ORNL/TM-2014/338

Weatherization Works - Summary of Findings from the Retrospective Evaluation of the U.S. Department of Energy's Weatherization Assistance Program

Bruce Tonn
David Carroll
Scott Pigg
Michael Blasnik
Greg Dalhoff
Jacqueline Berger
Erin Rose
Beth Hawkins
Joel Eisenberg
Ferit Ucar
Ingo Bensch
Claire Cowan

September 2014

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE US DEPARTMENT OF ENERGY

EXECUTIVE SUMMARY

In April 2009, the U.S. Department of Energy (DOE) tasked Oak Ridge National Laboratory with conducting an evaluation of DOE's low-income Weatherization Assistance Program (WAP). This directive came at the same time that the American Recovery and Reinvestment Act of 2009 was passed. The Recovery Act boosted WAP's funding from approximately $225M per year to $5B over a three year period. It was decided at that time to evaluate WAP as it was administered both before and during the Recovery Act period. The former is known as the 'retrospective' evaluation of WAP and focuses on Program Year (PY) 2008. This report summarizes findings from the twenty individual studies that comprise the retrospective evaluation.[1]

Through WAP, DOE provides grants to states, territories, and Washington, DC (i.e. Grantees) to fund the weatherization of low-income homes. The Grantees provide grants to local weatherization agencies (also known as Subgrantees) to deliver weatherization services. Grantees and Subgrantees also leverage their DOE funds to acquire additional funds for low-income weatherization. Subgrantees accept applications for weatherization, confirm households' income eligibility for the program, conduct energy audits of the homes, install weatherization measures, and inspect each home post-weatherization. Common weatherization measures include: air sealing, wall and attic insulation, duct sealing, and furnace repair and replacement. The program operates across all climate zones in the United States, and weatherizes all manner of homes, from single family detached units to mobile homes to large multifamily buildings.

The retrospective evaluation concentrated on estimating program impacts (e.g., energy savings) and on assessing program administration. To accomplish these tasks, the retrospective evaluation collected a great deal of data, including:

- Housing characteristics and weatherization measures installed in ~20,000 single family and mobile homes
- Building characteristics and weatherization measures installed in ~10,000 multifamily building units and detailed data on over 100 large multifamily buildings weatherized in New York City
- Fuel type and basic occupant characteristics for ~20,000 homes
- Electricity and natural gas billing histories for ~8,000 weatherized and comparison homes collected from over 1000 natural gas and electric utilities
- Program implementation survey data from 50+ Grantees and ~900 Subgrantees
- Demographic, health-related, energy use behavior, and client satisfaction survey data from ~1400 households (treatment plus comparison group homes)
- Demographic and career-related survey data from ~600 weatherization auditors, crew leaders, crew members
- Indoor environmental quality data measurements (CO, radon, formaldehyde, humidity and temperature) pre- and post-weatherization for a national sample of ~500 treatment and control group homes and radon measurements post-weatherization in ~18 homes that received ventilation packages meeting ASHRAE 62.2 standards

[1] A similar summary report will be prepared for the Recovery Act Period WAP evaluation. All reports will be posted at http://weatherization.ornl.gov

- Detailed in-field observations of ~450 weatherization audits, measure installation processes, and final inspections conducted by 19 Subgrantees around the country

- In-field assessments of 105 homes weatherized in 2008 that appeared to save much more or much less energy than expected from modeling analyses

- Materials and interview notes to prepare 14 in-depth case studies of high-performing and unique local weatherization agencies

- Training experiences and career path expectations from a survey of over 800 individuals who received training at DOE weatherization training centers

In PY 2008, the impact component of the retrospective evaluation found that:

- Approximately 35 million households were eligible for WAP in PY 2008

- WAP funds supported the weatherization of 97,965 units in PY 2008: 59% single family site built, 18% mobile home, 5% small multifamily, and 18% large multifamily

- DOE expenditures on WAP were $236,000,000; including leveraged funding, the total expenditures on units weatherized were $481,000,000. The total spent by the national weatherization network in PY 2008 for weatherization was $850,000,000

- The average cost to weatherize a unit was $4,695 (the DOE share was 48%)

- WAP and leveraged expenditures supported directly and indirectly 8,500 jobs and increased national economic output by $1.2 billion

- The estimated first year program energy savings is 2,270,000 MMBtus.[2] This is equivalent to nearly 400,000 barrels of oil.

- Site built homes averaged 29.3 MMBtus of savings in the first year[3]

- Households appeared not to take-back energy savings post-weatherization

- Large variations in energy savings are more influenced by changes in occupant behaviors and changes in primary heating fuel and use of secondary heating sources than by work quality issues

- The net present value of the program energy cost savings in 2013 dollars is $420,000,000 and the net present value per unit weatherized is $4,890, $340,000,000 and $4243 in 2008 dollars.

- 78% of these savings accrued to households and 22% to rate payers of utilities that have Percentage of Income Payment Programs

- Carbon emissions were reduced by 2,246,000 metric tons[4]; criteria pollutants by 5,271 short tons

[2] This is a conservative estimate as it only includes about one-third of the units weatherized in large multifamily buildings in PY 2008, those in New York City.
[3] For comparison purposes, WAP saved an average of 17.6 MMBtus of energy in site built homes in PY 1989.
[4] This about the amount of carbon emitted by 600,000 average automobiles in the US.

- The net present value of the environmental emissions benefits is $252,000,000; the net present value per weatherized unit is $2,932; a water savings benefit is $186 per unit for a total benefit of $14,000,0000

- Weatherization effectively deals with CO issues found in homes, and slightly increases formaldehyde in mobile homes and radon levels in site built homes located in high radon areas of the country

- Ventilation installed according to ASHRAE5 62.2 guidelines may reduce radon levels in weatherized homes

- The surveyed households reported that post-weatherization: their homes were less drafty: the general health of the household members improved; respondents suffered fewer asthma symptoms; their homes were less infested with pests; there were fewer instances of thermal stress; and respondents missed fewer days of work

- The present value of a limited set household health and home-related non-energy benefits for the WAP is approximately $1,137,000,000; the present value per single family and mobile home is $14,148

The process component of the evaluation found that:

- There is a richness and diversity in how local weatherization programs are organized and operated across the country, by crew (in-house vs. contractor), energy audits (computerized vs. priority lists), context (urban vs. rural impacts job scheduling)

- Weatherization is complex, involving over 100 different categories of work and over 800 different actions

- The national weatherization network offers a comprehensive set of training opportunities and certifications

- Weatherization work performed in the field is generally well done but there are opportunities to improve the technical aspects of the work and client energy education

- Successful local programs exhibit the characteristics of well-managed non-profit organizations with respect to mission, commitment, respect, quality, innovation, and resilience

- 94% of surveyed households were satisfied or very satisfied with the weatherization program

- Over 80% of auditors, crew chiefs, and crew members are satisfied or very satisfied with almost every aspect of their jobs

WAP faces numerous challenges and opportunities moving forward. The main challenges are related to maintaining and improving work quality, dealing with health and safety issues found in homes, and meeting the likely growing demand for program services over time. Major opportunities are related to increasing cooperation and leveraging relationships with the healthy homes and medical communities to achieve even higher levels of energy savings and non-energy benefits.

[5] American Society of Heating, Refrigerating and Air Conditioning Engineers