

Energy Division

Characterization of the Weatherization Assistance Program Network

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## ABSTRACT

The Characterization of the Weatherization Assistance Program (WAP) Network was designed to describe the national network of State and local agencies that provide WAP services to qualifying low-income households. The most recent national evaluation of the WAP was completed in 1984 utilizing data from 1981. Since 1984 there have been changes in the structure and operation of the WAP. The objective of this study was to profile the current WAP network. To achieve the objective, two national surveys were conducted: one survey collected data from 49 State WAP agencies (including the coterminous 48 States and the District of Columbia), and the second survey collected data from 920 (or 81 percent) of the local WAP agencies.

The specific goals of this study included collecting data for analysis of: (1) the relationships between the WAP network and non-network programs and the extent of these relationships; (2) the interest and availability of potential partners for future energy-efficiency efforts; (3) the level of technical assistance, client education and training skills; (4) the range of experience and technical expertise for diagnosing weatherization needs and installing retrofit measures; (5) the ability of the network to provide market information on client needs and to provide feedback on the performance of new technologies; and (6) the array of innovations and cutting-edge initiatives being implemented or tested in the field.

Subject to certain caveats, the report catalogues the total network financial support for energy programs and the total network program staff working on energy programs of both State (\$590.6 million, 687 FTE) and local WAP agencies (\$486.6 million, 8586 FTE). The total number of network weatherization completions for local WAP agencies in Program Year 1989 was 243,268. A complete breakdown of financial support by source and type is provided, as well as a complete breakdown of program staff by source and type. An interpretation of the results is provided utilizing both network means and medians. Other analyses performed as part of this report include: an assessment of the type and frequency of network staff training; the interaction of network agencies with non-network energy programs; and an analysis of recommended service improvements based upon respondents' recommendations from the two surveys. A particular focus of the study is on innovations and initiatives being implemented by the WAP network.

Energy Division

The Scope of the Weatherization Assistance Program:  
The Weatherized Population and the Resource Base

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## ABSTRACT

This study is one of five parts of the U.S. Department of Energy's national evaluation of its Weatherization Assistance Program (WAP). It has three major goals: 1) to enumerate the size and sources of investment in low-income weatherization; 2) to provide a count of the number of low-income units weatherized by all weatherization programs and characterize the type and tenure of those homes; and 3) to document the extent to which the DOE/WAP funding has been expanded through use of external resources.

Data on the cumulative number and characteristics of the units weatherized in five periods from Program Year (PY) 1978 through PY 1989 were collected from surveys of state WAP managers and utility conservation program managers. WAP managers were asked to provide data on all major publicly funded federal, state, or local programs and on any private sector initiatives about which they had data. In addition, a national sample of 443 utilities was surveyed. Information was solicited regarding energy conservation investments which were delivered as a package of measures and/or were comparable to the major measures approved for the DOE/WAP program itself, and contributions that were added to such efforts. Furthermore, this analysis considered only funding for weatherization programs targeting low-income households whose incomes did not exceed current federal standards for DOE/WAP or Low Income Home Energy Assistance Program (LIHEAP) eligibility.

Cumulative expenditures of \$4.36 billion and weatherization of 3.9 million low-income units were reported cumulatively in the twelve program years PY 1978 - PY 1989. Nearly 77 percent of all reported resources were expended by state DOE/WAP programs pursuant to DOE/WAP program regulations. In addition, utility programs for low-income households, energy conservation initiatives administered by LIHEAP and miscellaneous state and local weatherization initiatives all provided significant resources. However, the nature and comprehensiveness of the non-DOE programs were not in all cases comparable to DOE/WAP.

Significant changes in funding sources and uses over the twelve-year period were identified. Differences in resources and the characteristics of programs were evident among climate regions. Type of dwelling unit (e.g: single-family or multifamily) and occupancy characteristics of weatherized homes also were reported. A second phase of this study will provide more detailed data on the characteristics of the households and housing units occupied than were available from program reports.

**NATIONAL IMPACTS OF THE WEATHERIZATION ASSISTANCE  
PROGRAM IN SINGLE-FAMILY AND  
SMALL MULTIFAMILY DWELLINGS**

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## ABSTRACT

**Introduction.** In 1990, the U. S. Department of Energy (DOE) initiated a national evaluation of its low-income Weatherization Assistance Program. This report, which is one of five parts of that evaluation, evaluates the energy savings and cost effectiveness of the Program as it has been applied to the largest portion of its client base — low-income households occupying single-family dwellings, mobile homes, and small (2- to 4-unit) multifamily dwellings. The study is based upon a representative national sample (of 368 agencies, 14,971 weatherized dwellings and 11,795 control dwellings) that covers the full range of conditions under which the program was implemented in the 1989 Program Year (PY 1989).

