (6) Cost Allocation and Expenses by Program

All energy efficiency expenses are tracked through a unique set of account numbers. The following table shows the allocation of costs to the various programs for program year 2008.

Programs	Admin.	Promotion	M&V	Incentives	NMMFA	Development	Total Costs
Residential Insulation	\$ 31,953	\$ 28,605	\$ 1,702	\$ 398,111		\$ 8,972	\$ 469,343
Energy Star Home	\$ 15,444	\$ 28,398	\$ 1,702	\$ 21,115		\$ 8,972	\$ 75,631
Low Income Weatherization	\$ 18,288	\$ 28,364	\$ 1,702	\$ -	\$ 812,038	\$ 8,972	\$ 869,364
Commercial Food Service	\$ 15,571	\$ 28,511	\$ 1,702	\$ 2,765		\$ 8,972	\$ 57,522
Commercial HE Water Heating	\$ 15,321	\$ 28,367	\$ 1,702	\$ 300		\$ 8,972	\$ 54,662
Gas Efficiency Bundle (Discontinued)	\$ -	\$ -	\$ -	\$ 2,251		\$ -	\$ 2,251
Energy Star Thermostat (Discontinued)	\$ -	\$ -	\$ -	\$ 2,202		\$ -	\$ 2,202
Water Heater Wrap (Discontinued)	\$ -	\$ -	\$ -	\$ 340		\$ -	\$ 340
<b>Total</b>	\$ 96,577	\$ 142,244	\$ 8,512	\$ 427,085	\$ 812,038	\$ 44,860	\$ 1,531,315

The PNM energy efficiency department consisted of five full-time staff members as of January 30, 2009. Staff time in 2008 was spent on the existing gas and electric energy efficiency programs, as well as on developing new electric and gas programs. All general administrative expenses were allocated equally among the gas energy efficiency programs except those costs specific to individual programs.

Promotional expenses for 2008 were used primarily for raising awareness on all programs through brochures and advertising campaigns. (Please see the Promotional Activities section below for more details on specific promotional activities).

Measurement and Verification expenses were allocated equally across all programs and consisted of the expenses incurred in program year 2008 to complete the 2007 M&V report which was submitted on April 1, 2008. The analysis of the Low Income Weatherization program for program year 2008 had not been completed at the time PNM closed on the sale of its gas assets to NMGC. Therefore that expense has not been included in the program year 2008 costs. The cost of the Gas Potential Study and associated expert witness costs are being recovered over

a three-year period which began in 2006. The cost was allocated equally among all the programs in program year 2008.

### C. (7) Program Specific Metrics

The following tables present program-specific information, including forecasted savings, actual achieved savings, the number of participants, net participant costs, the cost per therm of saved energy, the economic benefits realized in 2008 and the economic benefits to be expected over the life of the measures. The labeling of items a) through g) correspond to the items listed in section 17.7.2.13.C(7) of the Rule. Please see the above section for the utility costs by program and Appendix A for avoided cost information (which corresponds to item (d) in the Rule)

Programs	(a) Forecasted Savings (therms)	Achieved Savings (therms)	Achieved Lifetime Savings (therms)	(b) Program Participants
Residential Insulation	89,600	70,082	1,752,050	1,046
Energy Star Home	37,800	8,316	249,480	66
Low Income Weatherization	65,600	104,068	2,601,705	321
Commercial Food Service	20,160	4,433	66,495	11
Commercial HE Water Heating	30,280	606	12,120	1
Gas Efficiency Bundle (Discontinued)	-	362	3,618	54
Energy Star Theromstat (Discontinued)	-	608	6,080	76
Water Heater Wrap (Discontinued)	-	465	4,653	33
<b>Total</b>	<b>243,440</b>	<b>188,940</b>	<b>4,696,201</b>	<b>1,608</b>

