Hood River Conservation Project

Profile #12, 1992

Executive Summary

The Hood River Conservation Project was an unprecedented direct installation weatherization project implemented between 1983 and 1985 in Hood River and Wasco Counties, Oregon. The Project was conceived by the Natural Resources Defense Council, which enlisted the cooperation of Pacific Power & Light Company, Bonneville Power Administration, the Hood River Electric Cooperative, the Northwest Power Planning Council, the Northwest Public Power Association, and the Pacific Northwest Utilities Conference Committee. All of these groups participated in a Regional Advisory Group, providing input and reaching consensus on decisions regarding project planning, implementation, and follow-up research.

In achieving its goals, HRCP was phenomenally successful. Although energy savings were less than predicted, the project was able to meet its objectives, particularly in regard to evaluation. The conclusions and recommendations developed by HRCP have been useful in a variety of other DSM plans.

Many facets of HRCP made it unique. A detailed evaluation plan was developed, which included a community assessment and household surveys in three communities before the project began. The project had a continuing commitment to the collection and management of high-quality data, and to reporting not only its successes, but also its failures. The project sought to remove any economic barriers from the weatherization process. On average, homeowners contributed a mere 1% of the cost to install any of 15 weatherization measures, which ranged from enhanced insulation to water heater wraps, while HRCP paid the remaining 99%.

HRCP had an ambitious time schedule, in which energy audits were to be conducted and recommended installations completed within a two year period. The Project was successful in staying within its time constraints, thanks to the flexibility of project managers to change certain conventions, such as elimination of the requirement that only local contractors be used.

The Project sought to achieve 100% participation at a time when typical participation rates in utility-sponsored conservation programs were on the order of 3% to 6%. A comprehensive marketing strategy was developed in hopes of meeting that goal, but community interest was so high that a 91% participation rate was achieved and most of the marketing budget was never used.

Data collection goals and research efforts were designed prior to project startup, and continued dialogue between evaluators and implementers insured that the research goals could be met even as the project specifics remained flexible enough to deal with unforeseen difficulties.

Hood River Conservation Project

Regional Advisory Group Members:	Bonneville Power Administration, Pacific Power & Light, Hood River Electric Cooperative, Northwest Power Planning Council, Natural Resources Defense Council, Northwest Public Power Association, Pacific Northwest Utilities Conference Committee
Sector:	Residential
Measures:	Insulation, window and door retrofits, infiltration reduction, hot water heating improvements.
Mechanism:	Energy audits performed and measures installed as part of a large research and demonstration project.
History:	Measures installed between 1983 and 1985, data collected through 1989.

Program Data

1st Year Energy savings:	2,600 kWh/house
Lifecycle energy savings:	341.9 GWh
Peak capacity savings:	1.76 kW/house
Cost:	$22.5 million
Participation rate:	91% for audits 85% had at least one major measure installed

Conventions

For the entire 1992 profile series all dollar values have been adjusted to 1990 U.S. dollar levels unless otherwise specified. Inflation and exchange rates were derived from the U.S. Department of Labor's Consumer Price Index and the International Monetary Fund's International Financial Statistics Yearbook: 1991.

The Results Center uses three conventions for presenting program savings. **Annual savings** refer to the annualized value of increments of energy and capacity installed in a given year, or what might be best described as the first full-year effect of the measures installed in a given year. **Cumulative savings** represent the savings in a given year for all measures installed to date. **Lifecycle savings** are calculated by multiplying the annual savings by the assumed average measure lifetime. **Caution:** cumulative and lifecycle savings are theoretical values that usually represent only the technical measure lifetimes and are not adjusted for attrition unless specifically stated.

Regional Advisory Group Overview

The Hood River Conservation Project (HRCP) was a collaborative effort conceived by the Natural Resources Defense Council (NRDC), funded by the Bonneville Power Administration (BPA), principally administered by Pacific Power & Light, and implemented in the Hood River Electric Cooperative service area as well as part of Pacific Power & Light's service area. In addition, the Northwest Power Planning Council, the Northwest Public Power Association, and the Pacific Northwest Utilities Conference Committee, participated in a Regional Advisory Group; all were instrumental in the Project's evolution.

At the time, the use of a Regional Advisory Group was a truly innovative approach to DSM project management. The HRCP Regional Advisory Group met monthly for about 5 years to discuss and act on project management issues. Through a consensus process, decisions were made and messages relayed to top managers at BPA and Pacific Power & Light. The input of this group, and the willingness of the project managers to consider and act upon their suggestions, were vital factors in the success of HRCP. [R#12,14]

Because HRCP was a unique cooperative effort, this section will provide overviews of each of the collaborators. Each of the groups described below had varied levels of participation in the project, however all were represented in the Regional Advisory Group. Once HRCP had been accepted conceptually, NRDC moved to the background, with Pacific Power & Light and BPA becoming the most important players.

HRCP STATISTICS

Number of eligible homes in project area	3,500	
Total homes audited	3,189	91%
Total homes retrofited	2,989	85%

	HREC	Pacific	Total
Homes included in 1985/86 data analysis	872	1,490	2,362
Homes included in 1987/88 data analysis	801	1,196	1,997
Mean 1982/83 electricity use for HRCP participants (kWh)	23,486	16,933	19,561
Mean 1987/88 electricity use for HRCP participants (kWh)	20,689	15,936	17,842
Average electric rate in 1982 (1990 ¢/kWh)	3.4	6.5	N/A
Average electric rate in 1988 (1990 ¢/kWh)	4.1	4.3	N/A

NATURAL RESOURCES DEFENSE COUNCIL

NRDC conceived of HRCP as a means toward resolving an ongoing dispute regarding the appropriate role of conservation in power planning.

NRDC is a nonprofit organization with 170,000 members and a diverse staff of lawyers, scientists, and other environmental specialists. For years prior to the conception of HRCP, NRDC had been involved in power planning, advocating conservation as an alternative to new power plant construction. NRDC has participated in the Northwest Power Planning Council's planning process since the early 1980's and has been highly successful at convincing utilities to "buy into" demand-side management as a viable energy resource that can be effectively delivered as an energy service.[R#4]

PACIFIC POWER AND LIGHT

NRDC approached Pacific Power & Light (Pacific), with the HRCP concept because Pacific had significant prior experience with DSM and seemed the ideal company to administer a project like HRCP.

Pacific is an investor-owned utility that is held by PacifiCorp, and based in Portland, Oregon. The utility provides electric service to over one million customers in the Pacific Northwest.[R#2] Pacific provides electricity to approximately two-thirds of the residents of Hood River County, that is, those county residents who live in the relatively small portion of the county which comprises the city of Hood River.