**Data collection.** Dwelling-specific and agency-level data on dwelling characteristics, measures installed, costs, and service delivery procedures were collected from the sampled agencies. Fuel-consumption data were requested from the 926 utilities which provided gas and/or electricity to the sampled dwellings that heated primarily with gas or electricity. Estimates of fuel-oil savings from a companion Fuel-Oil Study were incorporated into the analysis. No effort was made to gather fuel consumption records for dwellings that heated primarily with other fuels such as kerosene, liquified propane gas, wood, or coal.

**Energy savings.** Energy savings were calculated by applying the Princeton Scorekeeping Method (PRISM), which is a weather normalization procedure, to gas and electric consumption records for a year before and a year after weatherization. For gas-heated dwellings, national net savings averaged 17.3 MBtu, or 13% of total gas usage, and 18% of gas used for space heating. For electrically heated dwellings, national net savings averaged 1,830 kWh, or 18.9 MBtu's/year. This represents a 12% reduction in total electricity, and a 36% reduction in electricity used for space heating. For all fuel types, the national estimate of annual savings was 17.6 MBtu's per weatherized dwelling resulting in a 13.5% reduction in total energy use, an 18.2% reduction in the energy used for space heating, and an annual decrease of \$116 in the low-income participant's energy burden.

During PY 1989, the Weatherization Assistance Program weatherized 198,000 single-family or small multifamily homes, resulting in a total savings of 3,487,000 MBtu's during the first year. At an equivalence of 5.8 MBtu's per barrel of oil, the Program saved 601,000 barrels of oil during 1990. Over the 20-year lifetime of the weatherization measures, the anticipated savings amount to 69,740,000 MBtu's, or 12 million barrels of oil.

**Cost effectiveness.** From the societal perspective, which includes both energy and nonenergy (e.g., employment and environmental) benefits and both installation and noninstallation (i.e., overhead and management) costs for the gas-heated dwellings, the Program in PY 1989 was cost effective, with a national benefit/cost ratio of 1.61. Because electricity prices are higher than gas prices, energy savings benefits in electrically heated dwellings are worth more than those in gas-heated dwellings. Cost-effectiveness results, therefore, were generally more favorable for the electrically heated dwellings, with a national benefit/cost ratio of 2.33. For all fuel types combined, the benefit/cost ratio was 1.61.

**Factors influencing savings and cost effectiveness.** The analysis indicates that energy savings and cost effectiveness are highest in the Program's dominant submarkets (including cold and moderate climate regions and single-family detached homes), where DOE Weatherization activity is concentrated. Service delivery procedures that correspond with higher-than-average gas savings include the weatherization of high energy users and the use of integrated envelope/heating system audits. Weatherization measures associated with higher-than-average savings include heating system replacements and attic, wall, and floor insulation.

IMPACTS **OF** THE WEATHERIZATION ASSISTANCE PROGRAM  
IN **FUEL-OIL** HEATED HOUSES

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## ABSTRACT

In 1990, the U.S. Department of Energy (DOE) initiated a national evaluation of its low-income Weatherization Assistance Program. This report, which is one of five parts of that evaluation, evaluates the energy savings and cost-effectiveness of the Program as it had been applied to single-family houses heated primarily by fuel-oil. The study was based upon a representative sample (41 local weatherization agencies, 222 **weatherized** and 115 control houses) from the nine northeastern states during 1991 and 1992 program years.

Dwelling-specific and agency-level data on measures installed, costs, and service delivery procedures were collected from the sampled agencies. Space-heating fuel-oil consumption, indoor temperature, and outdoor temperature were monitored at each house. Dwelling characteristics, air-leakage measurements, space-heating system steady-state efficiency measurements, safety inspections, and occupant questionnaires were also collected or performed at each monitored house.

We estimate that the Program weatherized a total of 23,400 single-family fuel-oil heated houses in the nine northeastern states during program years 1991 and 1992. Annual fuel-oil savings were calculated using regression techniques to normalize the savings to standard weather conditions. For the northeast region, annual net fuel-oil savings averaged 160 gallons per house, or 17.7% of pre-weatherization consumption. Although indoor temperatures changed in individual houses following weatherization, there was no average change and no significant difference as compared to the control houses; thus, there was no overall indoor temperature take-back effect influencing fuel-oil savings.