Programs	(c) Participant Costs	(e) Cost per therm Saved	(f) 2008 Economic Benefits	(g) NPV of Total Economic Benefits
Residential Insulation	\$ 1,594,519	\$ 0.27	\$ 121,232	\$ 1,822,613
Energy Star Home	\$ 126,593	\$ 0.30	\$ 20,696	\$ 407,410
Low Income Weatherization	\$ -	\$ 0.34	\$ 183,004	\$ 2,774,039
Commercial Food Service	\$ 6,035	\$ 0.84	\$ 5,392	\$ 50,167
Commercial HE Water Heating	\$ 1,418	\$ 4.37	\$ 737	\$ 8,185
Gas Efficiency Bundle (Discontinued)	\$ 3,041	\$ 0.62	NA	NA
Energy Star Theromstat (Discontinued)	\$ 1,750	\$ 0.36	NA	NA
Water Heater Wrap (Discontinued)	\$ 353	\$ 0.07	NA	NA
<b>Total</b>	<b>1,733,708</b>	<b>\$ 0.33</b>	<b>\$ 331,062</b>	<b>\$ 5,062,415</b>

The various categories are described below:

- (a) Forecasted savings are based on the target participation levels for program year 2008 as filed in NMPRC Case No. 07-00273-UT.
- (a) Achieved savings were determined by applying the validated savings per participant for each program, adjusted for the free-rider rate, times the number of participants.
- (a) Achieved lifetime savings are annual savings times the useful life of the measure.
- (b) Program participants are those who participated in program year 2008.

- (c) Participant costs are the costs contained on the receipts for purchasing and installing the measures as submitted by participants less the rebates they received. The average installed costs were taken from the 2007 M&V Report and applied to the total number of participants in program year 2008.
- (e) The cost per therm saved is determined by dividing the program cost by the lifetime therms saved.
- (f) The 2008 economic benefit for each program was determined by multiplying the avoided cost of energy times the actual annual savings.
- (g) The net present value of the total economic benefits was determined by taking the discounted value of the annual avoided costs times the annual savings over the useful life of each program measure.

### C. (8) Non-Energy Benefits

The following table shows the emission reductions associated with the portfolio of programs. The lifetime avoided emissions are determined by multiplying the emissions rates times the lifetime MWh and therms saved by the portfolio of programs.<sup>1</sup>

Emission Type	Avoided Electric Emissions Rate (lbs/MWh)	Avoided Gas Emissions Rate (lbs/therm)	Lifetime Avoided Emissions (tons)
SO2	1.5	-	12.1
NOx	3.0	0.091	238
CO2	1,459	1,170.8	2,760,905
Particulates	0.082	-	0.7

### C. (9) Rate of Return Impacts

All costs of the PNM Energy Efficiency Program are recorded under a special balancing account and are not included in base rates. The funds collected through Rider 15 are used to offset the balance in this account. Therefore there is no impact on PNM's allowed rate of return.

### C. (10) Self-Direct Programs

There were no customer applications for the self-direct program in program year 2008.

### ***Additional 2007 Program Information***

This section of the report provides additional information about the gas energy efficiency programs in calendar year 2008.

### **Promotional Activities**

#### Targeted Communication

<sup>1</sup> The avoided NOx emissions rate for gas combustion was taken from EPA's AP-42, Fifth Edition, Compilation of Air Pollutant Emission Factors. The avoided CO2 emissions rate for gas combustion was taken from U.S. Department of Energy - Energy Information Administration Instructions for Form EIA -1605. The electric emissions rates are taken from continuous emission monitoring or emission testing at PNM's generation facilities.

PNM conducted targeted communications efforts for several programs including the Energy Star Home, the Commercial Food Service and the High Efficiency Water Heating programs. These efforts focused on outreach to the vendor and contractor community.

Mass Media Communications

In the third quarter of 2008, a broad-based energy efficiency communication campaign titled “Bright Idea – Save Energy, Save Money” was developed to help increase the awareness of PNM energy efficiency programs across the PNM customer base. Launching in October 2008, newspaper, radio, and the PNM bill were used to develop customer awareness statewide. In addition, outdoor advertising in the Albuquerque area was purchased for additional reach into the marketplace. An innovative online campaign was also used in which online activity was tracked to determine interest level. When it could be established that the individual on line was interested in energy efficiency or related topics, a PNM banner ad appeared on a web site page.