In 1991, most (78%) of Pacific's electric generation was from coal-fired plants, with hydroelectric generation and purchases comprising most of the remaining energy sources. In 1986, Pacific relied less on coal than it currently does, when 64% of its electricity was produced at coal-fired plants.[R#2]

In 1982-83, before HRCP, the annual electric demand for Pacific's customers in Hood River was 16,933 kWh/year. Pacific nearly doubled its electric rates between 1980 and 1982, just before the beginning of HRCP. (This rate increase contributed significantly to the lower than expected pre-project electricity use in Hood River, described further in the Program Savings section.) During the project, average electric rates for Pacific's residential customers in Hood River decreased, from 6.5 ¢/kWh in 1982 to 5.7 ¢/kWh in 1988. (HRCP Statistics) [R#6]

BONNEVILLE POWER ADMINISTRATION

In February, 1982, NRDC and Pacific submitted a funding proposal for HRCP to the Bonneville Power Administration (BPA). After months of review and discussion among the members of the Regional Advisory Group, BPA agreed to fund the project. In May, 1983, two contracts -- one for the weatherization program and one for the research and evaluation component -- were signed between Pacific and BPA.

BPA is a U.S. Government owned and operated wholesale electric utility company. It was created by Congress in 1937 as the marketing agent for power generated at the Bonneville Dam. Since then it has been organized as part of the Department of Energy and its mission expanded to market the power from the twenty-nine additional federal dams in the region. To accomplish this, BPA has designed and built a network of long distance high-voltage transmission lines which has grown over the last forty-seven years to become the backbone of the transmission system for the Northwest.

BPA serves the states of Washington, Oregon, Idaho, and Montana west of the Continental Divide, plus small adjacent portions of California, Nevada, Utah, and Wyoming. The service area covers approximately 300,000 square miles with a population of nearly 9 million people. BPA sells power to 173 wholesale customers made up of public systems, investor-owned utilities, industrial firms, federal agencies, and customers located outside of the region.[R#1] The Hood River Electric Cooperative is one of the 123 public systems that purchases power from BPA.

In 1980, under the Pacific Northwest Electric Power Planning and Conservation Act, BPA was assigned the additional responsibility of meeting the future growth in demand for electricity in the region through the acquisition of new generating resources and conservation measures. Through its Office of Conservation, BPA develops programs that present financial incentives to generators, transmitters, and end users of electricity for the purpose of obtaining the investment in and use of measures that increase the efficiency with which electricity is generated, transmitted, or used, and measures that employ renewable resources to displace consumption of electricity at the point of end use.

HOOD RIVER ELECTRIC COOPERATIVE

The fact that part of Hood River County received electric service from the Hood River Electric Cooperative (HREC) played an important role in the selection of the community as the location for the project.

HREC purchases power from BPA to provide electricity to its 2,783 (in 1990) customers in Hood River County.[R#3] HREC serves all but a small portion of the land area of Hood River County, although only one-third of the population. Through the Residential Conservation Agreement, the Hood River Electric Cooperative currently participates in many of the DSM programs funded by BPA.

In 1982-83, average electricity usage by HREC customers was 23,486 kWh/year, and was 20,689 kWh/year in 1987-88. The average electric rate was 3.4 ¢/kWh in 1982-83. (HRCP Statistics) [R#4]

NORTHWEST POWER PLANNING COUNCIL

The Northwest Power Planning Council participated in HRCP as a member of the Regional Advisory Group, and provided valuable input in the planning, implementation, and research phases of the project. With the 1980 passage of the Pacific Northwest Electric Power Planning and Conservation Act, the Northwest Power Planning Council was charged with the responsibility of developing a regional electric energy plan that provides a reliable electricity supply at the lowest cost. The Council is comprised of members from Idaho, Montana, Oregon, and Washington states. As the Council formulated the regional power plan under the Act, conservation was considered on equal terms with new generation.

NORTHWEST PUBLIC POWER ASSOCIATION

Another Regional Advisory Group member was the Northwest Public Power Association (NWPPA), a membership organization comprised of public utilities in the Pacific Northwest, including Alaska and Canada. NWPPA is concerned primarily with training and educational issues, and with representing and coordinating the interests of its public power members.

PACIFIC NORTHWEST UTILITIES CONFERENCE COMMITTEE

Also represented in the Regional Advisory Group was the Pacific Northwest Utilities Conference Committee, a membership organization representing both IOUs and public utilities in the Northwest. Because this group's focus is on power generation and other engineering and technical issues, their input was valuable in the planning stages of HRCP.

The Hood River Conservation Project (HRCP) was a comprehensive weatherization program implemented in Oregon between 1983 and 1985. The project was undertaken in an effort to quantify the energy savings and associated costs that could result from implementing various energy-efficiency measures in the residential sector of a community. HRCP was implemented in Hood River County, Oregon, and in the neighboring community of Mosier, in Wasco County. The community was chosen as the site for the project because it was believed that the community contained elements representative of others in the Pacific Northwest. Hood River County was diverse, had a variety of house types and ages, and the citizens had a range of occupations and household characteristics.

HRCP was a cooperative effort whose final configuration was a result of discussions among several different organizations. The project was initially proposed by NRDC to Pacific as a means of determining the appropriate role of conservation in the Pacific Northwest region. Pacific, which had been offering free energy audits to its customers since 1977 and had significant experience in the implementation of DSM programs, worked with NRDC to formulate a proposal for BPA. In 1983, BPA agreed to fund HRCP, with $13 million allocated to the weatherization program and $7 million for research and evaluation (1983$). The funds were later redistributed to better accommodate the project needs.

HRCP sought to implement a conservation program in as many homes in as short a time as possible. The project did not emphasize education or conservation practices; the emphasis was on physical changes to dwelling units as a direct analogy to constructing a "conservation power plant".

Through this "construction" process, enough data was to be generated as to provide solid evidence of the costs and benefits of conservation as an energy resource. To that end, a detailed evaluation plan was developed prior to the onset of the project. The research and evaluation plan was reviewed and implemented primarily by staff of the Oak Ridge National Laboratory. The project had five specific objectives:

1. To determine the effects of weatherization measures on annual electricity use, individual customer load shapes, and the transmission and distribution system;

2. To detail participation and determine the maximum reasonable penetration rate for the program as a whole as well as for each of the retrofit measures installed;

3. To investigate a variety of marketing methods and determine their effectiveness;

4. To observe and analyze the social dynamics of implementing a conservation project, specifically, to determine social interactions and impacts; and

5. To document the costs of implementing and evaluating the project.

Several different components were encompassed by the project: the performance of an energy audit to identify appropriate measures for installation, installation of these measures, and follow-up monitoring and evaluation. Energy audits were performed on all participating homes between 1983 and 1985, measures were recommended and installed, and then data collection continued for several years after installation. HRCP attained 91% participation and generated a series of more than 24 reports analyzing the results of the program.

