Barriers to Household Investment in Residential Energy Conservation: Preliminary Assessment

December 1982

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BARRIERS TO HOUSEHOLD INVESTMENT IN
RESIDENTIAL ENERGY CONSERVATION:
PRELIMINARY ASSESSMENT

W. L. Hoffman, Principal Investigator^(a)
A. L. Nieves, Project Manager

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Pacific Northwest Laboratory
Richland, Washington 99352

(a) Now with the National Institute
for Social and Economic Research,
Boulder, Colorado

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INTRODUCTION AND SUMMARY

Overview

This report presents results of phase one analysis of a two phase effort to identify ways of overcoming barriers to homeowner investment in improved home energy efficiency. Phase one analysis has focused on four separately treated but related topics:

- o The frequency and distribution of self-identified obstacles to additional conservation investment and the characteristics of households who have been active in making energy conserving improvements to their homes.
- o The characteristics of households who seek conservation information by requesting a home energy audit.
- o The degree to which the length of payback (costs of installing conservation items divided by savings in energy bills) relates to household decisions to make conservation investments.
- o The extent of household knowledge about the economically attractive options for reducing energy costs which remain for their homes.

The second phase of this work will focus on the effectiveness of home energy audits as provided by utility companies under the federally mandated Residential Conservation Service (RCS) program. The subsequent analysis and report will assess the degree to which audits stimulate additional conservation effort and improve household knowledge of the improvements which would offer substantial energy bill savings.

These two reports will be final products of a project initiated in 1981 by the Urban Institute to identify "the residential conservation gap" - the economically attractive but underutilized options for retrofit of homes to reduce energy consumption and lower overall energy

costs.¹ To pursue this study within a very limited budget, we selected a case study approach with original data collection. The analysis in this report is based entirely on two original data sources:

- o a baseline survey conducted in the homes of respondents in selected low-to-moderate income neighborhoods in Washington, D.C. and Denver, Colorado;
- o an on-site energy audit conducted in a subsample of households to determine the costs and annual energy savings that could result from improvements in the dwelling unit.

A third phase of data collection has also been completed and this new information will be the basis of the analysis of energy audit effectiveness in the final report. Third phase data collection included:

- o a follow-up telephone survey to baseline sample households in both cities;
- o a telephone interview with two control samples of 100 households in each site who had not been previously contacted.

The baseline survey questionnaires were administered during early summer and early fall 1981 respectively in D.C. and Denver. A total of 631 interviews in the homes of sample respondents were completed. (D.C. N = 277; Denver N = 354). The survey was used to collect basic socioeconomic information on the household and characteristics of the dwelling unit, as well as information on household energy use habits, past and planned conservation activities, and on perceived barriers to further conservation improvements. The energy audits, representing

1. Initial data collection for the larger study was supported by a special grant from the Ford Foundation. Analyses of the data and preparation of a special report on the conservation efforts of elderly households was supported by contract funds from the Environmental Protection Agency and the Council on Environmental Quality. This previous report is: The Elderly and the Conservation Gap; project report #3030-01; (December, 1981) by Wayne Hoffman.

detailed on-site inspections, were conducted for about 25 percent of the sample households by participating utility companies using their Home Energy Audit procedures developed under Federal Residential Conservation Service (RCS) regulations. The audit results are the basis for an evaluation of alternative weatherization improvements in terms of costs and energy savings based on existing consumption patterns. A summary report based on the audit was presented free to each participating household and was provided to The Urban Institute for use in this study.²

The follow-up and control sample surveys were conducted by phone to limit data collection costs. These surveys involved shorter questionnaires which were appropriate for use in a phone interview format. The questionnaire for "previously contacted" households focused exclusively on the type and timing of recent conservation actions with a special supplemental section for households who said they had received an audit since our first interview.³ The supplemental form asked for specific recall of recommendations presented by audit and for the respondent's evaluation of the audit's usefulness. The "new" control sample questionnaire covered not only conservation activity but also selected information on household demographics, on dwelling unit characteristics and on other factors comparable to that in the baseline questionnaire.

2. Audits were paid for by The Urban Institute and/or provided free by the utilities participating in this study. Audited households agreed to the use of audit data for study purposes.

3. The majority of audited households were those who were audited as part of the study but the supplemental questions were also asked of households who had received an audit by other means.

A description and rationale for the original study design appears elsewhere.⁴ It is useful here to mention some of the main strengths and limitations of the design for the purposes of this and the planned subsequent analysis. The main limitation is that the samples of households are not nationally representative. Thus, the frequency of demographic and conservation attributes can not be extrapolated to larger universes. Measures of conservation activity in particular probably vary by climate, type of unit, development of housing patterns, and in the costs of energy and conservation measures. We structured the analysis primarily to focus on relationships among attributes, a procedure that provides great analytic advantage when universes are not represented.

The two samples, each representing a case in this study, were drawn from neighborhood sites in two cities. The city sites were selected because they were roughly similar (but not identical) in climate (heating and cooling degree days) and in the availability of active utility home audit programs. The sites are dissimilar in building practices, energy prices and public and governmental interest in residential energy conservation. In addition, the specific neighborhoods were chosen to include low-to-moderate income households, relative stability (low-turnover and moving rates), primarily older housing stock (constructed pre-1965), with diversity in structure type and a low density

4. See The Residential Conservation Gap Study: Purpose, Research Design and Data Description, U.I. Project Report #3030-01, October 1981 by Wayne Hoffman for the rationale for the study design; sample selection and tabulation of raw responses to the baseline survey.

of large multi-unit apartment building.⁵ These criteria intentionally produced an over-sampling of dwelling units likely to require, and to exhibit variety in, the potential for energy savings. They also produced an undersampling of renters who are not a prime interest in this analysis.⁶ The two cases permit testing for consistency in relationships of interest in the study. Analysis is performed and shown separately for each site throughout this report.⁷

Summary of Findings and Organization of this Report

This summary reports finding on patterns of relationships (or lack thereof) which are tentative but are evident in data from both study

5. The original data collection was also designed to over-sample units occupied by elderly persons who were the focus of previous research using these data bases.

6. The renters in the sample are most often excluded in our analysis. The radically different incentives for conservation that apply to renters make consideration of them more appropriate in a separate study. Renters who are in our sample tend to be more similar to homeowners than are all renters. Sample renters live in small, mostly single family structures, and have longer average tenure.

7. An additional limit on study findings was an unintended result in the research plan. We had hoped to perform energy audits in one-half of sampled households at both sites. All households interviewed were invited to have a free energy inspection requiring only a two hour time commitment and authorization to the Institute to use results in statistical analysis. Households would receive free the results of the audit in a report usually costing \$15 when performed by utilities for their customers. About 60 percent of households signed the request. However, for various reasons only about 30 percent completed audits and only 25 percent are in a form used in the analysis in this report.

Reasons for the drop off are not explored in this report. However, the major source of incompleted audits are households who changed their minds, could find no time for the audit, or could not be contacted in several telephone attempts. An additional source of drop off was error in utility company recordkeeping. About 15 percent of the audits that were completed for our samples could not be drawn from the companies' master computer files by use of unique identification codes as was originally planned. This problem varied substantially among the utilities involved. While providing interesting information on the difficulty of offering free audits, this result has required a special analysis (section IV) of possible bias in the characteristics of households audited.

sites. Section I reports analysis of barriers to energy conservation using a combination of two analytic approaches. We first examine the frequency of and distribution of self-identified barriers to further conservation investment.

- o The three reasons most frequently identified by homeowners are the inability to afford additional improvements, uncertainty about what needs to be done or whether it would save enough money/energy and the belief that nothing further can be done because the home is well insulated. This finding is consistent with common speculation about the major barriers and with the few other empirical studies that have addressed this issue.
- o Other hypothesized barriers including: difficulty in dealing with conservation markets (finding reliable contractors), concern over disruption of the home (renovation/redecorating) resulting from major improvements, and concern that energy improvements would not add to the value of the home are identified by some owners but are very infrequent as reasons for not making additional improvements.
- o As expected, the dominant reason for not making efficiency improvements among renters is the fact they do not own the structure.

A second approach to identifying obstacles relies on the observed variation in the characteristics of households who have been as active (versus inactive) in making conservation efficiency improvements. As alternative proxies for financial and informational barriers, total household income and years of formal education were related to various measures of activity.

- o Income and education are not highly related to conservation activity, particularly when the number of major efficiency improvements over the entire period of tenure is used as the measure of activity. In multi-variate regression analysis which reflects the correlation of these factors with length of tenure and "life cycle" of the household, income and education tend to be insignificant.

- o Conservation status of the home when moving in, the length of tenure, and household member period in life-cycle may be more important factors leading to improvements in residential thermal efficiency. This suggests an alternative bases for understanding barriers to conservation investment: the apparent correlation of conservation effort with socio-economic status masks the effects of tenure duration, life-cycle, and past efforts to weatherize the home on efforts to make additional needed improvements.

Section II of this report examines the relationship of similar factors to households' interest in receiving a free energy audit (measured by willingness to sign a form requesting an audit):

- o Households' willingness to accept the energy audit was not highly related to socio-economic status although (significant but small) correlations with education were observed. Long term residents and older households were significantly less interested in the audit.
- o Current thermal status of the unit was not significantly related to audit interest; households active in conservation were (slightly) more interested in the audit.
- o The predisposition toward conservation action (activities already planned-and belief that energy savings potential in the unit was high) were significantly related to audit interest.

Section III of this paper assesses rates of return that underly household investments in major conservation improvements. The rates of return are approximated by calculating an implicit monthly payback based on past or planned expenditures for major improvements and respondents report of experienced or expected monthly savings from these improvements.

- o The majority of households who have installed or who plan improvements say that the investment has only helped to keep their total home energy costs constant as energy prices rose.

- o Average implied payback periods for those reporting net positive savings from investment are in the range from 26 to 60 (winter) months which, on an approximated annual bases, yields four to ten year paybacks, or an (undiscounted) rate of return of 10 to 25 percent.
- o Average length of past or future payback is not systematically related to demographic or economic characteristics of households.
- o Experience with (high) rates of return on past investments is not related to expected (high) rates of return on planned investments.

Section IV of this report provides a special analysis of household knowledge of economically attractive investments by comparing high payback improvements specified by the energy audit with the list of "needed" or "desirable" conservation improvements identified by respondents.

- o No more than 30 percent of households could identify one or more items which the audit identified as offering a "high" payback (contractor installed cost with payback in 5 years or less). Correct identification tended to be greater however, for higher cost items-like insulation-than for the lower cost improvements like caulking, water heater insulation or clock thermostats.
- o Years of formal education is positively (but weakly related) to proportion of identifications which match audit recommendations; households more active in installing major improvements in the past were markedly less likely to identify high payback conservation improvements remaining for their units.
- o Typically, households were equally (or more likely) to identify improvements which had low payback (more than ten years) as they were to identify rapid payback improvements.

The Appendix included with this report provides a comparison of selected energy savings estimates from the audits of the three utility companies which participated in the study. It also includes sample copies of the audit results forms provided to the participating households.

I. IDENTIFYING THE MAJOR BARRIERS TO IMPROVEMENTS IN HOME ENERGY EFFICIENCY

Introduction

The purpose of this section is to provide a general assessment of the range of barriers which impede household investments in weatherization and other energy efficiency improvements for their homes. The premise of this analysis, and, indeed that of the entire project, is that substantial economically attractive opportunities for investment remain in the nation's residential dwellings.¹ The ultimate goal of this and related research is to provide a greater understanding of why the potential is under utilized or, put in other words, why the pace of investment is slower than what a simple economic model of investment might suggest.

Much speculative and empirical literature which is available on this subject suggests a consensus on two major obstacles to investment.² These investment impediments are:

- o Financial barriers - the high initial cost of major weatherization improvements (improved insulation, storm windows, etc.) impedes homeowner purchase of these items even if the energy savings in the short

1. This is the consensus of many studies which include: Saving Energy In America's Homes: The Problems and Prospects of Federal Regulation ed. by L. Yap, (Urban Institute Press), in press; and Energy Future: Report of the Energy Project at Harvard Business School ed. by Robert Stobough and Daniel Yergin. (Random House, New York, 1979); and "Drilling For Oil and Gas in Our Houses" by Robert H. Williams and Marc H. Ross, in Technology Review, March/April, 1980 pp. 24-36., and The Least Cost Energy Strategy by Steve Carhart, et al., Mellon Institute for Energy Productivity, 1980.

2. In Residential Energy Conservation Volume 1, (G.P.O. #052-003-00691-0, Washington, D.C.), The Office of Technology Assessment lists these and other factors which lead to imperfections in the "energy services market."

run would be substantial. The perceived unavailability of loans for conservation investment and the general reticence of households to finance home improvement on borrowed funds are components of the financial barrier;

- o Knowledge barrier - Households' lack general knowledge about remaining opportunities for savings (believe nothing more is to be done) and lack specific knowledge about conservation material and practices which may (often at low-cost) provide attractive energy savings.

In the initial proposal leading to this contract, we hypothesized related and additional factors which might act as barriers to conservation investment. These included:

- o The uncertainty and difficulty attached to calculating the rates of return for major conservation investments;
- o Inexperience in dealing with the markets that supply conservation products (difficulty in finding reliable contractors);
- o Belief that conservation investments do not add to the value of the home (cannot be recouped if the home is sold).

Detailed examination of the issues surrounding technical knowledge about conservation items and the calculation of payback to energy investments is provided in the subsequent section of this paper and in the final report.

This section provides an overview of the relative importance of these obstacles to conservation using two approaches. First, we present information on self-identified barriers to conservation collected from households during our baseline interview. Secondly, we examine the characteristics of active and inactive households classified by various measures of conservation activity. One focus of both analysis is on the

effects of household income and formal education (as rough indicators of financial and knowledge constraints) on a conservation activity.

Self-Identified Barriers

As part of our initial in-home survey, we asked respondents to specify the most important reasons why they would not make additional conservation improvements to their homes.³ Because this was an open-ended question, a wide range of responses were possible. Permissible answers included the response that "no additional improvements were necessary." We have classified these responses carefully trying to reflect the essential barrier represented by each answers. (The first two responses of each household were examined).

Table I-1 shows the classification and distribution of the most frequently mentioned responses in each study site. By large proportions the three most frequent responses in both sites were financial barriers, lack of knowledge about what would save the most money, and the belief that nothing more needs to be done (13 to 53 percent of respondents). Other responses related to hypothesized barriers - that reliable contractors were hard to locate or contractors were difficult to deal with, that improvement wouldn't add to the value of the home, or that the work would disrupt the home were for less frequently cited by both samples (less than 7 percent).

At the initiation of this study, we decide to focus primarily on homeowners because the incentives for renters to invest in conservation

3. This question appeared after several others which dealt with the past and planned conservation activity of the household and was in the later half of the interview.

TABLE I-1

REASONS FOR NOT UNDERTAKING ADDITIONAL INVESTMENT
TO IMPROVE HOME ENERGY EFFICIENCY^a

Reasons Cited as First or Second Most Important	Proportion of Households Citing Reason			
	D.C.		Denver	
	Entire Sample	Renters Only ^b	Entire Sample	Renters Only ^b
Everything is done, do not know what else I can do	13%	15%	31%	9%
Additional improvements would not save enough energy or I am uncertain what is needed	20%	11%	13%	1%
Cannot afford more (or need a loan to do more)	53%	19%	36%	23%
Reliable contractors too hard to find or deal with	7%	0%	2%	0%
Would not add to the value of my home	1%	0%	1%	0%
Work is too disruptive (tear apart walls, redecorate, etc.)	1%	0%	0%	0%
Plan to move soon	2%	4%	5%	2%
Do not own this home	6%	62%	20%	86%

a. These are responses to open-ended questions on main reasons for not making additional energy saving improvements (first or second mention).

b. Renters were under-represented in the samples; about 9 percent in D.C. and 21 percent in Denver.

would be substantially different and deserving of separate treatment. In the response distribution of the entire sample, we see that 6 percent (D.C.) and 20 percent (Denver) of respondents identified the main reason for inaction as "Don't Own this Home". This reason documented all other responses among renter households (62 and 86 percent).

