# An Evaluation of a Utility Weatherization Program: Using a PRISM Database for Weatherization Policy

by

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## ABSTRACT

There is an increasing interest in energy policy arenas to address the needs of low-income people. Federal energy assistance funds average to only $100 per household each year when spread across all qualifying households. In a colder climate, this level of assistance does little to alleviate hardships. (Williams, 1982) This recognition has spurred utility and government response in Wisconsin. The serious question of the commitment of resources required to address the problem, however, is not easily answered.

This paper reviews a utility weatherization program ordered by the Public Service Commission of Wisconsin in 1982 and administered by the major natural gas and electric utilities to reduce energy bills of low-income customers. The program was evaluated between 1985 and 1986 to determine the level of energy savings realized from it. Evaluation of the program was approached cautiously. There was interest in the evaluation results to address broader policy questions: (a) what were the potential energy savings, (b) what were the best weatherization measures to install, and (c) how much could customers bills be reduced? Not only were these questions being asked by utilities, but they were being asked by the state legislature to determine state involvement in weatherization and by advisory groups concerned with weatherization guidelines.

The process undertaken to accomplish the evaluation and the subsequent results are described. Information from the evaluation effort provided opportunities unforeseen at the time the evaluation was undertaken. The dividends from using the Princeton Scorekeeping Method (PRISM) in retrospect outweigh the considerable efforts to do the evaluation, particularly as subsequent evaluations are undertaken.

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## INTRODUCTION

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The process undertaken to accomplish the evaluation and the subsequent results are described below. Information from the evaluation effort provided opportunities unforeseen at the time the evaluation was undertaken. The dividends from using the Princeton Scorekeeping Method (PRISM) in retrospect outweigh the considerable efforts to do the evaluation, particularly as subsequent evaluations are undertaken.

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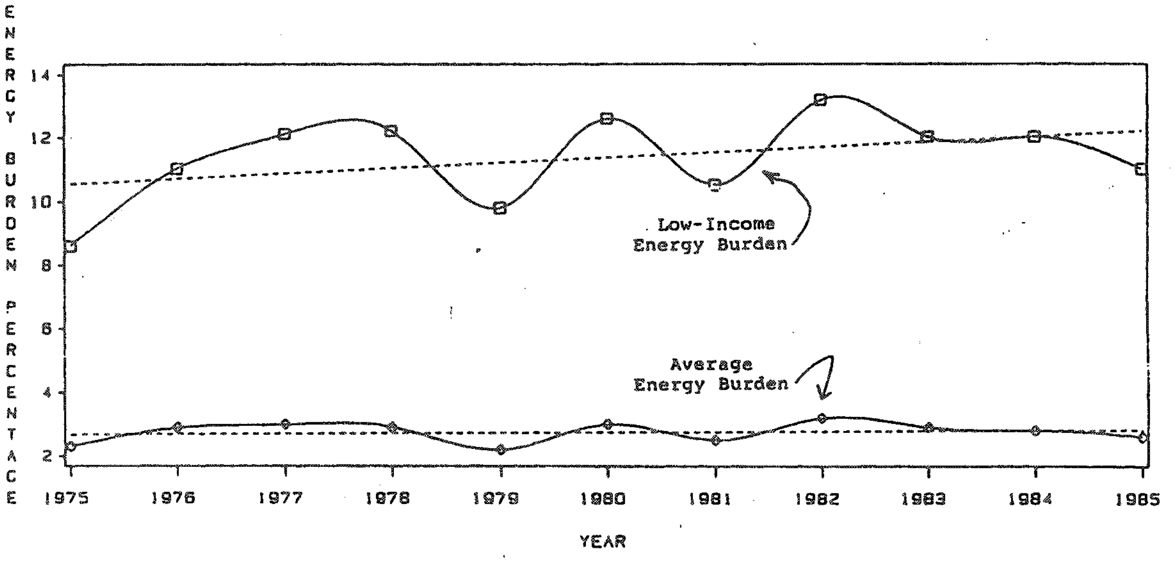
*At the time this paper was submitted, the author was associated with the Public Service Commission of Wisconsin.