An intensive marketing effort solicited participants who voluntarily signed up for energy audits. Outlet gaskets and water-heating efficiency measures were installed at the time the energy audit was conducted in each home. In conjunction with the installation, auditors also turned down water-heater thermostats as appropriate, giving additional energy savings with virtually no cost. After the energy audit was conducted, recommended measures were installed by independent contractors.

A cost-effectiveness cap was used to determine whether all recommended measures should be installed. This cap was based on the avoided cost of a new coal plant. If the cost of recommended measures exceeded the cap, homeowners had the option of making up the difference. Otherwise, only those measures whose costs did not exceed the cap were installed.

Several measures were included in the program: insulation, storm window installation, door replacement, infiltration reduction, installation of clock thermostats, and water heater improvements. Additionally, air quality was tested for the presence of radon and air-to-air heat exchangers installed in homes where necessary. The most common measure recommended was the installation of storm windows. This measure was recommended in 99% of all the homes, and installed in 89%. (All of this section is based on [R#4].)

MARKETING AND DELIVERY

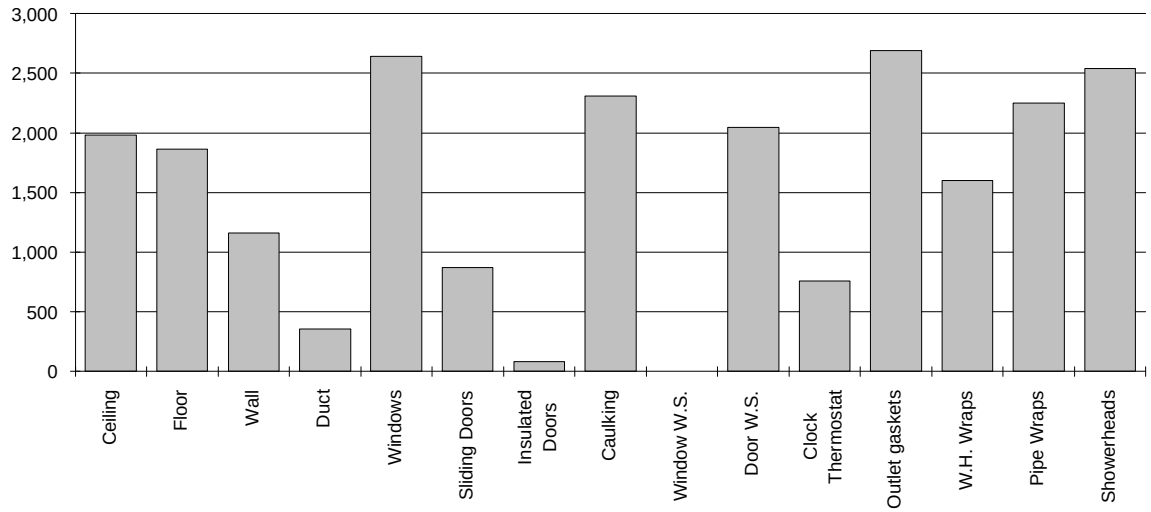
The HRCP achieved high participation due not only to a concentrated marketing effort, but to high community interest as well. A detailed promotional plan was developed prior to the start of the implementation phase. The plan had four elements: advertising, promotion, community activities, and personal contacts. Interest in the project was very high, and word spread quickly, generating high participation with minimum advertising and promotion. As a result, many of the planned marketing activities were deemed unnecessary, and about 75% of the marketing budget was never spent. [R#4]

When the project was initiated, newspaper advertisements were placed, and two billboards were erected with the message "Welcome to the Nation's Conservation Capital". For the duration of the project, advertisements and articles appeared in the local newspaper, and the project administrator appeared on several radio programs. Toward the end of the project, telephone calls and personal visits were made by project staff to eligible households that had not yet signed up for the program. [R#4]

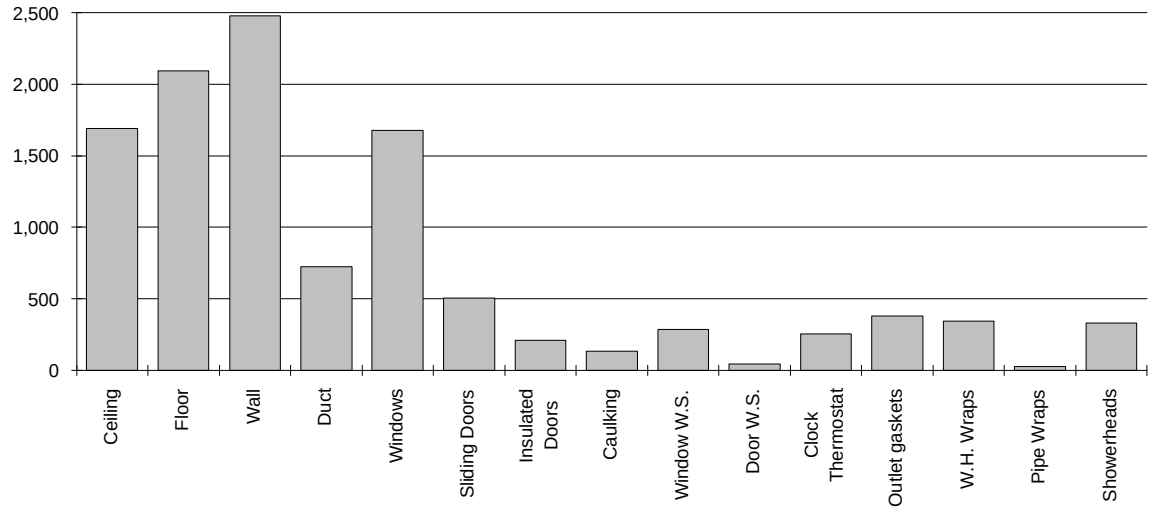
MEASURES INSTALLED

Any household in the project area that had permanently installed electric space heating equipment was eligible to participate in the program. Thus single family, multi-family, and mobile homes that met the criterion were included. An energy audit was conducted for each participating household. All audits were conducted by one vendor, who inspected each home and formulated recommendations for