The remaining reasons that we were able to classify included mention that the household planned to move soon. In Denver, this response was as common among owners as renters.⁴

In summary, it appears that at least at the level at which respondents can articulate reasons in response to an open-ended query, the major obstacles to further investment among homeowners are related to costs of conservation items, lack of general and specific knowledge about conservation options, and the belief that no other improvements are needed. The low frequencies with which we could find responses related to contracting and concern about the capitalized value of home conservation improvements suggest that as formulated these hypothesized barriers are not common. How the frequent barriers are distributed among types of households will be considered after identifying the types and frequency of conservation activity evident in the sample.

Types of Conservation Effort

Our baseline interview was also designed to obtain both a current and retrospective picture of household conservation actions. For each major conservation feature in place--attic and wall insulation--storm

4. About 9% of responses could not be classified into these categories. None were mentioned frequently enough to warrant a separate classification.

windows and storm doors—we are able to determine whether the initial installations of the item or additions/improvements to the item were performed by the current resident. We also obtained information on other major (floor insulation, solar) and "non-major" efficiency improvements including items such as caulking and weatherstripping—and on efforts to curtail energy use. The latter include specific mention by respondents of changes in family habits to, for instance, lower space and water heating temperatures settings, or to use air conditioning and appliances less frequently. It was not possible to weigh or to scale the difficulty of these various types of conservation activity into an overall measure of conservation effort. However, we assess the range of variation in each of these various measures and in measures which summarize combinations of activity.

Table I-2 provides information in the distribution of conservation actions in each study site. While only 19 to 30 percent of households report a major efficiency improvement recently (since 1979, top line), the proportion reporting major items ever installed is much greater. Over 57 percent report two or more in D.C. and over 47 percent report that many installations in Denver. Efforts to make other efficiency improvements and/or to curtail use is reported by over 65 percent of each sample.

A summary measure of conservation actions—reported at the bottom of the table—indicates that only a small proportion (3 to 6 percent) of households were totally inactive. Over 60 percent of households report both some type of curtailment of energy use and some efficiency improvement (either major or minor) sometime since moving into their unit.

TABLE I-2
 FREQUENCIES OF VARIOUS TYPES OF CONSERVATION ACTIONS
 D.C. AND DENVER^a

Summary Measure of Conservation Effort	D.C. Proportion of Households ^a	Denver Proportion of Households ^a
Have installed or added to at least one major item since 1979	19%	30%
Number of major items added since moving in ^b		
None or one	43%	54%
Two or three	26%	30%
Four	31%	17%
Proportion of in-place major ^b items added by current resident		
None	19%	27%
Up to 50%	22%	30%
51% to 75%	13%	24%
75% to all	46%	18%
Have made efficiency improvements in addition to major items ^c	64%	70%
Report one or more efforts to curtail energy use ^d	69%	76%
Have made only inexpensive conservation improvements	44%	59%
Have caulked/weatherstripped	30%	41%
Summary Conservation actions		
No improvements or curtailments	3%	6%
Curtailments only	5%	4%
Efficiency improvements only	28%	18%
Both curtailment and improvements	63%	72%
Major Features in Place ^e		
None or One	10%	11%
Two	29%	26%
Three or Four	61%	63%

a - Proportions are shown for homeowners only.

b - Four items are identified as major thermal efficiency items; attic and wall insulation, storm windows and doors.

c - Additional efficiency improvements may be major or minor but do not include the four major items identified above. Most common additional items are caulking and weatherstripping.

d - Respondent had to mention specific effort in reducing energy use or changing energy use habits. These included: lowering space or water heating temperatures, using appliances and lighting less frequently, using less hot water.

e - Inexpensive items have been classified irrespective of expenditures on the item and include caulking, weatherstripping, plastic window covering, heavy curtains, etc.

f - Major features include attic and wall insulation, storm windows and doors.

Many of these measures are by definition highly related but an indication that some type of conservation activity are relatively independent of others is provided by the correlation among items shown in Table I-3.

The number of major features in-place is highly correlated with the number of major actions undertaken by the household, implying that current status is due significantly to current resident's efforts. Measures of major conservation installations either—as number or proportion installed (items 3 and 4)—are only moderately related to other types of actions but the strength of these relationships vary between the two sites. Particularly noteworthy are the correlations involving "efforts to curtail use" an action that is positively, but weakly, related to major conservation installations (statistically significant at .16 in Denver and insignificantly at .03 in D.C.). This is evidence that curtailment effort and major conservation improvements are unrelated actions rather than tradeoffs or alternative approaches to controlling energy costs (significant negative relationship would be evident in that case).

The use of inexpensive efficiency improvements (a subset of all the efficiency improvements other than the four major installations previously defined) is also not highly related to major actions. (The strongest correlation is .23 in Denver). Inexpensive improvements (item 5) and caulking/weatherstripping actions (item 9) are significantly related to curtailing use (.27 and .22 in D.C. and .25 and .15 in Denver) but the positive relationship is not particularly strong.

TABLE I-3
RELATIONSHIP AMONG VARIOUS MEASURES OF CONSERVATION ACTIVITY^a

Measures of Conservation Status and Effort	D.C.							
	1. In-Place	2. Recently Installed	3. Ever- Installed	4. Proportion Installed	5. Inexpensive Items	6. Curtail Use	7. Summary Measure	8. Caulking/ Weatherstrip
1. Major features in-place ^b	1.0							
2. Installed major item since 1979 ^b	.14++	1.0						
3. Number of major items installed since moving-in ^b	.48++	.46++	1.0					
4. Proportion of in-place items added by current resident ^b	.01	.16++	.74++	1.0				
5. Number of inexpensive efficiency improvements ^c	.13++	.10++	.06	-.02	1.0			
6. Report efforts to curtail energy use ^d	.07+	.13++	.03	.01	.27++	1.0		
7. Additional efficiency improvements ^e	.09+	.07	.09+	.05	.71++	.24++	1.0	
8. Summary activity scale ^f	.10++	.19++	.27++	.38++	.37++	.62++	.44++	1.0
9. Recent caulking/weatherstripping	.09+	.05	.05	-.01	.79++	.22++	.50++	.27++
Denver								
1. Major features in-place ^b	1.0							
2. Installed major item since 1979 ^b	.16++	1.0						
3. Number of major items installed since moving-in ^b	.46++	.41++	1.0					
4. Proportion of in-place items added by current resident ^b	.16++	.46++	.77++	1.0				
5. Number of inexpensive efficiency improvements ^c	.08+	.13++	.23++	.18++	1.0			
6. Report efforts to curtail energy use ^d	.13++	.08++	.15++	.16++	.23++	1.0		
7. Additional efficiency improvements ^e	.09+	.06	.16++	.10++	.76++	.27++	1.0	
8. Summary activity scale ^f	.20++	.20++	.29++	.40++	.40++	.68++	.50++	
9. Recent caulking/weatherstripping	.05	.13++	.19++	.18++	.79++	.15++	.28++	

+ - indicates significance at .1 level.

++ - indicates significance at .05 level.

a - Correlations are Pearson's R.

b - Major features referred to are attic and wall insulation, storm windows and doors.

c - Number of inexpensive efficiency investments are other than the four major features identified above and include caulking/weatherstripping, water heater insulation, plastic window coverings or heavy drapes, clock thermostats.

d - This variable is coded "1" if any specific effort to curtail use or change family's energy use habits are reported (0 if not); includes using appliances and lighting less, turning down space and water heating temperatures, etc.

e - Any additional efficiency improvements other than four major identified above. Measure is inclusive of inexpensive items in c above but variable is coded "1" if any, "0" if more.

f - Summary activity measure is coded "0" if no improvements and curtailments were mentioned, "1" if curtailments only, "2" if efficiency investments only, "3" if both specific efficiency investments and curtailments were mentioned.

This evidence on the correlation among types of actions suggest that it is appropriate to consider several of these measures of conservation activity separately because they appear as discrete forms of conservation effort. Obstacles or barriers to conservation may differ with respect to these various types of activity. We follow this approach in the subsequent analysis.

How the Self-Identified Barriers are Distributed

Table I-4 presents information on the incidence of the three major reasons identified as obstacles to further investment among various demographic and conservation characteristics of households. While socio-economic status is sometimes related to the reasons mentioned by respondents in a way that meets a priori expectation, none of the relationships are large and most are not statistically significant. Considering first the respondents' mention of financial constraints ("Can't Afford More"), the table indicates a rate of response that is lower among upper income households in both sites. This financial concern is not consistently related to formal education. Financial concerns, however, are most strikingly (and significantly) related to the period of the life cycle of the respondent's family. Middle aged adults and families with children apparently feel the greatest financial constraint although the average income of these households (data not shown) is greater than among households in the other two stages of life cycle.

We would expect the second major reason for not making additional conservation improvements—"not sure what to do"—to be less evident among better educated households. This is true in Denver (although not

significant) and not at all evident in D.C. Based on income, the response is more frequent among the higher socio-economic groups but not statistically significant.

Households reporting that they do not believe additional conservation improvements are needed are found more frequently among the lowest income group but least frequently among middle income income groups. This pattern is neither monotonically consistent or statistically significant for education.

The most striking variation in the response pattern--reporting that additional improvements are not needed--is found with the life cycle classification with the highest response among the older households (statistically significant in Denver).

In general, it appears that the distribution of the major self-identified barriers to additional conservation are not well or simply understood on the bases of socio-economic status attributes while life-cycle factors offer some tentatively meaningful results. We anticipate that life cycle correlation with "Not needed" response may be related better to past activity levels rather than the life cycle difference itself.

The bottom portion of table I-4 shows the distribution of barriers among households with differing conservation activity rates. Some of these patterns bear closer scrutiny. The response that no additional improvements are needed significantly and consistently relates to two measures of major conservation actions and to the current status of the dwelling unit (classified by presence of major items). Whether or not

TABLE I-4
DISTRIBUTION OF MAJOR REASONS CITED FOR NOT MAKING
ADDITIONAL CONSERVATION IMPROVEMENTS^a

Socio-Demographic and Conservation Characteristics	D.C.			Denver		
	Not Needed	Not Sure What To Do	Cannot Afford More	Not Needed	Not Sure What To Do	Cannot Afford More
<u>Household Income</u>						
Less than \$10,000	17%	17%	61%	46%*	7%**	48%*
\$10,000-15,000	8%	23%	60%	29%	24%	45%
More than \$15,000	13%	23%	55%	34%	20%	34%
<u>Education^b</u>						
Less than high school	17%	21%	55%	38%	20%	42%
High school	10%	20%	60%	39%	15%	35%
More than high school	12%	22%	55%	19%	7%	44%
<u>Life Cycle^c</u>						
Young adults, no children	0%	13%	38%**	23%**	27%	31%**
Adults with children	12%	19%	64%	28%	17%	48%
Older adults, no children	17%	29%	31%	63%	12%	23%
<u>Previous Conservation</u>						
None	0%	13%	88%	38%	38%*	13%*
Cutbacks only	0%	39%	54%	25%	17%	33%
Some efficiency investments	14%	20%	56%	38%	15%	41%
<u>Number of Major Actions^d</u>						
Low	5%**	19%	66%**	25%**	20%	46%*
Medium	12%	20%	57%	47%	16%	31%
High	24%	23%	45%	57%	9%	34%
<u>Recent Major Actions^d</u>						
None	13%	21%	60%*	38%	19%	38%
Some	12%	21%	46%	36%	12%	48%
<u>Presence of Major Items</u>						
Poorly weatherized	4%**	24%	68%	14%**	17%	62%**
Moderate	8%	18%	63%	17%	24%	54%
Well weatherized	16%	22%	52%	49%	14%	29%
<u>Status and Actions</u>						
Poorly weatherized-no action	9%	17%	68%	22%	22%	63%
Moderately weatherized-few actions	10%	30%	50%	10%	24%	52%
Well weatherized-few actions	0%	21%	63%	43%	23%	23%
Moderately or well weatherized, few or many actions	20%	21%	45%	35%	18%	42%
Well weatherized, many actions	14%	23%	56%	49%	10%	32%

* Significant at .1 level.

** Significant at .05 level.

a - Reasons are the first or second most important mentioned by homeowner respondent for not making additional efficiency improvements.

b - Education is for most educated member of household.

c - Young adults are under age 33, older adults are over age 60.

d - Major actions are installation or improvement to attic and wall insulation, storm windows and doors. Recent actions are since 1979.

these perceptions are warranted, it is clear that past effort and crude measures of weatherization affect perceptions about remaining potential.

Financial constraints exhibit some significant but weaker relationships with past actions. Again, the number of major efficiency improvements and the current status of the unit seem to be inversely related to the frequency of response on financial constraints. Other measures of conservation action are not consistently related.

"Not sure what to do" as a major barrier is not related to conservation activity measures, with one exception: in Denver, those who report no action of any type are significantly more likely to cite this reason than are those who report either cutbacks or efficiency investments. This finding is doubtful in light of a non-comparable distribution in D.C.

A Second Approach to Assessing Conservation Barriers

While the reasons offered by households explaining their rational for not investing in additional conservation are plausible, the pattern of response overall is not highly or consistently related to socio-economic attributes as we had expected. Believing that further improvements are not needed (and financial constraints to a lesser degree) is related to the extent of previous activity. Uncertainty about what to do is not highly related to socio-economic variables or past activity.

A second approach which may be used is direct examination of the socio-economic attributes of households whose rates of conservation activity differ. In this case, we may correlate household socio-economic characteristics with the various measures of conservation

activity previously specified for each of our samples. The consensus of previous work is that higher socio-economic status households (interpreted as those with lower financial constraints, and greater general knowledge and sophistication about conservation options) engage in more conservation effort.⁵ One contribution of our approach over that previous work is the use several alternative measures of conservation effort including those that reflect investment over the entire period of tenure.

Table I-5 presents simple bi-variate relationships between four selected household characteristics representing socio-economic status, period in life cycle and tenure duration and various measures of conservation effort. We consider the findings for the specific measures of activity.

Income and education both show several significant relationships with conservation actions and status but these relationship are generally weak and not important in many instances. These socio-economic variables appear related to the current status of the unit, to recent major installations to "other non-major efficiency improvements and to efforts to curtail use. They are not related to number of major efficiency improvements ever made and are slightly negatively related to

5. For regression estimation of conservation actions see Hirst, Eric et al., Residential Energy Use and Conservation Action: Analysis of Disaggregate Household Data Oak Ridge National Laboratory, (ORNL/CON - 68), March, 1981; see also, Berry Linda et al.; Review of Evaluation of Utility Home Audit Programs Oak Ridge National Laboratory, (ORNL/CON) March, 1981, which reviews findings of numerous other studies. Most studies have compared the distribution of demographic attributes in the information available from audited households with that of the larger utility service area population to conclude that socio-economic status and conservation effort are related.