## BACKGROUND OF THE STUDY

The Public Service Commission of Wisconsin actively began to promote energy conservation programs in 1977, prompted by the natural gas emergencies at the time. In 1982, it moved to direct assistance of low-income utility customers by offering low-interest, deferred payment loans, and direct weatherization assistance. The order requiring the program of the major natural gas and electric utilities was issued after extensive hearings. In an environment of escalating energy prices, low-income energy burdens were increasing, although, as shown in Figure 1, these burdens reached their zenith by the time the order was issued. The goal for the program became the decline in low-income customer arrearages through absolute reductions in energy consumptions. By 1985, program spending had increased 97.9% from the initial $3.9 million in 1983, the first full program year.

FIGURE 1
COMPARISON OF AVERAGE TO LOW-INCOME HOUSEHOLD ENERGY BURDENS
WISCONSIN, 1975-1985



NOTE: ENERGY BURDENS WERE CALCULATED AS THE PERCENTAGE OF MEDIAN FAMILY INCOME TO AVERAGE ANNUAL NATURAL GAS SPACEHEATING COSTS, WHERE THE MEDIAN LOW-INCOME FAMILY INCOME WAS THE AFDC PAYMENT IN THE RESPECTIVE YEAR.

By 1984 sufficient data had been acquired to evaluate the program's effectiveness. *One* of the motivations was that utilities measured energy savings differently and, as a result, inter-utility comparisons were difficult. *Second*, the evaluation literature was cautioning that engineering calculations for predicted savings themselves tended to ignore the synersistic effects of conservation measures. Also, the literature made a strong case for control in determining net energy savings attributable to programs. (Chapman, 1980; Hirst, et al, 1982). *Third*, there was concern that some measures were being inappropriately recommended and others over-installed. Absent reliable statistical evidence on the interaction of weatherization measures on the observed level of savings, staff had difficulty disputing utility program decisions. *Also*, the state weatherization program administered by the state social service agency was being evaluated to determine its success in reducing energy bills. Preliminary results showed net savings of only ten percent. Concurrently, a low-income energy task force began addressing integration of the state and utility weatherization programs and needed information on program direction.

The commission staff had reviewed the energy conservation literature and was familiar with a variety of evaluation approaches. As part of the energy conservation initiatives adopted in the late 1970s, the commission required utility participation in an inter-utility committee, which served as a forum for new ideas and initiatives. A decision was made to cooperate through this committee to establish a procedure for evaluating all utility energy conservation programs. The staff believed that if utilities were to approach evaluation seriously, they had to be active participants in the development of evaluation guidelines and procedures. Also, the commission lacked the financial and staff resources to evaluate programs and, hence, needed another vehicle for conducting them.

In response to a staff memorandum outlining general methodologies for evaluating conservation programs, the inter-utility committee established a task force to develop overall program evaluation guidelines. The evaluation of the state weatherization assistance program was nearing conclusion and commission staff consulted with the University of Wisconsin Statistics Laboratory regarding the methodology used in the evaluation. At that time, staff knew only that the methodology produced information on normalized annual consumption, which was one of the approaches identified in their literature review, and had many salutory features, such as lower standard errors for energy savings than conventional statistical approaches. Commission staff shared information with the task force on PRISM and invited the statistics laboratory staff to discuss their model with them.

In the end, the inter-utility committee chose to contract with the university statistical laboratory to employ PRISM as the evaluation methodology. Between February 1984, when the original staff memorandum was written, and January 1985, when the final decision was made, meetings were held to reduce the concerns of the participating utilities with evaluation as a means for analyzing effective program management. These concerns were mollified by the distinction between impact and process evaluations - commission staff was primarily interested in the program impact while the locus of process evaluations were the utilities themselves. (Soderstrom, et al, 1981; Poister,

1984) Another utility concern was the data requirements of PRISM. Many viewed the need for thirteen months of data on each side of an installation as unreasonable and the need for control as unnecessary; this sentiment was the product of computerized data retrieval systems which stored between twelve to twenty-five months of consumption only, thus requiring microfiche retrieval of additional data.

