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Impact Evaluation of the SIGECO Residential Weatherization Pilot Program

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ABSTRACT

From 1994 through 1996, SIGECO implemented a comprehensive energy conservation program pilot program. The program implementation was completed on both all-electric, and combined gas and electric service customers. The program focused on providing the homes with the highest utility bills the most comprehensive package of energy conservation measures. The treatments that were available included Air Sealing, Duct Sealing, Duct, Attic, and Wall insulation, and Gas Furnace Efficiency Modification. All of the participant houses were audited. The houses where the primary package of measures was not cost effective, may have received some of the lower cost treatments such as: Water Heater Insulation, Furnace Efficiency Modification or other safety related repairs.

The impact evaluation was conducted using a non-participant comparison group. The participant group consisted of 411 gas and 323 all-electric customers. The non-participant group was slightly smaller with 236 gas and 166 all-electric customers. Utility bills were analyzed over a three year period and one year high resolution (hourly) whole house electrical data was used for peak and costing period analysis.

Savings estimates are presented from a variety of statistical analysis techniques. Statistical information is also provided on the condition of the housing stock, measures installed, savings estimates, and the savings that are attributable to individual measures.

EXECUTIVE SUMMARY

The SIGECO comprehensive weatherization pilot program focused the installation of energy conservation measures on those houses that had the most energy use for their size. This targeting approach was based on prior studies that show a close relationship between pre-retrofit energy consumption and energy savings. Since this relationship was already known to exist and because the program focused its efforts on higher use customers, the impact evaluation was expected to show greater energy savings in homes that were in worse condition and had higher bills. These houses were identified by the energy intensity variables calculated prior to visiting the site.

The purpose of this impact evaluation was the estimation of potential energy savings and peak reductions available from energy efficiency measures and how those reductions are affected by the customer stratum. The evaluation examined the savings using a variety of statistical models. The models were chosen to explore the depth of the data to inform future program decisions.

For gas heated homes receiving some combination of duct sealing, air sealing, high CO mitigation, attic insulation, or wall insulation, the average savings were 200 therms of gas and 1040 kWh of electricity per year. Individual measures that were significant contributors to the savings included eliminating major Carbon Monoxide problems, and installing wall and attic insulation.

Summer electrical consumption for gas heated customers selected for treatment was initially higher than the summer electrical consumption of the not-treated customers. After retrofits were applied to targeted homes (those with the with the highest available cost effective energy savings), the treated customers showed a decrease in annual consumption to near the consumption level of the not-treated customers. Peak day, coincident peak hour central air conditioner load is estimated to drop between 500 and 800 watts for targeted and treated customers.

The electrically heated homes had potential for electric savings in both cooling and heating, but these homes were newer and in better condition than the gas heated homes (less duct leaks, more insulation, etc.). Electrically heated homes receiving one or more major measure saved and average of 1497 kWh per year. Electrical consumption for customers selected for treatment was initially higher than the electrical consumption of the not-treated customers. After retrofits were applied to homes with the highest available cost effective energy savings, the treated customers showed a decrease in annual consumption to near the not-treated customers. Individual measures that showed significant savings were duct sealing and attic insulation.

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1. INTRODUCTION

From 1994 through 1996, SIGECO implemented a comprehensive energy conservation pilot. The program used a team to help guide and implement the program. The team included Bill Hill, Ph.D., Proctor Engineering Group, Jim Fitzgerald, and Conservation Services Group. The program was implemented with both all-electric, and combined gas and electric service customers. This pilot was designed, not as a production program based on cost effectiveness, but rather an investigation of measures and methods that could produce a cost effective program. Customers were randomly assigned to two groups, the participant group and the non-participant group.

One innovative approach used in the pilot involved selection of energy conservation measures based on the energy intensity ratio. The energy intensity ratio is roughly the energy use per square foot compared to similar homes in the same geographic area. The most comprehensive package of measures was applied to homes with the highest energy intensity ratio. The team also did the initial development of a crawlspace treatment that took advantage of special opportunities in the Evansville housing stock. Technicians tested air conditioner efficiency and capacity during the last year of the program.

The major treatments that were available included Air Sealing, Duct Sealing, Duct, Attic, and Wall insulation. Technicians audited all the participant houses and selected treatments based on consumption patterns, diagnostic tests, and projected savings. All participant homes, whether major treatments were cost effective or not, received a gas appliance safety check. Participant homes may have received lesser cost treatments including: Water Heater Insulation, Furnace Efficiency Modification, or safety related repairs to gas appliances[1].

The primary purpose of this evaluation is estimation of energy savings and peak reduction attributable to individual measures. The impact evaluation was conducted using a non-participant comparison group. The participant group consisted of 411 gas and 323 all-electric customers. The non-participant group was slightly smaller with 236 gas and 166 all-electric customers.

Utility bills were analyzed over a three year period and one year high resolution (hourly) whole house electrical data was used for peak and costing period analysis. The gas heated customers provided the best group for estimating the impact of individual measures. Gas heated homes were less well insulated, had leakier building shells, and had leakier ducts. Gas heated homes also supplied the opportunity for Furnace Efficiency Modifications, while the heating equipment in the electrically heated homes were not treated in the pilot. The gas heated homes had greater reductions in shell leakage and duct leakage, as well has having more insulation added. As a result, the changes to gas homes (both to gas heating consumption and electric cooling consumption) provided a larger "signal" against the background "noise" of customer behavior and other variables.

There were significant differences between the gas and all-electric housing stock. This has a direct impact on the types and effectiveness of the measures These differences are shown in Table 1-1.

[1] Evansville has a large percentage of furnaces and water heaters "serviced" by do-it-yourself hand-persons. Many of the appliances had safety problems.

Table 1-1. Measures Applied by Customer Group

Measure	Gas Customers	Electric Customers
CO Mitigation if flue CO>2000	6%	
Furnace Efficiency Package	51%	
No Major Measure	43%	31%
Air Sealing	45%	64%
Air Sealing Average Reduction at 50 pa	906 CFM	556 CFM
Crawlspace Treatment	< 1%	< 1%
Attic Insulation	28%	26%
Wall Insulation	9%	2%
Duct Sealing	21%	23%
Duct Sealing Average Reduction at 25 pa	498 CFM	344 CFM
Duct Insulation	3%	< 1%
Water Heater and Pipe Insulation	47%	54%

2. GAS HEATED RESIDENCES

Gas heat customers were treated between March 9, 1995 and November 7, 1996. The median treatment date was April 16, 1996. In this study, customers were randomly assigned to two major groups, "Participants" (those eligible for treatment n=374) and "Non-participants" (those not eligible for treatment n=236).

Within the Participant group, treatments were applied based on the estimated cost effectiveness of the treatment. This application methodology was unique, it targeted participants for treatment based on their historical consumption normalized to the local housing stock and to the size of the home. Forty-three percent of the Participants received no major treatment (n=160) based on the cost effectiveness test. Technicians analyzed the consumption patterns and visited every Participant's home.

For Participants, the "treatment date" was either the day the work was completed or, if no treatment was applied, the date of the initial visit. Each member of the Non-participant group was randomly assigned a pseudo-treatment date matching one of the Participant treatment dates.

The projected weather normalized gas savings are summarized in Section 2.5.

2.1 Savings estimate from Treated and Not-treated month-by-month means

The savings based on a simple comparison of group means is:

savings by month =[(ADC Treat Pre - ADC Not-treat Pre) - (ADC Treat Post - ADC Not-treat Post)] * days

annual savings = Sum (monthly savings)

<u>average annual savings = 200 therms/yr.</u>

where,

ADC = Average Daily Consumption[2]

The pre- and post-retrofit annual consumption estimates from the monthly comparisons are displayed in Figure 2-1.

This simple analysis does not fully take weather into consideration (except implicitly since the two groups experienced the same weather). An explicit weather normalization methodology is applied in later sections.

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[2] The gas consumption for all the customers in the group was summed for each billing period and divided by the number of customer billing days (number of customers times billing days) in the same period.

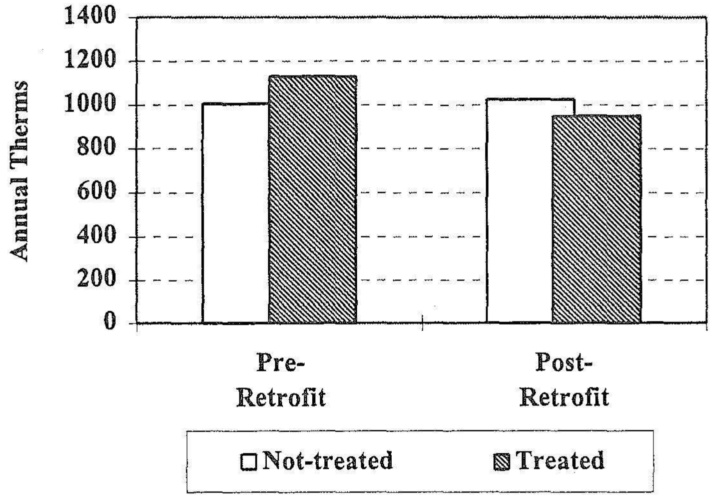

Figure 2-1 Yearly Gas Consumption Estimate From Month-by-month Analysis

The statistical summary of the analysis is in Appendix A.

2.2 Savings by month

The month-by-month savings estimates are shown in Figure 2-2. Due to the timing of the retrofits, every month does not have the same number of readings. The monthly savings estimate is questionable for February (Month 2) due to the small number of post-retrofit not-treated data points in that month[3].

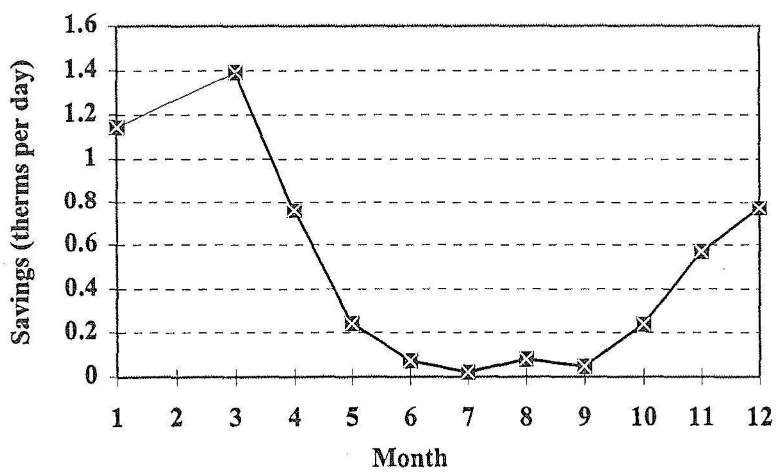

Figure 2-2. Gas Savings Estimate by Month

[3] The average number of post-retrofit non-participant data points for each month was 178. This month had the least data (64 points). The number of post-retrofit participant data was also a minimum in that month 106 points compared to an average 280. Pre-retrofit data is very robust because it covers over two years.

2.3 Savings using the cross sectional time series model

The effect of weather can be explicitly accounted for in a number of regression models. A fixed effects time series cross sectional model, which explicitly accounts for weather was used to re-estimate the annual savings for the Participant group.

> The average savings estimate for ALL Participants (both treated and the 43% that received no major treatment) using this analysis method is 142 therms/yr.

