THIRD YEAR ANALYSIS OF ELECTRICITY USE AND SAVINGS FOR THE HOOD RIVER CONSERVATION PROJECT

Final Report

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Executive Summary

The Hood River Conservation Project was a large scale research and demonstration project which installed high levels of retrofit measures in 95 percent of the homes with installed electric heating equipment in Hood River, Oregon. This report discusses persistence of energy savings in the third postretrofit year.

Three years of postretrofit data from the Hood River Conservation Project clearly show that participants increased their electricity use in the period of 1987/88, the third postretrofit year. Other regional samples of non-participants show the same phenomenon, but not to the same extent. It can be argued, however, that rather than making behavioral changes which reduced the retrofit savings, consumers increased electricity usage due to new loads. Analysis of available data provides some potential reasons for this increase in consumption.

1) Analysis of the billing records shows an increase in the number of consumers using electric space heat. Survey results support this conclusion.

2) There are more appliances in the homes of participants now than in the preprogram period.

3) Hood River participants are keeping their homes warmer in 1989 than in 1984.

4) Consumers heated more rooms in 1989, though there were fewer occupants per home than in 1984.

The amount of change from preretrofit usage was statistically significant for the third postretrofit year when compared to the first and second postretrofit years. A gross decrease in savings of about 900 kWh was found for the group comprised of all mixed-fuel homes between the second and third postretrofit years; and about 1,100 kWh for all dwellings with primarily electric heat. The magnitude of the decrease in kWh savings was the same for consumers served by each of the two utilities involved in the Project. Net savings appear smaller than gross savings, but cannot be accurately determined due to the lack of an in-community control group.

While changes are observed in both space heating and baseload energy use, the underlying causes are not clear. This decrease in savings and higher total consumption may be attributable to consumer take back of savings, to price effects, or to income effects. The real price of electricity for both utilities declined over the postretrofit period.

There is circumstantial evidence supporting the theory that the decrease in savings is at least partially new load. The Hood River community has been experiencing a booming local economy due to the influx of tourism relating to sail boarding. This is not occurring in the regional comparison group, where much of the economy is stagnant or declining due to uncertainties in the lumber and forest products industries.

The gradual increase in gross consumption mirrors patterns observed previously in booming economies, especially the early 1970s. It appears that consumption in Hood River decreased initially due to the Project retrofits, but is now increasing due to the favorable economic conditions. Hood River had experienced an economic downturn starting in the late 1970s, and the pre-retrofit usage recorded in 1983 was considerably lower than average usage in 1977. Due to the retrofits, it is unlikely that usage in these homes will ever climb back to those higher levels.

1. Introduction

The Hood River Conservation Project

The Hood River Conservation Project (the Project) was a major residential retrofit demonstration project, initially suggested by the Natural Resources Defense Council, operated by Pacific Power & Light Company (PP&L) in cooperation with the Hood River Electric Cooperative (HREC), and funded by the Bonneville Power Administration (Bonneville).

The Project sought to install as many cost-effective retrofit measures in as many electrically heated homes as possible in Hood River, Oregon. The retrofits were aimed at the building shell and water heaters to reduce electricity use for space- and water-heating; no heating or water-heating equipment was replaced. Energy audits were conducted and retrofit measures were installed by the Project between the fall of 1983 and the end of 1985. Data collection and analysis began in the spring of 1983 and continued through 1987.

The $11.5 million weatherization project[1] involved installation of higher levels of conventional retrofit measures than are generally offered in weatherization programs in the Pacific Northwest [e.g., R-49 ceiling insulation rather than the R-38 generally recommended in the Bonneville Residential Weatherization Program (RWP); see Bonneville (1982)]. In addition, Bonneville paid for installation of these measures up to a limit of $1.15/first-year estimated kWh saved,[2] almost four times the limit in Bonneville's RWP. Thus, the Project offered the chance to examine retrofit installation and subsequent energy savings when costs to the household and prior weatherization activities were largely removed as barriers.

Information on the purposes, design, and operation of the Project can be found in PP&L (1982 and 1983), Schoch (1987a), and French et al. (1985). First-year savings are reported in Hirst et al. (1987) and summarized in Hirst (1987). Second-year savings are reported in Schoch (1987b).

Study objectives

Savings stability three years after retrofit

The primary purpose of this report is to examine electricity use and savings in the third year following the completion of retrofits (1987/88). These

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[1] An additional $9.5 million was allocated towards a variety of research tasks associated with the weatherization.

[2] This corresponds to 5.5¢/kWh/year (in 1985 $), based on predicted savings, levelized over 35 years at a three percent real discount rate. If levelized over 44 years at the same rate, the predicted cost would be 4.9¢/kWh/year (in 1985 $).

results are compared to usage and savings estimates for the preceding two years (1985/86 and 1986/87) to determine whether savings continued to be constant, as found in the second-year analysis, or if they increased or decreased. A decrease in realized savings could be a "take back" effect, i.e. an increase in space heat usage for the purpose of increasing home comfort through higher indoor temperatures, heating a larger portion of the home, or reducing the use of wood as a heating fuel. Savings could also decrease if additional loads (e.g. appliances) were introduced into the house, or if behavioral patterns changed (e.g. the home was occupied more often so the heating equipment was used a larger portion of each day).

First-year savings take back was noted in Hirst et al. (1987), Tonn and White (1987), and Dinan (1987). Hirst et al., using both survey and monitored data, found savings take back of 300 kWh averaged over all homes. They attributed this to decreased use of wood for space heating. Tonn and White, using monitored data, also found that fuel switching from wood to electricity reduced first-year HRCP savings. Dinan later backed away from her conclusion of take back caused by increased indoor temperatures, acknowledging that other reasonable hypotheses could explain her observed differences (Dinan and Trumble, 1989). Keating (1990), after an extensive review of research on take back of savings, argues that only some of the early fuel switching in Hood River was take back, and that take back is a less important phenomenon than commonly supposed.

Confounding the measurement of program savings in later postretrofit years are changes in the economic conditions in the Hood River area. Hood River began experiencing a booming economy due to an influx of tourism relating to sail boarding. The fuel switching noted in the first postretrofit year could also be affected by the greater prosperity and higher employment in the community, which coincidentally began around 1985/86.

Changes in the community and their effect on savings

The secondary focus of this report addresses post-Project changes in energy-related attitudes and behavior, and in equipment and appliances. The analysis looks first at the above changes which occurred in the group of enduse monitored households and then measures the effect of these changes on changes in post-Project electricity use. The enduse households were also used to determine the extent of appliance, equipment, attitude, and behavioral changes over time.

Data and Methods

Data

The data used to analyze changes in electricity use are monthly household electricity bills from PP&L and HREC, and daily temperatures from the National Oceanic and Atmospheric Administration (NOAA) weather stations in Hood River and throughout the comparison region. The data are from July 1982 (preweatherization) through June 1988 (three years after weatherization).

In addition, survey information was available from random samples of households in PP&L's regional comparison group which provided information on type of dwelling unit. The random data were also matched against a master weatherization data base to determine which houses had been weatherized through utility-sponsored programs prior to 1983.

Figure 1 shows the data collection activities over time.

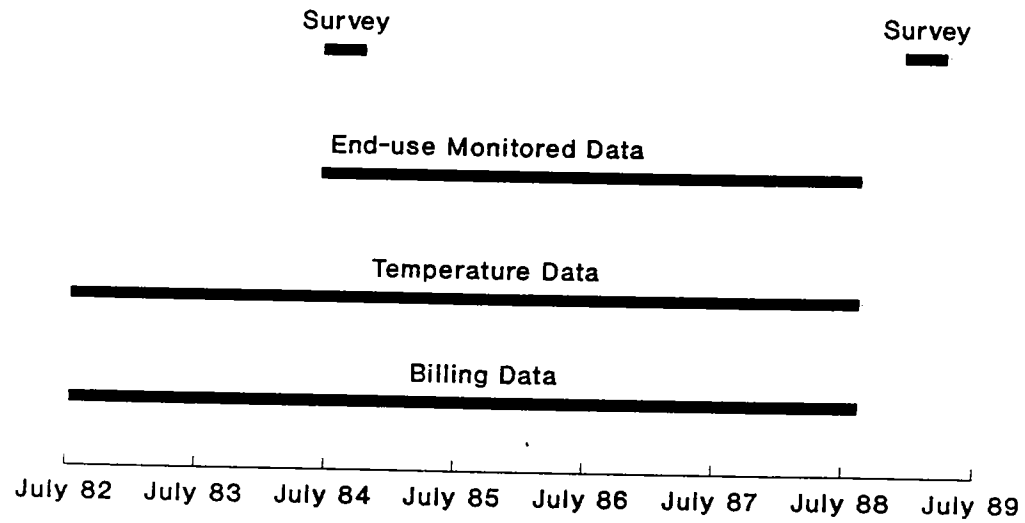

Figure 1. Timing of data collection activities.

The primary data set (called Somefit) excluded all master-metered dwellings and included all remaining households that had billing histories across study years with four or more bills that covered 270 days; most had 12 bills covering about 365 days. Households for which the year-to-year change in electricity use exceeded 80 percent of the prior year's consumption (about 5% of all homes) were considered outliers and were dropped from the analysis data set. In effect, this exclusion removed dwellings which had been vacant for extended periods.

The second analysis data set (called Goodfit) is a subset of Somefit. It includes only households whose electricity billing data closely fits the PRISM[3] model -- R^2 greater than 0.75, daily baseload and heat slope coefficients statistically significant at the 10 percent level or better, reference temperatures less than the maximum daily outdoor temperature for the entire year (from NOAA data), and a standard error in reference temperature of less than 20 °F -- for each year of analysis. Households whose billing histories met these criteria almost certainly used electricity for most or all of their space heating needs, corresponding with little or no use of wood. This method

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[3] Weather normalization was performed with the Princeton Scorekeeping Model (PRISM), see Fels 1986.

was used to determine which homes used electricity for space heat in all groups (see Table 1).

Table 1. Composition of data samples

Data set	Hood River PP&L	Hood River HREC	Hood River Total	Regional PP&L Comparison Group
Total	1,806	1,181	2,987	673
Somefit	1,196	801	1,997	435
Goodfit	221	172	393	79

Some attrition occurred between the third-year analysis and that done for the first and second postretrofit years (see Table 2). The same households were compared for all postretrofit years. Several checks for bias caused by sample attrition were performed, comparing first-year savings for homes in the first postretrofit year sample to first-year savings for homes in the third postretrofit year sample. The savings figures were not significantly different between the two groups for either the Somefit or Goodfit data sets (at alpha=0.05).

Table 2. Sample attrition

Sample		Data set	n	Data set	n
1st postretrofit year	(1985-86)	Somefit	2,362	Goodfit	615
2nd postretrofit year	(1986-87)	Somefit	2,120	Goodfit	466
3rd postretrofit year	(1987-88)	Somefit	1,997	Goodfit	393

Two in-home surveys were administered to all enduse monitored participants, one in 1984 and one in 1989. The 1984 survey was administered to all occupied dwellings at the time (n=314). The survey was administered in 1989 only if the same residents were still in place -- if an occupant change had occurred, the survey was not administered a second time (n=262). The survey instrument was a modified version of the Pacific Northwest Residential Energy Survey (PNWRES), last administered by Bonneville in 1983. These surveys included extensive appliance, heating equipment, and fuel use inventories; and questions on consumers' attitudes on energy use, cost, and scarcity. Other information gathered included income; household size; and age and gender of residents. Information on household temperatures under varying conditions and which rooms were heated during the winter are also included.