## DATA COLLECTION AND PROCESSING

The commission ordered each utility to file information on installation costs and measures, in addition to general customer demographic information. This information was filed on 5 1/4 inch floppy disks to reduce clerical costs. Utilities had an incentive to accurately report the information because only some measures were reimbursed through cost-sharing by the Solar Energy and Energy Conservation Bank.

Each utility was required to provide at least twenty-six months of consumption data for all weatherization customers and a control group. To estimate the savings attributable to the program, the total observed savings in weatherized houses had to be reduced by an amount which would have been achieved without the program. This is estimated by the savings in a control group, which was chosen from customers receiving weatherization after December 1984, the last month of available weatherization measure data. Utilities with less than 100 installations in their treated group were asked to supply an equal number of control customers; others were required to provide control customer consumption data for every two treated customers. A control customer was defined as those receiving weatherization services. Utilities used a customer identifier, such as an account number, and delineated the pre-weatherization period from the post-period with a numerical identifier. Further, meter reading dates were required with the consumption of natural gas in therms and/or electricity in kWh. An occupancy change code was included so the effect of occupancy turnover on energy savings could be determined later. Finally, the municipality in which the customer resided was included.

Utilities sent their data to the commission on 5 1/4 inch floppy disks in a standard print format file to avoid transcription errors. The staff spent two weeks eliminating data errors and standardizing meter reading codes using a data management software package. Some utilities had as few as five codes while others as many as several hundred: some codes differed depending on whether they were customer reads, utility reads, computer generated or accounting office estimates, rereads due to customer high bill complaints, etc. All were collapsed into three categories - actual, estimated or missing - because PRISM functions best with at least eight to thirteen actual readings. The staff also collapsed municipality names into county names so climatological data could be assessed for degree day adjustments. Table I shows how the data were trimmed of undesirable observations due to too few

Table I: Number of customers and meter readings, by utility

| UTILITY NAME | Number of Customers | Total Reads Reported | Percentage of Reads Estimated | Missing |
|---|---|---|---|---|
| Wisconsin Gas (WGC) | 1,055 | 33,889 | 46.8% | .9% |
| Wisconsin Public Service (WPS) | 623 | 20,667 | 2.2% | 1.3% |
| Wisconsin Natural Gas (WNG) | 252 | 9,256 | | |
| Wisconsin Power & Light (WPL) | 228 | 6,348 | 3.6% | .2% |
| Wisconsin Fuel & Light (WFL) | 186 | 5,568 | 2.1% | |
| Madison Gas & Electric (MGE) | 146 | 4,375 | 2.8% | .2% |
| Wisconsin Southern Gas (WSG) | 106 | 3,214 | .8% | |
| Wisconsin Electric Power (WEP) | 52 | 1,720 | 3.1% | 4.4% |
| Northern States Power (NSP) | 16 | 443 | 9.7% | 4.5% |
| Superior Water, Power & Light (SWP) | 8 | 238 | .4% | |
| TOTAL | 2,672 | 85,718 | 7.2% | 1.2% |

monthly readings or data errors. A concatenated data set was delivered to the statistics laboratory in May 1985.