The basic model for the cross sectional time series analysis was:

$$upd_{it} = \_cons + ddpd60_{it}*b1 + Npre_{it}*b2 + Nrdd60_{it}*b3 + Npost_{it}*b4 + Npdd60_{it}*b5 + Ppost_{it}*b6 + Ppdd60_{it}*b7$$

where:

upd_{it} is the use per day for customer i in billing period t

_cons is the intercept of the regression equation (roughly the base consumption)

b1 through b7 are the coefficients of the predictor variables

$ddpd60_{it}$ is the 60°F base degree days per day for customer i in billing period t

$Npre_{it}$ is 1 for Non-participant i and in the pre- period, otherwise 0

$Nrdd60_{it}$ is the 60°F base degree days per day for Non-participant i in pre- billing period t

$Npost_{it}$ is 1 for Non-participant i and in the post- period, otherwise 0

$Npdd60_{it}$ is the 60°F base degree days per day for Non-participant i in post- billing period t

$Ppost_{it}$ is 1 for Participant i and in the post- period, otherwise 0

$Ppdd60_{it}$ is the 60°F base degree days per day for Participant i in post- billing period t

The statistical summary of the analysis is in Appendix A

This weather normalized analysis produces a pre-weatherization participant annual gas consumption of 1195 therms and a heating gas consumption of 895 therms.

2.4 Savings estimates for individual measures

One of the primary goals of this analysis was the production of savings estimates for individual measures. In order to produce reasonably reliable estimates for individual measures, a six step analysis was completed.

First, the pre- and post-retrofit annual gas consumption for each customer was weather normalized based on historical Evansville weather data. The resulting annual consumption estimate is referred to as Normalized Annual Consumption (NAC). This normalization process was similar to a PRISM™ analysis with the heating reference temperature constrained to be one of three standard balance point values (55°F, 60°F, or 65°F).

Second, a multiple regression model was built and the measures were tested for inclusion. The result of this model is a predictive model of savings related to some of the measures.

Third, the regression model was tested for the influence of outliers, high leverage data, and the applicability of standard statistical assumptions.

Fourth, The coefficients of the regression model were taken as estimates of the effect of each measure as long as the coefficient was significantly different from zero.

Fifth, The mean value of the predictor[4] for homes treated with the measure was computed.

Sixth, The product of the mean predictor value and the regression coefficient was used to predict the average savings per home attributable to that measure.

This method provides the most robust estimates of savings due to individual measures. The results are shown in Table 2-1.

Table 2-1. Regression Based Gas Savings Estimates for Individual Measures

Measure	Savings Estimate (% of Pre-Weatherized Annual Use, 1165 therms)	Statistically Different from Zero
Correcting furnace CO in excess of 2000 ppm. (n=22)	151 therms per year (13%)	Yes
Sun Power furnace efficiency work (n=193)	28 therms per year (2%)	Yes
Duct sealing (n=73)	44 therms per year (0.089 therms per CFM25 reduction) (4%)	Yes
Blower door guided air sealing (n=193)	47 therms per year (0.052 therms per CFM50 reduction)	Yes
Insulating walls (n=35)	204 therms per year	Yes
Insulating attic (n=98)	52 therms per year (0.308 therms per change in UA)	Yes
Crawlspace Treatment (n=1)	194 therms per year	No

[4] 1 for "dummy" variables and arithmetic mean for variables such as change in CFM50, CFM25, or UA.

The statistical summary of the analysis is in Appendix A.

The regression coefficients are taken as an estimate of the savings associated with each measure. These estimates have a wide confidence interval as shown in Appendix A. These estimates need to be viewed in light of other empirical data on energy savings.

Correcting CO production of more than 2000 ppm in the flue has a regression estimated savings of 151 therms per year (13%). This savings is in line with the only other known data on repairing high CO-production residential furnaces (Proctor, 1991) which measured efficiency improvements correlated to a savings of 19% of heating use.

Sun Power Furnace Efficiency Modifications have been evaluated in many studies, mostly on low income homes. The early studies are summarized in Proctor and Foster (1986). Those studies found a range of savings from 5% to 15% of heating consumption. Savings differences have been observed to be related to how much feedback the technicians get on their work.

The regression model estimate for duct sealing heating savings estimate is lower than expected. Given a 498 cfm25 leakage reduction, savings of more than 10% would be expected (Proposed ASHRAE Standard 152P would predict over 20%). Savings of 4% were found.

The regression model savings estimate for air sealing is 0.052 therms per cfm50 leakage reduction. The Proctor Engineering Group air leakage model[5] predicts 0.081 therms per cfm50 leakage reduction for homes in the SIGECO climate with a 60% seasonal efficiency furnace. Seasonal furnace efficiency of 60% is typical in this housing stock. Newer housing typically has a slightly higher average.

The regression model savings estimate for insulating walls is within the expected range. A savings of over 200 therms should be expected for insulating exterior walls on a gas heated home in Evansville with approximately 1000 sq. ft of wall area.

The regression model savings estimate for adding attic insulation is 0.308 therms per unit change in UA[6]. This is significantly below the expected range of 0.7 to 0.9 therms per change in UA for the SIGECO climate with a 60% seasonal efficiency furnace.

The crawlspace treatment consisted of "putting the crawlspace in the house" by insulating the exterior wall of the crawlspace, laying a vapor barrier over the crawl floor, and closing the crawlspace vents. This process was used to bring the supply duct work into the home as well as reduce conduction and infiltration losses. This treatment was applied to 3 homes in the analysis (1 gas heated home and 2 electrically heated homes). Due to the small sample size, the savings cannot be estimated with any statistical certainty. The savings for the homes is quite high and the approach warrants additional investigation.

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[5] The air leakage model is based on the Lawrence Berkeley National Laboratory infiltration model.

[6] UA is the insulated area divided by the R value. For 1000 square feet, adding R-10 will change UA by 100.

2.5 Savings estimates for individual measures by stratum

The regression analysis in Section 2.4 should be taken as the best estimation of program energy savings by measure. The estimates in that section are more robust than estimates by stratum.

The method used in Section 2.4 was reapplied by stratum to look at differences as follows:

> When the regression coefficient for the stratum was significantly different from zero, the savings estimate in Table 2-2 is product of the coefficient and the mean value of the predictor for that stratum.
>
> When the coefficient was not significantly different from zero, the savings estimate in Table 2-2 is product of the coefficient for all treated customers and the mean value of the predictor for that stratum
>
> If no regression based value could be assigned, Proctor Engineering Group developed an engineering estimate based on standard equations and empirical data.

Table 2-2. Gas Savings Estimates for Individual Measures by Stratum

Pre-weatherization Therms	1165	1155	1362	1131	1028
Sample Size	371	213	52	60	46
EFFICIENCY MEASURES	all	stratum 1	stratum 2	stratum 3	stratum 4
CO > 2000	**150 (13%)**	153 (13%)	**150 (11%)**	**150 (13%)**	**150 (15%)**
Furnace Efficiency	**28 (2%)**	48 (4%)	**32 (2%)**	**26 (2%)**	**24 (2%)**
Water Heater Insulation	*22 (2%)*	*22 (2%)*	*22 (2%)*	*22 (2%)*	*22 (2%)*
Duct Sealing	**44 (4%)**	65 (6%)	39 (3%)	**55 (5%)**	34 (3%)
Attic Insulation	**53 (5%)**	55 (5%)	113 (8%)	**43 (5%)**	**45 (4%)**
Wall Insulation	**204 (17%)**	252 (22%)	153 (11%)	169 (15%)	-
Air Sealing	**47 (4%)**	38 (3%)	70 (5%)	54 (5%)	35 (3%)
Crawlspace Treatment	**194 (16%)**	-	-	-	-

Numbers in Italic are Engineering Estimates

2.6 Summary

Gas consumption of Treated homes was initially higher than the gas consumption of the Not-treated homes. After retrofits were applied to Participant homes with the highest available cost effective energy savings (both gas and electric), the Treated homes showed a decrease in annual consumption, while the Not-treated group showed a slight increase. The net savings for the treated homes was approximately 18% (200 therms per year) of their pre-retrofit annual gas consumption.

Individual measures were evaluated with a CDA multi-variate regression approach. The regression coefficients are estimates (with wide confidence bands) of the effect of the individual measures on savings. Two measures showed high savings that were in line with expectations based on other empirical studies. These two measures were Insulating walls and repairing incomplete burn on furnaces (repairing furnaces that have over 2000 ppm of CO). One new measure developed in this program had too little data to provide a statistically significant estimate of savings, but in its single application to a gas heated home the savings was estimated at 194 therms per year. The new measure was an innovative crawlspace treatment. Four measures that were evaluated had savings that were significant but less than expected from prior empirical studies. These measures were: Furnace Efficiency Modifications, Duct Sealing, Blower Door Guided Air Sealing, and Attic Insulation.

3. SUMMER ELECTRIC SAVINGS FOR GAS HEAT CUSTOMERS

The gas heat customers were generally treated during the summer of 1996. The summer electrical use of these customers received the most attention in the analysis since it provided the highest potential for information on the peak effects of the measures applied in this pilot. The same multi-step analysis applied to gas heating was applied to the summer electric consumption of the gas heated homes. The treatment dates were the same as used in the gas analysis.

These homes were first analyzed based on the largest possible data set (the monthly billing data) then analyzed in greater depth using the customers that had both billing data and hourly house meter data.

3.1 Savings estimate from group means

When ALL Participants (both treated and not-treated) are included the analysis, the savings based on a simple comparison of group means is:

savings by month =[($ADC_{Part\ Pre}$ - $ADC_{Non\text{-}part\ Pre}$) - ($ADC_{Part\ Post}$ - $ADC_{Non\text{-}part\ Post}$)] * days

summer savings = Sum (monthly savings for April through September billing periods)

average summer savings = 746 kWh/summer.

where,

ADC = Average Daily Consumption[7]

The estimated pre- and post-retrofit summer consumption estimates from the monthly comparisons is displayed in Figure 3-1.

This understates the savings for treated customers since not-treated customers are present in the sample. Only 57% of the participant group received any treatment expected to save summer electricity. The 746 kWh per summer represents the most common type of program implementation where all customers are treated the same. This pilot developed targeting and screening that can focus the effort on homes where savings can, and will, occur.

[7] The electric consumption for all the customers in the group was summed for each billing period and divided by the number of customer*billing days in the same period.

The estimated pre- and post-retrofit summer consumption estimates from the monthly comparisons is displayed in Figure 3-1.

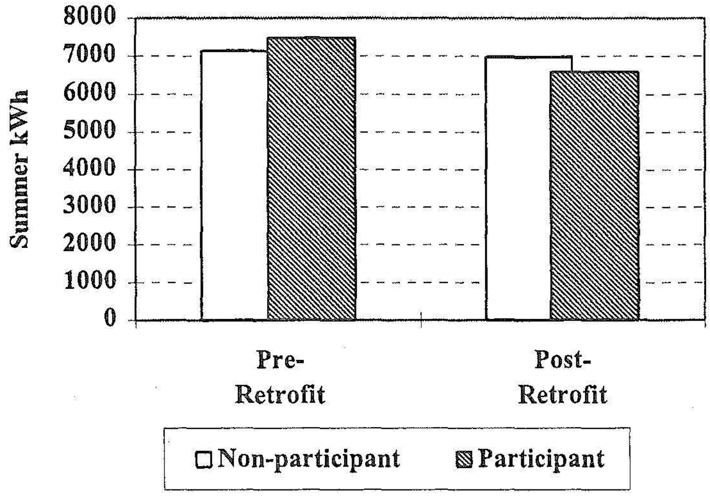


Figure 3-1 Summer Electric Consumption Estimate From Month-by-month Analysis

This simple analysis does not fully take weather into consideration (except implicitly since the two groups experienced the same weather). An explicit weather normalization methodology is applied in later sections.