NUMBER OF MEASURES INSTALLED



AVERAGE PREDICTED ANNUAL ENERGY SAVINGS FOR EACH MEASURE INSTALLED (KWH)



Predicted Savings Table	% of Recommended Measures Installed	Number of Measures Installed	Average Predicted Annual Savings per Measure (kWh)	Total Predicted Annual Savings (kWh)
Audit measures				
Outlet gaskets	100%	2,689	378	1,016,000
Water-heater wraps	100%	1,599	343	549,000
Hot-water pipe wraps	100%	2,251	25	56,000
Low-flow shower heads	100%	2,538	329	834,000
Total audit measures	**100%**			**2,455,000**
Retrofit Measures				
Insulation				
Ceiling	76%	1,980	1,691	3,348,180
Floor	72%	1,864	2,093	3,901,352
Wall	80%	1,163	2,480	2,884,240
Duct	63%	357	726	259,182
Windows and doors				
Windows	90%	2,641	1,678	4,431,598
Sliding doors	73%	872	504	439,488
Insulated doors	25%	86	208	17,888
Infiltration				
Caulking	88%	2,307	136	313,752
Window weather stripping	0%	2	284	568
Door weather stripping	77%	2,046	46	94,116
Clock thermostat	81%	758	253	191,774
Total retrofit measures	**79%**			**15,882,138**
Total Savings	**81%**			**18,337,138**

[R#4,8]

appropriate weatherization measures. Measures included insulation improvement, windows and doors enhancements, infiltration reduction, clock thermostat installations, water heater improvements, and air quality measures.

After the audit, the auditor's recommendations and observations were entered into a computer program which used Bonneville's Standard Heat Loss Methodology to calculate the costs and savings that could be expected from the recommended measures. If the recommended package of measures exceeded the cost-effectiveness limit, then the homeowner could elect to have the additional measures installed at their own expense, or some measures could be dropped to lower the cost.

The audit vendor had no connection with the contractors who installed all measures, eliminating the possibility of any conflict of interest. Additionally, HRCP staff inspected all of the installation contractors' work. Measures installed by the program and the predicted kWh/year savings are shown in Predicted Savings Table and the accompanying charts. A weighted average of 81% of the predicted savings of measures recommended were installed.

Radon monitoring and air exchange measurements were also conducted, and air-to-air heat exchangers were recommended and installed based on the results. The air quality measures were not included in the cost-effectiveness calculation.

STAFFING REQUIREMENTS

When the program began in 1983, the HRCP field office, located in Hood River, was originally staffed with 6 personnel. After the first year of implementation, when virtually no retrofits had been completed, it became clear that the original staffing level was inadequate, and 8 people were added to the field office staff. While the project initially had only 2 inspectors, the number was increased to 6 as part of the field office expansion.

Contractors were hired for a variety of tasks. The computer system for project tracking was designed and installed by an outside vendor. The energy audits were conducted by a vendor whose staff varied from 4 to 6 people. Five local contractors installed the weatherization measures, and six additional (not local) contractors began participating in the summer of 1984. The project initially allowed only local firms to install the weatherization measures, but it became apparent that the local firms could not keep pace with the demand of the program, so the restriction was lifted. Additionally, quality control problems necessitated dismissal of two of the original contractors involved in the weatherization measure installation.

Shortly after project startup, when the number of audit requests far exceeded what was anticipated, delays between audit request and performance of the audit were about 4 months. The contractor was able to reduce this delay as auditor efficiency improved; in general, the lag time was kept fairly constant, at an average of 3 months. Lag time between completion of the audit and installation of the recommended measures was much higher at the beginning of the project than at the end. The mean was about 9 months.[R#4]

MONITORING

The HRCP is one of the most extensively monitored projects of its type. The program has been tracked and documented not only from the concept stage to implementation, but also for several years after implementation. Principal data sources included results of end-use metering of 320 homes, monthly electric bills, National Oceanic and Atmospheric Administration weather data, and a number of household surveys.

EVALUATION

Numerous studies and analyses were conducted in conjunction with HRCP. Over 75 reports and papers have been published, including a series of 24 documents published by BPA and several others by Oak Ridge National Laboratory. A significant amount of the evaluation effort was undertaken by Oak Ridge National Laboratory.

The following are highlights of some of the studies performed as part of the HRCP.

• Analysis of pre- and post-retrofit electricity bills of participants was the primary method of determining project savings. These data, in conjunction with weather data, were used to determine first-, second-, and third-year project savings. After some attrition due to vacancies, the final data set was comprised of 1,997, or 67%, of the 2,989 retrofitted homes. Electricity bill analyses were also conducted in two similar communities for purposes of comparison. The results of these analyses are presented in the Savings section of this profile.

• End use meters were installed in 320, or 11%, of the retrofitted homes. As part of the end use monitoring (EUM) component, comprehensive household interviews were conducted in 1984 and 1989. The results of the EUM studies were used to determine load impacts, and are presented in the Savings section of this profile.

• Two random mail surveys (pre- and post-test) were completed in Hood River, and in two comparison communities (Grants Pass in southwest Oregon, and Pendleton in northeast Oregon). The surveys generated data on household characteristics, electricity prices, and changes in energy use and residents' attitudes. This information was used in the energy analyses and in determining net electricity-savings effects.

• In order to meet the goal of assessing community social interactions and the social impacts of the project, a sociological community assessment was conducted prior to project startup, and a final process evaluation was completed by an independent contractor at the end of the project. Through interviews with residents, contractors, and staff, the final process evaluation detailed the perceptions and attitudes of these players. HRCP was one of very few projects to publish its failures. The process evaluation concludes that "perhaps the greatest lesson to be learned is that such a project requires great flexibility in order to achieve its goals".[R#7]

• Detailed project records were maintained for the duration of the project. Records were kept regarding participation, participants, audit completion, measure installation, and all costs.[R#4]

• Distribution feeders were monitored in Hood River to determine the effects of the project on the distribution system.[R#4]

DATA QUALITY

Data generated by this project is very reliable. In addition to the numerous studies concerning the results of the project, detailed analyses of data quality were also completed.

Savings projections were validated through analysis of electric bills of most participating households for three years following retrofitting. Of 2,989 retrofitted households, 2,362 bills were analyzed during the first year after project comple-

tion (1985-86), 2,120 during the second year, and 1,997 during the third year. Attrition was due to failure of the household to meet the sample criteria, which excluded dwellings for which there were not enough bills to facilitate comparison as well as those that were determined to have been vacant for extended periods. The latter group was identified as those whose year-to-year change in consumption exceeded 80%.

