

**COMPARISONS AMONG PARTICIPANTS
AND NONPARTICIPANTS IN THE
BONNEVILLE POWER ADMINISTRATION
RESIDENTIAL WEATHERIZATION PILOT PROGRAM***

ERIC HIRST

RICHARD GOELTZ

*Oak Ridge National Laboratory
Oak Ridge, Tennessee*

BENSON BRONFMAN

*Evaluation Research Corporation
Portland, Oregon*

ABSTRACT

Between 1980 and 1982, the Bonneville Power Administration (BPA) operated a Residential Weatherization Pilot Program. The program offered free home energy audits and zero-interest loans to encourage installation of retrofit measures in electrically heated homes. The households that participated in the BPA program differed considerably from households eligible for the program that did not participate. Generally, participants had larger families, more education, higher incomes, and had fewer retrofit measures in place before the program started than did the nonparticipants.

Residential energy conservation programs are an important and growing element of utility activities. The federal Residential Conservation Service (RCS), mandated by the 1978 National Energy Conservation Policy Act [1], requires all major gas and electric utilities to offer energy audits to their residential customers. In the 1981/82 program year, more than one million audits were completed.

* Research sponsored by the Office of Conservation, Bonneville Power Administration, U.S. Department of Energy, under contract W-7405-eng-26 with Union Carbide Corporation.

Because the RCS and similar programs are voluntary, households that *choose* to participate in the programs are almost certain to differ from nonparticipating households in important energy-related ways. This self-selection is important for marketing, managing, and forecasting the effects of the program. For example, information on the characteristics of these groups can be used to modify marketing strategies to better reach groups that are not participating. Such data are also important in developing projections of likely future program impacts, which depend strongly on the characteristics of program participants. Finally, failure to account for self-selection in evaluations will lead to energy-saving estimates that include the effects of *both* the particular program and of self-selection.

This article discusses the characteristics of households that did and did not participate in the Bonneville Power Administration Residential Weatherization Pilot Program [2]. The program, which ran from 1980 through 1982, offered free home energy audits to identify cost-effective conservation measures to reduce energy use for space and water heating. The program also included zero-interest loans for installation of measures recommended in the audits.

The pilot program was funded by BPA and administered through eleven small utilities in Washington, Oregon, Idaho, and Western Montana. The eleven utilities serve approximately 60,000 customers. Of these, 50 to 80 percent were eligible for participation in the pilot. The eligibility requirements restricted participation to single-family homes that used electricity for space heating. During the program's two and one-half year lifetime, more than 7000 electrically heated homes were audited and about 4000 loans were made for weatherization improvements.

The program process was straightforward. Residential customers called their utility to arrange for a home energy audit. The auditor analyzed the home and completed forms on the condition of the house and the potential savings for installation of space heating and water heating conservation measures. The utility then solicited bids from local contractors to perform the recommended retrofits. BPA reimbursed the contractor (through the utilities) based on the lowest bid. After installation of recommended measures, the home was reinspected by the utility. If the work was satisfactory, payment was approved.

We recently completed a detailed evaluation of the BPA program [3]. The evaluation, which focused on the energy-saving effects of the program [4], was restricted to households in single-family detached homes, homeowners, houses that had electric heat, and to households that had lived in the same residence since March 1980. Three groups of households were sampled: participants who received both an energy audit and a weatherization loan (AL) between April 1 and October 1, 1981, participants who received an audit but not a loan (AO) during the same time period, and eligible nonparticipants (NP). We limited samples from the first two groups (AL and AO) to households that received program services in mid-1981 so that we would have a full heating season of

electricity bills before receipt of program services plus a full season of postprogram electricity bills.

To analyze the issues selected for the evaluation, several types of data were collected:

- utility bills, from September 1980 through June 1982;
- daily temperature data for each utility, to match with the utility bills (to adjust consumption for changes in weather);
- energy audit reports for the AO and AL households;
- weatherization completion forms for the AL households; and
- household demographics, attitudes, recent and planned conservation actions, and heating equipment and fuel type (obtained from telephone surveys conducted among households in all three groups).