Several lessons were learned in this phase of the evaluation. *First*, the tacit acceptance and recognition of regulated utilities was critical to the success of the evaluation. *Second*, despite the computer revolution in information management, many utilities do not archive to computer tape, but, instead, use microfiche as a storage medium. This makes data retrieval for PRISM, in particular, time-consuming and costly. For example, one utility estimated that it cost approximately two dollars per observation to compile the required data. *Third*, the manner in which a utility reads a meter strongly influences overall data quality. Referring again to Table I, for example, Wisconsin Gas required meter readings every other month, but, when failing to gain access to an internal meter, would estimate consumption for the period based on the prior year. The company's computer program would also reject any reading exceeding the prior month's reading by 10 percent and would re-estimate the bill based on prior consumption. Although this practice was uncharacteristic of other utilities, it caused some consternation because they had a large proportion of the total jobs. *Finally*, since the commission staff had initially gathered measures installed and demographic data - and had done so for two years prior to the commencement of the evaluation - it was easy to determine data requirements. However, it was unprepared for the number of treated and control households which might have been affected by other weatherization programs during the period under analysis. It was later estimated that approximately fifteen to eighteen percent of treated installations had work performed by other weatherization operators. Evaluators should be prepared for this other synergy when reviewing their low-income programs.

When the PRISM results were returned to the commission, it was put to immediate use because a low-income task force was in the throes of considering changes in state weatherization policy. The PRISM data was merged with the weatherization measures and cost data through the common account number. However, 22 percent of the jobs had not been entered on the computer, another six percent had leading zeros in one data set and not another and didn't match, and some measures and costs were in error. For example, early, the program had only a few categories for detailing costs and measures. For three percent of the jobs, a utility had lumped caulking and weatherstripping jobs which was discovered when costs appeared unreasonable. After these and other records were screened and, where possible, corrected, approximately 1,200 treated households remained. Of this number, only 606 treated records met a "good house" test of ten actual reads and $R^2$ of .90.

## EVALUATION RESULTS

A major question facing the commission staff upon receipt of the PRISM data was the impact of energy savings of the program. It was believed that the utility weatherization program would have higher energy savings than the state weatherization program because it was performance-based. Indeed, program results were almost twice the state program (Table II) and the energy savings had a narrow distribution (Figure 2). (Airriess, et al, 1985; Banerjee & Goldberg, 1985) Staff also believed that between 1983 and 1985 major changes had occurred in the administration of utility programs which would make major redirections of programs redundant, although there was quite a difference between utilities in energy savings (Table III). However, due to the quality of the data, it became possible to focus on policy questions regarding the most cost effective weatherization measures and the degree energy bill could be reduced. These questions became more important as the federal government proposed reductions in low-income energy assistance and $37.2 million Exxon oil overcharge settlement funds became available.

One unique feature of PRISM is the generation of parameters which allowed decomposition of the observed level energy savings. It was hoped that the resultant components analysis of changes in the parameters between the pre- and post-installation periods would address the question of measures responsible for the observed energy savings. This analysis was accomplished by analyzing the refraction results originally described by Fels and Goldberg. The results are presented in Table IV, which disaggregated the 1,200 records into common installation types.

The base energy savings represents reduced consumption from less appliance usage or increased applance efficiency. Shell changes are associated with structural retrofits or furnance efficiency improvements. The temperature component reflects the effect of changed thermostat settings on the observed level of saving; a negative value for this component indicates that,

Table II: Normalized annual consumption, absolute and percentage energy savings between state and utility programs

| PROGRAM | Pre-NAC Consumption | Post-NAC Consumption | Absolute Savings | Percent Savings |
|---|---|---|---|---|
| State Program | | | | |
| Treated | 1,324 | 1,170 | 154 | 10.8% |
| Control | 1,383 | 1,363 | 19 | .9% |
| Utility Program | | | | |
| Treated | 1,485 | 1,197 | 289 | 19.8% |
| Control | 1,459 | 1,442 | 86 | 4.7% |