Methods

Electricity use and savings are examined for the preretrofit year (1982/83) and the three postretrofit years (1985/86, 1986/87, and 1987/88).

This analysis looks at two different measures of program performance: gross and net electricity savings. Gross savings are the reduction in annual electricity use between preretrofit and postretrofit years achieved by Project participants. Net savings are that portion of the total savings that can be directly attributed to the Project as determined by comparison with a control group.

The two previous savings analyses for these consumers used two communities in Oregon as the comparison group, however Schoch (1989) showed that these communities were not truly representative of Hood River in terms of gross electricity usage. To remedy this, data from a random sample of PP&L consumers from throughout the Pacific Northwest region are used as the comparison group for PP&L participants in this analysis (see Figure 2); comparison data for HREC participants for all three postretrofit years are derived from analyses done on public utility consumers in the Pacific Northwest[4] (see also Appendix C).

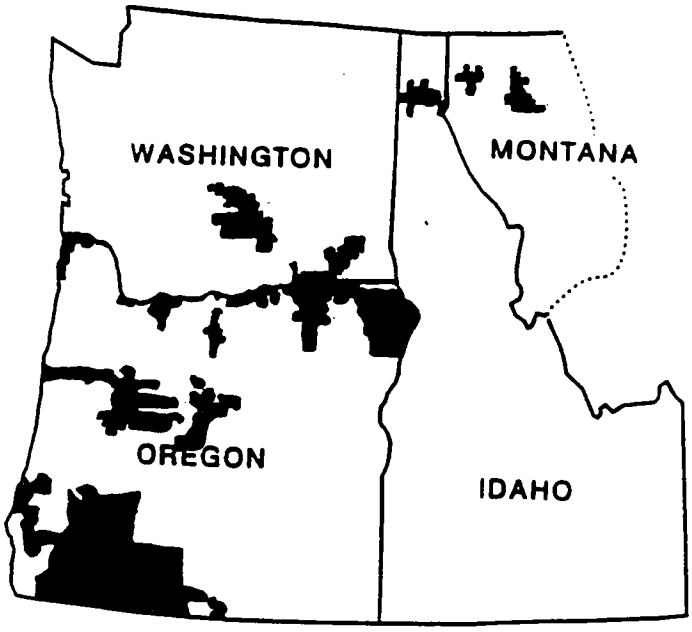

Figure 2. Geographic area represented by PP&L comparison group.

Gross and net savings are calculated using PRISM weather-normalized consumption to eliminate the effect of variations in weather on year-to-year energy use. Gross savings are calculated by subtracting 1987/88 usage from 1982/83 usage. Net savings are defined as the savings for which the Project is directly responsible. These are calculated by subtracting the average gross savings of the comparison groups from participant gross savings. Gross and net savings calculations are separated by utility due to the notable differences in energy consumption behavior found between consumers served by public and private utilities.

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[4] Data obtained from Goeltz et al. (1986) and Horowitz et al. (1987).

A subset of enduse monitored consumers, who received special and individual contact between 1983/84 and 1987/88, are analyzed separately to determine if this contact may have had an effect on energy consumption. Some of these homes also received an "incentive" measure if major retrofit measures were not cost-effective.

Monthly billing data are separated into analysis years, defined as July through June, and weather normalized using the PRISM model. Participants which met the Somefit criteria described above are separated by dwelling type, utility district, participation in a previous retrofit program, and participation in enduse monitoring. Each of these subsets is analyzed, as are all participants as a group, from the Somefit and Goodfit data sets.

Calculated third-year gross kWh savings are compared for each group to first- and second-year gross kWh savings to determine whether statistically significant differences are present. The gross differences between the pre-retrofit year (1982/83) and each of the three postretrofit years (1985/86 - 1987/88) are useful is assessing program efficiency. Savings are considered stable if the difference in savings between years is not statistically significant at alpha=0.05.

It is not possible to normalize consumption by square footage for the random sample of houses serving as the comparison group, as only survey data is available on these homes. Therefore, homes were separated into six size categories: less than 800 sqft, 801 to 1,200 sqft, 1,201 to 1,600 sqft, 1,601 to 2,000 sqft, 2,001 to 2,400 sqft, and greater than 2,400 sqft. Total usage for each year and gross savings for each of the postretrofit years are compared using analysis of variance procedures. These procedures incorporate the Waller-Duncan k-ratio t-test and Duncan's multiple range test to ensure that differences reported as significant are at an alpha level of 0.05 or better.

Consumers who participated in enduse monitoring are analyzed separately to determine whether their savings were affected by increased contact with Project staff, and also to determine causes for changes in energy savings between the second and third postretrofit years. The monitored homes are compared to nonmonitored homes to determine 1) whether consumption patterns changed; and 2) if the two groups were altering their consumption in the same manner and to the same degree.

The survey analysis of the enduse households uses the changes for each household between the two surveys. If a household did not complete either of the surveys, it could not be used.

The first step of the survey analysis is to separate key items relating to major appliances, space- and water-heating equipment, behavior (wood use, temperatures, number of heated rooms, and recent remodeling), demographics (income, number of residents, and owner or renter occupied), and attitudes towards energy. The number of appliance changes are totalled, e.g. removal of a refrigerator and addition of a freezer results in a net change of zero. For appliances, the variables are no change or addition of an appliance vs. removal of an appliance as well as no change or removal of an appliance vs. addition of an appliance. Each variable is then used as the independent vari-

able in a simple regression model where the dependent variable is the difference in energy consumption between the second and third postretrofit years:

$$(NAC86/87\text{-}NAC87/88) = f\ (variable89\text{-}variable84).$$

Each variable displaying a significant effect (alpha = 0.10 or better) is then placed into a larger model. Backwards stepwise regression models are examined, resulting in a final model with each independent variable significant at alpha = 0.10. Separate modeling is done for mixed-fuel homes (Somefit) and primarily electric homes (Goodfit). This process is also performed using gross third-year savings as the dependent variable.

The surveys are also examined as two independent samples to look at group differences rather than individual differences. The analysis compares the same variables initially selected for the regression modeling, as the other data available are judged irrelevant to changes in energy use. Chi-square tests of independence are performed on interval data, and Student's t-tests are used on continuous and binary data.

2. Results of Third-Year Analysis

Total Energy Consumption

Tables 3 and 4 show the total weather-normalized electricity consumption for the various subsets of Somefit and Goodfit homes. The same houses are compared across all years.

Table 3. Mixed-fuel participants (Somefit) total electricity consumption

		Pre	Post		
	n	82/83	85/86	86/87	87/88
All dwelling types					
Combined sample	(1,997)	19,600	17,000^{+}	17,000^{+}	17,800
PP&L	(1,196)	16,900$_{*}$	15,200^{+}	15,200^{+}	15,900$_{*}$
HREC	(801)	23,500*	19,600^{+}	19,700^{+}	20,700*
Single-family homes					
Combined sample	(1,361)	20,800	18,100^{+}	18,200^{+}	19,000
PP&L	(763)	18,700	16,800^{+}	16,900^{+}	17,600
HREC	(598)	23,600	19,700^{+}	19,900^{+}	20,800^{+}
Mobile homes					
Combined sample	(362)	19,700	17,200^{+}	17,000^{+}	18,000^{+}
PP&L	(186)	17,500*	16,000^{+}	16,000^{+}	17,000^{*+}
HREC	(176)	22,000	18,400^{+}	18,100^{+}	19,100^{+}

Table 4. Primarily electric heat participants (Goodfit) total electricity consumption

		Pre	Post		
	n	82/83	85/86	86/87	87/88
All dwelling types					
Combined sample	(393)	22,400$_{*}$	19,200^{+}	19,700^{*+}	20,800*
PP&L	(221)	18,100*	16,000^{+}	16,300^{+}	17,300^{*+}
HREC	(172)	27,800	23,400^{+}	24,100^{+}	25,200
Single-family homes					
Combined sample	(247)	25,100$_{*}$	21,200^{+}	21,800^{+}	22,800^{+}
PP&L	(127)	21,200*	18,400^{+}	18,700^{+}	19,800^{*+}
HREC	(120)	29,300	24,200^{+}	25,000^{+}	26,000^{+}
Mobile homes					
Combined sample	(95)	21,000*	19,300*	19,800*	21,200*
PP&L	(46)	18,500*	17,600*	18,000*	19,200*
HREC	(49)	23,400*	20,900*	21,500*	23,000*

NOTES FOR TABLES 3 AND 4: Superscripts indicate values which are *not* statistically distinct between years for the given subgroup, at alpha=0.05. For example, reading across the table for the combined sample of all participants (n=393) in Table 4, usage in 1982/83 is different from each of the postretrofit years, but 1985/86 and 1986/87 are similar, and 1986/87 and 1987/88 are similar. All estimates are rounded to the nearest 100 kWh.

The analysis of variance, which compared gross consumption over time for each subset of homes, showed that usage was significantly higher in 1987/88

than in either 1985/86 or 1986/87 for the Somefit combined-utility samples of mixed dwelling types (n=1,997) and for single-family homes (n=1,361, see Table 3). The change in usage was not statistically significant for the Somefit mobile home samples (n=362). For PP&L Somefit mobile homes (n=186), the third postretrofit year usage was no different from preprogram usage, though the usage was significantly different for the first and second postretrofit years.

Table 4 shows the analysis of variance results for Goodfit homes. The most striking result is the lack of significant retrofit impact on any of the primarily electric space heat mobile home samples (n=95).

The mixed dwelling type samples show an increase in total consumption over the three postretrofit years. For PP&L homes (n=221), the increase is such that usage between the preprogram and the third postretrofit years is not statistically different. For single-family homes (n=247), usage was not significantly different among the three postretrofit years.

Figure 3 graphically shows average usage per year for single-family homes. The lines representing mixed fuel users (Somefit) include the primarily electric heat homes also shown separately (Goodfit) for the combined sample, PP&L consumers, and HREC consumers.