TABLE I-5

RELATIONSHIP BETWEEN VARIOUS CONSERVATION ACTION AND
DEMOGRAPHIC FACTORS^a

Measures of Conservation Activities and Thermal Status of Merit	D.C.				Denver			
	Income	Education	Life- cycle	Length of Residence	Income	Education	Life- cycle	Length of Residence
Number of major features in-place ^b	.10*	.10*	.02	.12**	.17**	.06	.06	.22**
Number of recent major efficiency improvements ^c	.02	.03	-.13**	-.12**	.15**	.09*	-.10**	-.15**
Number of major efficiency improvements ever ^d	.00	.03	.12**	.38**	.00	.00	.15**	.22**
Proportion of current in-place major items installed by current resident	-.06	-.11**	.13**	.37**	-.05	.00	.14**	.17**
Have made other recent efficiency investments ^e	-.03*	.06	-.07	-.04	.08*	.12**	-.09*	.04
Report efforts to curtail energy use ^e	.08*	.07	-.22	-.18	.02	.09*	-.06	.00
Have done caulking/ weatherstripping recently	.00	.05	-.12**	-.11**	-.03	-.02	-.03	-.05

a - Correlations are Pearson's R; * significant .1 two-tailed; ** significant at .05.

b - Counts presence of attic and wall insulation, storm windows and doors.

c - Same item as b except counts if added over period since 1979 to present.

d - Counts same items as b that were added by current resident since moving.

e - Coded as "1" if respondent mentions any effort to curtail use, e.g. lower thermostat setting.

proportion of items in-place that were installed by current residents (A possible interpretation is that higher income households have moved more recently and into better weatherized homes.)

Tenure and life cycle variables appear more significant than income and education in this analysis but have both positive and negative effects on activity. Length of residence is positively related to the current status of the unit and also is strongly related to measures of effort over time--the number and proportion of major efficiency improvements ever made. Length of tenure is significantly negatively related to making recent improvements and (in D.C.) to the low-cost effort to caulk and weatherstrip. While weaker, the relationships of period in the life cycle generally mirror those of tenure duration except life cycle is unrelated to current status of the unit.

The four demographic factors are colinear in these samples and while the relationships between life cycle and tenure duration and between income and education are positive, there is also a significant negative relationship between the two groups of factors.⁶ In order to sort out these effects, we have tried several regression specifications using four selected measures of conservation status or action as dependent variables in an attempt to ascertain their independent effects. Results of the most complete specification for "Current Status of Unit" (major features in place), "Major Items Installed Ever,"

6. Tenure duration is correlated with income at $-.22$ in both samples, and at $-.14$ and $-.10$ with education. Life cycle is about $-.30$ with income. The correlation between income and education is between $.4$ and $.5$ and between life cycle and tenure about $.4$.

"Recent Major Installations" and "Report Effort to Curtail Use" are shown in Table I-6.

It is immediately evident that it is difficult to predict or explain these various measures conservation status and action utilizing even key demographic attributes of households.⁷ The maximum R^2 in these estimates is .18 and many of the equations are insignificant.⁸

While most variables have expected signs, few are significant at even the 10% level. Household income is significant only in explaining current status of unit (and only in Denver). Education is insignificant in all instances.⁹

Years of residence is significant in explaining current status of the unit and in number of major features installed and overwhelms any life cycle effects (evident in bivariate correlations), but not significant in the recent major installations or curtailed use equations. The only significant explanation of curtailed use is the negative effect of life cycle. (The aged do not cut back on use.)

We included in the final steps of these equations, two of the three major reasons mentioned as obstacles to further investment. "Can't Afford" response appears significant with consistent negative sign in

7. Efforts to predict total conservation savings due to efficiency improvements as performed by others show more significant equations (with R^2 from .14 to .41). However, the dependent variable was formulated to capture an interval measure of Btu savings over a set time period, rather than conservation effort, and included as predictors an estimate of total energy use (definitionally correlated with savings). See Table 9, in Hirst et al. op. cit.

8. We included these specifications even though insignificant so that we could compare the estimated parameters of the independent variables.

9. Even in stepwise analysis, with education and income entering only after tenure duration, these variables did not achieve significance.

TABLE I-6

MULTIPLE REGRESSION RESULTS FOR PREDICTING CURRENT
CONSERVATION STATUS AND CONSERVATION EFFORTS

Summary Statistics/ Independent Variables	Major Features In-Place ^a		Major Items Installed ^b		Recent Major Installed ^c		Curtailed Use ^d	
	D.C.	Denver	D.C.	Denver	D.C.	Denver	D.C.	Denver
R ²	.04	.11	.18	.08	.08	.05	.07	.11
F-Ratio	1.8	5.96	5.6	2.6	1.6	1.4	2.1	4.0
Step-at-F-Ratio Given	A5	A5	B8	B8	B7	B7	B9	B9
Constant	2.64	2.64	1.19	.82	.50	.23	.80	.71
A1 Years at current residence	.016**	.021***	.04***	.02**	-.004	-.004	-.005	.000
A2 Lifecycle 2 ^e	-.421	-.261	.40	.35	-.096	.025	-.19	-.12
A3 Lifecycle 3 ^e	-.388	-.078	.18	.30	-.208	.025	-.38*	-.17
A4 Household Income (\$1,000)	.007	.021**	.004	.005	-.001	.004	-.001	-.001
A5 Education ^f	.028	-.002	.003	.000	.010	.002	.009	-.005
B6 Cannot afford is major reason ^g	-.247	-.494***	-.37*	-.37*	-.14**	-.094	-.020	.056
B7 Not sure as major reason ^g	-.121	-.371**	-.13	-.13	-.19	.015	-.037	-.32***
B8 Estimated home value ^h	-	-	-.001*	.000	-.22	.000	-	-
B9 Major features in-place ^a	-	-	-	-	-	-	.037	.048*

Source: Regression results and statistical measures obtained from statistical package for social science (SPSS). Samples are homeowners only. N = about 250 and 275 respectively.

* F - ratio for variables significance is 3.0 or above; ** 4.5 or above; *** 9.0 or above.

a - Count of four major conservation features in the unit: attic and wall insulation, storm window and doors.

b - Number of the four major features installed or added to by current resident.

c - Coded '1' if any of four major features were added since 1979; '0' if not.

d - Coded '1' if any specific effort to curtail energy use is identified, '0' if not.

e - Lifecycle variables are dummy variables with lifecycle 2 equal to '1' if household has children present and lifecycle 3 equal to '1' if only household members are adults over age 60 with no children present.

f - Education is in years for most educated person in household.

g - Major reason measures are responses to open-ended question about major reason for not making additional conservation investments. Third major reason "not needed" is omitted because of high negative colinearity the with other two reasons.

h - Home value is respondent's estimate of current market value of home.

predicting current status (in Denver), Major Items ever Installed and Recent Major Installations (in D.C.). "Not Sure" what to do is negative in the same three equations but significant only for current status in Denver.

Summary of Findings on Barriers

This preliminary assessment of barriers which may impede additional conservation investment has produced very mixed results. The direct approach to identifying barriers by assessing respondents open ended responses concerning obstacles to investments seems to confirm the dominance of three general concerns (for homeowners): the belief that nothing more is needed, that costs of possible improvements are too high or can't be financed, and uncertainty over which and whether additional improvement would provide enough savings.

It also appears that conservation effort is a multi-dimensional phenomena with various approaches—including major improvements, low-cost improvements, curtailment of use—appearing neither as cumulative nor as sharply alternative emphases in conservation by households. The major barriers identified by respondents relate only loosely to the types of actions they have taken. The most significant finding in this regard is that past-effort (major installation) is correlated with the belief that little remaining conservation needs to be done.

The second approach to identifying barriers to further investment provides little support for the hypotheses that financial cost (assumed to be measured by household income) and uncertainty over what can be done (assumed to be related to formal education) effect conservation actions. The impression suggested by our multi-variate analysis is that

the findings of previous research on the correlations socio-economic status and conservation effort (when renters are excluded) may in fact be tenure and life cycle effects.

While not confirmed by this analysis, an alternative picture of the major obstacles to further investment might be portrayed as follows. The current energy efficiency status of the unit (as measured by major features) is a function of time. As households age and start families, they buy homes and move less frequently. During the course of tenure, various energy saving improvements are added (serially) to the home. As more improvements are made, (irrespective to the quality of improvements, deterioration over time, or the availability of more economically attractive opportunities developing as energy costs rise) the household comes to believe nothing more needs to be done. These life cycle effects are of course correlated with income. If this portrait is accurately, the essential question for research may be to assess the degree to which perception about remaining conservation opportunities (or lack thereof) are accurate and to identify how the degree of inadequate knowledge about conservation potential is distributed. The subsequent question is how might these perceptions be altered?

Unfortunately, this portrait suggests that those for whom the major barriers may be the belief that nothing more needs to be done are the least likely to seek additional information through sources such as energy audits. This topic is examined in the following section which identifies factors distinguishing the households who were willing to receive an audit from those who were unwilling to pursue this study's offer of a free energy audit.

II. INTEREST IN ENERGY AUDITS - BARRIERS TO BETTER INFORMATION

The premise of the RCS program and of one of its key components, the home energy audit, has been that households lack information on the remaining opportunities for energy savings in their unit. More specifically, audits have been designed to identify low-cost opportunities to save energy and to perform the (rather complex and time consuming) calculations to determine which energy improvements offer the best, or at least, the economically attractive investments.¹ Overall, audits have also been presented as a vehicle by which household interest in and effort to conserve energy can be enhanced even if the information provided by the audit is not the basis of specific subsequent conservation investments.

Using data from the study, it is possible to assess the degree to which audits are of interest to households who might benefit from the type of information they provide. Factors related to lack of interest in the audit may also be viewed as potential barriers to conservation investment since they impede obtaining information which may logically represent an important step in the decision to improve home energy efficiency.

All households in our initial survey were offered an energy audit which would be provided by a local utility company under the coordination and auspices of The Urban Institute. There was no charge for the audit. The principal cost of the audit was the time commitment of at least one member of the household. Since most audits were offered

1. A more detailed discussion of audit procedures in general and those used in this study in particular appears in Section IV.

during normal working hours (although audit could be conducted early evening or late afternoon to accomodate the household's work schedule) this may have involved loss of paid work time.² In addition, households were asked to sign a form indicating their willingness to have the audit and authorizing release of a duplicate copy for use in this study. (The request for a signed form may have decreased audit willingness by one to two percent of households). Over 57 percent of households in D.C. and 70 percent of households in Denver signed the request form. -

We have examined the relationship of a wide range of factors related to this indicator of audit interest (signed a request form) and the results of this analysis are presented in Table II-1. Characteristics of particular interest or which had a significant relationship are shown in Part A of the table. Part B lists factors that were not related to audit interest.

Among demographic factors, audit interest is higher among higher income and more highly educated households. However, income differences are not large or statistically significant. Education is significant at only the .1 level. There is a percentage difference of 11 points between those with high school or less versus post-high school education. Owner and renter households were not significantly different

2. Information gathered during the baseline interview on whether one or more adults were typically home during day time hours did not appear related to willingness to have the audit, however.

In D.C. a limited number of Saturday audit time slots were available but this did not appear to increase the willingness of households to have an audit. Only 6 Saturday audits were completed.

In Denver, Saturday audits were not available for the study and this did seem to have a dampening effect on audit completions. No systematic evidence is available on this effect, however.

TABLE II-1
CHARACTERISTICS OF HOUSEHOLDS REQUESTING A FREE ENERGY AUDIT

Part A: Notable Characteristics of Households With Audit Requests		
Characteristics of Household and Unit	D.C. Proportion and/or Mean	Denver Proportion and/or Mean
Entire Sample	57%	70%
<u>Socio-demographic Characteristics</u>		
Income		
Less than \$15,000	50%	69%
More than \$15,000	59%	75%
Mean \$1,000		
With Request	(\$27.0)	\$(20.4)
Without Request	(\$24.0)	\$(18.8)
Education		
Less than High School	48%*	66%*
High School or More	59%	75%
Years at Current Residence:		
0-6	78%**	85%**
7 to 20 years	59%	66%
20 and over	44%	57%
Life cycle		
Young, no children	75%**	96%**
Adults with Children	60%	75%
Over 60, no Children	33%	51%
Tenure Owner	55%	70%
Renters	73%	68%
<u>Conservation Activity</u>		
Type of Activity Over Tenure		
None	38%	63%
Cutback Only	46%	75%
Efficiency Improvements Only	48%	69%
Both Cutbacks and Efficiency Improvements	60%	72%
Major Activity Since Moving In		
High Level	52%	65%*
Low Level	60%	75%
Any Major Activity in Last		
Three-years-Some	52%**	78%*
No Activity	69%	68%
Identify Improvements Still Needed	58%*	78%*
No Improvements Needed	48%	51%
Plan to Make Improvements Soon ¹	66%**	78%**
Do Not Plan Improvements	48%	66%
Planned Improvements to be Self Installed	70%	81%
To Be Installed by Contractor	64%	61%

TABLE II-1 (continued)

<u>Conservation Characteristics of Unit</u>		
Well-Weatherized (Major Features) ^b	52%	68%
Poorly Weatherized	61%	73%
Attic Insulation Present	50%	69%
None Present	59%	76%
Wall Insulation Present	54%	71%
Not Present	59%	75%
Storm Windows Present	56%	69%
Not present	49%	73%
Full Storm Door Coverage	52%	65%
Partial or None	58%	79%
<u>Attitudinal Characteristics</u>		
Potential Savings From Additional Improvements:		
Moderate or Substantial	65%*	79%*
Little or Nothing	51%	68%
Major Reasons Mentioned For Not Taking Action		
Nothing Needed Mentioned	50%	61%**
Not Mentioned	56%	76%
"Not Sure" is Mentioned	50%	74%
Not Mentioned	57%	69%
Can't Afford Is Mentioned	59%	78%**
Not Mentioned	51%	65%
Expectation about Fuel/Utility Costs		
Will Rise Rapidly	53%	73%
Less Rapidly	63%	59%

Part B: Other Factors Not Significantly Related to Audit RequestList of Factors

1. Had heard of Energy Audit previously
2. Attitudes with regard to temperature setting and health
3. Respondent reports house is drafty
4. Fuel type (in D.C., gas versus oil heated)
5. Household closes off rooms in winter to save on heat
6. Race of respondent (White, Black in D.C.; White, Hispanic in Denver)
7. Type of unit - detached or row house
8. Construction material
9. Size of unit (# of rooms)
10. Value of home
11. Sex of respondent

* Significant difference at .1 level.

** Significant difference at .05 level.

a - Percentages for planned improvements are based only on proportion of sample who say some major improvement is still needed.

b - Weatherization status is based on presence of four major features as indicated by respondent - including attic and wall insulation, storm window and door coverage.

in audit interest although it is surprising to find that renters accepted audits at high rates.³

The most striking and significant differences in audit interest appear with tenure duration and life cycle attributes of households. Interest in the audit drops off sharply among those households with longer tenure and those with adults over age 60 without children.

The second part of the table relates conservation activity measures (both past and planned) to audit interest. Differences in audit interest are relatively weak or inconsistent between sites for measures of past activities. However, households who can identify any improvements still needed in their unit or who say improvements are planned are more likely to request the audit.

There are no significant differences among households requesting the audit based on dwelling unit thermal status (as measured by presence of major features) although there appears to be a tendency for greater audit interest among units with fewer major features in place.

The third section in part A of Table II-1 relates measures of respondents' assessment of potential savings from additional investment, the three major reasons for not undertaking actions, and expectations about future costs to audit interest. Those believing substantial

3. Evidence from utility company data shows that renter households request audits less frequently than homeowners. See Hempel, Robert F. and Owens, Ronald L. "Burden Allocation and Electric Utility Rate Structure Options" (Paper presented at Brookings Conference on High Energy Costs, October 1980) for data from the T.V.A. program. Renter audit interest in our sample may be accounted for by the fact that they are more like homeowners (live in one or two rent buildings) than are all renters, the audit was free, and our baseline interview explained that the audit also provided low-cost tips appropriate for renter households.

savings are possible are much more likely to request the audit, while those mentioning that nothing more is needed are less likely to request it (significant in Denver only). Future cost expectations appear to have no consistent or significant effect.