## **Appendix A – PNM Avoided Costs**

### Natural Gas Avoided Costs

The following tables provide the avoided energy costs used in the TRC model in units of dollars per MMBTU.

	Calendar	Split	Calendar
	Summer	Winter	Year
2008	\$ 12.47	\$ 12.71	\$ 12.16
2009	\$ 7.16	\$ 7.16	\$ 7.16
2010	\$ 7.16	\$ 7.16	\$ 7.16
2011	\$ 12.04	\$ 12.84	\$ 12.34
2012	\$ 12.19	\$ 13.01	\$ 12.49
2013	\$ 12.35	\$ 13.17	\$ 12.65
2014	\$ 12.50	\$ 13.34	\$ 12.81
2015	\$ 12.66	\$ 13.51	\$ 12.97
2016	\$ 12.82	\$ 13.68	\$ 13.13
2017	\$ 12.98	\$ 13.86	\$ 13.30
2018	\$ 13.14	\$ 14.04	\$ 13.47
2019	\$ 13.31	\$ 14.22	\$ 13.64
2020	\$ 13.48	\$ 14.41	\$ 13.82
2021	\$ 13.65	\$ 14.59	\$ 14.00
2022	\$ 13.83	\$ 14.78	\$ 14.18
2023	\$ 14.01	\$ 14.98	\$ 14.36
2024	\$ 14.19	\$ 15.17	\$ 14.55
2025	\$ 14.37	\$ 15.37	\$ 14.74
2026	\$ 14.56	\$ 15.58	\$ 14.93
2027	\$ 14.75	\$ 15.78	\$ 15.13
2028	\$ 14.94	\$ 15.99	\$ 15.33
2029	\$ 15.14	\$ 16.21	\$ 15.53
2030	\$ 15.34	\$ 16.42	\$ 15.73
2031	\$ 15.54	\$ 16.64	\$ 15.94
2032	\$ 15.75	\$ 16.87	\$ 16.16
2033	\$ 15.96	\$ 17.09	\$ 16.37
2034	\$ 16.17	\$ 17.32	\$ 16.59
2035	\$ 16.38	\$ 17.56	\$ 16.81
2036	\$ 16.60	\$ 17.80	\$ 17.04
2037	\$ 16.83	\$ 18.04	\$ 17.27
2038	\$ 17.05	\$ 18.28	\$ 17.50
2039	\$ 17.28	\$ 18.53	\$ 17.74
2040	\$ 17.52	\$ 18.05	\$ 17.98

**Appendix B – RLW (KEMA) Research Plan**

**Proposal**

**2006-07 MFA Weatherization Program  
Gas Billing Analysis**

**October 10, 2008**

**Prepared for:**



*A personal commitment  
to New Mexico*

Public Service Company of New Mexico

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Attn: Steve Bean

Energy Efficiency Program Manager

**Prepared by:**

A handwritten signature in blue ink, appearing to read "RLW", is written over a horizontal line.

**RLW ANALYTICS**

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## Introduction

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In response to PNM's 2007 Annual Report, stakeholders asked PNM to pursue additional analyses of the MFA Weatherization Program given there was no program M&V for the 2006 program and the 2007 M&V was inconclusive. The additional rigor and resources required are justified given the program accounts for a majority of the portfolio budget and gas savings.

RLW Analytics discussed several strategies for an enhanced evaluation of the MFA program with PNM, having already evaluated the 2007 MFA Weatherization program as well as assessing the 2006 program cost effectiveness. RLW already has complete population lists of all program participants as well as an estimate of their gas savings produced by the Department of Energy Weatherization tools. In addition, RLW performed onsite verifications and re-modeled several sites in 2007.

In order to best leverage the data available, RLW is pleased to propose the following billing analysis of the MFA Weatherization Program. A Statistically-Adjusted Engineering (SAE) billing analysis approach combined with RLW's preferred weather normalization techniques offers the most robust independent analysis of the program while also being more definitive and cost effective than a large number of onsite assessments, post-only performance tests, and re-modeling of energy savings.