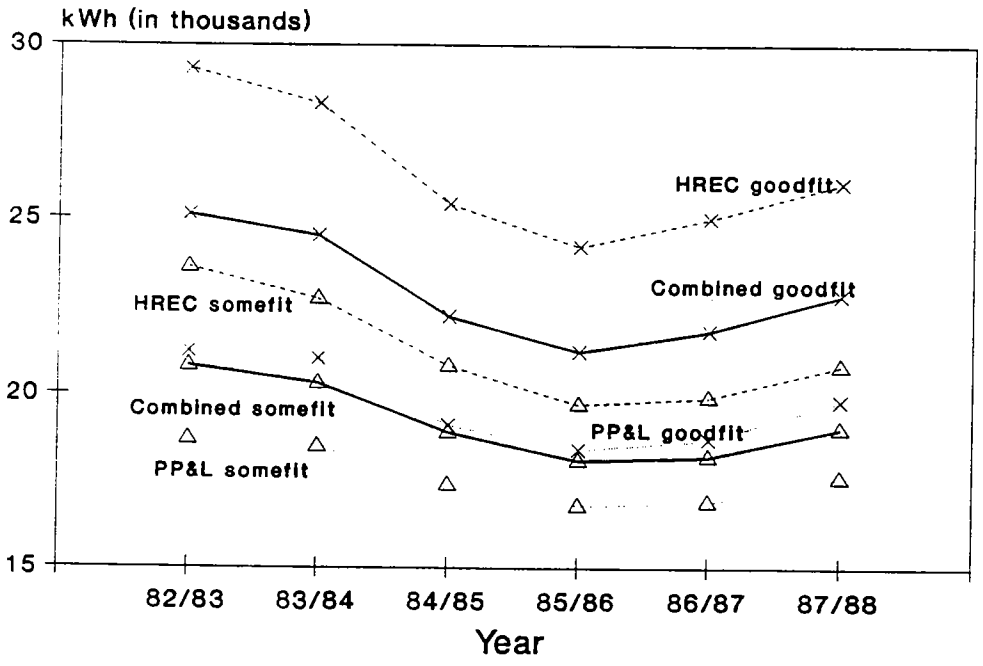

Figure 3. **Total electricity consumption for single-family homes, separated by utility service area and fuel use.**

Tables 5 and 6 show the total weather-normalized electricity consumption broken out by home size for Project participants.

As shown in Table 5, the difference in total usage between the three postretrofit years was not significant for any home size category. There is not a clear pattern among the categories to explain why some groups had third postretrofit year usage similar to preretrofit usage -- both very large and very small homes exhibited this characteristic.

Table 5. Total usage disaggregated by home size, mixed-fuel participants (Somefit)

		Pre	Post		
	n	82/83	85/86	86/87	87/88
All dwelling types	**1,991**				
Less than 800 sqft	(336)	14,400*	12,500+	12,700+	13,600*+
800 to 1,200 sqft	(584)	17,200	14,600+	14,600+	15,300+
1,201 to 1,600 sqft	(486)	19,700	17,300+	17,100+	17,900+
1,601 to 2,000 sqft	(270)	22,500	19,400+	19,500+	20,700+
2,001 to 2,400 sqft	(159)	24,200	21,200+	21,200+	21,900+
2,400 sqft or more	(156)	29,100*	26,100+	26,100+	27,300*+
Single-family homes	1,359				
Less than 800 sqft	(96)	16,300*	13,900+	14,600*+	15,600*+
800 to 1,200 sqft	(337)	17,600	14,600+	14,700+	15,300+
1,201 to 1,600 sqft	(377)	19,200	16,900+	16,800+	17,500+
1,601 to 2,000 sqft	(240)	22,300*	19,400+	19,600+	20,800*+
2,001 to 2,400 sqft	(154)	24,300	21,300+	21,200+	21,900+
2,400 sqft or more	(155)	29,000*	26,000+	26,000+	27,200*+

Table 6. Total usage disaggregated by home size, primarily electric heat participants (Goodfit)

		Pre	Post		
	n	82/83	85/86	86/87	87/88
All dwelling types	**393**				
Less than 800 sqft	(62)	14,200*	12,300*	12,600*	13,500*
800 to 1,200 sqft	(137)	19,400*	16,600+	17,200+	18,100*+
1,201 to 1,600 sqft	(81)	22,600	19,200+	19,700+	20,200+
1,601 to 2,000 sqft	(45)	27,600*	23,800+	24,000*+	26,100*+
2,001 to 2,400 sqft	(28)	30,200*	26,200*	26,500*	28,300*
2,400 sqft or more	(40)	33,200*	29,100*	29,700*	30,900*
Single-family homes	**237**				
800 to 1,200 sqft	(65)	20,300*	16,600+	17,200+	17,900*+
1,201 to 1,600 sqft	(65)	22,200	18,200+	18,900+	19,200+
1,601 to 2,000 sqft	(40)	27,200*	23,300*	23,700*	25,500*
2,001 to 2,400 sqft	(27)	30,400*	26,700*	26,800*	28,700*
2,400 sqft or more	(40)	33,200*	29,100*	29,700*	30,900*

NOTES FOR TABLES 5 AND 6: Reading across the rows, superscripted symbols indicate values which are *not* statistically distinct between years for the given subgroup, at alpha=0.05. All estimates are rounded to the nearest 100 kWh. Some homes had incomplete sqft data and are not included here.

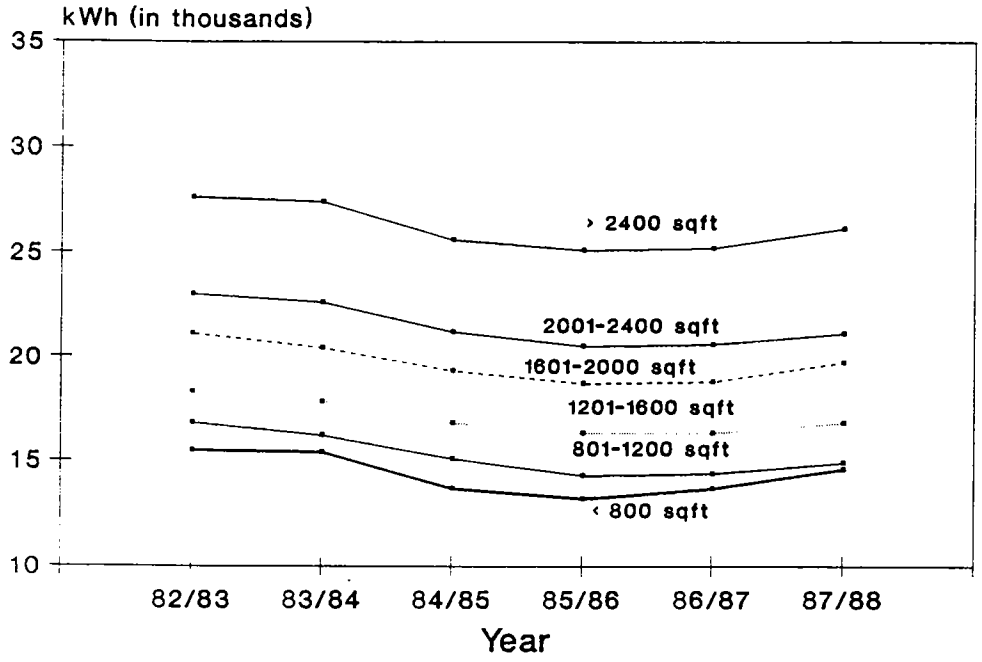

Figure 4. Total electricity consumption for mixed-fuel single-family homes (Somefit), by home size.

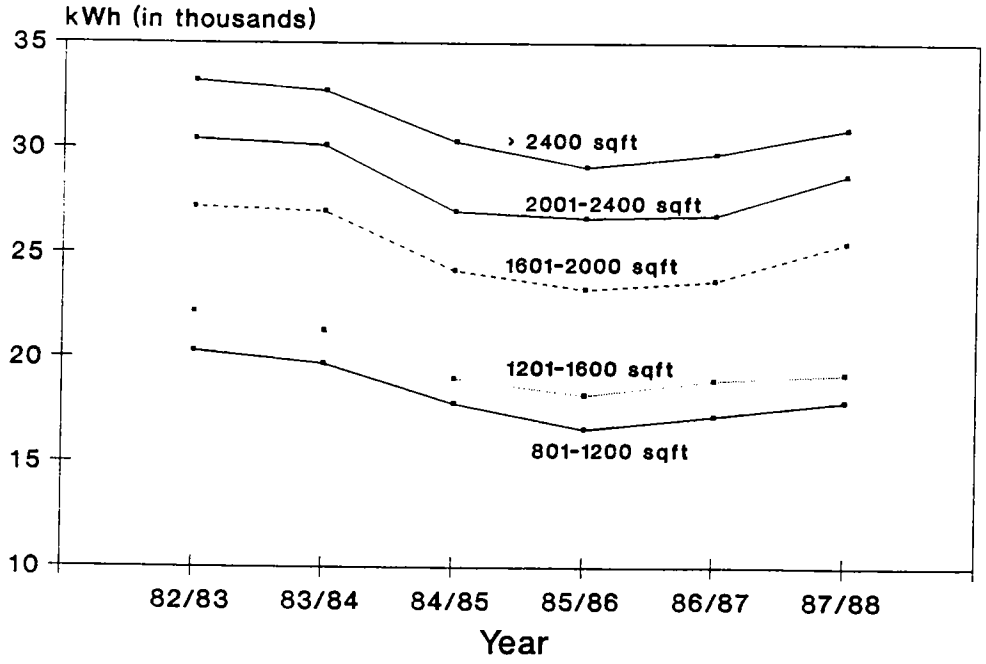

Figure 5. Total electricity consumption for primarily electric heat single-family homes (Goodfit), by home size.

For the group of homes which consistently used electric heat, there was much more similarity in size, shown graphically by comparing Figures 4 and 5. The decrease in savings was not significant for the primarily electric heat single-family homes, if the savings were significant in the first and second postretrofit years.

Figure 4 shows average usage per home for mixed-fuel single-family homes (Somefit), separated by size. Figure 5 provides the same information for primarily electric heat (Goodfit) single-family homes.

Stability of Gross Energy Savings

Because an in-community control group was not available, the reliability of net savings calculations using the regional control groups is less than perfect. Efficiency of the homes after weatherization is more reliably assessed using gross energy savings rather than net energy savings.

All participants

Almost all groups showed a significant decrease in savings between the second and third postretrofit years (see Table 7). Only mobile homes served by the HREC did not show a statistically significant difference, most likely due to high standard deviations among these homes. The magnitude of the difference was similar for all groups -- about 900 kWh.

Table 7. Mixed-fuel participants (Somefit) gross kWh savings

	n	1st Year kWh savings	2nd Year kWh savings	3rd Year kWh savings	3rd Year -2nd Year change
All dwelling types					
Combined sample	(1,997)	2,600*	2,600*	1,700	- 900
PP&L	(1,196)	1,700*	1,700*	1,000	- 700
HREC	(801)	3,900*	3,800*	2,800	-1,000
Single-family homes					
Combined sample	(1,361)	2,700*	2,700*	1,800	- 900
PP&L	(763)	1,900*	1,800*	1,100	- 700
HREC	(598)	3,900*	3,700*	2,800	- 900
Mobile homes					
Combined sample	(362)	2,500*+	2,600*+	1,700+	- 900
PP&L	(186)	1,400*	1,500*	500	-1,000
HREC	(176)	3,600*	3,800*	2,900	- 900

Table 8. Postretrofit savings disaggregated by home size, Mixed-fuel participants (Somefit)

	n	1982/83-1985/86	1982/83-1986/87	1982/83-1987/88
All dwelling types	1,991			
Less than 800 sqft	(336)	1,900*	1,700*	800
800 to 1,200 sqft	(584)	2,700*	2,600*+	1,900+
1,201 to 1,600 sqft	(486)	2,400*	2,600*	1,700
1,601 to 2,000 sqft	(270)	3,100*	3,000*	1,900
2,001 to 2,400 sqft	(159)	3,000*	3,100*	2,300*
2,400 sqft or more	(156)	3,000*	3,100*	1,800*
Single-family homes	1,259			
Less than 800 sqft	(96)	2,500*	1,700*+	700+
800 to 1,200 sqft	(337)	3,000*	2,800*	2,200*
1,201 to 1,600 sqft	(377)	2,400*	2,400*	1,700*
1,601 to 2,000 sqft	(240)	2,800*	2,700*	1,500
2,001 to 2,400 sqft	(154)	3,000*	3,100*	2,400*
2,400 sqft or more	(155)	3,000*	3,100*	1,800*

NOTES FOR TABLES 7 AND 8: Reading across the rows, superscripted symbols indicate values which are *not* statistically distinct between years for the given subgroup, at alpha=0.05. All estimates are rounded to the nearest 100 kWh. Some homes had incomplete sqft data and are not included here.