The weatherization work was performed cost effectively in these houses from the Program perspective, which included both installation costs and overhead and management costs but did not include non-energy benefits (such as employment and environmental). Total average costs were \$1819 per house (\$1192 for installation labor and materials, and \$627 for overhead and **management**), and the **benefit-to-cost** ratio was 1.48.

A general trend toward **higher-than-average** fuel-oil savings was observed in houses with high pre-weatherization fuel-oil consumption. Program savings could likely be increased by targeting higher energy consumers for weatherization, although equity issues would have to be considered. Weatherization measures associated with higher-than-average savings were use of a blower door for air-sealing, attic and wall insulation, and replacement space-heating systems. Space-heating system **tune-ups** were not particularly effective at improving the steady-state efficiency of systems, although other benefits such as improved seasonal efficiency, and system safety and reliability may have resulted. The Program should investigate methods of improving the selection and/or application of space-heating system tune-ups and actively promote improved tune-up procedures that have been developed as a primary technology transfer activity. Houses were more air-tight following weatherization, but still leakier than what is achievable. Additional technology transfer effort is recommended to increase the use of blower doors considering that only half the weatherized houses used a blower door during air sealing. A guidebook developed by a committee of experts and covering a full range of blower-door topics might be a useful technology transfer and training document. Weatherization appeared to make occupants feel better about their house and house environment.



Energy Division

**Description of the Weatherization Assistance Program  
in Larger Multifamily Buildings for Program Year 1989**

J. M. MacDonald

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Prepared for the

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# **Description of the Weatherization Assistance Program in Larger Multifamily Buildings for Program Year 1989**

J. M. MacDonald

## **ABSTRACT**

This report describes the nature and extent of weatherization activities under the U.S. Department of Energy (DOE) Weatherization Assistance Program (the Program) in larger multifamily buildings that have five or more dwelling units. DOE initiated this study to provide policy makers and program implementers with up-to-date, credible, and reliable information. Two national surveys were conducted as part of this study. The results from the two national surveys show the Program to have served about 20,000 dwellings in Program Year (PY) 1989. These 20,000 dwellings represent about 9% of the total number of units weatherized that year. The total costs for the Program efforts in these buildings are about 7% of total national costs for the Program. The energy savings and cost effectiveness of the Program were not estimated, because adequate energy use and cost data could not be obtained. Materials costs for the Program in multifamily buildings in PY 1989 are dominated by the cost of windows (80% of the total). The Program should begin ongoing case study evaluations of specific buildings and measures for these buildings to better understand the current state-of-the-art in multifamily weatherization under the Program, increase understanding of the performance of measures, and capture useful knowledge that can be transferred to other locations.

# UTILITY INVESTMENTS IN LOW-INCOME ENERGY-EFFICIENCY PROGRAMS

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## ABSTRACT

The objective of this study is to describe the energy-efficiency programs being operated by utilities for low-income customers. The study focuses, in particular, on programs that install major residential weatherization measures free-of-charge to low-income households. A survey was mailed to a targeted list of 600 utility program managers. Follow-up telephone calls were made to key non-respondents, and a random sample of other non-respondents also was contacted. Completed surveys were received from 180 utilities, 95 of which provided information on one or more of their 1992 low-income energy-efficiency programs for a total of 132 individual programs.

These 132 utility programs spent a total of \$140.6 million in 1992. This represents 27% of the total program resources available to weatherize the dwellings of low-income households in that year. Both the total funding and the number of programs has grown by 29% since 1989. A majority of the 132 programs are concentrated in a few regions of the country (California, the Pacific Northwest, the Upper Midwest, and the Northeast). Although a majority of the programs are funded by electric utilities, gas utilities have a significantly greater average expenditure per participant (\$864 vs. \$307 per participant).

The most common primary goal of low-income energy-efficiency programs operating in 1992 was "to make energy services more affordable to low-income customers." Only 44% of the programs were operated primarily to provide a cost-effective energy resource. Based on a review of household and measure selection criteria, equity and not the efficiency of resource acquisition appears to dominate the design of these programs. This is corroborated by a review of 10 Commission orders, which indicated that a majority of the mandated low-income programs are not subjected to strict resource cost tests, but are generally justified on the grounds of fairness and the equity of utility rate impacts.