## Analysis Approach

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### Methodology to Develop the Participant Analysis Group

The first step in the analysis of the will be to identify all participants that can contribute to the analysis. RLW will develop a sample of program participants receiving MFA weatherization rebates and will instruct PNM to construct a data set of all known participant's natural gas usage history from 2004 to current date. Once the billing data set is assembled it will be examined for consistency and to remove any anomalies. This examination consists of three steps.

The first step will eliminate incongruous bill information from participants. During this step records with unusually long or short number of days, and bills with unusually large or small consumption will be eliminated<sup>2</sup>. In addition, any individual billing records that are suspect will be eliminated from the analysis.

To avoid non-program changes from corrupting the analysis, we will investigate whether there was any turnover in the homeowners during the study period. We will require a minimum of one year of continuous customer data on each side of the measure installation for a site to be included in the analysis. This year does not include the month of installation, or the month preceding it, both of which will be removed from the analysis to avoid the transition itself from impacting the numbers.

The last step will be to check the billing history from each installation period. This check will omit customers that do not have enough data to be appropriately analyzed. This step will eliminate customers that do not have at least three months of winter data for a particular period. All participants in the "Participant Analysis Group" will be required to have pre-installation and post-installation data.

### Temperature Normalization Methodology

The temperature normalization procedure that will be used for this analysis is the *Princeton Scorekeeping Model* (PRISM) algorithm. Through years of experience, *RLW* has taken the fundamental concept of the PRISM methodology and has refined it to produce more accurate estimates of normalized annual consumption (NAC).

The PRISM algorithm develops a mathematical model that represents the temperature to energy consumption relationship. This model is shown in Equation 1.

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<sup>2</sup> Specifically, only records with a billing cycle with 25 to 35 days will be accepted. In addition, bills with unusually low or unusually high consumption, or certain billing code (i.e., no bill, rebill ect.). These parameters will be established by looking at the distribution of monthly consumption, and identifying a logical boundary values.

$$U_i = \alpha + \beta * DD_i(\tau) + e_i$$

Where;

$U_i$  = average daily consumption in interval  $i$ .

$DD_i(\tau)$  = average degree days in interval  $i$ , based on reference temperature  $\tau$ .

$\alpha, \beta$  = parameters to be estimated to minimize  $e$ .

$e$  = a random error term.

**Equation 1: The PRISM Heating Only Model**

The PRISM model reflects that a customer's energy usage is equal to some base level  $\alpha$ , and a linear function between a reference temperature  $\tau$ , and the outside temperature. The constant proportionality,  $\beta$ , represents a customer's effective heat-loss or heat-gain rate.

PRISM recognizes that each customer (and in the case of this program each customer before the measure and each customer after the measure) has unique space conditioning operating characteristics. To capture these unique space-conditioning characteristics, PRISM examines a range of heating and cooling reference temperatures. The model chosen to represent a customer's energy use is the model that best linearizes the relationship between usage and degree-days. For each customer, an optimal model based on a unique reference temperature ( $\tau$ ) is identified by the minimum mean squared error (MSE) of the regression.

Once the optimal parameters have been established, normalized annual consumption is estimated using Equation 2. In the application for the PSE project the NAC will be calculated based on the number of days in the heating period.

$$NAC = 365 * \alpha + \beta * DD_o(\tau)$$

Where:

$DD_o$  is the number of degree days expected in a typical year.

**Equation 2: Determination of Normalized Annual Consumption (NAC) <sup>3</sup>**

When this model is applied to a residence's heating characteristics, it is referred to as the *heating only model* (HOM).

<sup>3</sup> For a more comprehensive technical discussion of PRISM, see Impact Evaluation of Demand-Side Management Programs, Volume 1: A Guide to Current Practice, EPRI Report CU-7178,V1, pages 5-6.

For the analysis of gas consumption data we will use the *heating only model* (HOM). The standard PRISM approach to consider heating only loads is calculated using Equation 3.