Participants with primarily electric heat

Table 9 shows that almost all primarily electric heat groups recorded a significant decrease in savings, and the magnitude of the effect is about 200 kWh larger than the Somefit analysis above.

Table 9. Primarily electric heat participants (Goodfit) gross kWh savings

	n	1st Year kWh savings	2nd Year kWh savings	3rd Year kWh savings	3rd Year -2nd Year change
All dwelling types					
Combined sample	(393)	3,100*	2,700*	1,600	-1,100
PP&L	(221)	2,100*	1,800*	800	-1,000
HREC	(172)	4,500*	3,800*+	2,600+	-1,200
Single-family homes					
Combined sample	(247)	3,900*	3,300*	2,300	-1,000
PP&L	(127)	2,700*	2,400*	1,400	-1,000
HREC	(120)	5,100*	4,300*+	3,300+	-1,000
Mobile homes					
Combined sample	(95)	1,700*	1,200*	- 200	-1,400
PP&L	(46)	900*	500*+	- 800+	-1,300
HREC	(49)	2,500*	1,900*	400	-1,500

Table 10. Postretrofit savings disaggregated by home size, Primarily electric heat participants (Goodfit)

	n	1982/83-1985/86	1982/83-1986/87	1982/83-1987/88
All dwelling types	393			
Less than 800 sqft	62	1,900*	1,600*	700*
800 to 1,200 sqft	137	2,800*	2,300*+	1,300+
1,201 to 1,600 sqft	81	3,400*	2,900*	2,300*
1,601 to 2,000 sqft	45	3,800*	3,500*	1,500
2,001 to 2,400 sqft	28	4,000*	3,700*	1,900*
2,400 sqft or more	40	4,100*	3,500*	2,300*
Single-family homes	237			
800 to 1,200 sqft	65	3,700*	3,100*	2,400*
1,201 to 1,600 sqft	65	4,000*	3,300*	3,000*
1,601 to 2,000 sqft	40	3,800*	3,500*+	1,600+
2,001 to 2,400 sqft	27	3,700*	3,500*	1,700*
2,400 sqft or more	40	4,100*	3,500*	2,300*

NOTES FOR TABLES 9 AND 10: Reading across the rows, superscripted symbols indicate values which are not statistically distinct between years for the given subgroup, at alpha=0.05. All estimates are rounded to the nearest 100 kWh. Some homes had incomplete sqft data and are not included here.

Increased use of electric heat during the third postretrofit year

Based on PRISM results, the number of Somefit homes using primarily electric heat increased drastically between the second and third postretrofit years (see Figure 6). HREC consumers jumped from 53 percent primarily electrically heated in 1986/87 to 68 percent in 1987/88; while PP&L consumers jumped from 55 percent to 63 percent over the same period.

For both utilities, the percent of primarily electric heat homes in 1985/86 and 1986/87, the first two postretrofit years, is close to the percent of primarily electric heat homes in the preretrofit year of 1982/83.

Schoch's report on long-term electricity use (1989, page 29) also found an increasing level of reliance on electric heat for PP&L consumers in Hood River, though the method of electric heat use identification differs somewhat from the Goodfit criteria.[4]

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[4] The heat estimate had to be between 20 percent and 75 percent of the total NAC with a minimum heat estimate of 4,000 kWh and an r^2 of 0.75; or the heat estimate had to be between 25 percent and 75 percent of the total NAC with a minimum heat estimate of 4,000 kWh and an r^2 of 0.50. These criteria were determined from survey responses regarding fuels used for space heating.

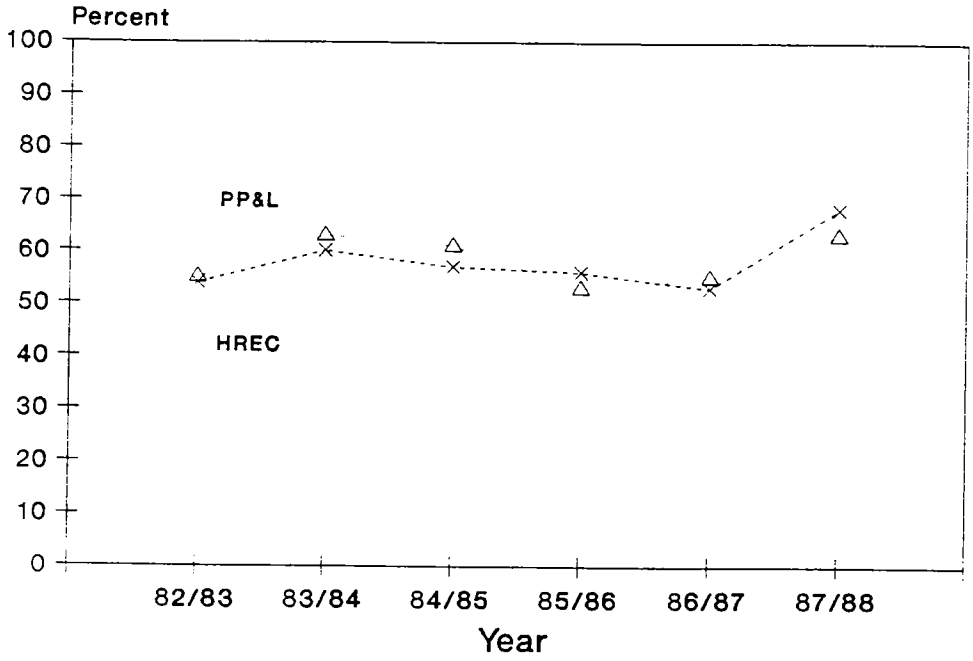

Figure 6. **Percent of homes using primarily electric heat (Goodfit) per year.**

Net Energy Savings

The comparison group randomly selected from PP&L consumers in the Pacific Northwest region decreased average kWh consumption over the first postretrofit period (1982/83 to 1985/86). They slowly increased usage during the second and third postretrofit periods, 1986/87 and 1987/88 [see Appendix C; also Schoch (1989) page 37]. Usage differences in the postretrofit years were not statistically significant for the random sample.

Table 11 shows the breakdown of gross and net savings for the various subgroups within PP&L for which there was comparison group data.

Using this method of calculating net Project savings, savings for mixed fuel users were negligible, and very low for primarily electric heat homes. Project mobile homes actually reduced their electricity consumption after retrofit less than their counterparts did in the region without the benefit of a targeted weatherization campaign.

These results, particularly the mobile home results, suggest that net savings generation may not be possible in the third postretrofit period, given that Hood River's economic condition is known to have diverged from that of the region at large.

Table 12 shows the breakdown of gross and net savings for groups of HREC participants for which there was comparison group data. The methodology for estimating energy savings and the data sources for the estimates are detailed

in Appendix A. Due to the necessity for estimation of the comparison group's energy use trends as well as the differing economic conditions in Hood River, these net savings are less reliable than those for the PP&L consumers.

Table 11. Gross and net kWh savings, PP&L consumers

	1st Year dNAC	2nd Year dNAC	3rd Year dNAC
PP&L participants, All Dwelling Types, Somefit			
Hood River	1,700	1,700	1,000
Region	- 900	- 600	- 800
	800	1,100	200
PP&L participants, All Dwelling Types, Goodfit			
Hood River	2,100	1,800	800
Region	- 900	- 500	- 700
	1,200	1,300	100
PP&L participants, Single-family Homes, Somefit			
Hood River	1,900	1,800	1,100
Region	- 600	- 400	- 500
	1,300	1,400	600
PP&L participants, Single-family Homes, Goodfit			
Hood River	2,700	2,400	1,400
Region	- 600	- 0	- 500
	2,100	2,400	900
PP&L participants, Mobile Homes, Somefit			
Hood River	1,400	1,500	500
Region	-2,500	-1,800	-1,600
	-900	-300	-1,100

All estimates rounded to nearest 100 kWh.

Table 12. Gross and net kWh savings, HREC consumers

	1st Year dNAC	2nd Year dNAC	3rd Year dNAC
HREC participants, Single-family Homes, Somefit			
Hood River	3,900	3,700	2,800
Region	-1,700	-1,700	-1,700
	2,200	2,000	1,100
HREC participants, Single-family Homes, Goodfit			
Hood River	5,100	4,300	3,300
Region	-1,700	- 700	-1,200
	3,400	3,600	2,100

All estimates rounded to nearest 100 kWh.

Differences Between Monitored and Nonmonitored Consumers

Gross savings

Table 13 shows that only in the first postretrofit year were there significant differences in savings between monitored and nonmonitored consumers. The primary difference was for PP&L Somefit consumers, which also caused a less significant difference for the combined utility Somefit group.

The preceding section on stability of savings reported statistically significant reductions in savings for all dwelling types and for single-family homes except Goodfit HREC participants. Table 14 shows that enduse monitored consumers only exhibit a significant reduction in savings between the second and third postretrofit years for combined utility Somefit homes in the all dwelling types and single-family homes groups. Differences in savings between these two years were not found at a statistically significant level for any group disaggregated by utility service area. The enduse monitored consumers had much more frequent contact with Project staff than did nonmonitored consumers -- in some cases every month for the duration of monitoring.

Table 13. Monitored vs. nonmonitored participants gross kWh savings

	1st Year		2nd Year		3rd Year	
	Mon.	Non-mon.	Mon.	Non-mon.	Mon.	Non-mon.
All Somefit participants						
Combined sample	3,200*	2,600*	3,000	2,600	2,000	1,800
PP&L	2,600**	1,600**	2,300	1,700	1,400	900
HREC	4,200	3,800	4,100	3,700	2,800	2,900
Single-family Somefit homes						
Combined sample	3,200	2,700	3,000	2,600	1,900	1,800
PP&L	2,300	1,800	1,900	1,800	1,200	1,100
HREC	4,600	3,800	4,500	3,600	3,100	2,800
Single-family Goodfit homes						
Combined sample	4,700	3,700	4,000	3,200	3,000	2,200
PP&L	3,000	2,700	2,400	2,500	1,500	1,300
HREC	6,400	4,900	5,600	4,000	4,500	3,200

All estimates rounded to the nearest 100 kWh.
*** = significant at alpha=0.01
** = significant at alpha=0.05
* = significant at alpha=0.10

Table 14. Enduse monitored consumers gross kWh savings

	n	1st Year kWh savings	2nd Year kWh saving	3rd Year kWh savings	2nd Year minus 3rd Year alpha[a]
All Somefit participants					
Combined sample	(244)	3,200	3,000	2,000	0.06
PP&L	(147)	2,600	2,300	1,400	NS
HREC	(97)	4,200	4,100	2,800	NS
Single-family Somefit homes					
Combined sample	(200)	3,200	3,000	1,900	0.08
PP&L	(120)	2,300	1,900	1,200	NS
HREC	(80)	4,600	4,500	3,100	NS
Single-family Goodfit homes					
Combined sample	(42)	4,700	4,000	3,000	NS
PP&L	(21)	3,000	2,400	1,500	NS
HREC	(21)	6,400	5,600	4,500	NS

All estimates rounded to the nearest 100 kWh.
[a] Statistical significance level. NS = not significant at alpha=0.10.