In determining program savings, data were analyzed for the main sample set, and a subset which represented households who very likely used electricity for most or all of their space heating needs. Numerous other data sets were analyzed, including separations by home size, dwelling type, and utility. Data presented in the Savings section of this profile are based on the 1,997 sample, which includes both utilities, all home sizes and types, and some households that may not rely solely on electricity for space heating.

Gross and net savings for data sets were determined using the Princeton Scorekeeping Model (PRISM), which allows for normalization of the effects of weather variations on energy use from year to year. Gross savings were determined to be a more reliable method of depicting project savings than net savings. The calculation of net savings, which exclude savings not attributable to the project, were characterized by project analysts as "less than perfect"; because virtually every household within Hood River County participated in the project, there was no valid in-community control group for comparison purposes. High standard deviations were found in the analyses for savings in mobile homes. Other data sets showed good correlations within the various subsets.[R#6]

The engineering estimates of savings (based on the energy audits) differed significantly from the real savings as determined by the bill analyses. The principle reason for this discrepancy was that pre-project electricity usage estimates were much higher than the actual usage documented later. Because of significant use of wood for space heating, and due to the high electricity rates in Pacific's service area, usage in Hood River single family homes was about 5,000 kWh/year less than was typical at that time in the region. As a result, the maximum savings were lower than what was expected initially.

Electricity load reductions on a typical weekday, a typical weekend day, and on the system peak day were determined based on the results of the end-use metering of 320 homes. Whole-house loads, baseloads, and spaceheating loads were analyzed. The sample analyzed was restricted to single-family detached housing that met certain screening criteria that eliminated homes that might not be comparable. Thus, the final sample consisted of 220 single-family end-use monitored homes.

The project budget was spent over the course of several years, and while detailed cost analyses present categorized budget data, they do not separate annual expenditures. Thus, it was difficult to determine a valid method of converting to 1990 dollars in accordance with The Results Center convention. For this reason, cost figures in the Costs Overview Table (pg. 14) are presented for the project as a whole in historic dollars spent, as well as in 1990$. The 1990$ figures in the Costs Overview Table assume that the total project budget was spent in 1985, and are converted based on the inflation rate in that year. The cost of saved energy as calculated in the Cost of Saved Energy Table (pg. 14), is based on the converted dollar costs per the convention.

Additionally, budget data were not available beyond the date of the final report in May, 1987. Yet research continued beyond that date, and costs were incurred: bill analysis continued through 1989, with the final bill report published in late 1990; meters in the 320 EUM homes were monitored and the results documented; a final persistence in load savings report was completed; and other studies were performed after publication of the project final report.

HOOD RIVER, 1992

When the Hood River community was selected as the ideal site for this conservation project, the planners anticipated that the community would remain fairly stable, both economically and in regard to resident permanency. Planners never predicted the huge influx of sail boarding enthusiasts who have dramatically changed the nature of the community. What was once a diverse community with representatives from many lifestyles and economic situations has become a town with a strong economic reliance on a tourist-based industry.

For program analysts, this unanticipated change has thrown an unwelcome wrench into the evaluation process. A large number of the residents who were present during the retrofit phase of HRCP no longer live in Hood River. Thus, for new residents in retrofitted homes, no savings can be attributed to changes in energy using behavior that often result after participation in a conservation project. Additionally, the higher economic status of Hood River has likely contributed to the decreased energy savings seen between the second and third years after retrofit. Improved economic status is often accompanied by such changes as decreases in the use of wood as a primary space heating fuel, increases in room temperature set points, and increases in the number of appliances in homes. These factors all contributed to the decreased energy and capacity savings seen in the third year after weatherization was completed.

Program Savings

Savings Overview Table	Average Energy Savings (kWh/household)			Whole House Electricity Load Savings (kW/house)		
Year After Retrofit Completed	Combined Sample	Single Family Homes	Mobile Homes	System Peak Day	Weekday	Weekend Day
1st year	2,600	2,700	2,500	1.76	0.79	1.35
2nd year	2,600	2,700	2,600	1.75	1.28	1.50
3rd year	1,700	1,800	1,700	1.46	0.78	1.00

Unlike other profiles, which present savings for each year of a program as it was implemented, program savings are presented in this profile for the three years following completion of the weatherization retrofits. Retrofits were installed between 1983 and 1985, and analysis occurred between 1985 and 1988. Thus, the savings discussed represent the first three years of the lifecycle savings of the measures.

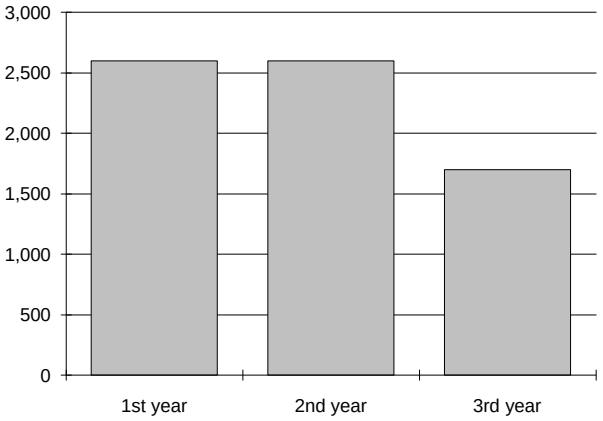
In the first year following retrofits, overall program savings averaged 2,600 kWh/year based on a sample of 1,997 retrofitted homes. This savings was 15% of the average pre-HRCP use. While second year savings remained unchanged, by the third year average savings had decreased to 1,700 kWh per home. The Savings Overview Table above shows energy and capacity savings for mobile homes, single family homes and the combined sample one, two, and three years after weatherization was completed in the 2,989 homes.[R#6]

First-year savings were lower than expected due primarily to the low pre-project electricity use. Many participants used wood as a primary heating fuel, did not heat all rooms in the household, or used low winter temperature settings. Additionally, customers were subject to substantial electricity price increases prior to the onset of the HRCP, and the local economy was in recession due to a decline in the wood products industry, which may have resulted in more conservation before the start of the project. All of these factors contributed to the lower than average pre-project electricity use. In fact, the actual electricity use in Hood River was about 5,000 kWh/year below the utility planners estimates.