3.2 Savings by month

The month-by-month savings estimates are shown in Figure 3-2. Due to the timing of the retrofits, every month does not have the same number of readings.

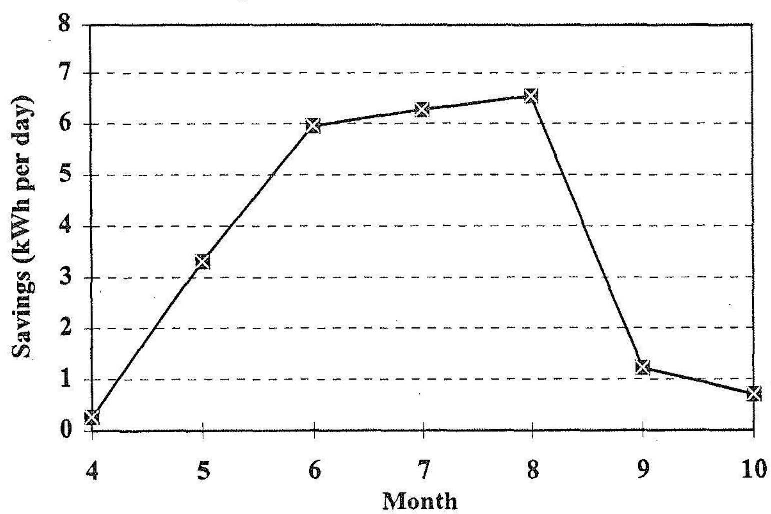


Figure 3-2. Summer Electric Savings Estimate by Month (Gas Heated Homes)

The statistical summary of the analysis is in Appendix A

3.3 Time series cross sectional analysis

The time series cross sectional analysis provides explicit weather terms. The time series cross sectional analysis was run on the data set. Weather normalization is relatively easy for heating climates with very cold winters. It becomes substantially less accurate when it is used on air conditioning since cooling energy consumption shows much more variability due to occupant interaction. It becomes even more problematic when large adjustments are necessary. The summer of 1996 was particularly cool and the prior summer particularly warm for Evansville. This is illustrated in Figure 3-3..

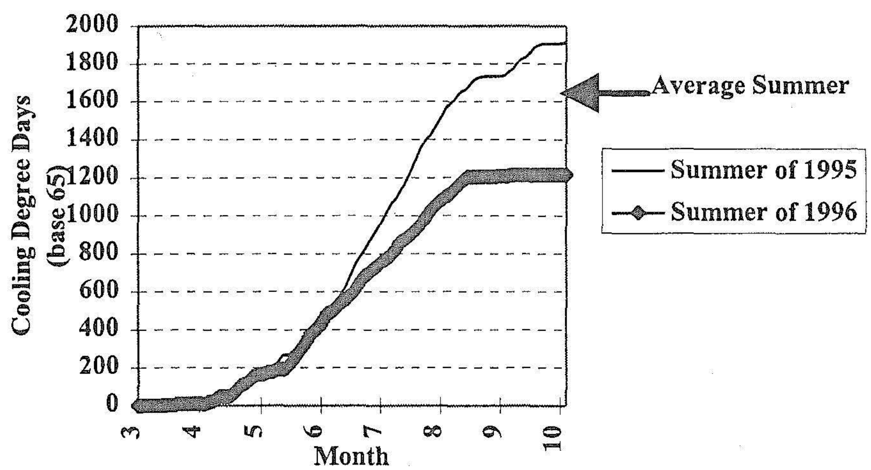


Figure 3-3. Cooling Degree Days for Pilot Program Summers

The effect of this cool summer is particularly evident at high reference temperatures (36 cooling degree days at base 80°F compared to 103 cooling degree days in an average summer and 201 cooling degree days in the summer of 1995). The time series cross sectional analysis did not provide a reliable estimate of changes in summer electric energy consumption for this group of customers

3.4 Savings estimate for treated participants

In order to refine the analysis, gas customers with both monthly billing data and hourly house meter data were selected. In order to obtain the best estimate of treatment effects, treated CAC participants were compared to both CAC Non-participants and to CAC not-treated customers. The two analyses produced essentially the same results. The same month-by-month analysis described in Sections 3.1 and 3.2 were repeated on these groups. As before:

savings by month =[(ADC $_{\text{Part Pre}}$ - ADC $_{\text{Non-part Pre}}$) - (ADC $_{\text{Part Post}}$ - ADC $_{\text{Non-part Post}}$)] * days

summer savings = Sum (monthly savings for April through September billing periods)

<u>average summer savings = 1040 kWh/summer.</u>

where,

ADC = Average Daily Consumption[8]

The pre- and post-retrofit summer consumption estimates from the monthly comparisons are displayed in Figure 3-4.

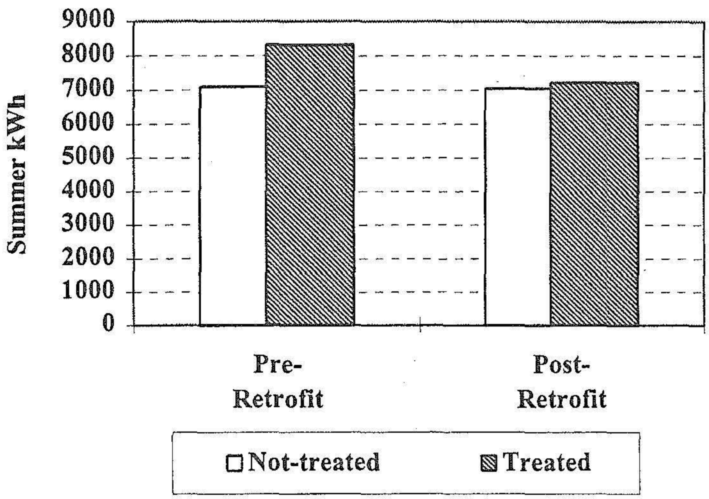
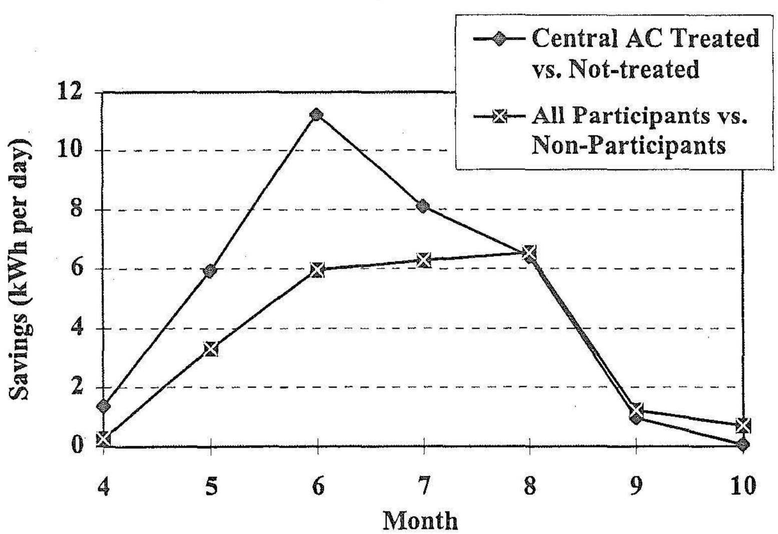


Figure 3-4 Summer Electric Consumption Estimate for Treated Central AC Gas Customers

3.5 Savings by month for treated participants

The month-by-month savings estimates for Treated versus Not-treated (Audit only) central air-conditioned homes are shown in Figure 3-5. The initial estimates using all participants is also shown for reference.



[8] The electric consumption for all the customers in the group was summed for each billing period and divided by the number of customer*billing days in the same period.

Figure 3-5. Summer Electric Savings Estimate by Month (Treated Central AC Gas Heated Homes)

The statistical summary of the analysis is in Appendix A

3.6 Summary

Summer electrical consumption for gas heated customers selected for treatment was initially higher than the summer electrical consumption of the not-treated customers. After retrofits were applied to homes with the highest available cost effective energy savings (both gas and electric), the treated customers showed a decrease in annual consumption to near the consumption of the not-treated customers. This is precisely in line with the design of the program. Customers were selected for treatment based on their excess energy use compared to similar homes. The pilot program was effective in reducing higher use customers to average levels. The net summer electrical savings for the treated gas customers was approximately 12.5% (1040 kWh per summer) of their pre-retrofit summer electrical (April through September) consumption.

4. SUMMER ELECTRIC DEMAND REDUCTIONS

The demand analysis focused on estimating differences in summer hourly electricity usage between the treatment and comparison houses. This is a typical treatment group to comparison group analysis. The key factors considered in the analyses were outdoor temperature, time of day, house strata, and treated versus not-treated.

4.1 Data Cleaning and Matching

Proctor Engineering Group first prepared the data for analysis. Temperature and hourly electric data were cleaned, combined, and synchronized. The usage data were first cleaned to eliminate homes where data was missing. Group (Participant vs. Non-Participant) and Strata information was corrected. In order to provide a direct link between the monthly billing analysis and the hourly analysis, any customers without monthly billing data were discarded from the hourly data set. This process provided 563 homes for analysis of hourly data. (Detailed in Table 4-1)

Table 4-1. Homes with Hourly Data

Group ID	Heating Type	Cooling Type	Income	Home Age	Participant or Comparison	Number of Homes
111	Electric	Central	Any	Any	Comparison	54
112	Electric Heat Pump	Central	Any	Any	Comparison	43
113	Electric	Room	Any	Any	Comparison	12
114	Electric	Central	Low	Any	Comparison	8
121	Electric	Central	Any	Any	Participant	33
122	Electric Heat Pump	Central	Any	Any	Participant	56
123	Electric	Room	Any	Any	Participant	0
124	Electric	Central	Low	Any	Participant	18
211	Gas	Central	Any	Any	Comparison	85
212	Gas	Room	Any	Any	Comparison	36
213	Gas	Central	Low	Any	Comparison	31
214	Gas	Central	Any	Post 1990	Comparison	29
221	Gas	Central	Any	Any	Participant	77
222	Gas	Room	Any	Any	Participant	24
223	Gas	Central	Low	Any	Participant	30
224	Gas	Central	Any	Post 1990	Participant	27
					TOTAL	563

4.2 Hourly Air Conditioner Energy Consumption Model

PEG explored a number of techniques for estimating the hourly air conditioner consumption from the hourly whole house data. In each case the results were checked against known AC connected loads for each treatment home[9]. One straight forward approach used "swing period" (at least 20 days in the spring or fall when the air conditioner is not in use) to establish the mean hourly use by hour of day. While this technique was acceptable, regression methods proved to produce results more consistent with the known connected AC loads.

PEG explored a number of regression methods and models for the disaggregation. Some of the regression models explored were; ordinary least squares, robust regression, and least-absolute value regression. Each of these estimate the central tendency of data, but deal with outliers in different manners. Because the whole house load has a number of near random excursions that exceed the connected load of the air conditioner, a least-absolute value model proved to provide the best estimate based on the comparison to connected load and known peak AC load shapes. This regression technique was used to estimate the median watt draw based on outdoor temperature for each hour of the day and for each home. There were 13,512 (563 customers * 24 hours) regressions. The median consumption for any particular hour is nearly constant against outdoor temperature until the outdoor temperature rises above that necessary to call for air conditioning.