Independent Variables Influencing Savings Reductions

Variables which were examined for partial explanation of the change in energy savings between the second and third postretrofit years are listed below. All variables which were significant at alpha=0.10 were then combined into a larger model. A positive number for a change in attitude means increasing agreement, while a positive number for a change in opinion means decreasing agreement. Some of the opinion questions were worded negatively, so in those cases a positive number indicates increasing agreement with the concept.

- difference in the net number of appliances
- number of appliances the same or higher in 1989 than 1984
- number of appliances the same or lower in 1989 than 1984
- change in whether residents burned wood
- difference in number of prestologs burned
- difference in number of cords of wood burned
- difference in temperature of water in water heater
- difference in day/evening indoor temperature when someone is home
- difference in day/evening indoor temperature when no one is home
- difference in indoor temperature during sleeping hours
- difference in number of rooms in home
- difference in number of rooms not heated
- difference in percent of rooms not heated
- change in income
- difference in number of residents
- change in owner/renter status
- change in whether someone was home during the day
- remodeling done since 1984
- change in primary space heating fuel

- change in use of secondary heating fuel
- change in primary space heating equipment
- change in secondary space heating equipment
- change in primary water heating equipment
- change in secondary water heating equipment
- change in water heater location (heated or not heated)
- change in primary water heating fuel
- change in secondary water heating fuel
- change in possession of air conditioner
- change in use of air conditioner
- change in attitude towards home energy efficiency
- change in attitude on environmental pollution in Oregon
- change in attitude on cost of energy in Oregon
- change in attitude on unemployment in Oregon
- change in attitude on scarcity of electricity in Oregon
- change in attitude on inflation in Oregon
- change in attitude on crime in Oregon
- change in attitude on electricity cost
- change in attitude on electricity scarcity
- change in attitude on natural gas cost
- change in attitude on natural gas scarcity
- change in attitude on heating oil cost
- change in attitude on heating oil scarcity
- change in attitude on gasoline cost
- change in attitude on gasoline scarcity
- change in attitude on wood cost
- change in attitude on wood scarcity
- change in opinion on hard to be comfortable at 68°F
- change in opinion on worth of reducing water heater temperature
- change in opinion on reason to conserve is to save money
- change in opinion on lower temperature worthwhile when no one home
- change in opinion on hard to get around to energy efficiency
- change in opinion on people have right to use as much energy as they want and can afford
- change in opinion that price of appliance is more important than efficiency
- change in opinion that conserving would change lifestyle

All fuels

The following variables were individually significant for the Somefit data set:

- difference in lower range of day/evening indoor temperature when someone is home
- difference in lower range of day/evening indoor temperature when no one is home
- difference in upper range of day/evening indoor temperature when no one is home
- difference in number of rooms not heated
- difference in percent of rooms not heated

- difference in number of residents
- remodeling done since 1984
- difference in the net number of appliances
- number of appliances the same or higher in 1989 than 1984
- change in primary space heating fuel
- change in attitude on cost of energy in Oregon
- change in opinion on hard to be comfortable at 68°F

The following model has an overall significance of alpha=0.01, with each component significant at alpha=0.06 or better. The model R^2 is 0.07.

Differences in savings varied in the same direction as differences in the lower indoor temperature while someone was home or differences in the number of residents; and varied negatively to changes in opinion that it is hard to be comfortable at 68°F.

DIFFERENCES IN SAVINGS =

907 + 327 (difference in lower indoor temperature range when someone is home)
+ 875 (difference in number of residents)
- 294 (change in opinion on comfort at 68°F scale -4 to +4)
+ error

Primarily electric homes

The following variables were individually significant for the Goodfit data set:

- difference in the net number of appliances
- change in income (in $10,000 increments)
- difference in number of residents
- change in opinion on lower temperature worthwhile when no one home
- change in opinion on hard to get around to energy efficiency

The following model has an overall significance of alpha=0.01, with each component significant at alpha=0.08 or better. The model R^2 is 0.27.

Differences in savings varied in the same direction as difference in the net number of appliances and difference in number of residents; and varied negatively to changes in income and changes in belief that lowering the temperature when no one is at home is worthwhile.

DIFFERENCES IN SAVINGS =

1,342 + 415 (difference in net number of appliances)
- 841 (change in income)
+ 512 (difference in number of residents)
- 338 (change in opinion on lower temperature worthwhile when no one is home scale -4 to +4)
+ error

Independent Variables Influencing Third-year Savings

The same variables as in the differences in savings analysis were examined for an explanatory effect on gross third-year kWh savings.

All fuels

The following variables were individually significant for the Somefit data set:

- change in whether someone was home during the day
- remodeling done since 1984
- change in owner/renter status
- change in primary space heat fuel
- change in primary space heating equipment
- change in opinion that reason to conserve is to save money
- change in opinion that price of appliance is more important than efficiency

The following model has an overall significance of alpha=0.02, with each component significant at alpha=0.06 or better. The model R^2 is 0.03.

Gross third-year savings varied in the same direction as whether there was a change in primary space heat fuel. Savings varied in the opposite direction with changes in attitude that the reason to conserve is to save money.

SAVINGS = -2,057 + 574 (change in opinion that reason to conserve is to save money scale -4 to +4)
- 3,136 (change in primary space heat fuel - Y/N)
+ error

Primarily electric homes

The following variables were individually significant for the Goodfit data set:

- difference in lower range of day/evening indoor temperature when someone is home
- difference in set day/evening indoor temperature when no one is home
- difference in lower range of day/evening indoor temperature when no one is home
- difference in lower range of indoor temperature during sleeping hours
- difference in upper range of indoor temperature during sleeping hours
- difference in net number of appliances
- change in primary space heat fuel
- change in primary space heating equipment
- change in attitude on inflation in Oregon
- change in opinion on lower temperature worthwhile when no one home

The following model has an overall significance of alpha=0.01, with each component significant at alpha=0.05 or better. The model R^2 is 0.27.

Gross third-year savings varied in the same direction as differences in the lower temperature range when no one was home. Savings varied oppositely from differences in the net number of appliances and differences in the upper temperature range during sleeping hours.

SAVINGS = -1,864 + 997 (difference in net number of appliances)
- 321 (difference in lower temperature range when no one is home)
+ 353 (difference in upper temperature range during sleeping hours)
+ error

Attitude and Behavioral Changes in Hood River

Variables significant in explaining savings reductions

The following sections describe the variables which were statistically significant in explaining reductions in savings.

All fuels

Difference in lower range of indoor temperature when someone is home. Thirty-two percent of the respondents lowered the bottom temperature range, mostly between 1°F and 10°F. Thirty-seven percent raised the bottom temperature range, mostly between 2°F and 8°F.

Difference in number of residents. Thirty-two percent of homes had fewer residents, compared to only thirteen percent with additional residents.

Change in opinion on comfort at 68°F. Forty-three percent of respondents were more comfortable at 68°F, compared to 21 percent who were less comfortable.

Primarily electric homes

Difference in number of appliances. Forty-three percent of respondents now have more appliances than in 1984, while 17 percent have fewer.

Change in income. Increases in income were reported by 39 percent of respondents, compared to 21 percent reporting decreases. Many households refused to answer this question.

Difference in number of residents. Thirty-four percent of homes now have between one and four fewer residents, while 13 percent of homes have one additional resident.

Change in opinion that lower temperature worthwhile when no one is at home. Forty-six percent of respondents decreased their level of agreement

with the worth of lowering the thermostat, while 18 percent increased their level of agreement.

Variables significant in explaining third-year savings

The following sections describe the variables which were statistically significant in explaining magnitude of savings.

All fuels

Change in opinion that main reason to conserve is to save money. Forty-two percent of respondents decreased their level of agreement with the idea that the main reason to conserve energy is to save money. Twenty percent of respondents, however, increased their level of agreement.

Change in primary heating fuel. Eleven percent of respondents reported changing their primary heating fuel since 1984.

Primarily electric homes

Difference in lower range of indoor temperature when no one is home. While 31 percent of respondents decreased the lower temperature range, mostly between 5°F and 10°F, 49 percent increased it, mostly between 1°F and 10°F.

Difference in upper range of indoor temperature during sleeping hours. Forty-two percent of respondents lowered the upper temperature range, mostly between 2°F and 5°F. Thirty-seven percent, however, raised the upper temperature range between 2°F and 10°F.

Difference in number of appliances. Forty-three percent of respondents now have more appliances than in 1984, while 17 percent have fewer.

Other changes

Survey responses from 1984 and 1989 were compared as two independent samples, ignoring whether respondents were part of the Somefit data set or even if they responded to both surveys. Many significant differences were found between the two sets of survey responses, mostly in the attitude and opinion categories. The same variables were analyzed as in the regression modeling analysis (list begins on page 25).

How do you feel about the energy efficiency of your home. In 1984, 73 percent of respondents thought that there could be moderate to a lot of improvement made to their homes, while only three percent thought no improvement could be made. In 1989, ten percent of respondents indicated that efficiency could still be improved by a moderate or larger amount, while 64 percent thought no further improvement could be made (alpha=0.01).

How do you feel about environmental pollution in Oregon. In 1984, 52 percent of the respondents felt that this issue was slightly or not serious.

In 1989, 65 percent of respondents felt that it was a moderately to very serious issue (alpha=0.01).

How do you feel about the cost of energy in Oregon. Eighty-one percent of respondents felt energy cost to be a moderately to very serious issue in 1984, compared to only 48 percent in 1989 (alpha=0.01).

How do you feel about unemployment in Oregon. Ten percent of 1984 respondents felt this issue to be of slight or no seriousness. This number rose to 40 percent in 1989 (alpha=0.01).

How do you feel about inflation in Oregon. In 1984, 21 percent of respondents said this issue was not serious or slightly serious, compared to 38 percent in 1989 (alpha=0.01).

How do you feel about crime in Oregon. Eighty-one percent of 1984 respondents called this a moderate to very serious issue, while 94 percent of 1989 respondents felt this way (alpha=0.01).

Is electricity cost a problem in Oregon. In 1984, 91 percent of respondents agreed there was a problem, compared to 83 percent in 1989 (alpha=0.04).