$U_i = \beta_0 + \beta_1 * HDD_i(\tau_1) + e_i$	
Where:	
$U_i$	= The electric usage during cycle i.
$HDD_i(\tau_1)$	= The heating degree days based on reference temperature $\tau_1$ , during cycle i.
$\beta_i$	= The coefficients to be estimated to minimize the error term.
$e_i$	= The error in predicting U.

**Equation 3: The PRISM Heating Only Model**

As with the standard PRISM procedure, the optimal heating model is determined by calculating the regression models assuming various reference temperature values ( $\tau_1$ ). Expected annual degree-days are applied to the optimal model to calculate a normalized annual consumption (NAC). The results of the model can be interpreted as:

- $\beta_0$  is an estimate of the average base load for a cycle; and
- $\beta_1$  represents the heating slope, or the increase in natural gas usage for each incremental increase in heating degree days.

The standard PRISM approach uses usage and degree-day data on a billing cycle basis. However, the data has an inherent variability associated with the varying lengths of billing cycles. For the estimation of the heating slopes ( $\beta_1$ ) the effects of the varying lengths of the billing cycle are mitigated. This is a result of the number of degree-days being directly correlated to the number of days in the cycle. However, the estimates of base load ( $\beta_0$ ) reflects the average base load per cycle and does not account for the days in the cycle. In effect, this estimate infers the base load will be  $\beta_0$ , regardless of the length of the cycle. Since base load usage is a function of time, this result may introduce a slight bias into the calculation. To eliminate this bias, the augmented PRISM approach uses usage per day as the dependent variable, and expresses the degree days on a per day basis.

The PRISM methodology assumes that there is a linear relationship between usage and temperature. However, if the assumption is not valid, it could lead to a violation of a basic regression assumption (i.e., the error terms are uncorrelated). To avoid any bias, an additional term is considered in developing individual customer gas load models. The term is heating degree-days squared. The incorporation of this variable is presented in Equation 4.

$$U_i = \beta_0 + \beta_1 * HDD_i(\tau_1) + \beta_2 * (HDD_i(\tau_1))^2 + e_i$$

**Equation 4: Gas PRISM Model, with Second Order Terms Incorporated**

Alternative models, with different numbers of independent variables, introduce a challenge to choosing an optimal model. The standard PRISM approach relies on the maximization of  $R^2$  to indicate the optimal model. However, in building mathematical regression models, the  $R^2$  statistic has a tendency to increase as the number of independent variables increases. Therefore, when comparing models with different numbers of regressors, the maximum  $R^2$  criteria may not lead to choosing the optimal model between alternative models. To avoid this possibility, an alternative method to determine the optimal model was used. The minimization of the mean squared error of the residuals (MSE) is a good alternative. The MSE accounts for the decrease in the degrees of freedom when an additional regressor is added to the equation. Therefore, the model that minimized the  $MS_E$  will be used to determine the optimal model to represent the temperature versus usage relationship.

Lastly, in an effort to obtain the most accurate models possible, a system of re-analyzing poor performing models will be employed. A "poor performing model" is defined as one that produced a negative heating load.

The determination of the optimal model will use a four-step approach. These steps are:

- 1) The optimal models are determined using all available data.
- 2) If the optimal model produced in Step 1 has a negative heating load, the model is re-estimated omitting the heating slope variables.
- 3) From the first two steps, the customers with poor models are identified. For these customers, their predicted monthly usage is compared to the actual monthly usage. The monthly usage that was associated with the prediction with the greatest error will be omitted, and the model re-estimated.
- 4) Step 2 is repeated for the models estimated in Step 3.

The optimal models generated by this algorithm are then used to estimate the Normalized Annual Consumption (NAC), for each customer during the pre-installation period and during the post-installation period.

### **Energy Impacts**

The energy impacts will be determined through Statistically-Adjusted Engineering (SAE) analysis. Instead of simply using an explanatory variable for pre-measure and post-measure, The SAE model leverages the engineering estimates of savings included in the

tracking data.<sup>4</sup> The regression coefficient in these models is the percentage of the engineering estimate of savings observed in changes in energy usage. For example, if the coefficient on the SAE term is 0.8, this means that the customers are on average seeing 80% of the savings realized from their engineering estimates. The SAE model can estimate realization rates for an overall customer savings estimate or for individual measure savings estimates if these estimates are placed within the model.