The model estimated an overall constant, a shift (occurring above the hourly base temperature), and the coefficients of two independent variables (outdoor temperature and outdoor temperature above the hourly base temperature). The model thus produced constants and coefficients specific to each home and each hour of the day. The form of the equation is:

$$Use_{it} = a_{it} + b1_{it} * Tout + c_{it} + b2_{it} * Tout$$

Where:

Use_{it} = Median whole house electrical use in house i at hour t

a_{it} = Regression constant for house i at hour t

$b1_{it}$ = Regression coefficient of outside temperature for house i at hour t

Tout = Outside temperature at hour t

c_{it} = Value shift when Tout > $Tref_t$ or 0.0 when Tout < $Tref_t$
This allows for a step function change at the reference temperature

$b2_{it}$ = Regression coefficient (slope adjustment) of outside temperature when Tout > $Tref_t$ or 0.0 when Tout < $Tref_t$

$Tref_t$ = Reference temperature for cooling in hour t
The cooling reference temperature (Tref) was estimated for each hour based on best fit criteria to a random sample of treatment homes.

[9] Many of the treatment homes were visited and air conditioner capacity and EER recorded.

The values for the regression constants, coefficients, shifts, and Tref's are listed in Appendix A.

The air conditioner watt draw is estimated as the shift plus the temperature slope adjustment times the outside temperature That is:

$$ACUse_{it} = c_{it} + b2_{it} * Tout$$

Where:

$ACUse_{it}$ = Air Conditioner electrical use in house i at hour t

This approach captures temperature dependent air conditioner effects and any other electric consumption that correlates with increasing outdoor temperature above the reference temperature. Refrigerators for example show this pattern. Since the method was the same in both the treatment and comparison group and since the information of primary interest is the difference between the two groups, this method will capture the information of interest.

4.3 Application of Model to Temperature Data

The regression model developed as described in Section 4.2, was used to estimate the air conditioner peak load shape for each customer stratum[10] for peak days. Hourly temperature data for SIGECO selected peak days from the summer of 1996 were used to populate the model. The peak days for 1996 were: July 1, July 18, July 19, August 6, August 7, August 19, August 20, August 21, August 22, and August 23.

4.4 Analysis Group Selection

Gas heated customers' homes provide the greatest opportunity for summer peak reductions from the energy efficiency activities in this pilot for these reasons:

- The gas heated homes had more building shell air leakage than the electrically heated homes
- The gas heated homes had more duct leakage than the electrically heated homes
- The gas heated homes had less insulation than the electrically heated homes
- The gas heated homes had identifiable energy savings from the treatments based on monthly gas and electric billing data.

The peak reduction analysis concentrated on gas heated homes.

[10] Stratum estimates were hourly use weighted averages for all customers in the stratum.

4.5 AC Peak Day Load Profiles

The most robust information is contained in the comparison between treated customers' homes and not-treated customers' homes (as in Section 3.4). The Treated group initially had higher summer electrical consumption than the Not-treated group. After the treatment the Treatment group energy consumption fell to slightly above the Not-treated group. Based on the monthly billing data the peak AC load profiles are expected to nearly match in the post-treatment period. These profiles are displayed in Figure 4-1.

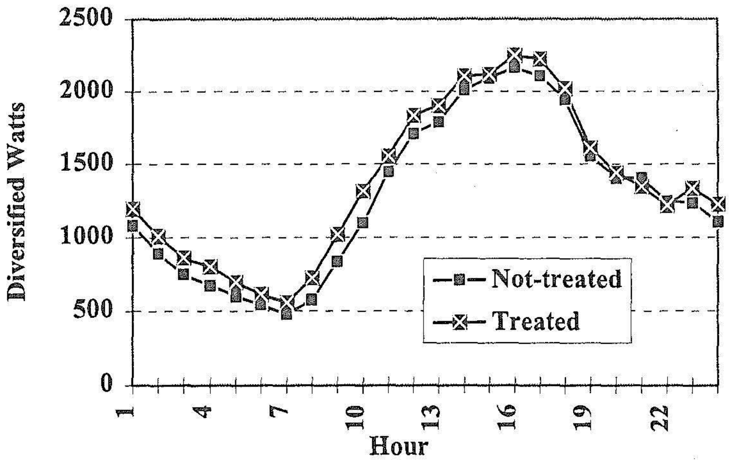


Figure 4-1. 1996 Summer Peak Day Diversified[11] Load Profile (Central AC)

The load profiles are in line with the expected results. The diversified peak load of the Treated group is nearly the same as the Not-treated group.

4.6 Peak Day Load Reduction Profile

On peak days the major treatments in this pilot have been found to be effective in reducing peak loads. Since the peak reduction is based on a reduction in cooling load, not AC equipment efficiency or connected load, the reductions do not occur in the same proportion throughout a peak day. For customers who lower their thermostat settings at some point in the day, cooling load reduction has no effect on AC watt draw until the home is cooled to the lower temperature setting. On homes with that type of control pattern, the run time necessary to reach the lower temperature is reduced by these treatments and a very large electric load reduction occurs after the home reaches the lower setting. A typical load reduction curve for these types of treatments is shown in Figure 4-2 (Blasnik et al. 1997). This profile was produced from submetered data on newly constructed homes in Las Vegas where two sets of homes were compared (one with standard construction, the other with improved standards - particularly reduced duct leakage).

[11] Diversified load is the load seen by the utility which is the average of all the different air conditioners.

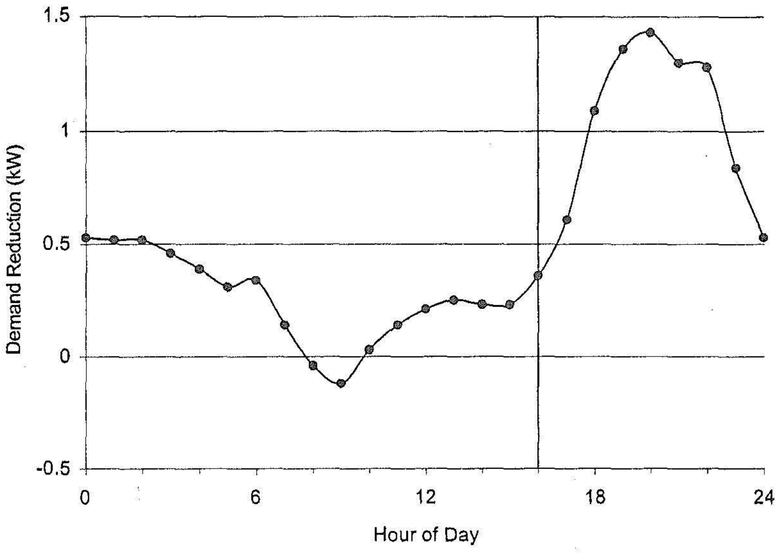


Figure 4-2. Typical Diversified AC Peak Day Load Reduction Profile for Duct Sealing

The peak consumption difference between the treatment and comparison groups for the newer home stratum (Group 214 vs. Group 224) is shown in Figure 4-3. That profile is consistent with the load reduction profile shown in Figure 4-2 except that the largest load difference occurs at an earlier hour (3 PM to 4 PM). AC load profiles hot dry climates (Fresno, California; Las Vegas Nevada; and Phoenix, Arizona) show peak residential AC use near 7 PM.

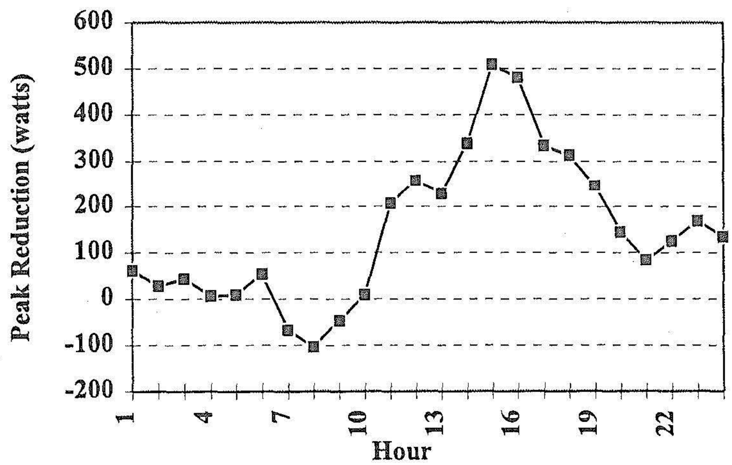


Figure 4-3. Diversified AC Peak Day Load Difference Profile for SIGECO Post-1990 Gas Heated Homes

This relationship is also similar to the relationship found in a 1991 study of peak reduction due to duct sealing in Fresno, California (Proctor, 1993). In that study, the duct systems in existing homes were repaired to reduce duct leakage. The submetered peak reduction in that study was 24% at 8 PM.

4.7 Peak Day Coincident Load Reduction Estimate

The average reduction in AC load predicted by the monthly billing data is 237 watts (1040 kWh/4392 hours). If the savings were proportional across all time periods, the peak day reduction in the coincident peak hour (3 PM to 4 PM) hour would be approximately 800 watts. The actual peak reduction is dependent on the peak-day load-difference profile for these customers. Based on the Section 4.6 analysis, the coincident peak reduction (peak days, 3 PM to 4 PM) for gas heated central air conditioned customers, targeted by relative consumption, and receiving major treatment is estimated to be 500 to 800 watts. Five-hundred watts is a safer planning estimate.

The peak day coincident load reduction by measure was estimated as proportional to energy savings (based on the fact that all the measures were cooling load reductions and none were equipment efficiency improvements). Table 4-2 shows the coincident peak reduction estimate by measure for an average, gas heated, central air conditioner, treated customer. The distinction between stratum was made based on the level of intervention accomplished for each measure in the pilot. It does not represent the absolute number for possible peak reduction.

Table 4-2a. Estimated Peak Demand Reduction for Individual Measures by Gas Stratum (based on average peak reduction of 500 watts for treated central AC gas heated customers)

	Stratum 1	Stratum 2	Stratum 3	Stratum 4
	Central AC	Room AC	CAC Low-Income	New with Central AC
Duct Leakage Reduction	0.32 kW	-	0.24 kW	0.14 kW
Ceiling Insulation	0.27 kW	0.14 kW	0.18 kW	0.19 kW
Sidewall Insulation	1.23 kW	0.19 kW	0.73 kW	-
Building Shell Sealing	0.19 kW	0.09 kW	0.23 kW	0.14 kW

Table 4-2b. Estimated Peak Demand Reduction for Individual Measures by Electric Stratum (based on average peak reduction of 500 watts for treated central AC gas heated customers)

	Stratum 1	Stratum 2	Stratum 3	Stratum 4
	Central AC non-Heat Pump	Heat Pump	Room AC	Low-Income with Central AC
Duct Leakage Reduction	0.14 kW	0.26 kW	-	0.09 kW
Ceiling Insulation	0.17 kW	0.12 kW	-	0.09 kW
Sidewall Insulation	-	-	-	-
Building Shell Sealing	0.11 kW	0.15 kW	-	0.05 kW

4.8 Estimates by Costing Period

PEG produced costing period central air conditioner usage estimates from the load data. Applying the peak AC model derived from 1996 hourly whole house data to the TMY2 temperature data for Evansville produced estimates of on peak and off peak electrical consumption. These estimates are shown in Table 4-3. These estimates are significantly different from the 60% on peak energy allocation used in the IRP. This 50% value is based on SIGECO specific data and is therefore probably a better estimate for the SIGEGO service territory..