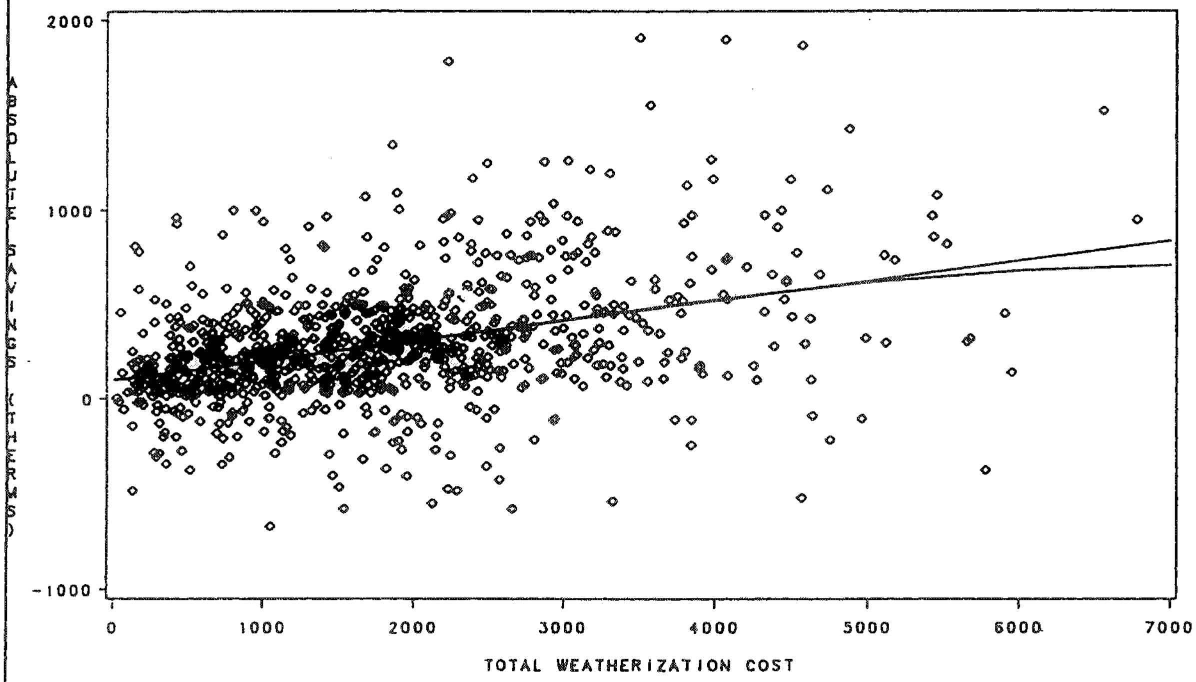
Source: Airriess, et al, 1985.

Table III: Control adjusted energy savings, by utility

| UTILITY | Number of Households | Control Adjusted Median Savings Absolute (therms/yr) | Percent |
|---|---|---|---|
| WPL | 165 | 308 | 20.7% |
| WSG | 53 | 278 | 20.4% |
| WFL | 93 | 272 | 18.1% |
| WPS | 361 | 249 | 16.7% |
| WGC | 677 | 233 | 18.7% |
| MGE | 73 | 192 | 13.2% |
| WNG | 144 | 180 | 12.1% |

Source: Banerjee and Goldberg, 1985.

FIGURE 2
COMPARISON OF ABSOLUTE ENERGY SAVINGS TO WEATHERIZATION COSTS
(N=928)



**NOTE: ABSOLUTE ENERGY SAVINGS REFER TO THE DIFFERENCE BETWEEN PRE- AND POST-NORMALIZED ANNUAL CONSUMPTION AS CALCULATED BY THE PRINCETON SCOREKEEPING METHOD.**

TABLE IV: Comparison of furnace and insulation projects under the Utility Weatherization Program