Among other factors (listed in Part B), it is important to note that familiarity with audits (had heard of audit's being offered by utility companies), size of the unit (proxy for space heating demand) and fuel type (gas versus oil heated in D.C.) did not appear to be significantly related to audit interest. The patterns evident from data in Table II-1 tend to be consistent with those from previous reviews of the utility audit programs in one major respect--audits are sought by those already planning or motivated (predisposed) to undertake activity.

Our findings support only a slight socio-economic bias in audit interest. However they reveal significant effects of tenure duration and life cycle which has not been strongly noted in previous research.⁴

In order to assess relative importance of these factors (other than audit predisposition), we estimated a regression equation for each sample which incorporated selected demographic and past activity variables and the reasons cited for not making further investments. Results are presented in Table II-2.

4. Reviews of utility audit programs have generally cited three apparent biases in the characteristics of households requesting audits (they are homeowners, of higher socio-economic status, and are already planning major conservation improvements). See Dubinsky, Robert, Technical Memorandum #1, op. cit., and Hirst, E. and Lazarre, P., Evaluation of a Computerized Home energy Audit Program, Minnesota, June 1980.

TABLE II-2
MULTIPLE REGRESSION FOR PREDICTING REQUEST
FOR FREE ENERGY AUDIT^a

Summary Statistics/ Independent Variables	D.C.	Denver
R ²	.12	.10
F Ratio	4.33	4.2
Constant	.78	.48
Years at Current Residence	-.003	-.007*
Life cycle 2 ^b	-.16	-.05
Life cycle 3 ^c	-.37**	-.26
Household Income	-.003	-.002
Education	.016*	.03**
Past Efforts to Curtail Use ^d	.06	.07
Number of Major Features in-Place	-.01	-.04
Can't Afford Is Major Reason ^e	-.08	-.02
"Not Sure" Is Major Reason ^e	.07	-.03
Number of Major Actions by Resident Since Moving In	-.006	.00

* Variable is significant with F ratio of 3.0 or higher.

** Variable is significant with F ratio of 5.0 or higher.

a - Dependent variable is coded '1' if respondent signed request for audit (this is distinct from receipt of audit discussed in Section III of the paper), '0' if not. Homeowners only are included in regression.

b - Lifecycle 2 is coded '1' if household has adults between ages 33 and 60 and children; '0' if otherwise.

c - Lifecycle 3 is coded '1' if only persons in household adults over 60; '0' if otherwise.

d - Variable for curtail use is coded '1' if one or more specific efforts are reported; '0' if none.

e - Reason variable are based on open-ended responses to question about major reasons for not making additional energy efficiency improvements. Coded '1' if this response is mentioned; '0' if not.

The results of this analysis are important in three respects. While statistically significant, these equations amount for only a small portion of the variance in audit interest. ($R^2 = .12$ and $.10$ in D.C. and Denver respectively). Thus, demographic factors (even if correlated with the predisposition factors which are omitted) do not well explain audit interest. However, it does appear that the more highly educated are likely to request the audit (those who may need it less). Years at current residence or life cycle do appear significant in at least one equation with expected negative effects.

Secondly, interest in audits is not significantly related either to the major features in place or to the number of major conservation improvements previously installed. (These items were entered separately in equations not reported and the individual effects were insignificant as well). This result suggests there is no bias toward inefficiently providing audits only to households already well insulated. This concern has been frequently expressed by utility companies, and others critical of audit programs. However the data also indicated that less well insulated homes are no more likely to be audited.⁵ Thirdly, households who say that "uncertainty about what to do" is the prime obstacle to further investment are no more likely to take advantage of an audit than are others. Thus, households whom we might expect to most want an audit because they lack the information it can provide do not respond well to a free offer of relevant information. This finding casts doubt on the importance of this obstacle to conservation

5. See Residential Conservation Service Program - Regulatory Analysis, U.S. Dept. of Energy, October, 1979. DOE-CS-0010411.

investment. Perhaps the response simply disguises a general unwillingness to pursue conservation opportunities.

Overall, the analysis of audit interest among households in our study is not strongly supportive of the potential of audits to stimulate conservation activity among households who may most need some additional stimulus to undertake further low cost or major conservation actions. While the socio-economic bias evident in other reviews of existing utility audit programs does not appear as strong in this data, a predisposition toward conservation action (improvements already planned) seems to be the strongest correlate of household interest in an audit.⁶ This result offers support to the summary picture portrayed in the previous section, that the greatest obstacle to further investment in energy efficiency is absence of perceived potential for additional energy savings.

6. These factors will be assessed in greater detail in the final report.

III. THE PAYBACK TO CONSERVATION INVESTMENT: HOUSEHOLD EXPERIENCES AND EXPECTATIONS

Energy audits provided by utilities under the RCS program offer detailed information on the costs of various conservation improvements and projected annual fuel/utility savings which would result from each option. A major component of the audit report to the household includes an estimated annual payback period (cost divided by savings) for each item based on the cost and savings calculations. The sophisticated user can presumably use such information for identifying the items that are most cost effective to install (given the unit's current thermal efficiency and household energy consumption).

Despite the sophisticated analysis embodied in the audit, there is little available evidence concerning the level of payback households might require before undertaking additional conservation investment or even whether households use such information in making decisions to improve their home. The payback period implies a rate of return on investment which households might heavily discount. The future stream of (annual) savings may not be attractive in light of high initial costs associated with many conservation items.

How required rates of return and related discount factors vary with household characteristics are questions without firm answers. The general consensus, however, is that the rates of return required and the discount rates applied by households are extraordinarily high - which simply means that households do not readily undertake conservation

improvements with rates of return which would normally be considered attractive opportunities in other investment areas.¹

Pursuing a much less sophisticated economic analysis, we can utilize data from our baseline survey to describe one version of payback on conservation items implied by the conservation expenditures and energy savings reported by sample households. Implied paybacks can be estimated both for past expenditures on conservation improvements—primarily attic or wall insulation, storm windows or doors and combinations thereof—and for a range of planned future investments. Savings estimates are unfortunately crude and approximate, reflecting, however, respondents estimates of how much their monthly energy bills have been or will be reduced by the conservation improvements with which they are familiar.

Table III-1 presents the distribution of estimates of monthly savings. Three sources of savings are identified: those from past improvements, those expected from future improvements, and those derived from curtailment in energy use—a measure which is presented for comparison. The table also indicates the proportion of the samples for whom the particular source of savings was not utilized and the proportion who

1. Two recent studies—one of consumer behavior with regard to airconditioner purchase and use and the other with regard to refrigerator pricing both imply relatively high discount rates. J. A. Hausman in Individual Discount Rates and the Purchase and Use of Energy Using Durables Bell J. of Economics, Vol. 10, No. 1. pp 33 to 54 finds that implied discount rates decline sharply with annual income class from 89% at \$6,000 or less to 5.1% at \$50,000 or more. D. Gately, in Comment on Housman's article in the same journal Vol. 11, #1 pp. 373-374 finds discount rates implied by differential pricing of more efficient and less efficient refrigerators to be between 45% and 300%.

TABLE III-1
HOUSEHOLDS' PAST AND EXPECTED SAVINGS FROM ENERGY CONSERVATION

Source of Savings	D.C.		Denver	
	Entire Sample	Most Active ^a	Entire Sample	Most Active ^a
Monthly Savings From Past Efficiency Improvements ^b				
None, Made No Conservation Effort ^c	29%		26%	
Can't Say	19%		12%	
Savings Lost to Higher Costs ^d	70%	77%	67%	68%
\$4-10 a month	6%	3%	14%	9%
\$10-25 " "	11%	10%	12%	15%
\$25-50 " "	6%	5%	5%	4%
\$50-Hi " "	7%	5%	2%	4%
Mean Savings ^d	\$43	\$43	\$21	\$26
Monthly Savings From Past Efforts to Cutback on Use ^b				
None, Did not Cutback ^c	50%		33%	
Can't Say	12%		9%	
Savings Lost to Higher Costs ^d	71%	72%	76%	77%
\$4-10 a month	8%	9%	11%	10%
\$10-25 " "	13%	11%	10%	7%
\$25-50 " "	6%	4%	3%	6%
\$50-Hi " "	2%	4%	0%	0%
Mean Savings ^d	\$29	\$34	\$17	\$11
Expected Monthly Savings From Planned Efficiency Improvements ^b				
None Planned ^c	60%		67%	
Can't Say	12%		8%	
Savings will Equal Higher Costs ^d	23%	26%	39%	47%
\$4-10 a month	21%	20%	26%	26%
\$10-25 " "	25%	32%	21%	42%
\$25-50 " "	19%	16%	10%	3%
\$50-Hi " "	12%	7%	5%	3%
Mean Expected Savings ^d	\$33	\$27	\$21	\$19

a - Most active measure is based on number of four major efficiency improvements installed during tenure.

b - Monthly savings are respondent answers with respect to direct questions on savings from past efficiency improvements, from past efforts to curtail use, and savings expected from planned efficiency improvements (before next winter) which respondent identifies.

c - Shows percentage of sample who say no conservation effort of that type completed (or planned).

d - Percentages based on proportion of sample who experienced some savings. Excludes "can't say" as well.

e - Mean based only on those mentioning a dollar savings.

could not provide an estimate of savings despite having made or being about to make efforts at energy conservation.

Perusal of the table indicates that 10 to 20 percent of households who have made or plan some conservation effort are not able to venture a guess at experienced or expected savings. With respect to past savings from investments or curtailments, 68 to 77 percent of households (both among the active and the entire samples) report that savings have been lost to higher energy prices. (Although far more households report not cutting back than report no efficiency improvements.) Clearly, the dominant return to conservation effort for households has been one of "offsetting" energy bill increases rather than achieving actual reductions in existing levels of costs.

Estimates of net reductions to bills that are reported range from \$4 to \$50 per month for past efforts with a typical modal savings of \$10 to \$25. Average saving (from among those reporting net reduction) ranges from \$11 to \$43 with D.C. residents consistently reporting higher average savings. It is also noteworthy that in all instances there are fewer and lower average reported returns to curtailment of energy use than from efficiency improvements.

Expectations about savings from improvements which are planned are more optimistic in that smaller proportions expect savings to be immediately offset by higher costs (although this proportion is from among only about 30% of households planning improvements). The mean expected net monthly savings range from \$19 among Denver households who were active in making past improvements to \$33 among the entire D.C.

sample. In summary, it appears that only a small proportion of households (even among activists) attempt to identify savings with specific accuracy and there is apparent consistency across questions and sites in responding to our query about savings. This suggests that conservation effort is mostly an effort to hold the line on costs rather than a sophisticated optimising strategy.²

Table III-2 presents measures of payback (in months) for past and planned investments by households at both sites by utilizing data where net savings and estimated costs of past or future conservation improvements were available. Average monthly paybacks range from 26 to 59 months.

The table also presents information on the distribution of the average length of payback for various demographic and conservation activity characteristics of the sample. The very small sample sizes which result from this breakdown and widely varying payback distribution results in few statistically significant relationships. Two relationships do lend support to the inherent meaning of the payback measures, however. Households who reported in a separate survey question that "substantial savings" from future savings were possible show consistently shorter payback experiences and expectations than do households reporting that they believe "little savings" are possible. In Denver, where the survey obtained an assessment of whether savings from past investments were "more, less, or about as expected" there is evidence

2. The response code, "savings lost," to higher costs was not an optional answer mentioned in the question. Rather, variants of this answer were so frequent we coded our response categories after survey pre-testing to accommodate this response.

TABLE III-2
DISTRIBUTION OF PAYBACK PERIODS FOR PAST
AND FUTURE EFFICIENCY INVESTMENTS

Characteristics of Dwelling Units/ Households	D.C.		Denver	
	Monthly Payback From Past Investments	Monthly Payback From Planned Investments	Monthly Payback From Past Investments	Monthly Payback From Planned Investments
Entire Sample	43	59	58	25
Household Income				
Less than \$15,000	29	62	84	25
More than \$15,000	49	60	49	26
Education:				
Less than High School	21	52	78	18
High School or More	50	63	44	29
Lifecycle: Young, no Children	—	56	38	28
With children	48	56	58	24
Older, no children	26	104	77	NA
Major Conservation Activity				
Active	52	41	79**	39**
Less Active	14	73	30	20
Proportion of Items in Place Installed by Current Occupant				
High	45	69	60	33*
Low	26	52	51	20
<u>Attitudinal Characteristics</u>				
Expect Future Energy Costs to Rise Rapidly	—	67	—	26
Rise More Slowly	—	51	—	21
Reasons for not making additional improvements:				
"Not sure what to do" is important	17	88**	38	17
not important	45	46	63	30
"Would not save enough" is important	75*	73	49	27
not important	32	51	60	29
"Can't Afford" is important	45	58	49	24
not important	40	61	63	26
Savings Potential From Investment				
Moderate to Substantial	28*	56	49	23
Little or nothing	70	72	66	29
Savings From Past Investments Were:				
More than Expected	—	—	36**	13
About as Expected	—	—	48	26
Less than Expected	—	—	122	28
<u>Current Conservation Status</u>				
Well weatherized	47	54	75**	23
Poorly weatherized	25	65	16	28

that the average length of payback accords with this assessment of past investments.

Table III-3 provides additional information on relationships among payback durations. The length of payback is highly related to size of investment, indicating that households who make large conservation expenditures expect to wait longer to fully realize their return on investment. There appears to be no significant relationship, however, between payback period experienced from past investments with that expected from future investments. (This correlation is based on only about 10% of the samples for whom past and expected payback measure were available.)

This information on payback experience and expectation can offer only limited evidence about the rate of returns households require before undertaking investments. In addition, to interpret these findings as annual payback requirements necessitates some translation from the monthly terms in which this information was gathered. Most references to energy savings during the course of our interview were in relation to winter heating costs. Because these savings estimates are probably associated with only the heaviest heating and (perhaps) peak cooling months, we cannot assume that full savings are realized over all twelve months of the year. Using six months (1/2 year) as an approximation of the period over which savings are realized would suggest that past average paybacks would be from 7 to 10 years. On the same basis, future payback expectations would range from 4 to 10 years (if savings accrued only from net reductions). However, without extensive

TABLE III-3

RELATIONSHIPS AMONG INVESTMENT COSTS
AND LENGTH OF PAYBACK

Items Correlated ^a	D.C.	Denver
Total Previous Investment ^b With Length of Payback	.62++	.78++
Total Planned Investment ^b With Expected Length of Payback	.29++	.52++
Length of Payback from Past Investment With Length of Payback Expected for Planned Investment	-.18	.06

++ Significant at .05 or better.

a - Correlations are Pearson's R.

b - Total investments are summed dollar figures provided by respondent for costs of various past investments (attic, wall insulation, storm doors) or total expected expenditures.

information on fuel price increases over the relevant time period, it is difficult to estimate the total savings involved.³

In summary, while our data can only be used as the bases for speculation, it appears that even among households who have had experience with or are planning efficiency improvements, most do not use—or at least cannot articulate—a sophisticated economic calculus for their investment decisions. Energy price changes would appear to be the confounding factor.⁴ Most households perhaps decided to make improvements to limit increases in fuel bills in the face of great uncertainty about future prices. Among households who do report net reduction in bills, paybacks have fallen typically within the 10 year or less range that is the key focus for conservation items evaluated by RCS audits.

3. It is possible that for past investments, households "made a mistake"—i.e. did not receive a rate of return they wanted or expected. The only evidence we can bring to bear on this would not support such an interpretation. Over 60 percent of the Denver sample said they saved about what they expected to, or more, while of 40 percent (who said they saved less or didn't know) most say that expected savings were lost to unexpected increases in energy prices.

4. Utilities also find it difficult to project future price paths—information which, from an investment perspective, is essential to evaluating any choices with paybacks of a few years or more. Audit evaluation frequently use only current prices or flat projected rate of increase as the basis of the savings estimates.