Table 4-3. Percent Central AC Electric Consumption by Summer Costing Period

Group ID	Heating Type	Cooling Type	Income	Treatment or Comparison	On Peak %
111	Electric	Central	Any	Comparison	49%
112	Electric Heat Pump	Central	Any	Comparison	49%
114	Electric	Central	Low	Comparison	47%
121	Electric	Central	Any	Treatment	51%
122	Electric Heat Pump	Central	Any	Treatment	48%
124	Electric	Central	Low	Treatment	51%
211	Gas	Central	Any	Comparison	53%
213	Gas	Central	Low	Comparison	55%
214	Gas	Central	Any	Comparison	54%
221	Gas	Central	Any	Treatment	52%
223	Gas	Central	Low	Treatment	53%
224	Gas	Central	Any	Treatment	53%

4.9 Summary

Electrical consumption for gas heated homes selected for treatment was initially higher than the summer electrical consumption of the not-treated homes. After retrofits were applied to homes with the highest available cost effective energy savings (both gas and electric), the treated customers showed a decrease in annual consumption to near the consumption of the not-treated customers.

As expected, analysis of hourly electrical data for the post-treatment period showed little difference between the treated and not-treated customers. Coincident peak hour, peak day load reduction was estimated based on the summer electric energy savings and a peak reduction load profile for treatments similar to those in the pilot. Peak day, coincident peak hour central air conditioner load is estimated to drop between 500 and 800 watts for targeted and treated customers.

5. ALL-ELECTRIC CUSTOMERS

The All-Electric Customer group was treated at the beginning of the pilot program starting May 24, 1994, with a median completion date of September 23, 1995. The customers were randomly assigned to "Participants" (those eligible for treatment n=304) and "Non-participants" (those not eligible for treatment n=166). The households were split evenly between heat pumps and standard central air conditioning systems.

Within the Participants, 31% received no remedial treatment. As with the Gas Customers, this was based on building diagnostic tests and the building's energy consumption compared to comparable buildings. The diagnostic tests analyzed the air tightness of the shell and ducts as well as the insulation levels. These audited values were used to determine the potential effectiveness of each measure.

All of the customers were assigned a "Completion" date for determination of the "Post" retrofit period. This was either the audit date (when no work was done), the work completion date, or (for the Non-participants) a randomly assigned date from one of the Participant customers.

The all-electric housing stock is very different from the gas heat group. Appendix B shows the characteristics of the two Participant groups and the measures installed.

5.1 Savings estimate from Treated and Not-treated month-by-month means

One estimate of savings was obtained by comparing the mean electric use of the treated homes to the mean use of the not-treated homes. The average savings is:

average savings = 1497 kWh/yr.

Where:

savings by month =[(ADC $_{\text{Treat Pre}}$ - ADC $_{\text{Not-treat Pre}}$) - (ADC $_{\text{Treat Post}}$ - ADC $_{\text{Not-treat Post}}$)] * days

annual savings = Sum (monthly savings)

ADC = Average Daily Consumption[12]

Sixty-nine percent of the participant group received treatment. This pilot developed targeting and screening that can focus the effort on homes where savings can, and will, occur.

[12] The electric consumption for all the customers in the group was summed for each billing period and divided by the number of customer*billing days in the same period.

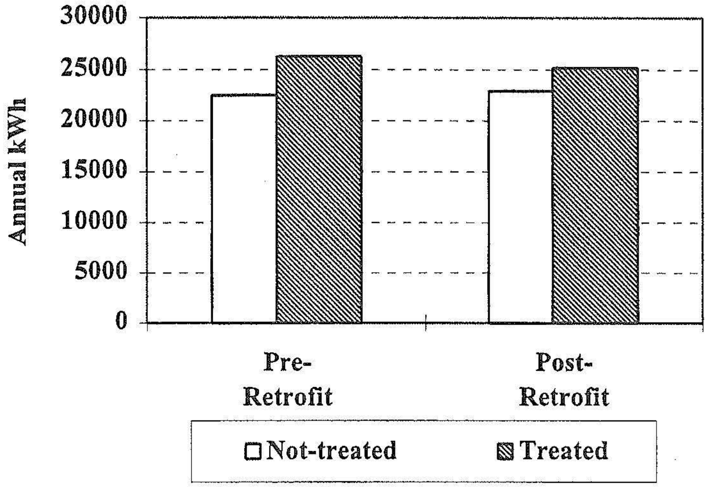


Figure 5-1 Yearly Electric Consumption Estimate From Month-by-month Analysis

The statistical summary of the analysis is in Appendix A.

5.2 Savings by month

The mean savings by month are shown in Figure 5-2.

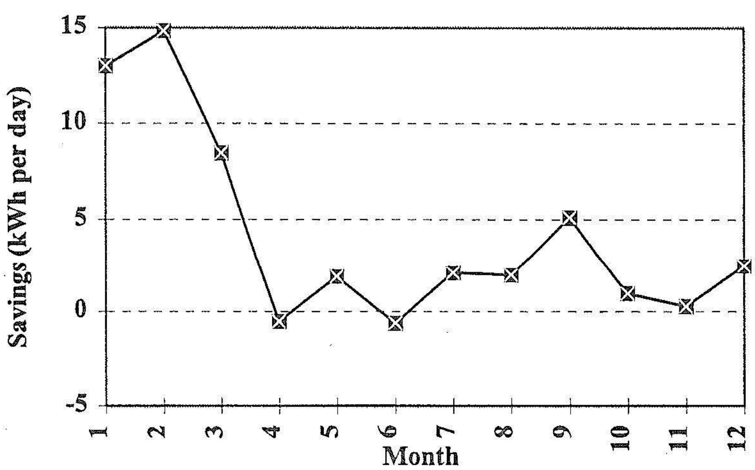


Figure 5-2 Electric Savings Estimate by Month

The statistical summary of the analysis is in Appendix A.

5.3 Savings using the cross sectional time series model

The overall savings was re-estimated using a time series cross sectional analysis with similar results. As with the electric consumption of the gas customers, the time series cross sectional model results were inconclusive.

5.4 Savings estimates for individual measures

Individual measure analysis provides information on the savings value of the measure. This followed the same multi-step process as the analysis for gas customers:

First, the pre- and post-retrofit annual electric consumption for each customer was weather normalized based on historical Evansville weather. This analysis allowed variation in both the heating and cooling reference temperatures (50/65, 50/70, 55/65, and 55/70). Cooling and heating were analyzed separately for best fit and the composite NAC was produced. The analysis used the best fit for each customer. This normalization process was similar to a PRISM™ analysis with constrained reference temperatures.

Second, a multiple regression model was created and each measure was evaluated for significance.

Third, the regression model was tested for the influence of outliers, high leverage data, and the applicability of standard statistical assumptions.

Fourth, The coefficients of the regression model were taken as estimates of the effect of each measure as long as the coefficient was significantly different from zero.

Fifth, The mean value of the predictor[13] for homes treated with the measure was computed.

Sixth, The product of the mean predictor value and the regression coefficient was used to predict the average savings per home attributable to that measure.

This method provides the most robust estimates of savings due to individual measures. The results are shown in Table 5-1.

Table 5-1. Regression Based Electric Savings Estimates for Individual Measures

Measure	Savings Estimate (% of Pre-Weatherized Annual Use, 28119 kWh)	Statistically Different from Zero
Duct Sealing (n=77)	1104 kWh per year (3.2 kWh per CFM25 reduction) (4%)	Yes
Insulating attic (n=79)	1891 kWh per year (19.8 kWh per unit change in UA) (7%)	Yes
Water heater insulation	240 kWh per year (1%)	No[14]

[13] 1 for "dummy" variables and arithmetic mean for variables such as change in CFM50, CFM25, or UA.

[14] The water heater insulation wrap variable had a very unstable coefficient from regression model to regression model.

The statistical summary of the analysis is in Appendix A.

The regression coefficients are taken as an estimate of the savings associated with each measure. These savings estimates have a wide confidence interval as shown in Appendix A. These estimates need to be viewed in light of other empirical data on energy savings.

5.5 Savings estimates for individual measures by stratum

The regression analysis in Section 5.4 should be taken as the best estimation of program energy savings by measure. The estimates in that section are more robust than estimates by stratum.

The method used in Section 5.4 was reapplied by stratum to look at differences as follows:

When the regression coefficient for the stratum was significantly different from zero, the savings estimate in Table 5-2 is product of the coefficient and the mean value of the predictor for that stratum.

When the coefficient was not significantly different from zero, the savings estimate in Table 5-2 is product of the coefficient for all treated customers and the mean value of the predictor for that stratum.

The air sealing estimate is based on the gas data converted to the kWh and with adjustments for efficiency differences.

If no regression based value could be assigned, Proctor Engineering Group assigned an engineering estimate based on standard equations and empirical data.

Table 5-2. Electric Savings Estimates for Individual Measures by Stratum

Pre-weatherization kWh	25972	26680	27064	19707	23824
sample size	293	120	150	5	18
MEASURES	All	Stratum 1	Stratum 2	Stratum 3	Stratum 4
Water Heater Insulation	*240 (1%)*	*240 (1%)*	*240 (1%)*	*240 (1%)*	*240 (1%)*
Duct Sealing	**1104 (4%)**	**721 (3%)**	**1608 (6%)**	-	**743 (3%)**
Attic Insulation	**1892 (7%)**	**2477 (9%)**	**1587 (6%)**	-	**1652 (7%)**
Air Sealing	**951 (4%)**	**777 (3%)**	**1092 (4%)**	-	**397 (2%)**

Numbers in Italic are Engineering Estimates

5.6 Summary

Electrical consumption for electrically heated homes selected for treatment was initially higher than the electrical consumption of the not-treated homes. After retrofits were applied to homes with the highest available cost effective energy savings, the treated customers showed a decrease in annual consumption to near the consumption of the not-treated customers. For those receiving treatments, estimated savings exceed 1497 kWh per year. Individual measures that showed significant savings were duct sealing and attic insulation.