The "final" data set used in this evaluation included 913 households. However, the number of households with usable electricity bills was 776 and with completed telephone surveys was 588. We carefully examined the representativeness of our data set relative to nonrespondents (i.e., households for which we did not have electricity bills or did not have completed telephone surveys) and found no statistically significant nonresponse bias. We also compared the five utilities within the evaluation with the other six in the pilot program. The five utilities accounted for 66 percent of the households in the eleven utilities, for 68 percent of the audits, and for 74 percent of the weatherization loans. Thus, participation rates were slightly higher in the five utilities than for the program as a whole. Our conclusion [2, Appendix B] is that the data set used in this evaluation can support conclusions valid for both the five utilities within the evaluation and for the pilot program as a whole.

ELECTRICITY USE

The AL group used substantially more (20%) electricity before the program (i.e., during the 1980/81 heating season) than did the other two groups (see Table 1). The difference between the AL and the other two groups is significant at the 1 percent level; differences between the AO and NP groups are not significant. The reduction in annual electricity use for AL households was much larger than for the AO and NP households: 4200 kWh vs 1800 and 1000 kWh.

These average values of electricity use and reduction in electricity use obscure the large variations among households (Figure 1). For example, the standard deviation is about 40 percent of the mean value for energy use. For change in energy use, the standard deviation is larger than the mean value. This variation, both across households and across time, was considered in greater detail in our analysis of energy use [2, Chap. 7; 3].

Two important findings emerge from this examination of electricity bills. First, AL households used substantially more energy during the preprogram

Table 1. Pre- and Post-Program Electricity Use (kWh/Year) by Group in the BPA Residential Weatherization Pilot Program^a

| | <i>Energy Use by Group^b</i> | | |
|-----------------------|--|-------------------|------------------------|
| | <i>Audit + Loan</i> | <i>Audit Only</i> | <i>Nonparticipants</i> |
| Preprogram (1980/81) | 27,500 | 23,200 | 23,500 |
| Postprogram (1981/82) | 23,300 | 21,400 | 22,500 |
| Change in Consumption | 4,200 | 1,800 | 1,000 |

^a These figures are the means for each group and time period. The data include 262 AL, 104 AO, and 407 NP households.

^b These estimates are "adjusted" for variations in winter severity and represent consumption normalized to long-run heating degree days.

period.¹ Second, these households reduced their electricity consumption between the two years by much more than did the other two groups.

STRUCTURE CHARACTERISTICS

The AO and NP houses already contained more weatherization measures before March 1980 than did the AL homes; that is, the AL homes had greater potential to reduce their energy consumption than did the homes of the other two groups (Table 2); this is confirmed by the higher preprogram electricity use experienced by the AL homes (Table 1). For all but one (wall insulation) of the weatherization measures included in the phone survey, the AL homes were least likely to have the measure in place before March 1980. On the other hand, the AO and NP homes were similar in their responses to these questions.

CONSERVATION MEASURES AND PRACTICES

Perhaps because of their greater need for retrofit, the AL households reported much more installation of weatherization measures *after* March 1980 than did the other two groups (Table 3). For all but two of the measures, the fraction of AL homes that installed the measure was much higher than the fractions of the other two groups. The exceptions, water heater insulation and shower flow restrictors, were often installed by the auditor during the audit; thus it is not surprising that the AO group was as likely to install these measures as the AL group; both audited groups show much higher installation rates for these two measures than does the NP group.

Adjusting the installation rates on the basis of the pre-March 1980 condition of the home shows that the AL households were still much more likely than either the AO or NP groups to install measures. While this is not conclusive evidence that the audit and loan influenced these retrofit actions, it suggests that the BPA pilot program had an influence on retrofit decisions.

¹ Similar findings occurred in other conservation programs [5-10].