A basic SAE model would look as follows:

$$E_i = B_1 S_i + \sum_{k=1}^K B_k X_k + e_{it}$$

where:

- $E_i$  = Average energy consumption for customer "i"; either pre-measure NAC or post-measure NAC, calculated for each site using the methodology outlined above.
- $S_i$  = The measure savings estimates in a SAE model for customer "i". For pre-measure NAC, this will be 0. For post-measure, the value will be equal to the engineering estimate of savings in the tracking data
- $X_k$  = Vector of other explanatory variables.
- $B_1 \dots B_n$  = Estimate coefficients.
- $e_{it}$  = Statistical error term, for unexplained variance in observed average energy consumption.

This technique was originally intended for use in billing analysis to calculate gross energy savings. It provides a method to incorporate all available information (most importantly engineering estimates) into the regression, while providing feedback on the accuracy of the engineering estimate. RLW will engage in standard regression diagnostics to make sure that these models are well characterized and their results reliable.

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<sup>4</sup> "Statistically Adjusted Engineering (SAE) Models of End-Use Load Curves," (Train et al. 1985); "The Economic Value of Energy-Saving Investments by Commercial and Industrial Firms." (Train and Igelzi 1987).

## Tasks, Budget, and Timeline

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The following task outline will be further refined in the workplan. These general tasks are the necessary steps to complete the scope of work detailed in the approach in line with the budget and timeline proposed.

### ***Task 1: Project Initiation***

#### *Task 1.1: Billing Data Sample*

Upon signing of a contract for this scope of work, RLW will send PNM an initial list of about 250 participants from the total 2006-07 MFA program population of 620 homes. PNM will develop a data set of billing history from 2004 to present.

#### *Task 1.2: Project Kickoff Conference Call*

The project kickoff conference call will follow these initial activities to will primarily address issues related to the availability and format of data and any issues with matching participants to their billing history. The conference call will also set final deadlines for the workplan and final report as well as detail deadlines for PNM to send billing history data and updated gas avoided cost forecasts. Weather data

### ***Task 2: Workplan***

#### *Task 2.1: Draft Workplan*

RLW will further develop each task in the draft workplan. It is important for the workplan to clearly outline each task and deliverable so there is mutual agreement between RLW and PNM on all expectations.

The research plan will detail the overall project and each task's objectives, methodology, and deliverables, forming the basis of the methodology section in the final report. The Research Plan will detail:

- The evaluation objective
- How the research objectives will be accomplished
- Sample design
- The method of evaluation
- A description of the key research components included in the study

A draft research plan will be submitted to the PNM project manager for comments and approval. All comments and changes will be modified in the draft research plan by the RLW team and again approved by the PNM project manager before the final research plan is distributed to the project team.

#### *Task 2.2: Final Workplan*

The workplan will be finalized after review by PNM and discussion and resolution of any issues in the draft plan.

### ***Task 3: Data Analysis***

#### *Task 3.1: Billing Data Resolution*

*In parallel to drafting the workplan, RLW analysts will work with PNM regarding resolving any issues with the provided billing histories. This task will continue after the workplan is finalized up until the data set is ready for the weather normalization and energy impact analysis.*

#### *Task 3.2: Weather Normalization*

The temperature normalization procedure that will be used for this analysis is the *Princeton Scorekeeping Model* (PRISM) algorithm. Through years of experience, *RLW* has taken the fundamental concept of the PRISM methodology and has refined it to produce more accurate estimates of normalized annual consumption (NAC).

#### *Task 3.3: Billing Analysis*

The energy impacts will be determined through Statistically-Adjusted Engineering (SAE) analysis. This technique was originally intended for use in billing analysis to calculate gross energy savings. It provides a method to incorporate all available information (most importantly engineering estimates) into the regression, while providing feedback on the accuracy of the engineering estimate.