IV. THE POTENTIAL FOR INCREASED ENERGY EFFICIENCY: A COMPARISON OF HOUSEHOLD PERCEPTIONS AND AUDIT RECOMMENDATIONS

Overview

This section provides more detailed information on the energy audits provided to households in this study. Then, utilizing data from both the audit results and the information from the baseline survey, we provide a detailed assessment of the degree of correspondence between households' perception of needed conservation improvements and the paybacks (rates of return) estimated for those items by the audit. While some error in audits undoubtedly exist, we will presume that the audit data is the "correct" identification of remaining conservation potential for the unit.¹ This analysis may be viewed as assessment of the sophistication in households' knowledge about conservation opportunities. Viewed from a different perspective, the analysis offers an assessment of the degree to which audits can supply additional or more accurate information to households who are unaware of—or mistaken about—the remaining options.²

1. Audit "error," the degree to which it does not accurately portray conservation opportunities for the unit, may be found in three sources. The first is imprecision in input measurements by the auditor or in the consumption data for the household. Consumption data based on utility records or computer estimates are the basis against which reductions in heat loss or gain in percentages tenure are applied. The second source of error may be found in the parameters of the models used to estimate heat loss and reductions in heat loss that result from thermal improvements. The third source of error is in the cost of materials and work (contractor or self-installed) which represent geographic area averages and may be out of date. In addition, it is likely that individual households will obtain materials or services that vary substantially around the averages used by the auditor.

2. An evaluation of audit effectiveness in altering respondent awareness of available options will be included in the subsequent project report.

Audit Measures of Energy Savings

Energy audits have been developed to provide detailed information on the remaining energy saving potential from additional investment in residential retrofit (or reveal that units have exploited all economically attractive measures). As designed and conducted by many private firms, numerous state agencies and a majority of utility companies, the two most notable features of the audit are:

- o An on-site inspection of the major thermal features in-place and of less obvious points of heating, cooling system or thermal shell inefficiencies.
- o An evaluation of the economic attractiveness of each of several specific options for weatherization improvement. The evaluation reflects the current heating/cooling requirements and energy use habits of the household. In addition to specifying cost and savings that may result from new features, the audit can show where improvements in existing features are appropriate.

The value of the on-site inspection is that trained auditors are equipped to quickly and easily obtain the information on factors central to the evaluation. These include space and volume measurements for the unit and for key components such as window areas; measurement and inspection of installed insulation; and characterization of the inherent insulation of the building structural material. Judgements about feasibility of installation of insulation in outside walls or attic crawl space, for instance, are also made during the inspection.

While audit results from different organizations might differ somewhat depending on cost and savings parameters in the model, audits have achieved a remarkable degree of consistency and provide information

that may be particularly costly or time consuming for homeowners to obtain on their own.³

Three utility companies provided audits of a subset of our sample households. While variations in audit procedures and presentation of results were evident among the utilities, we believe that the audit data derived from the on-site inspections are reasonably comparable and can be used as a single source of information.⁴

The items covered in the audit evaluations include the major features we have referenced throughout this report including attic and wall insulation, storm windows and doors. Other forms of insulation (primarily floor/crawl space), water heater insulation, caulking/weatherstripping, and installation of clock thermostats were the additional major items evaluated by the audits. These items are the common major features used in the following analysis.⁵

3. Audit evaluations differ in the detail provided on costs of weatherization features. At a minimum, they provide an estimate of typical contractor installation covering labor and materials. These may be presented as mean or median cost estimates obtained from a survey of local suppliers. Some audits also show costs of materials alone for items typically self-installed, such as attic insulation or storm windows. Self-installed costs were not provided in one of the three utility audit formats in this study.

4. We accompanied auditors on several occasions to observe the procedures followed in the household. A more detailed discussion of audit procedures is provided in a background report. The appendix to this paper presents a comparison of selected audit savings estimates and sample result forms from the audits that were provided both to the participating household and to this study as a source of data.

5. Audits may also consider the feasibility of solar hot water and space heating, solar swimming pool and green house, and wind generation for electricity needs. Evaluation of these items in our sample was available only in Denver and consequently these items are not included in our analysis.

Sample Bias in Characteristics of Households Receiving Audits

As part of the study, approximately 25 percent of the sample households received a free energy audit. Because households self-selected for the audit (by signing a request form) and because there was a great deal of variation in the way in which audits were scheduled, there is a possible bias in energy-related characteristics of the subsample which received audits relative to the full baseline sample.

The low-response audit completion rate is a result unintended in the original study design. We sought audits from 50 percent of households; obtained signed audit requests from 58 percent of survey households; and expected a much lower dropout rate. Assessing the characteristics of households that were audited becomes particularly important given the lower completion rate.

It is important to note that this analysis is distinct from that provided in section II of this report. There we assessed the factors related to requests for audits. About half of those households requesting audits did not complete them.⁶

Table IV-1 shows a variety of selected measures of the audited and unaudited households in both sites. The measures cover demographic attributes, past conservation actions and planned activities, current

6. The factors which account for the drop-off between audit request and completion may partially represent respondents' behavior. Some households changed their mind about receiving the audit or could not be reached to schedule an audit. However, our scheduling of the audits and utility company procedures also substantially affected who got an audit. In combination, we believe that several factors tended to randomize the resulting characteristics of the households who were audited. This analysis is directed at identifying any bias in resulting distribution and not at factors which determine who finally received an audit.

TABLE IV-1
COMPARISON OF CHARACTERISTICS OF AUDITED AND
UNAUDITED HOUSEHOLDS:
D.C. AND DENVER

Demographic, Conservation Activity, and Attitudinal Characteristics of Sample Households	D.C.		Denver	
	% or Mean of Households With Audit Which Had This Characteristic	% or Mean of House- holds Without Audit Which Had This Characteristic	% or Mean of Households With Audit Which Had This Characteristic	% or Mean of House- holds Without Audit Which Had This Characteristic
<u>Demographic Characteristics</u>				
Household Income >\$15,000 (\$1000, mean)	74%* (\$27.10)	61%* (\$24.0)	57% (\$18.7)	53% (\$18.7)
Education: High School and Above ^a (Mean years)	77%**	59%	38%	51%
Elderly Status: Those with only Elderly Persons in Household	18%	19%	17%	26%
Someone Is At Home During Most Workdays	72%	70%	83%	80%
<u>Past Conservation Characteristics</u>				
Report Making Some Effort to Conserve Energy ^b	90%	84%	93%	88%
Most Active in Making Past Major Weatherization Improvements (mean action) ^c	51% (1.5)	53% (1.7)	33% (1.0)	38% (1.2)
Major Action in Past Three Years	12%	17%	32%	23%
Report at Least One Specific Effort to Cutback on Energy Use	77%*	64%	78%	77%
Identify One or More Needed Efficiency Improvements	75%	66%	76%**	60%
Identify One or More Improvements to be Completed Before Next Winter ^d	57%	50%	48%	39%
Current Status - Mean Number of Major Features in Place	(2.6)	(2.6)	(2.3)	(2.9)
Size of Unit (mean rooms)	(7.2)	(7.0)	(6.2)	(6.0)
Years at Current Residence (Mean)	(15.8)	(18.1)	(11.0)	(13.1)
Value of Residence (\$1,000, Mean)	(\$74.8)**	(\$68.3)	(\$65.9)	(\$67.6)
<u>Attitudes and Beliefs</u>				
Say that Moderate to Substantial Energy Saving From Weatherization Are Possible	57%	51%	54%	41%
Expect Home Energy Costs to Continue to Rise at Rapid Rate	60%	69%	93%	90%
Agree that More Weatherization would Make Little Difference in Saving Energy	11%**	25%	12%	15%
Reason is Important in Not Making Additional Weatherization Improvements:				
Not Sure What to Do	15%	17%	12%	12%
Improvements Wouldn't Save Enough Money	21%	28%	18%	17%
Can't Afford Additional Improvements	34%	42%	41%	39%

* indicates significant difference at .1 confidence level between audited and unaudited homes.

** indicates significant difference at .05 confidence level or better between audited and unaudited households.

a - Education is measured for "most" educated adult in household.

b - This measure is based on response to general question about conservation (Q-39) without reference to specific improvements or actions.

c - Measure counts number of four major weatherization improvements installed by current resident. Active category includes two or more improvements.

d - Percentages based only on about 75% of households who say improvements are needed.

conservation status of the unit, and selected household attitudes and beliefs. Statistically significant differences between audited and unaudited households are noted.

We do find some evidence for bias toward higher socio-economic status of audited households. Audited households are more likely to have higher incomes (significant in D.C.). It appears, however, that we have more highly educated households in D.C. and less highly educated households in Denver within the audit subsample.

Measures of conservation effort do not significantly or systematically differ with the exception of the D.C. audit sample proportion who report curtailments in energy use. There is no difference in status as measured by major features in place. The size of audited dwelling units appears slightly larger than non-audited units; tenure duration is shorter in both audited subsamples. (These differences are not significant.)

It is important that audited units in both sites were more likely to identify one or more efficiency improvements as needed and to say that such improvements were definitely planned. While only one of these four relationships are statistically significant (at .05), this difference indicates that our audited sample is more likely to be concerned about the need for further improvements and likely to take subsequent actions than is than the unaudited sample. Some attitudinal responses support this picture (although also without consistent statistical significance). Households who believe that moderate to substantial savings from efficiency improvements are possible are more likely to be in the audit sample (by 6 percentage points in D.C. and 13

percentage points in Denver) and audited households are less likely to agree (significant in D.C.) that weatherization "makes little difference in energy savings."

There are no large, significant or systematic differences in the major reasons cited for not making additional conservation improvements (bottom portion Table IV-1).

Overall, in the following analysis it will be important to keep in mind that we probably have among audited households, those of slightly higher socio-economic status and who are more interested in impending conservation investment (an attitudinal characteristics not based on past activity or current dwelling unit status) and therefore, perhaps more knowledgeable than the full sample about remaining conservation potential in their units.

The Distribution of "Needed" Improvements

Table IV-2 provides simple frequency distributions of energy efficiency improvements identified as "needed" by the energy audits and by the households in the audit samples. To define "needed" items by audit standards, we have examined the payback ratios for each item (contractor installed cost/estimated annual savings) and used 5 years and 10 years paybacks as threshold levels. If the cost of the conservation improvement can be recouped through lowered energy bills in 5 years or less, the item is considered very attractive.

As is evident in the first column for each site, the energy audit identified at least some item from among the six summary categories that provide an attractive (5 year or less payback) for nearly all households. Only 3 percent of audited D.C. households and 13 percent of

TABLE IV-2
WEATHERIZATION IMPROVEMENTS IDENTIFIED BY THE ENERGY AUDIT AND
BY HOUSEHOLDS RECEIVING AUDITS

Conservation Feature	Proportion of Audit Households					
	D.C.			Denver		
	Audit Recommendation		Identified by Household	Audit Recommendation		Identified by Household
	Payback 5 yrs. ^a	Payback 10 yrs. ^b		Payback 5 yrs. ^a	Payback 10 yrs. ^b	
Nothing needed ^c	3%	0%	25%	13%	3%	23%
Insulation (attic, wall or floor)	51%	79%	47%	26%	83%	53%
Storm windows	0%	21%	42%	0%	29%	39%
Storm doors	0%	0%	21%	0%	0%	22%
Caulking/weatherstripping	16%	46%	26%	46%	71%	22%
Insulate pipes/hot water heater	88%	90%	1%	41%	42%	7%
Clock thermostat	17%	17%	1%	58%	68%	0%

a - Payback calculated as contractor installed cost divided by annual dollar savings (current energy price) in fuel/utility bills estimated to result from specific weatherization improvement (data from audit). Those with savings greater than 20% of costs are included (i.e. payback is 5 years or less).

b - As in (a) above, except annual savings are 10% or more of costs (payback is 10 years or less). Ten year payback items are inclusive of items with 5 year paybacks.

c - "Nothing needed" refers to units for which audit finds no five year (10 year) or less payback for the six specific items in the table and to household responses which do not identify any of the items in the table (other items not evaluated by the audit may have been mentioned - e.g., ceiling fans).

Denver households had no such item. The most common attractive improvement in D.C. is hot water heater or pipe insulation (for 88% of units) while the most frequent high payback item in Denver is a clock thermostat (58 percent). Improved caulking/weatherstripping offers high payback for 16 percent of households in D.C. and 46 percent of households in Denver. Some type of insulation (attic, wall or floor) had five years or less payback for 51 percent of households in D.C. and 26 percent in Denver.⁷

The frequency with which units would have paybacks of ten years or less is also shown in the table.⁸ No households in D.C. are without at least one 10 year payback option and only 3 percent of households audited in Denver would have no 10 year payback option. It is particularly noteworthy that the energy audits in both sites found no instances of five year or better payback for installation of storm windows or storm doors despite the fact that many audited households lack coverage of these items.⁹ On a ten year payback basis, improvements in storm window coverage would offer paybacks to 21 percent and 29 percent of households respectively in D.C. and Denver.

The frequency distribution of items identified as needed by households who were audited is quite different than that recommended by

7. These insulation items were combined (although paybacks were calculated separately) for comparability to our survey coding scheme.

8. Conservation items with five year or less paybacks are, by definition, a subset of items with 10 year or less paybacks.

9. This finding is consistent with the general impression we gained from talking with conservation engineers who indicate that the cost of storm window installation in older homes is so high that it is difficult to achieve an attractive return. The average contractor installed cost for storm windows estimated for Denver by the audits was approximately \$625; but ranged up to \$3000. In D.C. the average storm window cost was \$750 ranging up to \$5800.

the audits. This distribution is based on the (up to three) responses by each household to the question "what things do you think (still) could be done to this house to cut down on its use of energy and make it more efficient?" First, despite the fact that the audit sample may be skewed toward households who are more likely to identify needed items, the response that "nothing more was needed" (25% and 23%) is much greater than that implied by the audit.

The proportion of audited households, however, who mentioned insulation (attic, wall or floor) is much closer to the ranges suggested by the audit payback findings. The proportion of households who thought that storm windows or doors could be added (in fact the most frequent responses following insulation) quite markedly exceeds the audit findings.

Attention to the less expensive improvements such as caulking, hot water heater insulation, and clock thermostats is considerably lower than it is to major items. In D.C., households perception of the need for additional caulking/weatherstripping (26 percent) falls between the proportion recommended by the audit under the 5 and 10 year payback criteria. In Denver, households under-estimate the potential of caulking and weatherstripping (22 percent) rather substantially relative to audit recommendations.¹⁰ Hot water heater (and pipe) insulation was identified by only 1 percent and 7 percent of the samples respectively. Clock thermostats apparently have received the attention of

10. This finding is particular noteworthy in Denver, since caulking can be done by a member of the household in many instances and the payback from the audits shown here are based on contractor costs. Thus, the under-estimation of caulking potential in Denver is very

almost no households as opportunities for energy savings. While setting back thermostat during periods of sleep or absence from the home can be performed manually, the auditors checked this practice with the household. Thus, the evaluation of payback substantially reflects the incremental savings due to automatic setback relative to the current practice of the household.

In summary, Table IV-2 suggests a rather strong mismatch between household and audit estimates of the opportunity for and the source of economically attractive efficiency improvements to the home.

For each household and each conservation item we have defined two types of "error" based on the comparison of conservation options identified by the audits and by our respondents. "Error type A" we attribute to households who do not identify a conservation item as needed but for which the audit has found that the payback would be 5 years or less. "Error type B" we attribute to households who identify an item as needed but for which the audit finds that the payback would be greater than ten years. Generally, speaking, both types of error reflect a lack of knowledge about the most appropriate sources of energy saving improvements.