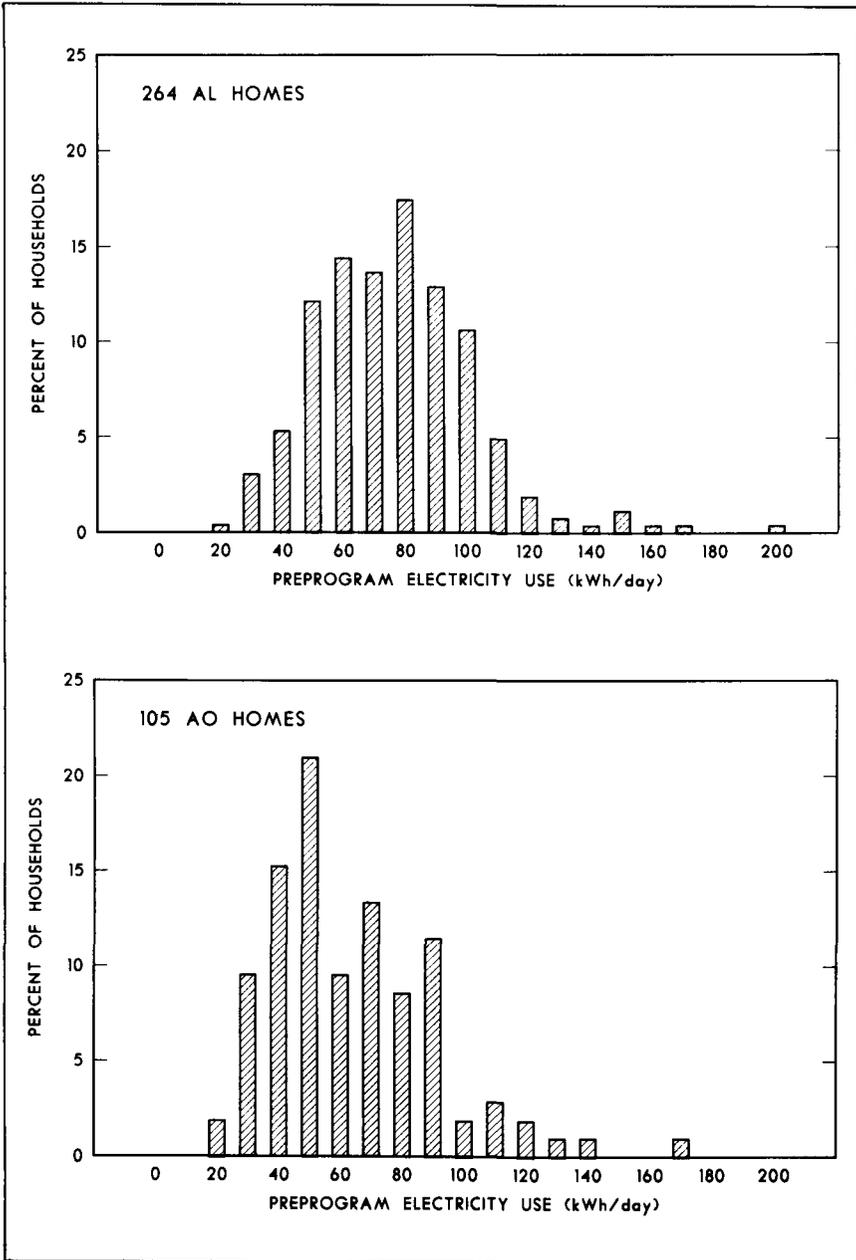


Figure 1. Histograms of preprogram electricity use (9/80-6/81), by group (Part 1).

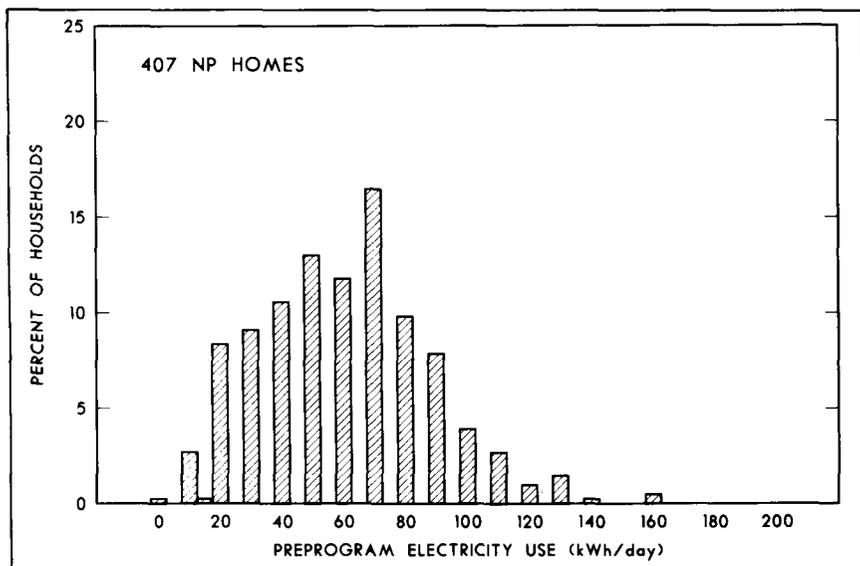


Figure 1. (Part 2).