In the winter, I find it difficult to be comfortable when the temperature in my home is 68°F. Forty-two percent of 1984 respondents strongly agreed with this statement, and 13 percent strongly disagreed. This compares to 31 percent of 1989 respondents with strong agreement and 28 percent strongly disagreeing. The less strong opinion percentages varied very slightly between the two surveys (alpha=0.01).

Reducing the temperature of the water heater from 140°F to 120°F saves enough energy to make it worth doing. In 1984, 32 percent of respondents strongly agreed with this statement, compared to 48 percent in 1989 (alpha=0.01).

The main reason to conserve energy is to save money. Eighty-one percent of 1984 respondents strongly or somewhat agreed, while only 58 percent of the 1989 respondents did (alpha=0.01).

During the winter, when no one will be home for two hours or more, turning down the temperature is worthwhile. Agreement and disagreement was consistent between the two surveys, however strength of opinion differed. In 1984, 14 percent somewhat disagreed and 13 percent strongly disagreed. In 1989, only seven percent somewhat disagreed while 25 percent strongly disagreed (alpha=0.01).

It's hard for me to get around to making my home more energy efficient. Fifty-seven percent of 1984 respondents somewhat or strongly agreed with this statement, compared to 42 percent of 1989 respondents (alpha=0.01).

The price I first pay for an appliance is more important to me than the energy savings. Two-thirds (67%) of 1984 respondents somewhat or strongly

disagreed with this statement, as did 70 percent of 1989 respondents. However, 30 percent strongly disagreed in 1984, compared to 47 percent in 1989 (alpha=0.01).

Number of cords of wood burned in last 12 months. In 1984, consumers reported an average of 3.5 cords of wood burned, compared to 2.8 cords in 1989 (alpha=0.01).

Lower range of indoor temperature during day or evening when someone is home. The average reported temperature was 69.4°F in 1984, compared to 70.0°F in 1989 (alpha=0.09).

Set indoor temperature during day or evening when no one is home. The average reported temperature was 62.0°F in 1984 and 65.2°F in 1989 (alpha= 0.01).

Lower range of indoor temperature during day or evening when no one is home. In 1984 the average was 61.7°F, compared to 63.8°F in 1989 (alpha= 0.01).

Upper range of indoor temperature during day or evening when no one is home. The average reported temperature was 62.8°F in 1984 and 64.7°F in 1989 (alpha=0.01).

Set indoor temperature during sleeping hours. In 1984 the average was 62.0°F, while in 1989 it was 65.0°F (alpha=0.01).

Lower range of indoor temperature during sleeping hours. The average reported temperature was 61.7°F in 1984 and 63.2°F in 1989 (alpha=0.01).

Upper range of indoor temperature during sleeping hours. In 1984 the average was 62.9°F, compared to 64.1°F in 1989 (alpha=0.04).

Total number of rooms in home. Consumers in 1984 reported an average 6.9 rooms in their home, compared to 7.8 rooms in 1989 (alpha=0.01). This may be indicative of a larger sample attrition rate in smaller dwellings than in larger ones.

During the months when heating is required, at least 1/2 of the time weekdays between 9:00 and 5:00 someone is home and the house is heated. This was true for 71 percent of the 1984 respondents, compared to 62 percent of the 1989 respondents (alpha=0.02).

Percent of total rooms in home not heated during winter months. Fifteen percent of the rooms were unheated in 1984, compared to 11 percent in 1989 (alpha=0.01).

Number of residents home at least six months of the year. There were an average of 2.9 residents in 1984, but only 2.7 residents in 1989 (alpha=0.01).

3. Conclusions and Discussion

Total electricity consumption rose among Hood River Project participants in the third postretrofit year, resulting in ostensibly lower electricity savings. It can be argued, however, that consumers were increasing electricity usage due to new loads being added as well as making behavioral changes which reduced the retrofit savings.

Total electricity consumption was significantly higher in the third postretrofit year than in either of the two preceding years for project participants. This difference does not exist for single-family homes in HREC's service area, or for mobile homes served by either utility, though it was found for the other subgroups.

Total consumption in the third postretrofit year was not different from that in the first and second postretrofit years for primarily electric heat single-family homes. For the subgroup of single-family primarily electric heat homes in PP&L's service area, third-year usage was also no different statistically from the preretrofit years.

House size was found to be an indicator of magnitude of use in single-family homes, but not for magnitude of savings or changes in savings among the postretrofit years. There is an indication that a sizable portion of the decrease in savings occurred in mid-sized single-family homes, particularly those with 1,601 sqft to 2,000 sqft. Because this decrease in savings is significant for the Somefit homes but not the Goodfit homes, it is most likely consumer take back in the form of increasing use of electric space heat.

Net savings were smaller than gross savings. The inaccuracies in computing net savings due to the lack of an in-community control group minimize the usefulness of these computations.

A gross decrease in savings of about 900 kWh was found for all mixed-fuel homes between the second and third postretrofit years; and about 1,100 kWh for all dwellings with primarily electric heat. The magnitude of the decrease varied by dwelling type, but was always found.

This decrease in savings and higher total consumption may be attributable to consumer take back of savings. The real price of electricity declined over the postretrofit period -- gradually for HREC consumers and sharply for PP&L consumers who received a nominal price decrease in the third postretrofit year. However, the magnitude of the decrease in savings was the same for consumers served by each utility.

Survey data comparisons on the monitored homes showed several changes in behavior which are normally considered as consumer take back of savings, and indicated that their homes were more comfortable at 68°F than before the homes were retrofit. These homes also reported an increase in the number of appliances, indicating that some of the additional usage is new load.

The group of monitored homes, however, did not register a significant difference between second-year and third-year savings. This lack of significance may be attributable to both high variance among the homes combined with small sample sizes. The magnitude of the savings decrease was the same as for non-monitored homes, for which the difference between second- and third-year postretrofit savings was statistically significant.

The behavior changes found through the consumer surveys included higher indoor temperatures, decreased wood use, and fewer room closures. Analysis of billing data also showed that the number of homes relying on electric heat increased in the third postretrofit year, supporting the survey finding of decreased wood use.

Supporting the theory that some of the higher consumption is new load is the change in economic conditions in Hood River. The Hood River community has been experiencing a booming local economy due to the influx of tourism relating to sail boarding. Hood River has become a world-class mecca for sail board enthusiasts.

This is not occurring in the regional comparison group. The bulk of PP&L's Oregon service area is dominated by the lumber and forest products industries, industries which have been in upheaval in the recent past. Consumers who are uncertain as to their future employment are not likely to add new load, hence the flat trend in usage despite lower real electricity prices.

The racheting upwards of gross consumption mirrors patterns observed previously in booming economies, especially the early 1970s. It appears that consumption in Hood River underwent a downward shift due to the Project retrofits, but is now increasing due to the favorable economic conditions. Hood River had experienced an economic downturn starting in the late 1970s, and the preretrofit usage recorded in 1983 was considerably lower than average usage in 1977. Due to the retrofits, it is unlikely that usage in these homes will ever climb back to those higher levels.

Appendix A. Utility Rate Schedules

Table A-1 shows the tail block prices charged by Pacific and the HREC as of January 1 for each year, normalized by the Consumer Price Index for Portland and Seattle to a common 1982 base. HREC's monthly customer charge increased sharply during this period, from $3.10 in 1980, to $4.16 in 1981, to $5.10 in 1982, $7.30 in 1983, and $8.00 afterwards (cf: Hirst et al. (1987):24). Pacific's Oregon monthly charge remained constant at $3.00 until mid-1987, when it rose to $5.00.

A weighted average of Pacific prices for the states of Oregon, Washington, Idaho, and Montana was used to calculate the values for Pacific's regional random sample. The monthly customer charge was about $3.00 between 1980 and 1987, and slightly over $4.00 in 1988. Bonneville's average sale price to public utility customers was used to generate the values for the public comparison consumption values -- these numbers can be used as comparative only due to additional charges which vary by public utility and for which data is not available.

Table A-1. Electricity prices during the study period

	Participants		Comparison	
	HREC	Pacific (Oregon)	Public (Region)	Private (Region)
Electricity prices (1982-¢/kWh)				
1980	1.8	2.9	0.7	2.6
1981	2.3	3.2	0.8	3.0
1982	2.5	4.8	1.1	4.4
1983	2.4	4.5	1.8	4.2
1984	3.4	4.6	2.1	4.4
1985	3.3	4.7	2.0	4.6
1986	3.2	4.7	2.0	4.6
1987	3.1	4.6	1.9	4.5
1988	3.0	4.2	1.9	4.2

Table A-2 shows the calculations for the private utility comparison group. Oregon customers represented 74.7 percent of the regional sample, Washington customers represented 24.6 percent, and Idaho customers comprised 0.7 percent. These percentages were used as weights in calculating the nominal and real regional costs/kWh.

The change in real electricity costs for the comparison groups were used to derive estimates for the public utility comparison group for 1986/87 and 1987/88. Only single-family homes were used for the public utility comparisons, matching available historic data.

Table A-2. Calculation of nominal and real private comparison rates

Year	Nominal cents/kWh per state Oregon	Wash.	Idaho	CPI Adj.	Nominal Regional	Real Regional
80	2.670	1.831	1.837	0.9315	2.458	2.639
81	3.069	2.561	1.975	0.9678	2.936	3.034
82	4.845	3.118	2.130	1.0000	4.401	4.401
83	4.689	3.148	3.509	1.0342	4.302	4.159
84	4.938	4.177	4.126	1.0680	4.745	4.443
85	5.179	4.576	4.769	1.1017	5.028	4.564
86	5.241	4.806	4.801	1.1152	5.131	4.601
87	5.241	5.008	5.018	1.1422	5.182	4.537
88	4.954	4.909	5.018	1.1811	4.943	4.185

The real rates for the private utility comparison group show a slight decrease in 1987, and a sharper decrease in 1988. Single-family homes using mixed fuels (somefit), however, show a very small change in total usage between 1984/85 and 1987/88 -- essentially a stable usage trend. Therefore, for the single-family somefit homes in the public utility comparison group, estimated usage for 1986/87 and 1987/88 is considered to be the same as in 1984/85, the last year for which data are available (see Table A-3).

Table A-3. KWh data for single-family homes using mixed fuels

Year	Private	Public
82/83	14,500[a]	24,000[b]
83/84	14,200	23,600
84/85	14,000	22,300
85/86	14,000	22,300[c]
86/87	14,200	22,300[d]
87/88	14,000	22,300[d]

[a] Source: Pacific billing records.
[b] Source: Goeltz, Hirst, and Trumble 91986).
[c] Estimated from Horowitz et al. (1987) data.
[d] Estimated from changes in real cost/kWh and simultaneous changes in consumption in comparable group of private utility customers.

The private utility comparison sample of single-family homes using primarily electric heating show much more variability in their year-to-year total usage. The estimates for the comparable group of public utility customers must therefore be more variable, and hence more likely to be incorrect. It must be stressed that these values are educated guesses (see Table A-4).