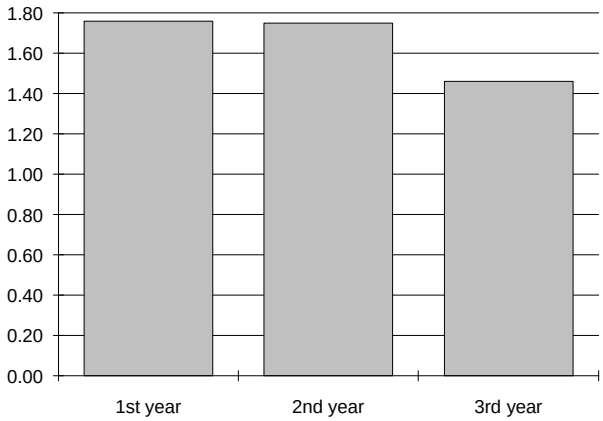
Finally, the takeback effect was experienced in Hood River, with many participants practicing less efficient behaviors following installation of the weatherization measures. Project analysts believe that if pre-project behaviors were practiced, actual measured savings would have been greater.

By the third year, measured savings had continued to drop. Several explanations for this decrease in energy savings

ENERGY SAVINGS IN YEARS AFTER RETROFIT (KWH/HOUSE)



WHOLE HOUSE ELECTRICITY SAVING ON SYSTEM PEAK DAY (KW/HOUSE)



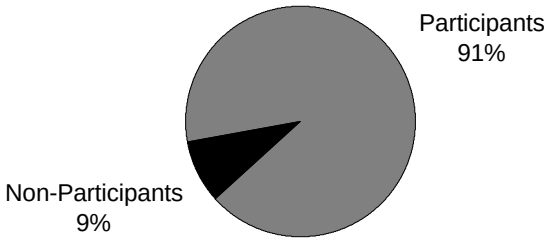
were developed in conjunction with the third-year savings analysis. The primary reasons were:

1) increase in the number of consumers using electric space heat (i.e. less wood use as primary space heating fuel);
2) an increase in the number of appliances in homes;
3) participants were keeping their homes warmer;
4) participants were heating more rooms;
5) the real price of electricity for both utilities decreased;
6) favorable economic conditions contributed to an increase in electricity use. (See Box: Hood River 1992.)

PARTICIPATION RATES

HRCP achieved extraordinary participation rates -- between 81% and 91%, depending on the method of analysis. For audits, the project attained a 91% overall participation rate, with 3,189 of the 3,500 eligible households receiving an audit.(Participation Table) Of the 311 homes that did not receive an audit, HRCP contacted 60 households and was unable to contact 251. The main reason for their lack of participation in the audit stage of the project was that the house was vacant or the occupants were unavailable.[R#4]

When measuring participation in terms of the number of homes installing measures after the audit to the total eligible homes, the participation rate was 85%. A total of 14,076 measures were installed in 2,989 households.



Participation Table	Number of Eligible Homes Participating	% of 3500 Eligible Homes
Audits	3,189	91%
Audit Measures	3,016	86%
Retrofit Measures	2,989	85%

[R#4,5]

Yet another method of measuring participation is by percent of recommended measures installed, based on estimated energy savings. Using this method, HRCP achieved 81% participation. (see Predicted Savings Table)

Of the 3,189 audit participants, 200 did not install any weatherization measures beyond what was installed at the time of the audit, (that is, the full set of "low cost/no cost" measures). Of the 200 who did not receive any major weatherization measures, the primary reason (145 households) was that the established cost-effectiveness cap was exceeded and the homeowners were unwilling to pay the difference. The remaining 55 households declined to participate after the audit had been conducted. Some of these 55 said they would install the measures on their own, some did not want to bother, while some did not want anyone on their property.[R#4,12]

MEASURE LIFETIME

Lifetimes of 35 years and 44 years were assumed for all the measures combined. The latter figure was arrived at using assumptions on retrofit lifetimes developed by the Northwest Power Planning Council. Thirty-five years was the average lifetime assumed in the determination of the cost-effectiveness limit, (see Cost of the Program section).

PROJECTED SAVINGS

Auditors predicted that annual savings would average 5,700 kWh/year, if all measures recommended were installed in 92% of the homes, and only audit measures were installed in the remaining 8%. Of course, not all measures could be recommended, nor were all recommended measures installed. The primary reasons for a measure not being installed in a participating home were that the measure was already in place, it was not cost-effective, physical constraints did not allow for an installation, or that the measure was not applicable to the house (eg floor insulation is not applicable to homes built on concrete slabs). A complete accounting of such barriers allowed a clear documentation of the difference between technical potential and achievable potential.[R#12]

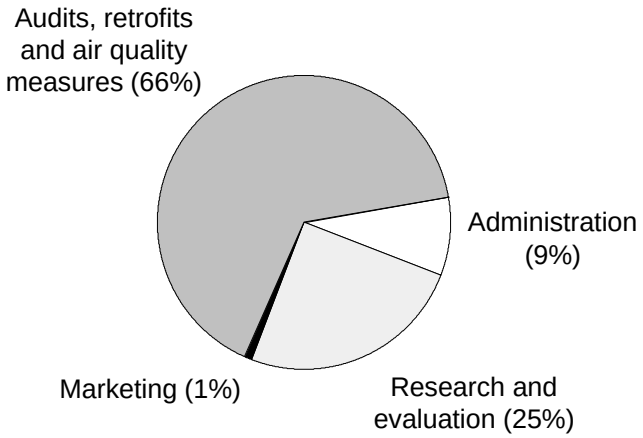
Audit predictions of the annual savings that would be realized from each measure installation revealed a total of 18.3 GWh annual savings. (Predicted Savings Table) The actual savings, as determined from bill analyses, were much less than projected, averaging 1,700 kWh of third year savings per house per year in 2,989 homes or 5.1 GWh/year.