Table 2. "Conservation" Status of Homes by Group in the BPA Residential Weatherization Pilot Program

| | <i>Percentage of Homes That Had Measure In Place As of March 1980, by Group</i> | | |
|----------------------|---|-------------------|------------------------|
| | <i>Audit + Loan</i> | <i>Audit Only</i> | <i>Nonparticipants</i> |
| Insulation | | | |
| Roof/Ceiling | 26 | 80 | 78 |
| Walls | 71 | 70 | 72 |
| Basement/Crawl Space | 20 | 37 | 42 |
| Heating Ducts | 21 | 31 | 42 |
| Storm | | | |
| Windows | 25 | 44 | 59 |
| Doors | 26 | 35 | 51 |
| Clock Thermostat | 51 | 48 | 55 |
| Hot Water | | | |
| Pipe Insulation | 26 | 43 | 43 |
| Jacket Insulation | 18 | 20 | 26 |
| Caulking | 36 | 54 | 46 |
| Weatherstripping | 33 | 61 | 57 |
| Number of Households | 203 | 72 | 313 |

Source: Telephone survey.

Differences among groups with respect to adoption of conservation *practices* is much less than are differences with respect to conservation *measures*. Both the AO and AL groups are more likely to report adoption of conservation practices than are the NP households. Responses to questions on temperature settings suggest that the AO households set their temperatures at lower levels than do either the AL or NP households (Table 4). The AO households are more likely to use wood for space heating than either the AL or NP households. Not surprisingly, they also report greater use of wood (in terms of cords/year, although the differences are not statistically significant).

We created simple summary (dummy) variables for each household to show whether they adopted any (one or more) conservation practices and measures. Consistent with our earlier discussion, the AL group was much more likely to report adoption of measures than was either of the other two groups; the AO group was more likely to report adoption of measures than was the NP group. On the other hand, differences among groups were much less with respect to conservation practices.

Table 3. Retrofit Measures Installed by Group in the BPA Residential Weatherization Pilot Program

| | <i>Percentage of Homes That Installed Measure After March 1980, by Group</i> | | |
|-------------------------|--|-------------------|------------------------|
| | <i>Audit + Loan</i> | <i>Audit Only</i> | <i>Nonparticipants</i> |
| Insulation | | | |
| Roof/Ceiling | 71 | 14 | 7 |
| Walls | 7 | 7 | 5 |
| Basement/Crawl Space | 65 | 15 | 3 |
| Heating Ducts | 28 | 9 | 4 |
| Storm | | | |
| Windows | 71 | 13 | 7 |
| Doors | 65 | 11 | 5 |
| Clock Thermostat | 1 | 1 | 2 |
| Hot Water | | | |
| Pipe Insulation | 46 | 10 | 7 |
| Jacket Insulation | 48 | 49 | 23 |
| Caulking | 52 | 10 | 14 |
| Weatherstripping | 56 | 16 | 10 |
| Shower Flow Restrictors | 46 | 47 | 20 |

Source: Telephone survey.

Table 4. Comparisons among Groups in the BPA Residential Weatherization Pilot Program

| | <i>Mean Values by Group</i> | | |
|--|-----------------------------|-------------------|------------------------|
| | <i>Audit + Loan</i> | <i>Audit Only</i> | <i>Nonparticipants</i> |
| Floor Area (ft ²) | 1970 ^{a,b} | 1520 | 1600 |
| Number of Floors | 1.5 ^a | 1.6 | 1.3 ^c |
| Home Age (Years) | 24 | 22 | 24 |
| Thermostat Setting (°F) | | | |
| Day | 67 ^b | 64 | 67 ^c |
| Night | 62 ^b | 59 | 62 ^c |
| Use Wood for Heating (%) | 64 ^e | 76 | 60 ^c |
| Cords Wood Used Per Year | 3.7 | 4.4 | 3.8 |
| Adopted Conservation | | | |
| Measures | 96 ^{a,b} | 71 | 51 ^c |
| Practices (%) | 58 ^a | 56 | 42 ^e |
| Estimated Energy Savings as of 4/81 | | | |
| Potential (%) | 47 ^{a,b} | 37 | 34 |
| Implemented (%) | 28 ^{a,b} | 6 | 3 |
| Retrofit Lifetime (Years) | 22 ^{a,b} | 16 | 15 |
| Number Household Members | 3.4 ^{a,d} | 2.9 | 2.8 |
| Education (Years) | 13.5 ^{a,d} | 12.5 | 12.5 |
| Income (Thousand-\$) | 26.0 ^a | 23.8 | 21.6 |
| Attitudes toward | | | |
| Conservation | +0.8 ^{a,b} | -1.1 | -0.3 |
| Audits | +2.2 ^{a,b} | -1.1 | -1.2 |

^a The difference between Audit + Loan (AL) and Nonparticipant (NP) households is significant at the 1 percent level or better.