Table IV-3 provides an indication of the frequency of these types of errors by item for the audited households. The first column shows simply the proportion of households who identify the conservation item as needed out of all households for whom the item offers five year payback.¹¹ In both sites, households did best in identifying the

11. Storm windows and doors are not considered because audits found no households with 5 year payback on these items.

TABLE IV-3

ACCURACY OF HOUSEHOLD PERCEPTIONS OF
NEEDED CONSERVATION IMPROVEMENTS

Efficiency or Weatherization Improvements Evaluated by Audit	Proportion of Households					
	D.C.			Denver		
	Proportion Correctly Identifying Item as Needed which Has 5 year Payback ^a	Proportion of Those Who Identify Item as Needed for which Payback is Greater Than 10 years ^b	Proportion of Entire Sample Who Identify Item as Needed When Payback is Greater Than 10 years	Proportion correctly Identifying Item as Needed which Has 5 year Payback ^a	Proportion of Those Who Identify Item as Needed for which Payback is Greater Than 10 years ^b	Proportion of Entire Sample Who Identify Item as Needed When Payback is Greater Than 10 years
No Improvements ^d	0%	100%	21%	33%	100%	12%
Insulation (attic, wall or floor)	49%	17%	8%	57%	17%	9%
Storm windows ^e	NA	81%	34%	NA	70%	27%
Storm doors ^e	NA	100%	21%	NA	100%	22%
Caulking/weatherstripping	25%	50%	13%	25%	27%	6%
Hot water heater/pipe insulation	2%	0%	0%	4%	60%	7%
Clock thermostat	0%	N=1 ^g	2%	0%	0%	0%
One or more items ^f	29%	-	-	30%	-	-

a - For units for which the audit found that installation or improvement of the specific weatherization feature would offer a five year or less payback (contractor installed basis), this is the proportion of households who identified the item as needed.

b - This column shows the proportion of households who identified this item as one of the three most important improvements yet needed but for which the audit finds that contractor installed payback period would be more than ten years. Referred to in text as error type B.

c - This column shows the proportion of entire audited sample who cite the item as needed but for which contractor installed payback is ten years or greater.

d - Row shows respectively the proportion of those who say no improvements are needed for which no item with five year payback is available; the proportion of those who say no improvement is needed and for which all improvements would require 10 years or greater payback; and the proportion of entire sample who say no improvements are needed and for which all improvements require a ten year or greater payback.

e - Audits in both cities found no households with contractor installed windows or doors that would provide a payback in five years or less.

f - First column figures show proportion of all households who identify correctly as needed one or more items that have a 5 year or less payback.

g - Cell proportion is 100% based on one household who said clock thermostat was needed but for which contractor installed payback would exceed 10 years.

attractive potential of improved insulation of attic, walls, or floors i.e. made the least type A error. Roughly half the households for whom insulation offered an attractive payback "correctly" identified it.

While many households (25%) said nothing more was needed, in D.C. none of these households were in the dwelling units for which the audit found no 5 year payback options. In Denver, only one-third of households without 5 year paybacks "correctly" said nothing more was needed. About one quarter of households with attractive (5 year) paybacks from caulking/weatherstripping identified that needed improvement in both sites. There was extremely low correct identification of water heater insulation and clock thermostats.

Overall, only 29 percent of households in D.C. and 30 percent in Denver could identify as needed one or more items suggested by the audit.

Column two for each site in Table IV-3 shows the incidence for each item of error type B. The most frequent errors are apparent for storm windows and doors. Eighty are percent of households in D.C. and 70 percent of households in Denver who identified storm windows would not receive a payback from this option in less than 10 years. Over 20 percent made the equivalent "error" for storm doors. Those households who suggested caulking/weatherstripping had relatively high error rates as well (50 percent and 27 percent respectively). In Denver, of even the few households who said that water heater insulation was needed, 60 percent would find that the payback was not attractive.

While the figures in column one and two indicate errors for households identifying a particular item, column three offers a picture

of the distribution of the greatest source of error across the entire sample. If households were to act on the improvements they identified, their figures would represent the proportion of households making the least attractive improvements.

The greatest misdirection of conservation effort would be for storm windows. Thirty-four percent of the D.C. sample and twenty seven percent of the Denver sample believe that storm windows are appropriate when their payback exceeds 10 years.¹² Storm doors are the next most frequent mention of the less attractive improvement. The proportion selecting storm windows and doors equal to or exceed the proportion of households who would "erroneously" make "no improvements." Investment in caulking/weatherstripping or water heater/pipe insulation would be inappropriately be undertaken by only a relatively small proportion of households.

Summary Assessment of Household Conservation Knowledge

This section has been devoted to identifying various aspects of household knowledge concerning the most economically attractive options for energy saving improvements to their home. While these comparisons were relative (depending in part as our choice of 5 year and 10 year payback thresholds), it appear that there is a low knowledge within the samples about the potential for improvement overall and about the most appropriate sources of savings. Despite the apparent tendency for our

12. Ten year payback may still be attractive to a household and the investment may be appropriate. The ten-year payback threshold is used only as a benchmark for analysis. Our figures should be used to identify relative ranking of appropriate investments rather than as accurate percentages of households for whom each investment is appropriate.

audited subsamples to be households more attentive to the potential for energy savings and to be planning conservation investments, about one quarter fail to identify any improvements (most have one or more) and except for insulation, tend to identify the "wrong" or less attractive item. While the most frequently cited rationale for utility audits is their stimulative effects—getting households to invest in some energy saving improvement—it appears that they also offer a potential to redirect household investment choices both away from less attractive items and toward more cost-effective (more frequently, lower cost) energy saving options.

From this perspective and because audits are a limited resource it may be important to direct audits toward those households least knowledgeable about conservation options. Identifying such households may not be easy, however.

As a preliminary assessment of the distribution of accurate knowledge on conservation options, we have examined the relationship of several measures of conservation knowledge with selected household and dwelling unit characteristics. Table IV-4 shows these relationships.

For subgroups, the table reports the proportion of households correctly identifying any item with a five year or less payback, the mean number of "correctly identified (5 year payback) items and the mean proportion of "correctly" identified items out of all items with 5 year paybacks. These measures capture different aspects of the extent of household knowledge but, upon examination, reveal similar patterns.

Perusal of Table IV-4 indicates some interesting results. First, household income is positively but weakly related to the measures of

TABLE IV-4
CHARACTERISTICS OF HOUSEHOLDS WITH KNOWLEDGE OF
NEEDED WEATHERIZATION IMPROVEMENTS

Demographic, Conservation Activity, and Attitudinal Characteristics of Households	D.C.			Denver		
	Proportion Correctly Identifying Any Item with 5 Year Payback	Mean Number of Correctly Identified Items with 5 Year Payback	Mean Proportion of Correctly Identified Items Out of All Items with 5 Year Payback	Proportion Correctly Identifying Any Item with 5 Year Payback	Mean Number of Correctly Identified Items with 5 Year Payback	Mean Proportion of Correctly Identified Items Out of All Items with 5 Year Payback
<u>Demographic Characteristics</u>						
Income Less Than \$15,000	21%	.21	.10	23%	.30	.10
Greater Than \$15,000	32%	.34	.19	26%	.36	.17
Education: Up to 8 years	18%	.18	.07*	23%	.33	.13
Some high school or more	31%	.33	.24	27%	.35	.15
Elderly Only in Household ^a	14%	.14	.07*	17%	.41	.14
Some Non-Elderly	32%	.32	.19	26%	.32	.15
<u>Conservation Characteristics</u>						
Active in Major Improvements ^b	18%	.20*	.10**	9%	.22	.09
Less Active	41%	.41	.24	33%	.39	.16
Well Weatherized Unit ^c	16%	.18**	.08**	25%	.39	.16
Poorly Weatherized	77%	.47	.29	27%	.27	.11

* Significantly different at .1 level.

** Significantly different at .05 level.

a - "Elderly only" households have one or more adults over age 60 and no other persons.

b - Scale is based on number of major efficiency improvements made since moving into unit (includes attic and wall insulation, storm windows and doors).

c - Scale based on presence of four major efficiency improvements (as in 'b' above) as identified by respondent.

conservation knowledge. Formal education of the household member shows a expected relationship with better educated having higher scores on each measure in both sites (only one relationship is significant at .1 or better, however). Elderly households are markedly less likely to score high in D.C. (one significant relationship) but this pattern is not true in Denver.

The relationship of conservation knowledge to two key conservation characteristics of households shows several non-obvious and significant results. Households who have been most active in the past in installing major features have lower scores on all conservation knowledge measures. Even if these households live in units with better thermal status (as captured in measure three), the active households typically identify a lower proportion of the (fewer) remaining attractive items.

A similar pattern exists for households differentiated by the weatherization status of their units in D.C. D.C. households in poorly weatherized units, in fact, are significantly more likely to correctly identify potential sources of savings. In Denver, households in well-weatherized units do not significantly indicate greater conservation knowledge.

In interpreting these findings, we can suggest two possible factors. Those who have been active or who live in units with major conservation features in place are "guessing" at what needs to be done. They may fail to identify improvement to existing thermal features and may "misspecify" other items which do not offer returns as attractive as improvement to existing features. Alternatively, these households still interested in further conservation may be willing to accept (presumably)

lower paybacks (not attractive by 10 year criteria) as they "fine tune" the efficiency of their units.¹³

These findings offer two extended implication. In section II, we found that education was among the few factors related to audit interest. In this section we find that based on several rather exacting tests of conservation knowledge, the better educated or more knowledgedable. This supports contention that audits may be requested by those less likely to benefit from them.

The second implication, however, is that audits might still be directed to active households and those well weatherized. Audits could contribute to more rational decisions on further investments by these households. They might in fact deter some investment. Thus, they could contribute to overall "efficiency" in the purchase of energy services but dampen reductions in energy consumption. These issues pertaining to the effect of the audit in conservation improvements will be addressed in the subsequent report.

13. This would be consistent with results of section III where we find that detailed payback calculations are not a dominant feature of conservation decision making.

Appendix

**Material Related to Energy Audits Conducted
by Three Utility Companies For This Study**

This Appendix provides supplemental information on the energy audits which were used in this study. The audits were conducted by utility companies at our request under the RCS format. Included in the latter half of the appendix are samples of the results forms showing the cost, annual savings, payback calculations and related information for conservation items which was provided in written form to audited households.¹

The three utilities involved (two in D.C. and one in Denver) each used its own model for calculating the proposed energy savings. Essential information provided to the household was similar for each utility in most respects, with the exception of the number of items evaluated.² Presentational format differed, however, as is evident in the sample results forms provided.

The most important difference in presentation was between D.C. utility #2 and the other two companies. Utility #2 sent audit results to the home in booklet form two to three weeks after the audit was conducted. The other two utilities used a telephonic time-sharing computer hook-up by which audit input data was transmitted to a central computer facility. Within five to fifteen minutes, the data on potential payback for installation of conservation items was available. Consequently, the audit recommendations could be discussed with the household member by the auditor and the results left at the

1. For discussion of the procedures by which audit was conducted, see text of this paper and sections of background paper The Residential Conservation Gap Study: Purpose, Research Design and Data Description, Paper #3030-01, October 1981.

2. The Denver audit provides extensive evaluation of several solar options which were not covered in the D.C. audits conducted for the study.

site upon completion of the visit. It is not known whether these different approaches might affect the subsequent effectiveness of the audit in stimulating conservation investment.

Because the audit results are important to several aspects of this study, we attempted to assess whether there was any basic incompatibility between audit results from the three utilities. Site differences between Denver and D.C., of course, were to be expected because of housing construction practices and the typical conservation status of the housing stock which varies by region and climate. Unfortunately, we are not able to perform extensive multi-variate analysis which would permit comparison among utilities of houses similar on all factors relevant to the audit. However, several simple comparisons do support our confidence in audit comparability.

Information in Table A-1 provides two summary comparisons of audit results for six items evaluated by all three utilities. The first comparison is in terms of the proportion of audited units with non-zero savings on each conservation item; the second comparison is of average savings for all units that had some savings potential identified (this is done without respect to conservation costs or payback).

Columns 1 and 7 show the first measure for both DC utilities combined and the Denver utility. Caulking/weatherstripping savings are evident for 90% percent of households in both sites. Savings for attic insulation, wall insulation and floor insulation is evident in a majority of households in both D.C. and Denver.

The proportion of households with floor insulation, storm doors and water-heater insulation savings is quite a bit lower in Denver than in

TABLE A-1
COMPARISON OF EVALUATION OF MAJOR FEATURES
AMONG THREE UTILITIES PROVIDING AUDITS^a

Conservation Items Evaluated By All Utilities	D.C. Utilities						Denver	
	Combined D.C.		Utility #1	Utility #2			% With Non-zero Savings	Average Annual Savings
	% With Non-zero Savings	Average Annual Savings	Average Annual Savings	Average Annual Savings	Gas-Heated Homes Savings	Oil-Heated Homes Savings		
Caulking/ Weatherstripping ^b	90%	\$26	\$22	\$29	\$25	\$39	91%	\$37
Attic Insulation	75%	\$145	\$89	\$175	\$147	\$226	81%	\$53
Wall Insulation	55%	\$165	\$107	\$204	\$163	\$258	77%	\$83
Floor Insulation	59%	\$41	\$19	\$32	\$46	\$64	39%	\$30
Storm Windows	78%	\$69	\$59	\$75	\$68	\$96	65%	\$39
Storm Doors	49%	\$15	\$10	\$18	\$18	\$21	17%	\$2
Water Heater Wrap	90%	\$16	\$17	\$14	\$14	\$14	42%	\$5

a - Three different utility companies provided audits for the study. Utility #1 in D.C. and the Denver utility did audit only for gas-heated homes for which utility records provided consumption data. D.C. utility #2 audits were divided roughly between two-thirds gas-heated homes and one-third oil heated homes. Actual consumption data was available for about half of each group for this utility. An estimated consumption figure was provided for the other half of homes audited by the utility. All dollar figures are the utility's estimated annual savings which would result from installing or adding to the measure whether or not it offered a high pay back. Averages as presented are means over all households for which non-zero savings were identified.

b -Caulking and weatherstripping were evaluated separately by D.C. utility #1 and the Denver utility. D.C. utility #2 provided only a combined estimate of caulking and weatherstripping savings. For comparability across all three utilities, we summed the savings for both items when it originally appeared separately.

D.C. The first two items probably reflect real differences in housing characteristics (all D.C. households have basements, many Denver homes are on slabs. The (90% versus 42%) difference in proportions of water heater savings may reflect differences in the audit assumptions about water heater insulation and the feasibility of insulating water heaters located in heated space. (Utilities tend to estimate savings from water-heater insulation as a flat dollar amount which does not reflect household usage--probably because water heater insulation is both a low-cost and a source of low savings.

In the comparison, more striking differences between sites are found in the average annual savings estimates (shown only on the bases of units with non-zero savings--columns 2 and 8). The D.C. audits estimate substantially larger savings for attic insulation; for example savings average \$145 in D.C. (column 2) compared to only \$53 in Denver (column 8).

These differences may reflect average differences in existing levels of insulation as well as fuel price, climate, and consumption patterns. Attic insulation is more common in Denver. (In our baseline survey, 77 percent of households report some attic insulation versus 56 percent in D.C.). Average fuel/electricity prices are also lower in Denver. Winters are colder and summers less hot. Since attic insulation savings also came from reduced summer cooling costs in the audit models, (if air conditioning is used) climate could have a large effect on savings potential.