Cost of the Program

Costs Overview Table	Admin. & Computer System (x1000)	Market-ing (x1000)	Energy Audits (x1000)	Retrofit Measures (x1000)	Air Quality (x1000)	Research & Eval. (x1000)	Total Cost (x1000)	Cost per Audited Home
1983$ - 1987$	$1,683	$113	$171	$11,141	$1,294	$4,116	$18,518	$5,807
1990$	$2,040	$140	$210	$13,530	$1,570	$5,000	$22,490	$7,053

[R#5]

Note: 1990$ are based on 1985$ conversion



Cost of Saved Energy (¢/kWh)	Discount Rates						
	3%	4%	5%	6%	7%	8%	9%
35 year lifetime	9.53	10.98	12.51	14.13	15.82	17.58	19.39
44 year lifetime	8.45	9.97	11.60	13.32	15.11	16.96	18.86

HRCP was funded with $15.9 million for administration, marketing, energy audits, and retrofit measures. An additional $1.6 million was spent on air quality measures, and $5.0 million was allocated to the research and evaluation component.(Costs Overview Table)

COST EFFECTIVENESS

HRCP set a cost-effectiveness cap based on the net present value of building and operating a new coal-fired power plant. This figure was set at $1.15/kWh, which, when annualized over a 35 year lifetime at a 3% real discount rate, is equivalent to 5.2 ¢/kWh.[R#4,13]

Because HRCP was a research and demonstration project, the research and evaluation cost component was so high as to not be comparable to any other similar projects. Thus, these costs are not included in The Results Center calculation shown in the Costs of Saved Energy Table. The figures, in 1990 dollars per The Results Center convention, are based on annual energy savings 2,600 kWh/house, and are calculated for a 35 and a 44 year lifetime. Assuming a 5% discount rate, the annualized cost of saved energy was 12.51 ¢/kWh for a 35 year lifetime, and 11.60 ¢/kWh for a 44 year lifetime. The cost of saved energy figure most commonly associated with HRCP is 7.1 ¢/kWh. This figure was calculated by HRCP using a 44-year lifetime and a 3% real discount rate using the 2,600 kWh/house saving figure, but the figure is not in 1990$.

Using HRCP's own criteria, or threshold, for cost effectiveness, the project was not cost-effective. That is, the 7.1 ¢/kWh figure exceeded 5.2 ¢/kWh. However, HRCP calculated the annualized cost of saved energy for the Project in a number of ways. In fact, one detailed paper published in 1990, presents the cost of saved energy for the project under a variety of scenarios, with costs ranging from 2.7 to 7.6 ¢/kWh. For example, the paper discusses the fact that HRCP purposely included many measures which were not cost-effective, in an effort to determine which measures were too expensive to include in future projects. If the conversion of double-pane windows to triple-pane windows had not been included in the project, the cost of saved energy would have been about 0.5¢/kWh less than the base cost.[R#13] The information provided by HRCP in regard to which measures are and are not cost-effective has undoubtedly influenced many project managers, saving countless dollars which are obviously not included in these figures.

COST PER CUSTOMER

The average cost per household, as calculated by HRCP was $4,400. This cost does not include the cost of air quality measures installed and is a weighted average of retrofit costs by house type. The Results Center calculation, shown in the Costs Overview Table, includes all costs at $7,053 per audited home.

FREE RIDERSHIP

Because HRCP was designed to offer major measures in packages significantly in advance of the accepted practice at the time, free-ridership was not considered to be an issue for the HRCP. While some households may have installed a few of the measures, virtually none would have installed all of the measures. The high costs and the unavailability of certain measures (eg. triple pane glass was not readily available outside of the project) precluded the possibility of households implementing such a comprehensive retrofit on their own.

COST COMPONENTS

Of the total project cost of $22.5 million, $17.5 million was spent on fieldwork and $5.0 million on data collection and analysis. Originally, the project funding was differently apportioned, and funds were reallocated on recommendation of the Regional Advisory Group as the project needs dictated. This unique flexibility in funding enhanced the ability of project managers to meet the project goals.

The measures installed at the time of the audit comprised less than 1% of the installed measures costs, while providing 13.4% of the first-year energy savings. Of the major measures, most expenditures were on insulation, windows, and doors.

Environmental Benefit Statement

Marginal Power Plant	Heat Rate BTU/kWh	% Sulfur in Fuel	CO2 (lbs)	SO2 (lbs)	NOx (lbs)	TSP* (lbs)
Coal	**Uncontrolled Emissions**					
A	9,400	2.50%	737,226,000	17,490,000	3,536,000	354,000
B	10,000	1.20%	786,124,000	6,770,000	2,283,000	1,693,000
	Controlled Emissions					
A	9,400	2.50%	737,226,000	1,749,000	3,536,000	28,000
B	10,000	1.20%	786,124,000	677,000	2,283,000	113,000
C	10,000		786,124,000	4,514,000	2,257,000	113,000
	Atmospheric Fluidized Bed Combustion					
A	10,000	1.10%	786,124,000	2,069,000	1,128,000	564,000
B	9,400	2.50%	737,226,000	1,749,000	1,414,000	106,000
	Integrated Gasification Combined Cycle					
A	10,000	0.45%	786,124,000	1,392,000	226,000	564,000
B	9,010		707,135,000	504,000	170,000	34,000
Gas	**Steam**					
A	10,400		428,795,000	0	978,000	0
B	9,224		372,374,000	0	2,332,000	110,000
	Combined Cycle					
1. Existing	9,000		372,374,000	0	1,429,000	0
2. NSPS*	9,000		372,374,000	0	677,000	0
3. BACT*	9,000		372,374,000	0	94,000	0
Oil	**Steam--#6 Oil**					
A	9,840	2.00%	620,624,000	9,403,000	1,110,000	1,053,000
B	10,400	2.20%	658,238,000	9,328,000	1,395,000	677,000
C	10,400	1.00%	658,238,000	1,332,000	1,121,000	354,000
D	10,400	0.50%	658,238,000	3,912,000	1,395,000	215,000
	Combustion Turbine					
#2 Diesel	13,600	0.30%	823,737,000	1,640,000	2,546,000	139,000
Refuse Derived Fuel						
Conventional	15,000	0.20%	977,953,000	2,520,000	3,318,000	737,000

Avoided Emissions Based on 341,941,600 kWh Saved over lifecycle

In addition to the traditional costs and benefits there are several hidden environmental costs of electricity use that are incurred when one considers the whole system of electrical generation from the mine-mouth to the wall outlet. These costs, which to date have been considered externalities, are real and have profound long term effects and are borne by society as a whole. Some environmental costs are beginning to be factored into utility resource planning. Because energy efficiency programs present the opportunity for utilities to avoid environmental damages, environmental considerations can be considered a benefit in addition to the direct dollar savings to customers from reduced electricity use.

The environmental benefits of energy efficiency programs can include avoided pollution of the air, the land, and the water. Because of immediate concerns about urban air quality, acid deposition, and global warming, the first step in calculating the environmental benefit of a particular DSM program focuses on avoided air pollution. Within this domain we have limited our presentation to the emission of carbon dioxide, sulfur dioxide, nitrous oxides, and particulates. (Dollar values for environmental benefits are not presented given the variety of values currently being used in various states.)