APPENDIX A - MODEL INFORMATION

2.1 GAS SAVINGS ESTIMATES FROM GROUP MEANS

Daily Gas Consumption Pre and Post for Air Sealing, Duct Sealing, and Insulation and CO

	Pre	Pre-Retrofit			Post-Retrofit		
	month	Not-treated	Treated	Difference	Not-treated	Treated	Difference
Mean	1	6.45	7.29	0.84	5.51	5.20	-0.31
Mean	2	5.81	6.63	0.82	5.42	4.98	-0.44
Mean	3	5.17	5.98	0.81	5.33	4.75	-0.58
Mean	4	3.02	3.51	0.49	4.01	3.74	-0.27
Mean	5	1.60	1.75	0.15	1.66	1.57	-0.09
Mean	6	0.84	0.90	0.06	0.77	0.76	-0.01
Mean	7	0.70	0.70	0.00	0.63	0.61	-0.02
Mean	8	0.64	0.68	0.04	0.63	0.59	-0.04
Mean	9	0.68	0.70	0.02	0.65	0.62	-0.03
Mean	10	1.07	1.09	0.02	1.16	0.94	-0.22
Mean	11	2.61	2.91	0.29	3.05	2.77	-0.27
Mean	12	4.69	5.24	0.56	5.10	4.88	-0.22
	Annual	1007	1131	124	1027	951	-76
							200
n	1	724	382		281	134	
n	2	669	359		121	49	
n	3	645	340		139	65	
n	4	678	366		234	103	
n	5	985	531		268	123	
n	6	892	483		267	127	
n	7	826	441		375	174	
n	8	884	480		398	187	
n	9	789	421		374	190	
n	10	782	407		439	215	
n	11	818	433		391	204	
n	12	757	400		412	216	
StD	1	3.46	2.85		2.34	1.79	
StD	2	3.67	3.02		3.02	1.98	
StD	3	2.79	2.60		2.07	1.73	
StD	4	1.77	1.80		1.71	1.49	
StD	5	0.92	0.82		0.89	0.73	
StD	6	0.61	0.56		0.38	0.42	
StD	7	0.65	0.34		0.36	0.29	
StD	8	0.58	0.46		0.52	0.32	
StD	9	0.56	0.34		0.46	0.44	
StD	10	0.89	0.55		1.49	0.50	
StD	11	2.03	1.75		2.14	1.52	
StD	12	2.77	2.28		2.55	2.09	

2.3 GAS SAVINGS ESTIMATES FROM CROSS SECTIONAL TIME SERIES

where:

_cons is the intercept of the regression equation (roughly the base consumption)

ddpd60 is the 60°F base degree days per day

Npre is 1 for Non-participant in the pre- period

Nrdd60 is the 60°F base degree days per day for Non-participant in pre- billing period

Npost is 1 for Non-participant in the post- period

Npdd60 is the 60°F base degree days per day for Non-participant in post- billing period

Ppost is 1 for Participant in the post- period

gupd	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ddpd60	0.2400	0.0013	182.4950	0.0000	0.2374	0.2426
Npre	(dropped)					
Nrdd60	0.0089	0.0021	4.2260	0.0000	0.0048	0.0131
Npost	-0.2276	0.0418	-5.4530	0.0000	-0.3095	-0.1458
Npdd60	0.0021	0.0032	0.6620	0.5080	-0.0042	0.0084
Ppost	-0.0952	0.0334	-2.8460	0.0040	-0.1607	-0.0296
Ppdd60	-0.0510	0.0027	-19.0820	0.0000	-0.0562	-0.0458
_cons	0.8221	0.0132	62.4460	0.0000	0.7963	0.8479
account	F(613,19075) =		27.699	0	(614 categories)	

	Total NAC	Gross savings	Net savings	Heat NAC	Gross savings	Net savings
NACPpre	1195			895		
NACNpre	1203			903		
NACPpost	970	225	**142**	705	190	190
NACNpost	1120	83		903	0	

2.4 SAVINGS FOR GAS CUSTOMERS BY INDIVIDUAL MEASURE

Where:

CO= CO production over 2000 ppm

furneff= furnace efficiency adjustments made in heat rise and fan off temp.

NAC=normalized annual consumption

c25red=reduction in duct leakage @25Pa. pressure (in cfm)

muaattic=change in attic U-value per sq. ft. of building (in ^Ua/sq. ft.)

wallrchg=change in wall R-value (in R's)

bdred=reduction in the house leakage @50Pa. pressure (in cfm)

mcsi=crawl space insulation and sealing crawl ventilation

_cons=constant

Source	SS	df	MS
Model	10061157.6	8	1257644.70
Residual	12596023.2	601	20958.4413
Total	22657180.9	609	37203.9095

Number of obs	=	610
F(8, 601)	=	60.01
Prob > F	=	0.0000
R-squared	=	0.4441
Adj R-squared	=	0.4367
Root MSE	=	144.77

sav	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
co	150.8267	32.05432	4.705	0.000	87.87462	213.7788
furneff	28.2533	13.88255	2.035	0.042	.9890985	55.5175
NAC	.1183747	.013685	8.650	0.000	.0914985	.1452509
c25red	.0888744	.0324202	2.741	0.006	.0252037	.152545
bdred	.0521312	.0126471	4.122	0.000	.0272934	.076969
wallrchg	16.98185	2.4639	6.892	0.000	12.14295	21.82075
muaattic	.3080201	.0706191	4.362	0.000	.1693299	.4467103
mcsi	194.9356	145.5532	1.339	0.181	-90.91912	480.7903
_cons	-5.983901	17.45894	-0.343	0.732	-40.27185	28.30405

2.5 GAS SAVINGS ESTIMATES BY MEASURE AND STRATUM

	GAS		1165	1155	1362	1131	1028
		all		1	2	3	4
Mean	muaattic		171.60	174.60	194.40	176.60	127.70
Coefficient			0.31	0.32	0.59	NS	NS
Savings			**52.85**	55.09	113.88	**54.39**	**39.33**
Percent			5%	5%	8%	5%	4%
Mean	bdred		900.70	781.45	1332.90	1029.50	663.90
Coefficient			0.05	0.05	NS	NS	NS
Savings			**46.93**	37.51	**69.44**	**53.64**	**34.59**
Percent			4%	3%	5%	5%	3%
Mean	c25red		498.80	509.10	438.60	622.60	385.40
Coefficient			0.09	0.13	NS	NS	NS
Savings			**44.29**	64.55	**38.95**	**55.29**	**34.22**
Percent			4%	6%	3%	5%	3%
Mean	wallrchg		12	12	12	12	0
Coefficient			16.98	20.98	12.79	14.12	
Savings			**203.76**	251.76	153.48	169.44	
Percent			17%	22%	11%	15%	

3.1 ELECTRIC SAVINGS ESTIMATES FOR GAS CUSTOMERS FROM GROUP MEANS

Summer Month Daily Electric Consumption of Gas Customers Pre and Post for Participants and Non-Participants

	Pre				Post		
	month	Non-Participants Pre	Participants Pre	Difference Pre-Retrofit	Non-Participants Post	Participants Post	Difference Post-Retrofit
Mean	4	28.17	25.41	-2.77	24.29	21.25	-3.04
Mean	5	21.94	22.96	1.03	26.44	24.15	-2.29
Mean	6	31.50	34.41	2.91	37.08	34.03	-3.05
Mean	7	45.84	50.24	4.40	49.04	47.17	-1.87
Mean	8	58.57	63.21	4.64	49.89	47.99	-1.90
Mean	9	47.68	48.37	0.68	41.58	41.05	-0.53
	Total	7138	7474	360	6975	6589	-386
							746
n	4	343	578		103	154	
n	5	374	595		123	199	
n	6	321	501		129	214	
n	7	281	438		202	318	
n	8	291	452		215	341	
n	9	221	354		208	346	
Std. Dev.	4	26.54	14.95		17.64	12.85	
Std. Dev.	5	14.45	13.80		17.30	15.04	
Std. Dev.	6	19.72	18.52		22.56	20.45	
Std. Dev.	7	23.96	25.49		24.90	23.03	
Std. Dev.	8	29.62	33.13		28.49	23.61	
Std. Dev.	9	24.58	22.84		22.14	21.41	

3.3 TIME SERIES CROSS SECTIONAL ANALYSIS

gupd	Coef.	Std. Err.	t	P>|t|	[95% Con	f. Interval]
cddpd65	2.34	0.03	84.21	0.00	2.28	2.39
Npre	(dropped)					
Ppost	2.94	0.51	5.76	0.00	1.94	3.93
Npost	0.72	0.64	1.12	0.26	-0.54	1.97
Npcdd65	0.18	0.07	2.49	0.01	0.04	0.33
Ppcdd65	0.13	0.06	2.03	0.04	0.00	0.25
Nrddpd65	-0.26	0.04	-5.90	0.00	-0.35	-0.18
_cons	18.83	0.23	83.23	0.00	18.38	19.27

	Total NAC	Gross savings	Net savings	NAC cool		
NACPpre	10683			3806		
NACNpre	10252			3375		
NACPpost	11960	-1277	-287	4011	-205	523
NACNpost	11242	-990		4104	-728	

3.4 SAVINGS ESTIMATE FOR TREATED PARTICIPANTS

Non-Participants

Mean daily consumption (kWh)
Mean Days in period
observations

	Stratum 1		Stratum 2		Stratum 3		Stratum 4	
month	Pre	Post	Pre	Post	Pre	Post	Pre	Post
4	30.57	21.72	29.3	24.15	25.03	25.08	34.04	28.17
	30.84	31.83	32.31	33.29	31.17	31.06	30.03	30.61
	131	29	55	14	41	16	33	18
5	22.99	28.42	16.5	22.95	18.43	25.02	27.55	29.9
	31.53	29.16	30.59	29.63	32.82	30.07	33.83	29.58
	133	43	56	19	55	15	46	19
6	34.8	39.36	31.36	30.89	27.74	36.43	38.59	39.72
	31.93	31.33	32.77	32.61	31.18	30.95	31.02	32.12
	126	45	57	23	49	19	45	17
7	52.1	52.9	44.87	44.59	44.31	44.02	52.4	47.08
	31.74	31.41	31.43	30.04	31.51	29.89	31.05	30.37
	179	73	79	27	61	27	60	27
8	55.7	49.98	46.29	46.02	44.93	43.22	56.54	50.29
	29.45	28.38	30.35	29.29	30.08	28.83	29.92	28.5
	187	81	81	31	77	29	66	26
9	44.11	43.25	34.47	38.01	34.73	36.78	42.98	41.43
	31.5	30.99	30.79	31.53	31.21	31.19	31.61	31.07
	165	75	71	34	57	26	57	27
10	24.96	23.07	18.78	18.96	21.22	22.47	27.61	26.54
	29.38	29.33	30.06	29.85	29.68	29.15	29.96	29.59
	164	96	68	39	62	33	56	29

Participants WITHOUT SIGNIFICANT WORK DONE THAT WOULD EFFECT AC KWH CONSUMPTION

Mean daily consumption (kWh)
Mean Days in period
observations

	Stratum 1		Stratum 2		Stratum 3		Stratum 4	
month	Pre	Post	Pre	Post	Pre	Post	Pre	Post
4	29.87	22.64	30.13	11.3	23.55	19.33	34.14	29.58
	30.58	32.18	32.92	30.2	34.18	32	30.85	29.25
	45	11	12	5	17	6	13	4
5	21.32	22.86	17.19	20.32	19.6	16.32	25.52	22.71
	31.19	29.31	33.4	29.33	30.88	30	34.46	28.67
	43	16	15	6	17	7	13	6
6	37.51	34.53	32.98	21	27.95	24.51	31.37	27.58
	30.78	31.29	31.53	30.2	30.94	35	31.17	32.67
	37	17	15	5	17	8	12	6
7	49.05	47.29	43.04	38.25	42.19	37.07	44.99	43.42
	32.06	30.57	31.24	30.44	31.96	32.91	31.63	30.44
	64	23	17	9	25	11	19	9
8	50.97	47.09	49.75	39.42	43.53	36.3	49.62	42.24
	29.81	28.7	30.11	28.5	29.48	29.08	29.21	28.56
	63	23	19	8	25	13	19	9
9	40.05	43.11	34.04	32.44	36.15	28.52	35.8	37.14
	31.07	30.2	32.47	31.5	31.31	31.1	31.88	30
	59	25	19	8	26	10	17	9
10	22.97	24.25	19.39	14.59	20.24	16.83	22.38	22.7
	29.49	29.11	29.56	28.78	29.68	29.07	29.71	30.3
	55	28	16	9	22	14	17	10