Table A-4. kWh data for primarily electric single-family homes

Year	Private	Public
82/83	18,900[a]	26,200[b]
83/84	18,700	25,700
84/85	18,200	24,500
85/86	18,200	24,500[c]
86/87	18,800	25,500[d]
87/88	18,400	25,000[d]

[a] Source: Pacific billing records.
[b] Source: Goeltz, Hirst, and Trumble 91986).
[c] Estimated from Horowitz et al. (1987) data.
[d] Estimated from changes in real cost/kWh and simultaneous changes in consumption in comparable group of private utility customers.

Appendix B. Means, Standard Deviations, and Number of Observations

The following table contains the mean, standard deviation, and number of observations for Hood River participants. This data are shown in aggregate and for several subsets -- separated by utility, by participation in previous weatherization programs, by primary use of electric heat, by dwelling type, and by participation in enduse monitoring.

Group	Variable	Mean	Standard Deviation	n
Combined utilities				
All participants (mixed fuel uses)	1982/83 NAC	19,561	9,444	1,997
	1983/84 NAC	19,067	9,247	
	1984/85 NAC	17,842	8,484	
	1985/86 NAC	16,974	8,047	
	1986/87 NAC	16,986	8,262	
	1987/88 NAC	17,842	8,971	
	1st Year dNAC	-2,588	5,214	
	2nd Year dNAC	-2,575	5,677	
	3rd Year dNAC	-1,719	6,290	
By ft^2 category				
Less than 800 ft^2	1982/83 NAC	14,414	10,459	336
	1983/84 NAC	14,473	13,370	
	1984/85 NAC	13,270	9,022	
	1985/86 NAC	12,501	8,452	
	1986/87 NAC	12,706	8,639	
	1987/88 NAC	13,579	9,733	
	1st Year dNAC	-1,913	4,466	
	2nd Year dNAC	-1,708	4,887	
	3rd Year dNAC	-836	5,869	
800 to 1,200 ft^2	1982/83 NAC	17,235	6,629	584
	1983/84 NAC	16,589	6,438	
	1984/85 NAC	15,654	6,058	
	1985/86 NAC	14,562	5,535	
	1986/87 NAC	14,614	5,857	
	1987/88 NAC	15,288	6,349	
	1st Year dNAC	-2,673	4,425	
	2nd Year dNAC	-2,621	4,648	
	3rd Year dNAC	-1,947	5,254	
1,201 to 1,600 ft^2	1982/83 NAC	19,681	7,034	486
	1983/84 NAC	19,017	6,706	
	1984/85 NAC	17,879	6,358	
	1985/86 NAC	17,269	6,053	
	1986/87 NAC	17,094	6,477	
	1987/88 NAC	17,937	7,011	
	1st Year dNAC	-2,412	4,811	
	2nd Year dNAC	-2,587	5,309	
	3rd Year dNAC	-1,744	5,770	

Group	Variable	Mean	Standard Deviation	n
By ft^2 category				
1,601 to 2,000 ft^2	1982/83 NAC	22,517	8,712	270
	1983/84 NAC	21,795	8,536	
	1984/85 NAC	20,294	7,858	
	1985/86 NAC	19,431	7,361	
	1986/87 NAC	19,528	7,120	
	1987/88 NAC	20,662	8,194	
	1st Year dNAC	-3,086	5,565	
	2nd Year dNAC	-2,989	6,001	
	3rd Year dNAC	-1,855	6,983	
2,001 to 2,400 ft^2	1982/83 NAC	24,223	9,980	159
	1983/84 NAC	23,740	9,758	
	1984/85 NAC	22,122	8,783	
	1985/86 NAC	21,211	8,291	
	1986/87 NAC	21,167	8,598	
	1987/88 NAC	21,914	8,875	
	1st Year dNAC	-3,012	7,532	
	2nd Year dNAC	-3,056	8,255	
	3rd Year dNAC	-2,309	8,128	
All participants (primarily electric)	1982/83 NAC	22,356	10,240	393
	1983/84 NAC	21,916	10,170	
	1984/85 NAC	20,248	9,377	
	1985/86 NAC	19,240	8,767	
	1986/87 NAC	19,696	8,897	
	1987/88 NAC	20,759	9,467	
	1st Year dNAC	-3,116	4,322	
	2nd Year dNAC	-2,659	4,620	
	3rd Year dNAC	-1,596	4,942	
Single-family homes (mixed fuel uses)	1982/83 NAC	20,838	9,183	1,361
	1983/84 NAC	20,340	9,064	
	1984/85 NAC	18,861	8,290	
	1985/86 NAC	18,089	7,820	
	1986/87 NAC	18,177	8,027	
	1987/88 NAC	19,026	8,774	
	1st Year dNAC	-2,748	5,446	
	2nd Year dNAC	-2,661	5,898	
	3rd Year dNAC	-1,811	6,481	
Single-family homes (primarily electric)	1982/83 NAC	25,115	9,801	247
	1983/84 NAC	24,535	9,736	
	1984/85 NAC	22,177	8,912	
	1985/86 NAC	21,223	8,412	
	1986/87 NAC	21,792	8,645	
	1987/88 NAC	22,819	9,112	
	1st Year dNAC	-3,892	4,771	
	2nd Year dNAC	-3,322	5,080	
	3rd Year dNAC	-2,295	5,410	

Group	Variable	Mean	Standard Deviation	n
By ft^2 category				
800 to 1,200 ft^2	1982/83 NAC	20,301	7,807	65
	1983/84 NAC	19,678	7,053	
	1984/85 NAC	17,843	6,298	
	1985/86 NAC	16,631	5,626	
	1986/87 NAC	17,220	5,842	
	1987/88 NAC	17,938	6,244	
	1st Year dNAC	-3,669	3,633	
	2nd Year dNAC	-3,080	3,879	
	3rd Year dNAC	-2,363	3,957	
1,201 to 1,600 ft^2	1982/83 NAC	22,248	6,228	65
	1983/84 NAC	21,296	5,942	
	1984/85 NAC	19,049	5,587	
	1985/86 NAC	18,240	5,303	
	1986/87 NAC	18,938	5,529	
	1987/88 NAC	19,229	5,310	
	1st Year dNAC	-4,008	3,813	
	2nd Year dNAC	-3,309	3,885	
	3rd Year dNAC	-3,019	4,444	
1,601 to 2,000 ft^2	1982/83 NAC	27,162	9,087	40
	1983/84 NAC	26,970	8,834	
	1984/85 NAC	24,210	7,749	
	1985/86 NAC	23,319	6,970	
	1986/87 NAC	23,700	7,007	
	1987/88 NAC	25,536	7,991	
	1st Year dNAC	-3,843	4,781	
	2nd Year dNAC	-3,462	4,810	
	3rd Year dNAC	-1,626	4,487	
2,001 to 2,400 ft^2	1982/83 NAC	30,386	11,403	27
	1983/84 NAC	30,052	12,008	
	1984/85 NAC	27,037	10,756	
	1985/86 NAC	26,652	9,466	
	1986/87 NAC	26,847	8,927	
	1987/88 NAC	28,730	8,316	
	1st Year dNAC	-3,734	6,810	
	2nd Year dNAC	-3,539	7,495	
	3rd Year dNAC	-1,657	8,081	

Group	Variable	Mean	Standard Deviation	n
All participants (mixed fuel uses) (enduse monitored)	1982/83 NAC	21,217	7,394	244
	1983/84 NAC	20,644	7,108	
	1984/85 NAC	20,027	6,790	
	1985/86 NAC	18,000	6,072	
	1986/87 NAC	18,223	6,418	
	1987/88 NAC	19,234	6,934	
	1st Year dNAC	-3,218	5,068	
	2nd Year dNAC	-2,994	5,721	
	3rd Year dNAC	-1,984	6,050	
Single-family homes (mixed fuel uses) (enduse monitored)	1982/83 NAC	21,165	7,460	200
	1983/84 NAC	20,792	7,066	
	1984/85 NAC	20,218	6,792	
	1985/86 NAC	17,953	6,095	
	1986/87 NAC	18,212	6,491	
	1987/88 NAC	19,236	7,059	
	1st Year dNAC	-3,212	5,096	
	2nd Year dNAC	-2,953	5,755	
	3rd Year dNAC	-1,929	6,047	
Single-family homes (primarily electric) (enduse monitored)	1982/83 NAC	24,688	7,608	42
	1983/84 NAC	23,543	6,978	
	1984/85 NAC	22,871	6,678	
	1985/86 NAC	19,999	6,127	
	1986/87 NAC	20,688	6,091	
	1987/88 NAC	21,699	6,470	
	1st Year dNAC	-4,690	4,299	
	2nd Year dNAC	-4,001	4,501	
	3rd Year dNAC	-2,990	5,111	
All participants (mixed fuel uses) (not monitored)	1982/83 NAC	19,353	9,690	1,743
	1983/84 NAC	18,856	9,498	
	1984/85 NAC	17,525	8,651	
	1985/86 NAC	16,839	8,291	
	1986/87 NAC	16,825	8,489	
	1987/88 NAC	17,652	9,221	
	1st Year dNAC	-2,514	5,235	
	2nd Year dNAC	-2,528	5,680	
	3rd Year dNAC	-1,701	6,331	
Single-family homes (mixed fuel uses) (not monitored)	1982/83 NAC	20,791	9,448	1,160
	1983/84 NAC	20,272	9,364	
	1984/85 NAC	18,634	8,503	
	1985/86 NAC	18,118	8,084	
	1986/87 NAC	18,177	8,267	
	1987/88 NAC	18,987	9,040	
	1st Year dNAC	-2,672	5,503	
	2nd Year dNAC	-2,614	5,925	
	3rd Year dNAC	-1,794	6,558	

Group	Variable	Mean	Standard Deviation	n
Single-family homes (primarily electric) (not monitored)	1982/83 NAC	25,202	10,206	205
	1983/84 NAC	24,738	10,212	
	1984/85 NAC	22,034	9,311	
	1985/86 NAC	21,473	8,799	
	1986/87 NAC	22,019	9,075	
	1987/88 NAC	23,049	9,560	
	1st Year dNAC	-3,729	4,856	
	2nd Year dNAC	-3,183	5,189	
	3rd Year dNAC	-2,153	5,471	
Multifamily homes (primarily electric) (all are Pacific)	1982/83 NAC	8,908	4,596	41
	1983/84 NAC	9,199	4,686	
	1984/85 NAC	8,865	4,721	
	1985/86 NAC	7,958	4,057	
	1986/87 NAC	7,913	3,820	
	1987/88 NAC	8,480	4,170	
	1st Year dNAC	-950	1,748	
	2nd Year dNAC	-995	2,049	
	3rd Year dNAC	-428	2,307	
Mobile homes (mixed fuel uses)	1982/83 NAC	19,654	7,275	362
	1983/84 NAC	18,918	6,910	
	1984/85 NAC	18,108	6,744	
	1985/86 NAC	17,189	6,208	
	1986/87 NAC	17,040	6,672	
	1987/88 NAC	18,002	7,182	
	1st Year dNAC	-2,465	4,985	
	2nd Year dNAC	-2,614	5,761	
	3rd Year dNAC	-1,652	6,265	
Mobile homes (primarily electric)	1982/83 NAC	21,016	6,616	95
	1983/84 NAC	20,558	6,531	
	1984/85 NAC	20,227	6,484	
	1985/86 NAC	19,303	5,847	
	1986/87 NAC	19,780	5,927	
	1987/88 NAC	21,166	6,745	
	1st Year dNAC	-1,713	2,942	
	2nd Year dNAC	-1,236	3,290	
	3rd Year dNAC	+150	3,795	