### ***Task 4: Cost Effectiveness Analysis***

For each program year RLW will perform program level Total Resource Cost (TRC) testing. The TRC test is used to determine program cost effectiveness. To be considered cost-effective, programs must demonstrate a minimum TRC of 1.0, which in short means that the present value of the benefits outweigh the present value of the costs.

RLW has significant experience conducting cost effectiveness testing for both residential and commercial programs, including each of the measures included in PNM's 2006-07 gas program offerings. PNM will be required to work with RLW on some of the inputs to the TRC test, including updated gas avoided costs for PNM's service territory and regions. Using final measure installation rates for each program and each program year, RLW will conduct the TRC test. RLW will review all suggested changes to PNM inputs prior to the final report.

### ***Task 5: Reporting***

RLW will produce a draft report for PNM review and following review will develop the final report. Most likely the report will have an executive summary, methodology and results, but the report may also be formatted to become an appendix or addendum to

the previous 2006 and 2007 M&V reports. The format will be discussed and finalized at the kickoff meeting and subsequent project meetings.

**Task 6: Project Management and Progress Reporting**

All Key staff on the RLW Team will be available by all modern business practices (phone, cell, email, fax, etc.) during regular business hours (M-F, 8am-6pm) for the entire duration of the study. Responses to the PNM project manager’s communications will be made within ½ business day within reason.

RLW will provide bi-weekly updates to PNM on an agreed day and time. These may be conference calls that include discussion of study progress and any issues related to the study or simple email updates if there are no issues and everything is proceeding on schedule.

**Timeline**

	Task	2008												2009														
		October				November				December				January				February				March				April		
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
<b>1</b>	<b>Project Initiation</b>																											
1.1	Billing Data Sample	x																										
1.2	Project Initiation Meeting		x																									
<b>2</b>	<b>Workplan</b>																											
2.1	Draft Workplan			x	x																							
2.2	Final Workplan				x	x																						
<b>3</b>	<b>Data Analysis</b>																											
3.1	Billing Data Resolution		x	x	x	x			x	x	x	x																
5.1	Weather Normalization													x	x	x	x	x	x	x								
5.2	Billing Analysis														x	x	x	x	x	x	x	x						
<b>4</b>	<b>Cost Effectiveness</b>																											
3.1	Cost Effectiveness															x						x						
<b>5</b>	<b>Reporting</b>																											
5.1	Draft Final Report															x	x	x	x	x	x	x						
5.2	Final Report																				x	x	x					
<b>6</b>	<b>Project Management</b>																											
6.1	Ongoing Project Management	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	

**Budget**

PNM 2008 Gas Energy Efficiency Annual Report

Task#	Task	\$130	\$130	\$100	\$115	\$85	Cost
		Metoyer	Bernier	Young	Cracknell	Analyst	
<b>1</b>	<b>Project Initiation</b>						<b>\$1,640</b>
1.1	Billing Data Sample	1	2	2	2		\$820
1.2	Project Initiation Meeting	1	2	2	2		\$820
<b>2</b>	<b>Workplan</b>						<b>\$4,490</b>
2.1	Draft Workplan	4	4	6	6		\$2,330
2.2	Final Workplan	4	6	4	4		\$2,160
<b>3</b>	<b>Data Analysis</b>						<b>\$26,230</b>
3.1	Billing Data Resolution	2	4	14	4	20	\$4,340
3.2	Weather Normalization	6	10	20	10	40	\$8,630
3.3	Billing Analysis	2	20	30	20	60	\$13,260
<b>4</b>	<b>Cost Effectiveness</b>						<b>\$4,120</b>
4.1	Cost Effectiveness Re-Analysis	16				24	\$4,120
<b>5</b>	<b>Reporting</b>						<b>\$8,140</b>
5.1	Draft Final Report	6	14	8	4	4	\$4,200
5.2	Final Report	6	12	8	4	4	\$3,940
<b>6</b>	<b>Project Management</b>						<b>\$5,200</b>
6.1	Ongoing Project Management	14	26				\$5,200
	<b>Project Totals</b>	<b>62</b>	<b>100</b>	<b>94</b>	<b>56</b>	<b>152</b>	<b>\$49,820</b>