| Project Description | Project Cost | Dollar Savings | Therm Savings | MEAN ENERGY SAVING COMPONENTS (therms) | | | Percentage Savings | Cost of Conserved Energy ($/therm) |
|---|---|---|---|---|---|---|---|---|
| | | | | Base (α) | Shell (β) | Temperature (τ) | | |
| **FURNACE INSTALLATIONS** | | | | | | | | |
| a. Replacement Furnace (n=23) | $1,633 | $200 | 316.4 | 191.1 | 302.0 | 176.7 | 27.7% | $.347 |
| | ( 93.6) | ( 30.3) | ( 62.4) | ( 38.3) | ( 30.6) | ( 57.4) | | |
| b. with Vertical Insulation (n=6) | $1,913 | $379 | 643.6 | 105.3 | 396.1 | -142.2 | 39.2% | $.185 |
| | ( 96.0) | (182.5) | (293.8) | (186.8) | (414.2) | (335.1) | | |
| · with Infiltration Measures (n=6) | $3,210 | $386 | 525.6 | -436.5 | 66.9 | -907.9 | 30.9% | $.453 |
| | (1,009.8) | ( 66.7) | ( 99.5) | (515.9) | (178.6) | (532.2) | | |
| · and Rehabilitation (n=4) | $2,973 | $339 | 499.8 | -144.3 | -147.1 | -797.2 | 33.5% | $.413 |
| | (1,031.4) | (167.6) | (225.0) | (314.1) | (583.7) | (830.4) | | |
| c. with Horizontal Insulation (n=21) | $2,129 | $258 | 428.8 | 16.1 | 213.6 | -199.1 | 26.3% | $.314 |
| | ( 240.0) | ( 62.5) | (118.8) | ( 62.0) | (191.1) | (217.1) | | |
| · with Infiltration Measures (n=3) | $1,746 | $310 | 539.3 | 182.6 | 417.8 | -61.1 | 27.5% | $.235 |
| | ( 607.5) | (241.4) | (439.9) | (113.9) | ( 97.1) | (316.8) | | |
| · and Rehabilitation (n=14) | $2,930 | $195 | 444.0 | 48.7 | -115.3 | -386.8 | 24.5% | $.439 |
| | ( 456.6) | ( 60.0) | ( 97.9) | ( 60.9) | (198.0) | (263.7) | | |
| d. with Horizontal and Vertical Insulation (n=25) | $1,961 | $212 | 377.6 | 19.9 | 249.4 | -108.3 | 22.3% | $.301 |
| | ( 148.0) | ( 80.7) | ( 84.0) | ( 57.7) | (136.0) | (133.2) | | |
| · with Infiltration Measures (n=9) | $2,226 | $158 | 334.1 | 118.5 | 330.3 | 114.7 | 21.4% | $.449 |
| | ( 324.9) | ( 30.4) | ( 36.6) | ( 58.4) | (143.9) | (112.3) | | |
| · and Rehabilitation (n=29) | $3,658 | $267 | 432.9 | -66.1 | 392.6 | -67.6 | 29.1% | $.534 |
| | ( 436.3) | ( 97.3) | (148.1) | ( 96.7) | (193.0) | (234.3) | | |
| e. All Furnace Installations (n=315) | $2,621 | $224 | 384.5 | 23.8 | 192.1 | -36.6 | 24.6% | $.482 |
| | ( 77.4) | ( 11.5) | ( 18.2) | ( 14.6) | ( 35.3) | ( 37.4) | | |
| **INSULATION INSTALLATIONS** | | | | | | | | |
| a. Vertical Insulation | | | | | | | | |
| · with Infiltration Measures (n=1) | $1,143 | $93 | 145.9 | -29.2 | .0 | -175.1 | 11.8% | $.582 |
| · with Water & Furnace Modifications (n=2) | $1,176 | $140 | 220.2 | 51.1 | 374.5 | 205.4 | 17.7% | $.434 |
| | ( 12.0) | ( 52.2) | ( 81.8) | .0 | (162.1) | ( 80.3) | | |
| · and Rehabilitation (n=9) | $1,323 | $30 | 53.2 | 84.0 | 137.6 | 120.7 | 2.2% | $2.047 |
| | ( 515.0) | ( 58.8) | ( 98.8) | ( 55.4) | (159.2) | (112.9) | | |
| b. Horizontal Insulation | | | | | | | | |
| · with Infiltration Measures (n=15) | $752 | $167 | 192.8 | -179.8 | 316.1 | -134.5 | 5.8% | $.265 |
| | ( 107.3) | ( 76.2) | (132.1) | (132.5) | (181.8) | (343.9) | | |
| · with Water & Furnace Modifications (n=0) | | | | | | | | |
| · and Rehabilitation (n=49) | $2,025 | $93 | 153.3 | -11.0 | 168.1 | 1.7 | 7.1% | $.912 |
| | ( 192.0) | ( 18.9) | ( 31.5) | ( 39.9) | ( 96.1) | ( 82.6) | | |
| c. Total Shell Insulation | | | | | | | | |
| · Horizontal & Vertical Insulation (n=13) | $801 | $133 | 221.2 | 21.9 | 183.4 | -42.9 | 13.5% | $.186 |
| | ( 168.7) | ( 53.4) | ( 96.6) | (125.6) | (135.6) | (192.9) | | |
| · and Infiltration Measures (n=15) | $1,143 | $148 | 207.9 | 230.4 | 267.5 | 411.8 | 12.4% | $.336 |
| | ( 158.1) | ( 47.8) | ( 78.9) | (125.4) | (207.2) | (359.8) | | |
| · and Rehabilitation (n=123) | $1,712 | $172 | 274.9 | 103.0 | 22.9 | -123.7 | 17.8% | $.385 |
| | ( 105.8) | ( 32.9) | ( 49.5) | ( 44.5) | ( 91.0) | (139.4) | | |
| · with Water & Furnace Modifications (n=7) | $1,319 | $195 | 312.4 | 25.6 | 336.2 | 175.2 | 18.9% | $.291 |
| | ( 83.7) | ( 40.0) | ( 60.1) | ( 96.6) | (130.0) | (187.7) | | |
| · and Rehabilitation (n=49) | $1,519 | $106 | 177.3 | -11.0 | 282.1 | -19.4 | 11.7% | $.561 |
| | ( 126.3) | ( 18.9) | ( 31.5) | ( 39.9) | ( 96.1) | ( 83.5) | | |
| d. All Insulation Installations (n=957) | $1,420 | $156 | 252.0 | 7.3 | 152.8 | 16.1 | 12.5% | $.379 |
| | ( 44.0) | ( 7.2) | ( 11.5) | ( 9.7) | ( 25.4) | ( 26.8) | | |