Participants WITH SIGNIFICANT WORK DONE

Mean daily consumption (kWh)
Mean Days in period
observations

	Stratum 1		Stratum 2		Stratum 3		Stratum 4	
month	Pre	Post	Pre	Post	Pre	Post	Pre	Post
4	32.7	21.88	32.36	12.78	29.92	23.98	35.05	36.89
	31.98	30.57	30.5	32	30.92	31.4	30.46	30.83
	85	14	22	6	26	10	24	6
5	28.57	26.94	19.38	15.32	18.38	21.63	23.44	25.34
	31.58	29.32	32.11	29.13	30.48	29.77	32.58	29.14
	80	19	27	8	25	13	33	7
6	46.72	36.75	33.43	20.97	31.33	31.38	36.74	36.35
	31.33	31.29	30.35	31.57	31.08	30.69	31.21	32.67
	78	21	26	7	26	13	29	9
7	64.27	55.71	41.49	32.05	53.25	41.16	54.61	49.88
	31.62	30.48	31.89	29.77	30.92	30.25	31.2	30.69
	109	40	28	13	36	16	40	13
8	70.96	55.6	52.39	43.19	51.33	42.79	56.08	52.26
	29.44	29.84	31.09	28.75	30.2	30.47	29.69	28.5
	107	44	34	12	44	15	35	16
9	54.25	51.96	33.3	30.29	39.67	37.07	44.88	47.35
	31.82	30.87	31.29	33.47	30.84	31.53	31.38	31.06
	95	45	31	15	38	17	34	17
10	29.33	26.9	17.66	17.46	22.56	21.69	24.31	26.7
	29.63	29.1	30.29	28.87	29.23	29	29.59	29.42
	100	50	28	15	35	17	32	19

4.2 HOURLY AIR CONDITIONER PEAK CONSUMPTION MODEL

hour		No work Done	Work Done	hour		No work Done	Work Done	hour		No work Done	Work Done
1	B2it	83.29	81.44	9	B2it	71.88	81.58	17	B2it	79.20	100.42
	Cit	-5213.98	-4962.21		Cit	-4944.82	-5538.79		Cit	-4869.02	-6623.11
Treft=66	B1it	3.75	5.79	Treft=70	B1it	1.86	5.26	Treft=79	B1it	15.66	20.13
	Ait	420.62	356.50		Ait	591.49	510.30		Ait	-130.00	-325.00
2	B2it	78.27	81.05	10	B2it	84.79	98.03	18	B2it	82.35	105.96
	Cit	-4932.58	-5023.31		Cit	-6046.33	-6949.77		Cit	-5130.77	-7083.35
Treft=66	B1it	3.00	5.31	Treft=73	B1it	3.63	7.84	Treft=77	B1it	18.92	24.20
	Ait	426.21	336.80		Ait	470.46	319.72		Ait	-192.50	-427.04
3	B2it	69.53	78.65	11	B2it	105.78	111.42	19	B2it	89.73	117.17
	Cit	-4378.99	-4936.67		Cit	-7630.65	-8008.32		Cit	-5871.35	-8135.73
Treft=66	B1it	3.51	5.70	Treft=75	B1it	5.06	9.75	Treft=76	B1it	20.86	25.17
	Ait	381.01	296.32		Ait	363.08	172.69		Ait	-206.35	-388.83
4	B2it	61.46	72.34	12	B2it	113.20	124.73	20	B2it	84.78	100.37
	Cit	-3816.24	-4481.64		Cit	-8163.57	-9043.78		Cit	-5415.27	-6656.74
Treft=65	B1it	1.52	2.35	Treft=77	B1it	5.25	10.01	Treft=74	B1it	19.47	23.36
	Ait	478.28	458.03		Ait	364.50	148.60		Ait	-49.96	-205.49
5	B2it	62.94	72.41	13	B2it	116.37	135.17	21	B2it	89.24	100.16
	Cit	-3990.87	-4587.70		Cit	-8532.80	-10087.14		Cit	-5620.01	-6539.69
Treft=65	B1it	1.31	3.00	Treft=80	B1it	11.02	16.83	Treft=71	B1it	16.38	21.17
	Ait	498.75	428.08		Ait	27.78	-232.68		Ait	179.18	19.86
6	B2it	57.93	65.28	14	B2it	118.27	128.05	22	B2it	84.77	96.01
	Cit	-3681.25	-4148.07		Cit	-8524.62	-9303.94		Cit	-5230.74	-6117.70
Treft=65	B1it	0.83	2.58	Treft=80	B1it	11.93	17.45	Treft=69	B1it	17.50	22.35
	Ait	572.18	507.48		Ait	-43.29	-285.79		Ait	86.70	-42.98
7	B2it	50.25	57.49	15	B2it	102.17	103.43	23	B2it	87.34	98.96
	Cit	-3180.08	-3629.11		Cit	-7092.89	-7180.69		Cit	-5386.11	-6168.09
Treft=65	B1it	-0.87	0.47	Treft=80	B1it	12.33	19.24	Treft=68	B1it	11.52	16.25
	Ait	771.25	796.05		Ait	-60.79	-417.51		Ait	252.80	115.98
8	B2it	54.25	70.61	16	B2it	88.20	92.61	24	B2it	86.28	81.70
	Cit	-3586.76	-4695.48		Cit	-5798.48	-6114.56		Cit	-5383.29	-4920.09
Treft=68	B1it	1.98	3.84	Treft=80	B1it	12.01	16.80	Treft=67	B1it	6.72	9.66
	Ait	623.39	633.01		Ait	9.97	-239.54		Ait	347.91	243.03

4.5 AC PEAK DAY LOAD PROFILE

Peak Days based on Summer 1996

hour	Peak AC Not Treated	Peak AC Treated
1	1082.4	1194.8
2	891.0	1006.5
3	745.7	860.0
4	670.2	799.1
5	597.8	691.0
6	541.9	610.7
7	478.4	556.0
8	574.2	720.4
9	834.3	1020.3
10	1101.2	1314.5
11	1445.7	1551.1
12	1707.8	1832.9
13	1788.9	1902.8
14	2012.9	2105.4
15	2092.4	2117.9
16	2166.1	2247.9
17	2108.3	2224.3
18	1943.3	2018.7
19	1552.9	1605.8
20	1400.3	1436.6
21	1403.5	1343.1
22	1245.3	1217.8
23	1234.6	1332.9
24	1104.7	1223.9

5.1 ELECTRIC SAVINGS ESTIMATES FROM GROUP MEANS

Daily Electric Consumption Pre and Post for Treated and Not-treated

	month	Pre Not-treated	Treated	Difference Pre-Retrofit	Post Not-treated	Treated	Difference Post-Retrofit
Mean	1	90.29	109.49	19.21	98.28	104.51	6.23
Mean	2	98.37	120.83	22.46	103.42	111.05	7.63
Mean	3	76.67	96.10	19.43	78.02	89.00	10.98
Mean	4	68.96	73.30	4.34	63.32	68.19	4.87
Mean	5	43.68	49.09	5.41	43.32	46.84	3.52
Mean	6	45.67	50.18	4.50	46.41	51.54	5.13
Mean	7	57.62	65.77	8.15	55.02	61.09	6.07
Mean	8	58.91	68.95	10.04	55.05	63.13	8.07
Mean	9	49.75	59.56	9.81	47.42	52.15	4.73
Mean	10	37.84	43.07	5.23	35.79	40.05	4.26
Mean	11	47.03	51.42	4.39	52.93	57.03	4.11
Mean	12	68.23	79.31	11.08	76.99	85.59	8.60
	Annual	22527	26282	3755	22915	25173	2258
							1497
n	1	323	272		215	162	
n	2	295	251		228	168	
n	3	293	243		180	154	
n	4	375	276		248	191	
n	5	559	449		225	177	
n	6	552	460		184	153	
n	7	488	393		277	220	
n	8	544	452		250	201	
n	9	479	395		285	217	
n	10	431	361		337	266	
n	11	413	355		332	250	
n	12	359	310		378	287	
StD	1	32.62	35.57		37.39	26.89	
StD	2	36.61	40.99		40.75	32.78	
StD	3	29.02	39.36		30.84	24.32	
StD	4	31.84	31.23		25.52	21.64	
StD	5	18.97	22.45		16.83	16.33	
StD	6	20.95	21.67		20.90	22.09	
StD	7	27.14	27.04		22.83	25.54	
StD	8	24.09	28.09		23.70	26.68	
StD	9	23.49	27.10		22.70	20.75	
StD	10	16.83	19.33		14.87	17.43	
StD	11	19.57	19.85		19.86	20.96	
StD	12	26.08	27.89		28.49	27.16	

5.3 ELECTRIC SAVINGS ESTIMATES FROM CROSS SECTIONAL TIME SERIES

where:

_cons is the intercept of the regression equation (roughly the base consumption)

cddpd65 is the 65°F base cooling degree days per day

Npre is 1 for Non-participant in the pre- period

Ncdd65 is the 65°F base cooling degree days per day for Non-participant in pre- billing period

Ppcdd65 is the 65°F base cooling degree days per day for Participant in pre- billing period

hddpd50 is the 50°F base heating degree days per day

Npost is 1 for Non-participant in the post- period

Nphdd50 is the 50°F base degree days per day for Non-participant in post- billing period

Pphdd50 is the 50°F base degree days per day for Participant in post- billing period Ppost is 1 for Participant in the post- period

gupd	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
cddpd65	1.305	0.046	28.396	0.000	1.215	1.395
Ncdd65	-0.340	0.076	-4.464	0.000	-0.489	-0.191
Npcdd65	0.400	0.096	4.167	0.000	0.212	0.588
Ppcdd65	0.490	0.076	6.449	0.000	0.341	0.639
hddpd50	4.432	0.049	89.862	0.000	4.335	4.529
Nhdd50	-0.831	0.082	-10.142	0.000	-0.991	-0.670
Nphdd50	-0.719	0.081	-8.898	0.000	-0.877	-0.561
Pphdd50	-0.545	0.068	-8.001	0.000	-0.679	-0.412
Ppost	-6.059	0.660	-9.178	0.000	-7.353	-4.765
Npost	(dropped)					
Npre	8.210	0.896	9.160	0.000	6.453	9.966
_cons	40.425	0.365	110.691	0.000	39.710	41.141

	NAC total	Raw Savings	Net Savings
NACPpre	25573		
NACNpre	26391		
NACPpost	23087	2485	907
NACNpost	24813	1579	

	NAC cool	Raw Savings	Net Savings	NAC heat	Raw Savings	Net Savings
NACPpre	2120			8687		
NACNpre	1568			7059		
NACPpost	2917	-797	405	7618	1069	1288
NACNpost	2770	-1201		7278	-219	

5.4 SAVINGS FOR ELECTRIC CUSTOMERS BY MEASURE

SAVINGS FOR ELECTRIC CUSTOMERS BY MEASURE

Where constant=savings per year (Kwh)

mua=(measure) change in attic U-value per sq. ft. of building (in ^Ua/sq. ft.)

c25red=reduction in duct leakage @25Pa. pressure (in cfm)

Source	SS	df	MS
Model	537234369	2	268617184
Residual	6.4798e+09	465	13935054.6
Total	7.0170e+09	467	15025770.3

Number of obs	= 468
F(2, 465)	= 19.28
Prob > F	= 0.0000
R-squared	= 0.0766
Adj R-squared	= 0.0726
Root MSE	= 3733.0

sav	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
mua	19.84438	3.85987	5.141	0.000	12.25943	27.42933
c25red	3.201798	.9887425	3.238	0.001	1.258841	5.144754
_cons	1584.593	190.0249	8.339	0.000	1211.179	1958.007