Other factors may be important in addition to these site differences, however. We have noted that one of the D.C. utilities (#2)

has markedly higher savings estimates (compare columns 3 and 4.) While differences in audit procedures between the two D.C. utilities might be responsible, a large portion of that difference can be explained by the fuel type of the households audited. D.C. utility #1 audited only gas heated homes (as did the Denver utility) while about 40% of the audits of D.C. utility #2 were in oil-heated homes. The average savings estimates are much more comparable among the gas heated homes (compare columns 3 and 5) although still somewhat higher by utility #2. The higher costs of heating with fuel oil coupled with the likelihood that oil-heated homes are larger, older and more poorly insulated in D.C. (many restoration and repairs to older homes in this area in D.C. include conversion to gas heat) are possible causes of the larger average savings for these homes which were estimated by utility #2.

That remaining differences in average savings might reflect differences in the utility models cannot be ruled out for certain. However, based on this comparison of typical savings variation by type of heating, and other possible differences in the characteristics of these homes and climate differences, we believe the evidence is in favor of at least rough comparability of the evaluation outputs produced by the three utilities' audit models.

Sample

Audit Results Forms

from

D.C. Utility #1

These forms were filled-in by the auditor and left with the household member. Results were explained by the auditor and questions about the recommendations were answered at the completion of the audit.

Residential
Energy
Conservation
Analysis

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RESULTS

Prepared for _____ Phone _____ CUSTOMER ACCOUNT NO. _____
Address _____ City _____ Zip _____

ENERGY CONSERVATION PRACTICES

(✓) Item is checked if applicable to your home. It is recommended that these practices be implemented before installation of any conservation or renewable resource measures.

☐ 1) Clean and perform combustion efficiency adjustment on your gas or oil furnace regularly, at least once per heating season.	☐ 10) Lower the thermostat setting to 55°F when your home is empty for four hours or longer in the heating season.
☐ 2) Replace the air filters on your central heating system regularly.	☐ 11) Turn off the air conditioner in the cooling season when no one is at home.
☐ 3) Lower the bonnet or plenum thermostat temperature to 80°F on your gas or oil forced air furnace.	☐ 12) Turn the water heater off when your home is vacant for two days or longer.
☐ 4) Turn the pilot light off on your gas furnace during the summer months.	☐ 13) Install scrap insulation or other pliable fireproof material in gaps around pipes, ducts, fans, or other items which enter your attic or basement from a heated space.
☐ 5) Lower the thermostat control setting for the furnace in the heating season to a maximum of 55°F during sleeping hours.	☐ 14) Install fireproof material to plug any holes around any damper in your fireplace.
☐ 6) Limit the thermostat control setting for the furnace in the heating season to a maximum of 68°F during waking hours.	☐ 15) Add insulation to your attic or basement door.
☐ 7) Limit the thermostat control setting for the air conditioner in the cooling season to a minimum of 78°F.	☐ 16) Seal leaks in your heating or cooling ducts.
☐ 8) Restrict the flow of water in your shower heads or faucets to a maximum of three gallons per minute using either flow restrictors or replacing existing shower heads and faucets with those having built-in provisions for water flow reduction.	☐ 17) Tighten or plug leaking joints in your hot water or steam pipes.
☐ 9) Reduce the water heater thermostat setting to 120°F and reduce use of heated water for clothes washing. (Caution—some dishwashers require 140°F water.)	☐ 18) Replace the washers in your leaking water faucets.
	☐ 19) Use your shades and drapes to:
1) block the sunlight from entering your home in the cooling season
2) allow the sunlight to enter your home during the heating season, and
3) cover your windows tightly at night during the heating season.

The Energy Conservation Practices as checked above have been explained to me.

ENERCOM®

Enercom® - A service
of Washington Gas Light Co.

Customer
Signature _____

Energy
Analyst _____ Date _____

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Tempe, AZ

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Residential Energy Conservation Analysis

RESULTS

Prepared for _____ Phone _____
Address _____ City _____ Zip _____

CUSTOMER ACCOUNT NO. _____

ENERGY CONSERVATION MEASURES

DESCRIPTION OF MEASURES	ESTIMATED FIRST YEAR ENERGY SAVINGS	ESTIMATED COST AND PAYBACK PERIOD			
		Estimated Cost	Payback	Estimated Cost	Payback
		c	Years d	c	Years d
1) Ceiling Insulation f	\$	\$		\$	
2) Wall Insulation g	\$	\$		\$	
3) Floor Insulation h	\$	\$		\$	
4) Storm/Insulated Windows	\$	\$		\$	
5) Storm/Insulated Doors	\$	\$		\$	
6) Shading Sun Exposed Glass	\$	\$		\$	
7) Caulking Doors/Windows	\$	\$		\$	
8) Weatherstripping Doors and Windows	\$	\$		\$	
9) Water Heater Insulation Wrap	\$	\$		\$	
10) Clock Thermostat	\$	\$		\$	
11) Duct Insulation	\$	\$		\$	
12) Pipe Insulation	\$	\$		\$	
13) Flue Opening Modification	\$	\$		\$	
14) Electric or Mechanical Ignition Systems	\$	\$		\$	
15) Replacement Oil Burner ☐ Replacement Furnace ☐	\$	\$		\$	
16) Replacement Air Conditioner j	\$	\$		\$	

See reverse side for notes a through k.

TAX CREDIT CALCULATION

The federal government provides tax incentives to encourage the installation of energy conservation products. A tax credit applies to the cost of items installed after April 19, 1977 and before January 1, 1986. Details can be found in IRS publication 903, or by calling your local IRS office.

If a state credit is shown in the sample calculation, you may determine more specific information by contacting your local tax office.

The sample calculation provided here applies to item(s) _____ of the analysis.

Cost of System	\$ _____
Federal Tax Credit	\$ _____
State Tax Credit	\$ _____
Cost of System with tax credit deducted	\$ _____

The results of this Residential Energy Conservation Analysis and the notes on the back of this form have been explained to me and I have been offered assistance in arranging installation and financing of the Energy Conservation Measures.

ENERCOM®
Customer
Signature _____
Enercom® - A service
of Washington Gas Light Co.

Energy
Analyst _____

Date _____

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Tempe, AZ

Sample

Audit Results Forms

from

D.C. Utility #2

The following are selected pages from the report, summarizing audit recommendations for the dwelling unit. The report was sent to the household one to three weeks after the utility's on-site inspection. Low-cost tips checked in the booklet were discussed at the time of the audit. One distinctive feature of this audit report is inclusion of a recommended list of insulation contractors and of local financial institutions which make loans for conservation improvements.

PROFESSIONAL HOME ENERGY AUDIT
SECTION II-A
INSULATION RECOMMENDATIONS

A COMPARISON WAS MADE BETWEEN THE EXISTING INSULATING QUALITIES OF YOUR HOME AND THOSE RECOMMENDED. THE FOLLOWING HOME IMPROVEMENTS ARE SUGGESTED TO MAKE YOUR HOME MORE ENERGY EFFICIENT AND TO INCREASE ITS LEVEL OF COMFORT.

SURFACE	AREA SQ. FT.	PRESENT R VALUE	RECOMMENDATIONS
DOORS			THE DOORS WITHOUT A STORM DOOR, EXCEPT FOR SLIDING GLASS DOORS, SHOULD BE PROTECTED WITH A STORM DOOR.
WINDOWS			THE SINGLE GLASS WINDOWS SHOULD BE PROVIDED WITH STORM WINDOWS
WALLS	1480.	0.0	THE THERMAL INSULATION IN THE WOOD FRAME WALLS SHOULD BE INCREASED TO AN R VALUE OF 11.0
CEILINGS	135.	0.0	THE THERMAL INSULATION IN THE CEILING BELOW THE VENTILATED ATTIC SHOULD BE INCREASED TO AN R VALUE OF 30.0
	663.	7.0	THE THERMAL INSULATION IN THE CEILING BELOW THE VENTILATED ATTIC SHOULD BE INCREASED TO AN R VALUE OF 30.0
WEATHERSTRIPPING AND CAULKING			THE OVERALL CONDITION OF THE CAULKING AND WEATHERSTRIPPING AROUND DOORS AND WINDOWS SHOULD BE UPGRADED TO ACHIEVE COST SAVINGS AND COMFORT.
WATER HEATER STORAGE TANK INSULATION			ADDITIONAL BLANKET INSULATION SHOULD BE ADDED TO YOUR GAS WATER HEATER STORAGE TANK. IT IS AVAILABLE IN KIT FORM FROM LOCAL DEALERS AND HARDWARE STORES.

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PROFESSIONAL HOME ENERGY AUDIT
SECTION II-B
INSULATION RECOMMENDATIONS

IN ADDITION TO THE RECOMMENDATIONS MADE IN SECTION II-A, THE REMAINING AREAS OF YOUR HOME WERE EVALUATED WITH RESPECT TO PEPCO STANDARDS.

THE FOLLOWING STRUCTURAL AREAS MEET OUR RECOMMENDED THERMAL INSULATION STANDARDS.

FLOORS OVER CRAWL SPACE

THE FOLLOWING STRUCTURAL AREAS WERE CHECKED AND DID NOT MEET OUR RECOMMENDED THERMAL INSULATION STANDARDS. A SPECIFIC IMPROVEMENT RECOMMENDATION WAS NOT MADE BECAUSE OF THE DEGREE OF DIFFICULTY AND/OR EXPENSE USUALLY ENCOUNTERED IN MAKING THE IMPROVEMENT.

WALLS MASONRY, FURRED
CEILINGS FLAT ROOF

PROFESSIONAL HOME ENERGY AUDIT
SECTION IV
INSULATION IMPROVEMENT VALUE

THE RECOMMENDATIONS ARE RANKED BELOW IN THE ORDER IN WHICH THEY SHOULD BE PERFORMED. FOR EACH ITEM, WE ESTIMATED THE FIRST-YEAR HEATING AND COOLING SAVINGS AND THE COST TO BUY AND INSTALL. THEN WE ESTIMATED THE NUMBER OF YEARS NEEDED TO PAY BACK THE COST OF THE IMPROVEMENT. KEEP IN MIND THAT YOUR ENERGY COSTS WILL VARY DEPENDING ON THE WEATHER, ENERGY PRICES, AND THE WAY YOU USE YOUR SYSTEMS, SO THE DOLLARS AND THE YEARS SHOWN MAY NOT BE EXACTLY WHAT YOU WILL EXPERIENCE. BUT BECAUSE THE CALCULATIONS WERE MADE THE SAME WAY FOR EACH ITEM, THE RANKING SHOULD STAY THE SAME.

IMPROVEMENT RANK	SURFACE	ESTIMATED ANNUAL OPERATING COST SAVINGS			ESTIMATED INSTALLED COST	IMPROVEMENT, YEARS PAYBACK
		HEATING	COOLING	TOTAL		
1	CEILINGS	\$ 155.	\$ 66.	\$ 221.	\$ 482.	2.2
2	WATER HEATER	\$ 14.	\$ 0.	\$ 14.	\$ 40.	2.9
3	WALLS	\$ 319.	\$ 73.	\$ 392.	\$1347.	3.4
4	WINDOWS	\$ 72.	\$ 14.	\$ 86.	\$1119.	13.0
5	DOORS	\$ 8.	\$ 2.	\$ 10.	\$ 180.	18.0

HEATING AND COOLING COSTS VARY WITH THE WEATHER, FUEL RATES AND THE WAY THE SYSTEMS ARE USED. THE ESTIMATED ANNUAL SAVINGS SHOWN ABOVE ARE BASED ON CALCULATIONS WHICH PROJECT THE ANNUAL HEATING COST TO BE ABOUT \$1640 AND THE ANNUAL COOLING COSTS TO BE ABOUT \$ 484.

IF THE AVERAGE COSTS ACTUALLY EXPERIENCED DIFFER FROM THESE PROJECTIONS, THE ESTIMATED ANNUAL SAVINGS SHOWN FOR IMPROVING THE THERMAL INSULATION OF YOUR HOME MAY BE ADJUSTED PROPORTIONALLY.

THE INSTALLED COST OF EACH IMPROVEMENT HAS BEEN ESTIMATED BASED ON AVERAGE LABOR RATES AND MATERIAL PRICES FOR A GOOD QUALITY PRODUCT. THE ACTUAL COST MAY VARY SIGNIFICANTLY FROM THE ESTIMATE DEPENDING ON WHO PERFORMS THE WORK, WHAT MATERIAL IS USED AND HOW DIFFICULT THE JOB MAY BE. THE COST OF SOME JOBS MAY BE SIGNIFICANTLY REDUCED IF YOU PERFORM THE WORK YOURSELF.

THE ESTIMATED SAVINGS FROM INSULATION FOR HEATING AND COOLING COSTS HAVE BEEN CALCULATED BY ASSUMING THAT CAULKING AND WEATHERSTRIPPING AROUND DOORS AND WINDOWS WILL BE IMPROVED AS RECOMMENDED IN SECTION II. IF THE WEATHERSTRIPPING AND CAULKING ARE IMPROVED AND THE RECOMMENDED INSULATION IMPROVEMENTS ARE MADE AN ADDITIONAL SAVINGS OF \$ 61.00 IN HEATING AND COOLING COSTS COULD BE OBTAINED.

PROFESSIONAL HOME ENERGY AUDIT
SECTION V
CHECKLIST

THE FOLLOWING STEPS SHOULD ALSO BE CONSIDERED TO REDUCE YOUR HOME'S ENERGY REQUIREMENTS. THEY WILL ALSO MAKE IT A MORE COMFORTABLE PLACE TO LIVE.

1. AWNINGS INSTALLED ON WINDOWS AND DOORS FACING THE SUN REDUCE THE AMOUNT OF UNWANTED HEAT ENTERING YOUR HOUSE DURING THE COOLING SEASON. —
2. IMPROVE COMFORT AND LOWER AIR CONDITIONING COSTS BY INSTALLING SPECIAL HEAT REFLECTIVE MATERIAL ON SOUTH FACING WINDOWS AND GLASS DOORS. THIS SPECIAL MATERIAL IS TYPICALLY A PLASTIC/METALLIC FILM INSTALLED ON THE INSIDE OF THE WINDOW.
IT COSTS ABOUT \$1.50 PER SQUARE FOOT TO BUY. —
3. A KITCHEN EXHAUST FAN SHOULD IDEALLY BE LOCATED DIRECTLY OVER THE RANGE AND VENTED TO THE OUTDOORS. IT CAN IMPROVE COMFORT IN SUMMER BY REMOVING UNWANTED HEAT AND MOISTURE BUT SHOULD BE USED SPARINGLY IN WINTER. —
4. AN EXHAUST FAN IN THE BATHROOM VENTED TO THE OUTDOORS CAN IMPROVE COMFORT BY REMOVING UNWANTED HEAT AND MOISTURE IN SUMMER. THE BEST LOCATION FOR THE FAN IS IN THE CEILING BUT NOT DIRECTLY OVER THE TUB OR SHOWER. USE IT SPARINGLY IN THE WINTER. —
5. PROPER ATTIC VENTILATION IS IMPORTANT IN REDUCING THE POSSIBILITY OF UNWANTED MOISTURE BUILD-UP IN THE ATTIC DURING WINTER MONTHS. PROPER ATTIC VENTILATION WILL ALSO KEEP THE HOUSE COOLER IN SUMMER BY REDUCING THE AMOUNT OF HEAT BUILD-UP IN THE ATTIC. —
6. YOUR ATTIC SHOULD HAVE TWO SQUARE FEET OF FREE VENT AREA FOR EACH 300 SQUARE FEET OF ATTIC FLOOR. THE VENTS SHOULD BE LOCATED AT OPPOSITE ENDS OF THE ATTIC. (FREE VENT AREA IS AREA UNOBSTRUCTED BY LOUVERS AND/OR SCREENING. IF A VENT COVERING IS USED, THE AREA OF THE OPENING MUST BE INCREASED AS DESCRIBED IN OUR "DO-IT-YOURSELF INSULATION GUIDE.") —
7. A POWER VENT FAN INSTALLED IN YOUR ATTIC ROOF OR GABLES CAN REDUCE THE HEAT GAIN OF YOUR HOME IN THE SUMMER. THIS WILL REDUCE THE AMOUNT OF HEAT THAT YOUR AIR CONDITIONER HAS TO REMOVE TO COOL YOUR HOME TO THE DESIRED TEMPERATURE. IT MAY ALSO ELIMINATE THE NEED FOR USING YOUR AIR CONDITIONING SYSTEM IN ALL BUT THE HOTTEST DAYS IN THE SUMMER. IT WILL NOT, HOWEVER, REMOVE UNWANTED MOISTURE FROM YOUR HOME IN THE SUMMER. —

A POWER VENT FAN IS USUALLY CONTROLLED BY A THERMOSTAT AND CANNOT BE USED TO REMOVE MOISTURE FROM YOUR ATTIC IN THE WINTER.