Definitions: Vertical Insulation is any sidewall, kneewall, sillbox, or foundation insulation installed, plus miscellaneous insulation applied to windows, doors and mail slots; Horizontal Insulation is attic, attic access, attic ventilation, floor and crawl space insulation; Infiltration measures are caulking and weatherstripping; Water Modifications are a water heater blanket and low-flow showerhead; Rehabilitation includes any structural change to accomodate weatherization such as new windows or doors, or to preserve installed weatherization measures such as roof repair to prevent attic insulation from becoming wet; Furnace Modifications includes tuning and cleaning to increase operating efficiency; Total Shell Insulation includes both vertical and horizontal insulation. Mean standard errors appear in parentheses. Dollar Savings were calculated as the product of the therm savings times each utility's commodity rate. The Cost of Conserved Energy was found by dividing the annualized cost of a retrofit package by the annual energy savings.

on average, spaceheating was required at higher outdoor temperatures during the post-weatherization period than during the pre-weatherization period, or that there was an increase in indoor temperature. This has been termed a "snapback" or "takeback" effect where people believe thermostat settings can be increased to be more comfortable without higher energy costs.

For expositional purposes, measures have been bundled to evaluate the incremental relationships of the most cost effective group of measures and degree to which energy bills could be reduced. The 1,200 treated households were divided into two groups - furnance and insulation installations - then subdivisions were drawn within each group by segmenting the households by the type of measures which were installed in them. In some cases there were too few households to draw valid conclusions, others contained questionable results as will be noted later.