Utility-funded low-income energy-efficiency programs differ in significant ways from DOE's Weatherization Program. Lighting and appliance measures were common ingredients of utility low-income programs and are not generally a part of DOE's Program. Also, major measures such as insulation, storm windows, and doors were installed in a smaller percentage of the dwellings that participated in utility-sponsored programs compared to the DOE Program. This is consistent with the greater level of investment per participant in DOE's Program. Sixty-eight percent of the respondents indicated that their programs coordinated the delivery of their low-income programs with local agencies that provided energy services under DOE's Weatherization Program. Coordination consists of utilizing the local agencies to deliver energy services, in whole or in part, under utility programs. The utilities that coordinate with local agencies account for a total of \$115 million (or 83%) of the total utility expenditures on low-income energy-efficiency programs in 1992.

# Five Case Studies of Multifamily Weatherization Programs

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## ABSTRACT

The multifamily case studies that are the subject of this report were conducted to provide a better understanding of the approach taken by program operators in weatherizing large buildings. Because of significant variations in building construction and energy systems across the country, five states were selected based on their high level of multifamily weatherization. This report summarizes findings from case studies conducted by multifamily weatherization operations in five cities: New York City; Springfield, Massachusetts; Chicago, Illinois; St. Paul, Minnesota; and Seattle, Washington. The case studies were conducted by members of the staff of the Synertech Systems Corporation between January and November 1994.

This document is the last in a series of reports to be delivered to the U.S. Department of Energy by Oak Ridge National Laboratory in support of the National Evaluation of the Weatherization Assistance Program. It builds on findings from earlier work which documented the results of an extensive survey of multifamily weatherization operations in 33 states (MacDonald 1993).

Each of the case studies involved extensive interviews with the staff of weatherization subgrantees conducting multifamily weatherization, the inspection of 4 to 12 buildings weatherized between 1991 and 1993, and the analysis of savings and costs. Draft reports of each case study were circulated to local agencies for their feedback, much of which has been incorporated into the current versions that are included in this report.

The case studies focused on innovative techniques which appear to work well.

Several highlights of findings follow:

- Weatherization program operators in two of the cities studied make it a point to gather historical energy consumption data. They use it both to inform building auditing and to develop options for energy conservation retrofits. These agencies also tend to concentrate their attention during the audit in the boiler room. Frequently, control changes and equipment revitalization or replacement are undertaken when patterns of fuel consumption and the result of instrumented audits suggest that such tactics merit implementation. Weatherization jobs in these cities are usually quite cost-effective.

In the hands of skilled technicians, modern energy auditing tools, including audit software, can be used to determine what is likely to be cost effective, to produce a work order for contractors, and to make it clear to all parties that a professional job is contemplated. **This** last feature, coupled with a good record of prior weatherization work, is useful in attracting investments from building owners.

Building owner cooperation (and investment) is further enhanced in New York City by an organization which specializes in conducting financial analyses of conservation-related cash flow and arranging for low-interest funding.

- Much multifamily weatherization work includes replacement windows. In most cases these save at least some energy (depending on the condition of the windows replaced and other factors, of course), but their expense rarely results in cost-effective work when only the reduction in energy costs is considered. This fact is used by some agencies to forge favorable financial agreements with building owners, most of whom are anxious to have new windows installed.
- Most multifamily weatherization operations now routinely include the replacement of inefficient incandescent lighting with more efficient compact fluorescent lighting or (outside) high-pressure sodium fixtures. These lighting retrofits are almost universally cost-effective.
- New efforts by weatherization organizations on water conservation and on replacement of inefficient refrigerators with high efficiency units are important for larger multifamily buildings. New York City had recently started a pilot project on refrigerator replacement at the time of our surveys, and they also had a water conservation program that targets buildings with high water usage.

Multifamily buildings tend to be complex, and it is sometimes difficult to understand how their systems interrelate. There remain a number of elements of multifamily weatherization which continue to be difficult to analyze. Even with what is known, there is substantial unevenness in **skill** levels within the weatherization community. Many analyses are conducted on more complex multifamily buildings using single family housing analysis methods. However, the multifamily buildings are often quite different, with the result that analysis results are inadequate or incorrect.

Therefore, in parallel with the advancement of practical research in building science, there is a need for effective sharing of information on any advances in methods throughout the weatherization community and beyond. Well-conceived and conducted training and technical assistance could usefully cover a range of topics, from energy auditing to the honing of skills in construction management.

**All** multifamily weatherization operations studied are eager for the opportunity to expand their programs and are largely well equipped to do so.