^b The difference between AL and Audit Only (AO) households is significant at the 1 percent level or better.

^c The difference between AO and NP households is significant at the 1 percent level or better.

^d The difference between AL and AO households is significant at the 5 percent level or better.

^e The difference between AO and NP households is significant at the 5 percent level or better.

Source: Telephone survey.

Using information from the energy audits, we estimated for each household the potential energy saving (based on self-reports in the phone survey of measures *not* in place as of March 1980; see Table 2) and the actual energy saving they achieved (based on self-reports of measures installed after March 1980; see Table 3). Again, these results confirm our earlier discussion. AL households had a larger potential saving before the program than the other two groups; and the AL group saved much more energy (post-3/80) than the other two groups. In addition, the AL households were much more likely to install measures with long lifetimes (such as attic insulation) than were the AO and NP households (which installed measures such as caulking and weatherstripping). The average lifetime (weighted on the basis of each measure's expected energy saving) for AL households is twenty-two years, compared with sixteen years for the AO homes and fifteen years for the NP homes.

DEMOGRAPHIC CHARACTERISTICS

The AL households have larger families, the adults have more education, and they have higher incomes than do the AO and NP households (Table 4). These demographic differences are similar to those found in evaluations of other home energy audit programs [11-15]. Differences between participants and non-participants are probably greater than indicated here; recall that this evaluation is limited to households that live in single-family homes that they own (i.e., renters and occupants of multi-family units are excluded).

The attitudes of the AL group to home energy audits and to conservation (as measured by responses to fourteen questions in the survey) are much more positive than are the attitudes of the AO and NP groups. Because there was no preprogram measure of attitudes, we do not know whether the positive attitudes influenced the AL households to participate in the program or whether their participation led to these positive attitudes.

BPA ENERGY AUDITS

The survey included questions about the home energy audit (asked of the AO and AL households) and its influence on subsequent retrofit actions. Almost one-third of the AL and one-half of the AO households cited "energy costs" as the main reason for requesting an energy audit (Table 5). Smaller fractions were primarily interested in the financing available, curious about what needed to be done to their homes, or generally interested in energy conservation.

Audited households were asked whether the energy audit was "very," "somewhat," or "not" important in their decisions to adopt each retrofit measure. Large fractions of the AL households credited the audit as "very important" in their decision; the percentage ranges from 44 percent for caulking

Table 5. Reasons Given for Having an Energy Audit

| | <i>Percentage of Households by Group</i> | |
|-------------------------------------|--|-------------------|
| | <i>Audit + Loan</i> | <i>Audit Only</i> |
| Concerned about Rising Energy Costs | 35 | 49 |
| Because of the Financing | 18 | 11 |
| To See What Needs to be Done | 15 | 16 |
| Interested in Conservation | 7 | 13 |
| Other | 25 | 11 |

Source: Telephone survey.

to 76 percent for storm windows. The percentages of AO households crediting the audit as "very important" are less than the percentages of AL households for all measures except water heater jacket insulation. These results suggest that the audit (or the loan) was quite influential for AL households and less so for AO households.

The AL respondents were asked whether they would have made the retrofit improvements if BPA financing had not been available. Almost half (45%) said they probably or definitely would *not* have installed the measures without the loan. This is strong evidence on the program's effectiveness in stimulating retrofit investment.

The energy audits provide additional information with which to compare the AO and AL homes. The audit results, in terms of estimated annual energy use, potential energy savings, and house size, are similar to those discussed above. The AL homes are larger, use more energy, and have larger conservation potentials than do the AO homes. In fact, three of the ninety-seven AO homes were "perfect"; i.e., there were no auditor energy-saving recommendations.

CONCLUSIONS

This article compared the characteristics of participants and nonparticipants in BPA's Residential Weatherization Pilot Program. AL households consumed substantially more energy preprogram than did AO or NP households; differences between the AO and NP groups were not statistically significant. The AO and NP households contained more weatherization measures before March 1980 (when the pilot program began) than did the AL households, according to telephone responses. Perhaps because of their greater need for weatherization and the influence of the pilot program, the AL households reported much more installation of measures after March 1980 than did the other two groups.