HOW TO USE THE TABLE

1. The purpose of the previous page is to allow any user of this profile to apply the Pacific and HREC levels of avoided emissions saved through the Hood River Conservation Project to a particular situation. Simply move down the left-hand column to your marginal power plant type, and then read across the page to determine the values for avoided emissions that you will accrue should you implement this DSM program. Note that several generic power plants (labelled A, B, C,...) are presented which reflect differences in heat rate and fuel sulfur content.

2. All of the values for avoided emissions presented in both tables includes a 10% credit for DSM savings to reflect the avoided transmission and distribution losses associated with supply-side resources.

3. Various forms of power generation create specific pollutants. Coal-fired generation, for example, creates bottom ash (a solid waste issue) and methane, while garbage-burning plants release toxic airborne emissions including dioxin and furans and solid wastes which contain an array of heavy metals. We recommend that when calculating the environmental benefit for a particular program that credit is taken for the air pollutants listed below, plus air pollutants unique to a form of marginal generation, plus key land and water pollutants for a particular form of marginal power generation.

4. All the values presented represent approximations and were drawn largely from "The Environmental Costs of Electricity" (Ottinger et al, Oceana Publications, 1990). The coefficients used in the formulas that determine the values in the tables presented are drawn from a variety of government and independent sources.

*** Acronyms used in the table**

TSP = Total Suspended Particulates

NSPS = New Source Performance Standards

BACT = Best Available Control Technology

LESSONS LEARNED

The HRCP was the first comprehensive weatherization program to be undertaken with a goal of 100% participation, strict time constraints, and a set of ambitious objectives in regard to costs, savings, and evaluation. Extensive planning played a big role in the overall success of the project, and helped to minimize the number and extent of unforeseen problems.

Overall, the project did achieve its goals, albeit occasionally in surprising ways. Virtually no traditional marketing techniques (e.g. paid advertisements) were necessary to achieve the 91% participation rate for audits, and the 85% participation rate for installations, as the community was highly receptive to the project. Such high participation rates were virtually unheard of in the mid 1980's, and HRCP set an important precedent when it achieved this level of participation. While savings were less than what was anticipated in the project proposal, the project was still able to generate significant peak load savings as well as energy savings in all homes. The cost effectiveness limit, set unusually high for this project at $1.15/kWh of first year savings, (5.2 ¢/kWh annualized), was exceeded. However the primary goal -- to show that significant savings could be realized through DSM -- was certainly met.

The concept of a shell retrofit was totally new at the time HRCP was implemented. Weatherization technology was not well advanced at the time HRCP was ongoing, and as a result, the project had to remain flexible to accommodate new information as it became available. For example, air-to-air heat exchangers were at first installed in every home, because no standard for their use had yet been established. During the implementation phase of the project, standards for air exchange were developed, and these were put to use by HRCP.

HRCP did not seek to educate community members as to correct conservation practices. Nonetheless, through participation in the program many customers became better informed about energy efficiency. Unfortunately, this associative knowledge was lost whenever residents of retrofitted homes moved out of their homes or the community. After three years of energy use analysis, it was determined that energy and capacity savings had dropped significantly from their first-year level. This drop has been attributed in part to the loss of any education that was achieved during the project implementation phase, and points to the importance of an ongoing educational effort in any DSM program.

As a research and demonstration project, HRCP sought to analyze its successes and failures in a complete manner. A detailed process evaluation report was prepared by an objective outside contractor, as was a logistics report, evaluating the implementation of the project as seen from the project managers' perspective.

Thirteen recommendations were made in the HRCP final report, which summarizes the results of the process evaluations.

1. The project manager must have autonomy and flexibility in expenditures and personnel decisions.

2. The service departments within the utility provide valuable support for project management and administration.

3. While local contractors can be given preference, the pool from which contractors are selected should not be so limited.

4. Close supervision of contractors is vital. Criteria should be clear and penalties enforced for work that is substandard.

5. The community advisory committee should be chosen so that it represents a cross-section of the community in regard to geography, occupation, and values. Non-participating members should be replaced.

6. A community assessment is a valuable tool for planning marketing strategies and gaining wide acceptance for the project.

7. Homeowners should not be subject to false promises, particularly in regard to scheduling.

8. Establishment of a central office facilitates communication among auditors, inspectors, and field specialists, in turn enhancing work efficiency.

9. Early establishment of research and evaluation goals allowed the project to proceed toward meeting those aims.

10. If the project is on a tight schedule, as HRCP was, then it may be advantageous to allow the use of measures and equipment that are available from more than one supplier.

11. Contractors should not be responsible for informing homeowners about the details of the work to be performed. Project staff should perform this function.

12. The use of unit pricing, rather than competitive bidding, produced significant cost savings in both weatherization and administration. The unit prices used by HRCP were developed based on the competitive bidding process, thus competitive bidding was necessary in order to establish appropriate unit prices.

13. Materials and installation specifications should be clearly defined prior to the initiation of any fieldwork.

TRANSFERABILITY

HRCP proved that conservation was a viable energy resource that could be considered on equal ground with supply-side options both in the Northwest and around the world.

The Regional Advisory Group was an unprecedented collaboration which enhanced the ability of the project managers to meet the project goals. Through teamwork and consensus building, all points of view were taken into account before decisions regarding the project and its management were finalized. This group was perhaps the first DSM Collaborative, and the concept is now implemented in a number of other regions.

The lessons learned from the project were well documented in order to facilitate transferability and provide insight for use in new projects. HRCP was a leading edge DSM program of its time, and as a result provided valuable new data regarding the cost-effectiveness of a variety of measures. For example, the project found that adding underfloor insulation and converting double-pane windows to triple-pane were not cost-effective measures. HRCP also implemented the House Doctor infiltration reduction technique in 75 homes after retrofitting, only to find that there were no incremental savings that could be attributed to the treatment.

These important results have been used extensively by BPA, Pacific, and many other utilities and power planners in the development of ongoing DSM programs. A similar community-wide weatherization project funded by Ontario Hydro in the town of Espanola is underway, and many of the recommendations that resulted from HRCP were considered in the project design. At Espanola, project managers have placed a high priority on meaningful community input in management decisions.

The unprecedented research and evaluation effort undertaken at Hood River has made it a valuable tool for DSM. Although HRCP was not cost-effective in terms of the expenses and the energy saved in each home in Hood River, the efforts put forth in planning and analysis have precluded the need for such extensive efforts in other projects of this type worldwide. HRCP laid the groundwork for similar community-wide weatherization projects to be implemented in a cost-effective manner. In this larger sense, the savings from HRCP are priceless.

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