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PROFESSIONAL HOME ENERGY AUDIT
SECTION V
CHECKLIST

LOW COST/NO COST WAYS TO SAVE ENERGY

THE AMOUNT OF ENERGY USED IN YOUR HOME IS LARGELY DETERMINED BY THE WAY YOU USE ENERGY CONSUMING EQUIPMENT AND BY YOUR HABITS. THE FOLLOWING ENERGY SAVINGS TIPS GENERALLY COST LITTLE OR NOTHING AND CAN HELP YOU REDUCE ENERGY CONSUMPTION.

HEATING SEASON

9. THE RECOMMENDED WINTER HEATING THERMOSTAT SETTING IS 68 DEGREES DURING PERIODS WHEN THE HOME IS OCCUPIED. EVERY DEGREE OVER 68 DEGREES INCREASES THE HEATING ENERGY REQUIRED BY ABOUT 3 PERCENT. _____
10. IN ORDER TO MAINTAIN THIS SETTING OF 68 DEGREES IN ALL HEATED AREAS OF THE HOUSE, THE DUCT OR AIR DISTRIBUTION PROBLEM THAT EXISTS SHOULD BE CORRECTED BY A HEATING AND AIR CONDITIONING CONTRACTOR. _____
11. IF YOU PLAN TO BE AWAY FROM HOME FOR A FEW DAYS OR LONGER, THE TEMPERATURE SETTING SHOULD BE REDUCED TO 55 DEGREES. TO PREVENT WATER PIPES FROM FREEZING AND BURSTING, IT SHOULD NOT BE TURNED OFF ENTIRELY. _____

COOLING SEASON

12. SET AIR CONDITIONING THERMOSTATS NO LOWER THAN 78 DEGREES. EVERY DEGREE UNDER 78 DEGREES USES ABOUT 5 PERCENT MORE ENERGY. _____
13. IN ORDER TO MAINTAIN THE RECOMMENDED THERMOSTAT SETTING OF 78 DEGREES IN ALL AREAS OF THE HOME, THE DUCT OR AIR DISTRIBUTION PROBLEM SHOULD BE RESOLVED BY A HEATING AND AIR CONDITIONING CONTRACTOR. _____
14. TURN OFF OR SET UP THE THERMOSTAT ON WINDOW AIR CONDITIONERS IN ROOMS THAT WILL BE UNOCCUPIED FOR SEVERAL HOURS. CLOSE THE DOORS TO ROOMS LEFT UNOCCUPIED. _____
15. WHEN STARTING THE AIR CONDITIONER, DO NOT SET THE THERMOSTAT LOWER THAN 78 DEGREES IN AN EFFORT TO COOL YOUR HOUSE FASTER. SUCH A PRACTICE IS INEFFECTIVE AND WILL WASTE ENERGY IF OVERCOOLING OCCURS. _____
16. CLOSE DRAPES BLINDS AND CURTAINS ON WINDOWS FACING THE SUN TO REDUCE THE AMOUNT OF UNWANTED HEAT ENTERING YOUR HOUSE DURING THE COOLING SEASON. _____

PROFESSIONAL HOME ENERGY AUDIT
SECTION VII
LOAD AND OPERATING COST SUMMARY

THE STRUCTURAL CHARACTERISTICS OF THE HOME HAVE BEEN USED TO CALCULATE HEAT LOSS AND HEAT GAIN DATA AS WELL AS ANNUAL ENERGY REQUIREMENTS AND THE CORRESPONDING OPERATING COSTS. THE PRIMARY USE OF THIS REPORT IS TO PROVIDE THE HOMEOWNER WITH ADDITIONAL INFORMATION WITH RESPECT TO THE WAY ENERGY IS BEING USED FOR SPACE HEATING AND COOLING.

HEAT LOSS AND HEAT GAIN:

SURFACE/USAGE	WINTER		SUMMER	
	ESTIMATED HEAT LOSS BTUH	PERCENT	ESTIMATED HEAT GAIN BTUH	PERCENT
DOORS	1700.	1.5	570.	0.9
WINDOWS	18350.	16.3	17790.	27.9
WALLS	41780.	37.0	12420.	19.5
CEILINGS	15000.	13.3	9430.	14.8
FLOORS	2340.	2.1	60.	0.1
INFILTRATION	33630.	29.8	5550.	8.7
APPLIANCES	0.	0.0	3200.	5.0
DEHUMIDIFICATION	0.	0.0	14710.	23.1
TOTAL	112800.		63730.	

THE HEAT LOSS AND GAIN SHOWN AS INFILTRATION IS THE ENERGY REQUIRED TO HEAT AND COOL THE OUTSIDE AIR THAT LEAKS INTO YOUR HOME. THE APPLIANCE HEAT GAIN IS FOR THE OCCUPANTS AND HEAT PRODUCING EQUIPMENT IN THE HOME. THE DEHUMIDIFICATION HEAT GAIN IS FOR REMOVING WATER VAPOR FROM THE HOME IN SUMMER.

HEATING AND COOLING ENERGY AND COSTS:

	ELECTRICITY	FUEL
SPACE HEATING		
ANNUAL ENERGY	749. KWHRS	3846. THERMS
ANNUAL COSTS	\$ 41.	\$1600.
AIR CONDITIONING		
ANNUAL ENERGY	6539. KWHRS	0. THERMS
ANNUAL COSTS	\$ 484.	\$ 0.

THE ELECTRIC USAGE SHOWN FOR SPACE HEATING IS FOR THE ELECTRIC PUMPS OR FANS REQUIRED FOR THE FUEL FIRED SYSTEM TO OPERATE.

PROFESSIONAL HOME ENERGY AUDIT
SECTION VI-A
RECOMMENDED CONTRACTORS

COST ESTIMATES FOR INSULATION, STORM DOORS AND STORM WINDOWS INCLUDE MATERIAL AS WELL AS LABOR FOR INSTALLATION. A SUGGESTED PROCEDURE FOR SELECTING AN INSULATION CONTRACTOR IS OUTLINED IN OUR BROCHURE "THE ENERGY-WISE HOME". CALL US AT 32-5554 TO OBTAIN A COPY OF THIS BOOKLET. YOU SHOULD NOTE THAT DUE TO RECENT DEMANDS FOR INSULATING MATERIAL AND SERVICES, THERE MAY BE A DELAY IN ESTIMATING AND/OR PERFORMING REQUESTED WORK BY THE CONTRACTOR.

IF YOU DECIDE TO USE A CONTRACTOR TO PERFORM THE INSULATION WORK, YOU SHOULD CONSIDER THOSE WHO HAVE AGREED TO FOLLOW OUR STANDARDS FOR INSULATION AND VENTILATION. THEY ARE LISTED BELOW. IF YOU SELECT ONE OF THESE RECOMMENDED CONTRACTORS, WE ENCOURAGE YOU TO CONTACT ~~THE CONTRACTOR~~ AFTER YOU HAVE SETTLED ON A DATE FOR THE WORK TO BE PERFORMED. THIS WILL ASSIST PEPCO IN MONITORING THE WORK OF RECOMMENDED CONTRACTORS AND WILL HELP TO ASSURE YOU OF A QUALITY INSULATION JOB.

A. C. & R. INSULATION CO., INC.
10310 SOUTHWARD DRIVE
BELTSVILLE, MD. 20705
937-4710

B & B INSULATION COMPANY
12324 WILKINS AVENUE
ROCKVILLE, MARYLAND 20852
881-2700

DAVENPORT INSULATION COMPANY
8420 TERMINAL ROAD
SPRINGFIELD, VA. 22150
550-9600
(AREA CODE 703)

HODGES HOME INSULATING
6856 LEE HIGHWAY
ARLINGTON, VA. 22213
532-0184

INSULATORS OF MARYLAND, INC.
5951 HALPINE ROAD
ROCKVILLE, MARYLAND 20795
933-5566
(AREA CODE 301)

PROFESSIONAL HOME ENERGY AUDIT
SECTION VI-B
LENDING INSTITUTIONS

IF YOU WOULD LIKE TO CONSIDER A LOAN TO MAKE RECOMMENDED IMPROVEMENTS TO YOUR HOME, WE SUGGEST THAT YOU CONSULT YOUR OWN BANK REGARDING THE AVAILABILITY OF FINANCING. IN THE EVENT THAT YOUR BANK DOES NOT OFFER SUCH TYPES OF LOANS, WE ARE FURNISHING A PARTIAL LISTING OF MAJOR FINANCIAL INSTITUTIONS WHO HAVE INDICATED THEIR WILLINGNESS TO ACCEPT APPLICATIONS TO FINANCE HOME IMPROVEMENTS WHICH CONSERVE ENERGY.

AMERICAN SECURITY BANK
1501 15TH AND PENN. AVE. N.W.
WASHINGTON, D.C. 20005
624-4000

UNITED NAT'L. BK. OF WASH.
1850 K STREET, N.W.
WASHINGTON, D.C. 20006
828-4333

MADISON NATIONAL BANK
1730 M ST. N.W.
WASHINGTON, D.C. 20036
452-5500

NATIONAL SAVINGS AND TRUST
15TH AND NEW YORK AVE. N.W.
WASHINGTON, D.C. 20005
659-5900

FIRST AMERICAN NATIONAL BANK OF
740 15TH ST. N.W.
WASHINGTON, D.C. 20005
637-6100

SUBURBAN TRUST CO.
6495 NEW HAMPSHIRE AVE.
HYATTSVILLE, MD. 20783
270-7960

INDUSTRIAL NATIONAL BANK
4812 GEORGIA AVE. N.W.
WASHINGTON, D.C. 20011
722-2000

MCLACHLEN NATIONAL BANK
11TH AND G ST. N.W.
WASHINGTON, D.C. 20005
626-0100

NATIONAL BANK OF WASHINGTON
619 14TH ST. N.W.
WASHINGTON, D.C. 20005
537-2000

RIGGS NATIONAL BANK
1503 PENN. AVE. N.W.
WASHINGTON, D.C. 20005
624-2000

CITIZENS BANK AND TRUST OF MD.
6200 BALTIMORE BLVD.
RIVERDALE, MD. 20840
699-7235

FIRST NATIONAL BANK OF MARYLAND
1 BANK STREET
GAITHERSBURG, MD. 20760
926-0700

Sample

Audit Results Summary

from

Denver Utility Company

These computer printed results were left with the household member at completion of the audit. Savings and payback data on the second page are keyed to page numbers in an accompanying printed booklet also provided at the time of the audit. The booklet pictured, described and explained the use of the conservation item and a simplified method of self-installation if appropriate.

ELECTRIC ENERGY USE SUMMARY

COMPONENT	ESTIMATED ANNUAL KWH	PERCENT OF TOTAL
MAJOR APPLIANCES		
OVEN	250.	3.11
RANGE TOP	78.	.97
WATER HEATING	0.	0.00
CLOTHES DRYER	0.	0.00
MICROWAVE	0.	0.00
REFRIGERATOR	2977.	37.03
FREEZER	1181.	14.69
CLOTHES WASHER	104.	1.29
DISHWASHER	0.	0.00
TELEVISION	81.	1.00
WATER WELL PUMP	0.	0.00
MISCELLANEOUS ELECTRIC	257.	3.19
MISCELLANEOUS APPLIANCES		
SAUNA	0.	0.00
HOT TUB / POOL HEATER	0.	0.00
KILN	0.	0.00
SPACE HEATER	0.	0.00
WATER BED HEATER	0.	0.00
MAJOR USES		
LIGHTING	796.	9.90
ELECTRIC SPACE HEATING	0.	0.00
ELECTRIC COOLING	2316.	28.81
TOTAL KWH	8040.	100.00

GAS ENERGY USE SUMMARY

COMPONENT	ESTIMATED ANNUAL CCF	PERCENT OF TOTAL
MAJOR APPLIANCES		
OVEN	0.	0.00
RANGE TOP	0.	0.00
WATER HEATING	227.	14.98
CLOTHES DRYER	10.	.67
MISCELLANEOUS APPLIANCES		
SAUNA	0.	0.00
HOT TUB / POOL HEATER	0.	0.00
KILN	0.	0.00
SPACE HEATER	0.	0.00

MAJOR USES

SUMMER PILOT LIGHT USE	24.	1.57
SPACE HEATING	1254.	82.78
SPACE COOLING	0.	0.00
<hr/>		
TOTAL CCF	1515.	100.00

RECAP FOR:

SUGGESTED MEASURES	PAGE -NO-	ANNUAL SAVINGS \$	HOMEOWNER COSTS			CONTRACTOR COSTS		
			LOW \$	HIGH \$	PAYBACK YEARS	LOW \$	HIGH \$	PAYBACK YEARS
CAULKING	- 5-	0	0	0	0	0	0	0
WEATHERSTRIPPING	- 5-	0	0	0	0	0	0	0
CEILING INSULATION	- 6-	0	0	0	0	0	0	0
WALL INSULATION	- 6-	158	0	0	0	1051	2102	7
FLOOR INSULATION	- 6-	0	0	0	0	0	0	0
WATER HEATER INSUL.	- 6-	10	5	35	2	10	50	3
DUCT/PIPE INSULATION	- 7-	0	0	0	0	0	0	0
REPLACE HTG. SYSTEM	- 7-	0	0	0	0	0	0	0
REPLACE OIL BURNER	- 7-	0	0	0	0	0	0	0
FURNACE VENT DAMPER	- 7-	0	0	0	0	0	0	0
NEW IGNITION SYSTEM	- 7-	17	0	0	0	100	400	9
REPLACE CENTRAL A/C	- 7-	0	0	0	0	0	0	0
CLOCK THERMOSTAT	- 7-	35	35	120	2	50	150	3

SUGGESTED MEASURES	PAGE -NO-	ANNUAL SAVINGS \$	HOMEOWNER COSTS			CONTRACTOR COSTS		
			LOW \$	HIGH \$	PAYBACK YEARS	LOW \$	HIGH \$	PAYBACK YEARS
STORM WINDOWS	- 8-	0	0	0	0	0	0	0
STORM DOORS	- 8-	0	0	0	0	0	0	0
HEAT REFLECT. GLASS	-10-	70	311	1247	8	389	1481	9
HEAT ABSORBING GLASS	-10-	70	584	1169	9	974	1949	12
LOAD MANAGEMENT SYS.	-11-	0	0	0	0	0	0	0
SOLAR DIRECT GAIN	-13-	0	0	0	0	0	0	0
THERMOSIPHON AIR FNL	-14-	0	0	0	0	0	0	0
ATTACHED SUNSPACE	-15-	0	0	0	0	0	0	0
SOLAR POOL HEATING	-16-	0	0	0	0	0	0	0
SOLAR HOT WATER HTG.	-16-	0	0	0	0	0	0	0
SOLAR SPACE HEATING	-17-	0	0	0	0	0	0	0
COMBINED DHW HEATING	-17-	0	0	0	0	0	0	0
WIND POWER GENERATOR	-18-	0	0	0	0	0	0	0

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