Large fractions (roughly one-half to two-thirds) of the AL households credited the audit as being "very important" in their decision to retrofit; the comparable percentages for the AO households are lower (roughly one-fifth to one-half). Almost half (45%) of the AL respondents said they probably or definitely would *not* have installed the retrofit measures without the zero-interest loan.

The AL households have larger families, the adults have more education, and they have higher incomes than do the AO and NP households; these differences are all statistically significant.

The "upscale" characteristics of program participants is consistent with experience in other residential conservation programs and with the diffusion of innovation theory. Early participants in these programs are also those who innovate in other ways (purchase Japanese cars, install solar systems, use personal computers). This suggests that the characteristics of conservation program participants will change as programs mature. This has happened with the Tennessee Valley Authority (TVA) Home Insulation Program (HIP). HIP began in 1977; the demographic profile of its early participants was much like that shown here for the BPA program. Current participants, however, are much more "average" in their demographic characteristics. Unfortunately, the effect on program energy savings of these temporal changes in the composition of participants has not been analyzed. Thus, it is difficult to forecast future program energy savings, based solely on the savings experienced by early participants.

Findings on participant characteristics can be used to target marketing efforts to particular groups that have not yet participated extensively. For example, TVA recently began several efforts to encourage greater participation in their program among low-income households. Only 9 percent of the participants between 1978 and 1981 were low-income. Since then, the special marketing efforts have steadily increased low-income participation rates, to 36 percent in early 1983 [16].

REFERENCES

1. U. S. Congress, *National Energy Conservation Policy Act*, Public Law 95-619, November 9, 1978.
2. Bonneville Power Administration, *Residential Weatherization Pilot Program*, 1980.
3. E. Hirst, et al., *Evaluation of the BPA Residential Weatherization Pilot Program*, Oak Ridge National Laboratory, ORNL/CON-124, June 1983.
4. E. Hirst and R. Goeltz, *Estimating Energy Savings Due to Conservation Programs: The BPA Residential Weatherization Pilot Program*, Oak Ridge National Laboratory, October 1983.
5. T. D. Dukich, Testimony before the Idaho Public Utilities Commission, Case No. P-300-24, Washington Water Power Company, June 1982.

6. T. Burnett, Measuring Weatherization Effectiveness: Portland General Electric Company's Experience, *Proceedings of the EPRI Workshop on Measuring the Effects of Utility Conservation Programs*, Electric Power Research Institute, EPRI EA-2496, July 1982.
7. _____, *Weatherization Within Single-Family Residences, Report III – Estimation of Savings Through Weatherization*, Portland General Electric Company, Load Planning Department, September 1982.
8. S. Grady and E. Hirst, *Evaluation of Utility Home Energy Audit Programs: A Wisconsin Example*, Oak Ridge National Laboratory, ORNL/CON-88, March 1982.
9. C. S. Weiss and T. M. Newcomb, *Evaluation of the Home Energy Check Program*, Seattle City Light, October 1981.
10. M. G. Kushler and J. A. Saul, *Fuel Consumption Impacts of the Michigan RCS Program: First Year Results*, Michigan Energy Administration, January 1983.
11. L. Berry, J. Soderstrom, and E. Hirst, *Review of Evaluations of Utility Home Energy Audit Programs*, Oak Ridge National Laboratory, ORNL/CON-58, March 1981.
12. M. G. Kushler and J. A. Saul, *The Results of a Survey Evaluation of the Michigan RCS Program*, Michigan Energy Administration, July 1982.
13. L. McCutcheon, *Characteristics of Participants in Puget Power's Conservation Program, Single-Family Residential Homes*, Interim Report No. 1, Puget Sound Power & Light Company, February 1983.
14. K. Kozloff, *The Effectiveness of Residential Energy Audits in Minnesota – A Process Evaluation*, Minnesota Department of Energy, Planning and Development, August 1982.
15. J. Ainsworth and K. Griffin, *Preliminary Highlights of the RCS Follow-Up Survey*, California Energy Commission, Conservation Division, July 1982.
16. A. T. Hagood, *Trends in Low-Income Participation in the Home Insulation Program, Single-Family Homes*, Tennessee Valley Authority, July 1983.

Direct reprint requests to:

Eric Hirst
Energy Division
Oak Ridge National Laboratory
Oak Ridge, TN 37831