5.5 SAVINGS FOR ELECTRIC CUSTOMERS BY MEASURE BY STRATUM

Pre-weatherization Annual consumption (kWh)		25972	26680	27064	19707	23824
Units		293	120	150	5	18
Stratum		all	1	2	3	4
Mean	c25red	345	225	416	-	232
Coefficient		3.20	NS	3.87	-	NS
Savings		1104	721	1608	-	743
Percent		4%	3%	6%	-	3%
Mean	bdred	550	449	631	-	230
Coefficient		1.73	1.73	1.73	-	1.73
Savings		951	777	1092	-	397
Percent		4%	3%	4%	-	2%
Mean	mua	95	112	80	-	83
Coefficient		19.84	22.14	NS	-	NS
Savings		1891	2477	1587	-	1653
Percent		7%	9%	6%	-	7%

APPENDIX B - SUMMARY OF AUDIT FINDINGS

GENERAL HOUSE INFORMATION

GAS CUSTOMERS						ELECTRIC CUSTOMERS				
Variable	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
age of ac	215	9.16	8.26	0	45	86	12.31	6.86	1	28
attic "R" post	115	26.88	4.52	11	40	80	30.38	4.94	24	43
attic"R"pre	**370**	**11.17**	**7.49**	**0**	**30**	**291**	**15.69**	**7.48**	**0**	**48**
attic sq. ft.	368	1131	411	396	3004	292	1226	426	133	3000
basement	375	0.54		0	1	294	0.26		0	1
blower door post	195	3192	1633	1050	12100	200	2270	1064	800	6760
blower door pre	**374**	**3616**	**2056**	**725**	**15950**	**294**	**2515**	**1333**	**700**	**11000**
duct leakage post	74	514	486	27	2787	75	357	219	0	1136
duct leakage pre	**78**	**962**	**703**	**150**	**4134**	**142**	**484**	**418**	**0**	**2706**
crawlspace	375	0.47		0	1	294	0.57		0	1
DHW insulation	367	0.47		0	2	273	0.54		0	1
# occupants	356	2.48	1.36	1	9	281	2.99	1.27	1	8
pool	**375**	**0.05**		**0**	**1**	**294**	**0.11**		**0**	**1**
sq. footage	375	1608	893	575	9543	294	1815	718	812	5194
total available reduction (cfm)	**374**	**2171**	**1930**	**-937**	**13365**	**288**	**564**	**817**	**-680**	**4216**
programmable thermostat	374	0.16		0	3	293	0.11		0	1
house volume	375	13625	8051	4368	80750	294	14622	6073	1200	40932
wall "R" pre	**350**	**5.87**	**5.68**	**0**	**26**	**292**	**11.01**	**1.37**	**2**	**19**
year house built	**367**	**1951**	**27**	**1850**	**1993**	**292**	**1978**	**9**	**1892**	**1994**

note: bold added to emphasize large differences energy consumption variables

Summary Table 1. Estimated Peak Electric Demand Reduction for Individual Measures by Gas Stratum

Source: Report Section 4 - Regression of hourly load data combined with Section 3.4 billing data analysis produces a minimum estimate of 500 watts for customers receiving major treatment (Section 4.7). Measure penetrations and regression based energy savings estimates (Section 2.5) were used to apportion the peak reduction.

Confidence: Estimate is adequate for planning purposes based on program delivery as practiced in the pilot. For some measures the potential reductions are higher than these estimates.

Sample Average: Sample average estimate may not represent a population average estimate since the sub-samples are not weighted by population strata. Strata with estimates of zero are included in the sample average.

	Stratum Description	Sample Size	Estimate	Confidence
Duct Leakage Reduction				
Sample Average			0.24 kW	
Stratum 1	Central AC	213	0.32 kW	High
Stratum 2	Room AC	52	-	
Stratum 3	CAC Low-Income	60	0.24 kW	Moderate
Stratum 4	New with Central AC	46	0.14 kW	Moderate
Ceiling Insulation				
Sample Average			0.23 kW	
Stratum 1	Central AC	213	0.27 kW	High
Stratum 2	Room AC	52	0.14 kW	High
Stratum 3	CAC Low-Income	60	0.18 kW	Moderate
Stratum 4	New with Central AC	46	0.19 kW	Moderate
Sidewall Insulation				
Sample Average			0.85 kW	
Stratum 1	Central AC	213	1.23 kW	Moderate
Stratum 2	Room AC	52	0.19 kW	Moderate
Stratum 3	CAC Low-Income	60	0.73 kW	Moderate
Stratum 4	New with Central AC	46	-	
Building Shell Sealing				
Sample Average			0.18 kW	
Stratum 1	Central AC	213	0.19 kW	Moderate
Stratum 2	Room AC	52	0.09 kW	Moderate
Stratum 3	CAC Low-Income	60	0.23 kW	Moderate
Stratum 4	New with Central AC	46	0.14 kW	Moderate

Summary Table 2. Estimated Peak Demand Reduction for Individual Measures by Electric Stratum

Source: Report Section 4 - Regression of hourly load data combined with Section 3.4 billing data analysis produces a minimum estimate of 500 watts for gas customers receiving major treatment (Section 4.7). Measure penetrations and measure specific regression based energy savings estimates (Sections 4.5 and 5.5) for gas and electric customers were used to apportion the peak reduction.

Confidence: Estimate is adequate for planning purposes based on program delivery as practiced in the pilot. For some measures the potential reductions are higher than these estimates. See report for details.

Sample Average: Sample average estimate may not represent a population average estimate since the sub-samples are not weighted by population strata. Strata with estimates of zero are included in the sample average.

	Stratum Description	Sample Size	Estimate	Confidence
Duct Leakage Reduction				
Sample Average			0.13 kW	
Stratum 1	Central AC non-Heat Pump	120	0.14 kW	Moderate
Stratum 2	Heat Pump	150	0.26 kW	High
Stratum 3	Room AC	5	-	
Stratum 4	Low Income with Central AC	18	0.09 kW	Low
Ceiling Insulation				
Sample Average			0.13 kW	
Stratum 1	Central AC non-Heat Pump	120	0.17 kW	High
Stratum 2	Heat Pump	150	0.12 kW	Moderate
Stratum 3	Room AC	5	-	
Stratum 4	Low Income with Central AC	18	0.09 kW	Low
Building Shell Sealing				
Sample Average			0.09 kW	
Stratum 1	Central AC non-Heat Pump	120	0.11 kW	High
Stratum 2	Heat Pump	150	0.15 kW	Moderate
Stratum 3	Room AC	5	-	
Stratum 4	Low Income with Central AC	18	0.05 kW	Moderate

Summary Table 3. Gas Savings Estimates for Individual Measures by Stratum

Sources: Number 1 Report Section 2.4 - Regression of change in Normalized Annual Consumption (savings) against predictor variables, Number 2 Report Section 2.5 Regression of savings against predictor variables by stratum, Number 3 Engineering Estimate.

Confidence: Confidence is consistently ranked as moderate. Estimates are adequate for planning purposes based on program delivery as practiced in the pilot. For some measures the potential savings may be higher than these estimates.

Sample Average: Sample average estimate may not represent a population average estimate since the sub-samples are not weighted by population strata. Strata with estimates of zero are included in the sample average.

	Stratum Description	Sample Size	Pre-pilot Therms	Estimate (therms)	Source
CO > 2000					
Sample Average				152	
Stratum 1	Central AC	213	1155	153	#2
Stratum 2	Room AC	52	1362	150	#1
Stratum 3	CAC Low-Income	60	1131	150	#1
Stratum 4	New with Central AC	46	1028	150	#1
Furnace Efficiency					
Sample Average				39	
Stratum 1	Central AC	213	1155	48	#2
Stratum 2	Room AC	52	1362	32	#1
Stratum 3	CAC Low-Income	60	1131	26	#1
Stratum 4	New with Central AC	46	1028	24	#1
Water Heater Insulation					
Sample Average				22	
Stratum 1	Central AC	213	1155	22	#3
Stratum 2	Room AC	52	1362	22	#3
Stratum 3	CAC Low-Income	60	1131	22	#3
Stratum 4	New with Central AC	46	1028	22	#3
Duct Sealing					
Sample Average				56	
Stratum 1	Central AC	213	1155	65	#2
Stratum 2	Room AC	52	1362	39	#1
Stratum 3	CAC Low-Income	60	1131	55	#1
Stratum 4	New with Central AC	46	1028	34	#1

	Stratum Description	Sample Size	Pre-pilot Therms	Estimate (therms)	Source
Attic Insulation					
Sample Average				60	
Stratum 1	Central AC	213	1155	55	#2
Stratum 2	Room AC	52	1362	113	#2
Stratum 3	CAC Low-Income	60	1131	43	#1
Stratum 4	New with Central AC	46	1028	45	#1
Wall Insulation					
Sample Average				193	
Stratum 1	Central AC	213	1155	252	#2
Stratum 2	Room AC	52	1362	153	#2
Stratum 3	CAC Low-Income	60	1131	169	#2
Stratum 4	New with Central AC	46	1028	0	
Air Sealing					
Sample Average				45	
Stratum 1	Central AC	213	1155	38	#2
Stratum 2	Room AC	52	1362	70	#1
Stratum 3	CAC Low-Income	60	1131	54	#1
Stratum 4	New with Central AC	46	1028	35	#1

Summary Table 4. Electric Savings Estimates for Individual Measures by Stratum

Sources: Number 1 Report Section 5.4 - Regression of change in Normalized Annual Consumption (savings) against predictor variables, Number 2 Report Section 5.5 Regression of savings against predictor variables by stratum, Number 3 Engineering estimate, Number 4 Engineering estimate based on conversion of gas data to electric efficiencies.

Confidence: Confidence is consistently ranked as moderate. Estimates are adequate for planning purposes based on program delivery as practiced in the pilot. For some measures the potential savings may be higher than these estimates.

Sample Average: Sample average estimate may not represent a population average estimate since the sub-samples are not weighted by population strata. Strata with estimates of zero are included in the sample average.

	Stratum Description	Sample Size	Pre-pilot kWh	Estimate (kWh)	Source
Water Heater Insulation					
Sample Average				240	
Stratum 1	Central AC non-Heat Pump	120	26680	240	#3
Stratum 2	Heat Pump	150	27064	240	#3
Stratum 3	Room AC	5	19707	240	#3
Stratum 4	Low Income with Central AC	18	23824	240	#3
Duct Sealing					
Sample Average				1164	
Stratum 1	Central AC non-Heat Pump	120	26680	721	#1
Stratum 2	Heat Pump	150	27064	1608	#2
Stratum 3	Room AC	5	19707	-	
Stratum 4	Low Income with Central AC	18	23824	743	#1
Attic Insulation					
Sample Average				1928	
Stratum 1	Central AC non-Heat Pump	120	26680	2477	#2
Stratum 2	Heat Pump	150	27064	1587	#1
Stratum 3	Room AC	5	19707	-	
Stratum 4	Low Income with Central AC	18	23824	1652	#1
Air Sealing					
Sample Average				902	
Stratum 1	Central AC non-Heat Pump	120	26680	777	#4
Stratum 2	Heat Pump	150	27064	1092	#4
Stratum 3	Room AC	5	19707	-	
Stratum 4	Low Income with Central AC	18	23824	397	#4

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