Furnace replacement jobs were generally more costly than insulation-only jobs, but furnace installations tended to save more installations. On average, the dollar savings associated with furnace versus insulation installations was forty percent greater and the actual therm savings fifty percent more. Of course, there is a tradeoff for these savings: furnace installations tended to be eighty percent more costly than insulation-only installations. The cost of conserved energy calculations show that the increased therm and dollar savings from furnace installations come with a ten cent incremental cost per therm. Also, on a cost per therm saved, many furnace installations proved just as cost effective as insulation installations.

These findings notwithstanding, the disposition analysis shows the difficulty in attempting to determine causal effects in a disaggregated manner. Not only does there appear to be substantial difference in the components within groupings, but other factors seem to be at play as well. For example, the large base level contribution in furnace installations suggests that intermittent ignition devices and flue dampers make a large contribution to overall savings, but the magnitudes of the base savings suggest that other measures could have been installed but were either unreported or were not filtered out, e.g. low-flow showerheads and water heater blankets although each subdivision was examined for these measures. Furthermore, examination of the standard errors - numbers appearing in brackets - demonstrates that little confidence can be placed in such a disaggregated components analysis without substantially more observations in each grouping. Only at larger aggregations do the standard errors become smaller and the degree of confidence increases.

In terms of these findings on overall weatherization policy, PRISM had, on the one hand, many salutary features. First, because it was the first evaluation of an energy conservation program authorized by the commission, PRISM offered a convenient methodology for determining energy savings with a high degree of confidence. Consequently, the methodology tended to receive less focus than the results, which were of primary interest. Second, since the results were highly reliable, staff was able to use the data to forecast energy savings which might eventuate from different weatherization strategies. For example, weatherization groups had expressed a desire to reduce the low-income energy burden percentage from the historically observed twelve percent to nine percent. Also, these groups had expressed a policy objective of weatherizing approximately 300,000 low-income households by the year 2000, a scant fifteen year period. Staff was able to demonstrate that these goals would be difficult to achieve simultaneously unless vast sums of money were available. To achieve an energy burden of nine percent would have required a significant number of furnace installations so energy savings in excess of twenty percent could be realized. Consequently, groups eschewed this goal in favor of reaching the numerical objective within fifteen years.

On the other hand, the components analysis - which was expected to offer a better understanding of the causal relationships for the observed level of savings - did not meet statistical tests of confidence when disaggregated without substantially more data. Regression analysis of these relationships was, therefore, used with much greater satisfaction to explain what measures contributed most to lower energy bills. For example, use of dichotomous variables can be used to explain the contribution of a group of measures and linear probability models to evaluate the marginal contribution toward certain payback objectives. Presented in an understandable manner to lay audiences, regression results can be easily understood and analyzed.

## CONCLUSIONS

Public policy in the area of weatherization has been evolving over the past few years. During legislative hearings on state weatherization programs, questions tended to focus on storm windows and doors vis-a-vis furnaces and insulation. Indeed, recently repealed energy tax credits favored the more prophylactic measures of doors and windows. When committing ratepayer or public dollars, however, there has been increasing attention to more cost-effective measures and reaching the greatest number of houses at least cost. The robust nature of th PRISM data allowed the Public Service Commission staff to investigate in depth some of the causal relationships in installing conservation measures so a rational approach could be taken in developing state policy. As a result, the commission staff was able to affect programs beyond their own due to data quality. In the fall, a larger and final investigation will be undertaken of both the state and utility weatherization programs. Lessons from the earlier studies will be used to facilitate the data gathering and analysis.

The results of this study have shown that there is a definite trade-off between installing furnaces as the primary weatherization measure versus insulation. Insulation installations were found not to yield sufficient energy savings to significantly reduce historical energy burdens. Larger per unit investments in furnaces offers more total savings at a small incremental cost per therm. When attempting to evaluate disaggregated data, however, components analysis was shown not to offer many insights into causal relationships due to large standard errors and too few observations. Energy evaluators may find regression analysis more satisfying in this respect.

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