Group	Variable	Mean	Standard Deviation	n
HREC customers				
All participants (mixed fuel uses)	1982/83 NAC	23,486	10,703	801
	1983/84 NAC	22,528	10,536	
	1984/85 NAC	20,751	9,712	
	1985/86 NAC	19,582	9,068	
	1986/87 NAC	19,677	9,423	
	1987/88 NAC	20,689	10,302	
	1st Year dNAC	-3,903	5,993	
	2nd Year dNAC	-3,808	6,643	
	3rd Year dNAC	-2,797	7,371	
All participants (primarily electric)	1982/83 NAC	27,836	10,603	172
	1983/84 NAC	26,938	11,095	
	1984/85 NAC	24,709	10,218	
	1985/86 NAC	23,361	9,399	
	1986/87 NAC	24,082	9,398	
	1987/88 NAC	25,225	10,091	
	1st Year dNAC	-4,475	5,010	
	2nd Year dNAC	-3,754	5,500	
	3rd Year dNAC	-2,611	5,786	
Single-family homes (mixed fuel uses)	1982/83 NAC	23,581	10,581	598
	1983/84 NAC	22,700	10,508	
	1984/85 NAC	20,772	9,600	
	1985/86 NAC	19,698	8,940	
	1986/87 NAC	19,865	9,193	
	1987/88 NAC	20,804	9,986	
	1st Year dNAC	-3,883	6,111	
	2nd Year dNAC	-3,716	6,697	
	3rd Year dNAC	-2,778	7,382	
Single-family homes (primarily electric)	1982/83 NAC	29,288	10,703	120
	1983/84 NAC	28,284	11,157	
	1984/85 NAC	25,402	10,115	
	1985/86 NAC	24,169	9,616	
	1986/87 NAC	25,036	9,842	
	1987/88 NAC	26,005	10,370	
	1st Year dNAC	-5,119	5,421	
	2nd Year dNAC	-4,252	5,864	
	3rd Year dNAC	-3,283	6,055	
Single-family homes (primarily electric) (no prev. programs)	1982/83 NAC	30,400	10,667	106
	1983/84 NAC	29,612	11,055	
	1984/85 NAC	26,439	10,144	
	1985/86 NAC	25,051	9,714	
	1986/87 NAC	25,906	9,973	
	1987/88 NAC	26,931	10,476	
	1st Year dNAC	-5,349	5,664	
	2nd Year dNAC	-4,494	6,112	
	3rd Year dNAC	-3,469	6,253	

Group	Variable	Mean	Standard Deviation	n
Single-family homes (primarily electric) (prev. participants)	1982/83 NAC	20,870	6,577	14
	1983/84 NAC	18,226	5,388	
	1984/85 NAC	17,551	5,493	
	1985/86 NAC	17,495	5,474	
	1986/87 NAC	18,449	5,511	
	1987/88 NAC	18,996	6,173	
	1st Year dNAC	-3,375	2,488	
	2nd Year dNAC	-2,421	2,820	
	3rd Year dNAC	-1,874	4,160	
All participants (mixed fuel uses) (enduse monitored)	1982/83 NAC	23,822	7,884	97
	1983/84 NAC	22,957	7,397	
	1984/85 NAC	22,152	7,193	
	1985/86 NAC	19,602	6,430	
	1986/87 NAC	19,755	6,820	
	1987/88 NAC	20,991	7,854	
	1st Year dNAC	-4,220	5,557	
	2nd Year dNAC	-4,066	6,025	
	3rd Year dNAC	-2,831	6,789	
Single-family homes (mixed fuel uses) (enduse monitored)	1982/83 NAC	24,079	8,082	80
	1983/84 NAC	23,368	7,330	
	1984/85 NAC	22,551	7,242	
	1985/86 NAC	19,473	6,374	
	1986/87 NAC	19,573	6,795	
	1987/88 NAC	21,007	8,122	
	1st Year dNAC	-4,606	5,794	
	2nd Year dNAC	-4,505	6,262	
	3rd Year dNAC	-3,072	7,185	
Single-family homes (primarily electric) (enduse monitored)	1982/83 NAC	28,090	7,695	21
	1983/84 NAC	26,125	7,741	
	1984/85 NAC	25,315	7,266	
	1985/86 NAC	21,681	6,833	
	1986/87 NAC	22,483	6,452	
	1987/88 NAC	23,601	7,044	
	1st Year dNAC	-6,409	4,047	
	2nd Year dNAC	-5,607	4,445	
	3rd Year dNAC	-4,489	5,399	
All participants (mixed fuel uses) (not monitored)	1982/83 NAC	23,448	11,051	702
	1983/84 NAC	22,481	10,909	
	1984/85 NAC	20,539	9,997	
	1985/86 NAC	19,585	9,388	
	1986/87 NAC	19,671	9,742	
	1987/88 NAC	20,650	10,612	
	1st Year dNAC	-3,863	6,060	
	2nd Year dNAC	-3,777	6,736	
	3rd Year dNAC	-2,798	7,462	

Group	Variable	Mean	Standard Deviation	n
Single-family homes (mixed fuel uses) (not monitored)	1982/83 NAC	23,504	10,921	518
	1983/84 NAC	22,597	10,919	
	1984/85 NAC	20,497	9,891	
	1985/86 NAC	19,733	9,278	
	1986/87 NAC	19,910	9,514	
	1987/88 NAC	20,772	10,250	
	1st Year dNAC	-3,772	6,157	
	2nd Year dNAC	-3,594	6,759	
	3rd Year dNAC	-2,732	7,418	
Single-family homes (primarily electric) (not monitored)	1982/83 NAC	29,542	11,254	99
	1983/84 NAC	28,742	11,735	
	1984/85 NAC	25,421	10,651	
	1985/86 NAC	24,697	10,057	
	1986/87 NAC	25,577	10,365	
	1987/88 NAC	26,515	10,907	
	1st Year dNAC	-4,845	5,649	
	2nd Year dNAC	-3,965	6,103	
	3rd Year dNAC	-3,027	6,180	
Mobile homes (mixed fuel uses)	1982/83 NAC	21,972	7,878	176
	1983/84 NAC	20,699	7,430	
	1984/85 NAC	19,497	7,371	
	1985/86 NAC	18,416	6,936	
	1986/87 NAC	18,137	7,783	
	1987/88 NAC	19,111	8,198	
	1st Year dNAC	-3,556	5,403	
	2nd Year dNAC	-3,836	6,296	
	3rd Year dNAC	-2,861	6,656	
Mobile homes (primarily electric)	1982/83 NAC	23,403	7,156	49
	1983/84 NAC	22,656	7,035	
	1984/85 NAC	22,167	7,163	
	1985/86 NAC	20,935	6,412	
	1986/87 NAC	21,481	6,477	
	1987/88 NAC	22,975	7,648	
	1st Year dNAC	-2,468	2,764	
	2nd Year dNAC	-1,921	3,389	
	3rd Year dNAC	-428	4,133	

Group	Variable	Mean	Standard Deviation	n
Pacific customers				
All participants (mixed fuel uses)	1982/83 NAC	16,933	7,419	1,196
	1983/84 NAC	16,749	7,423	
	1984/85 NAC	15,893	6,901	
	1985/86 NAC	15,227	6,745	
	1986/87 NAC	15,184	6,817	
	1987/88 NAC	15,936	7,370	
	1st Year dNAC	-1,707	4,408	
	2nd Year dNAC	-1,749	4,753	
	3rd Year dNAC	-997	5,331	
All participants (primarily electric)	1982/83 NAC	18,090	7,596	221
	1983/84 NAC	18,007	7,317	
	1984/85 NAC	16,776	6,918	
	1985/86 NAC	16,032	6,683	
	1986/87 NAC	16,283	6,757	
	1987/88 NAC	17,283	7,268	
	1st Year dNAC	-2,058	3,347	
	2nd Year dNAC	-1,807	3,586	
	3rd Year dNAC	-807	4,008	
Single-family homes (mixed fuel uses)	1982/83 NAC	18,688	7,228	763
	1983/84 NAC	18,491	7,232	
	1984/85 NAC	17,363	6,735	
	1985/86 NAC	16,829	6,551	
	1986/87 NAC	16,854	6,694	
	1987/88 NAC	17,634	7,407	
	1st Year dNAC	-1,859	4,677	
	2nd Year dNAC	-1,834	5,039	
	3rd Year dNAC	-1,054	5,565	
Single-family homes (primarily electric)	1982/83 NAC	21,171	6,862	127
	1983/84 NAC	20,993	6,440	
	1984/85 NAC	19,129	6,258	
	1985/86 NAC	18,438	5,895	
	1986/87 NAC	18,727	5,911	
	1987/88 NAC	19,809	6,460	
	1st Year dNAC	-2,733	3,728	
	2nd Year dNAC	-2,444	4,037	
	3rd Year dNAC	-1,362	4,552	
Single-family homes (primarily electric) (no prev. programs)	1982/83 NAC	22,160	6,808	59
	1983/84 NAC	22,305	6,504	
	1984/85 NAC	20,401	6,539	
	1985/86 NAC	19,241	5,797	
	1986/87 NAC	19,459	5,790	
	1987/88 NAC	20,919	6,726	
	1st Year dNAC	-2,919	4,657	
	2nd Year dNAC	-2,701	5,124	
	3rd Year dNAC	-1,241	5,445	

Group	Variable	Mean	Standard Deviation	n
Single-family homes (primarily electric) (prev. participants)	1982/83 NAC	20,313	6,843	68
	1983/84 NAC	19,855	6,209	
	1984/85 NAC	18,025	5,830	
	1985/86 NAC	17,742	5,933	
	1986/87 NAC	18,092	5,983	
	1987/88 NAC	18,847	6,106	
	1st Year dNAC	-2,571	2,704	
	2nd Year dNAC	-2,221	2,794	
	3rd Year dNAC	-1,466	3,644	
All participants (mixed fuel uses) (enduse monitored)	1982/83 NAC	19,499	6,530	147
	1983/84 NAC	19,118	6,497	
	1984/85 NAC	18,625	6,143	
	1985/86 NAC	16,943	5,600	
	1986/87 NAC	17,213	5,950	
	1987/88 NAC	18,074	6,005	
	1st Year dNAC	-2,556	4,619	
	2nd Year dNAC	-2,287	5,416	
	3rd Year dNAC	-1,425	5,461	
Single-family homes (mixed fuel uses) (enduse monitored)	1982/83 NAC	19,222	6,339	120
	1983/84 NAC	19,074	6,356	
	1984/85 NAC	18,663	6,020	
	1985/86 NAC	16,940	5,707	
	1986/87 NAC	17,304	6,143	
	1987/88 NAC	18,056	6,002	
	1st Year dNAC	-2,282	4,356	
	2nd Year dNAC	-1,918	5,162	
	3rd Year dNAC	-1,166	5,040	
Single-family homes (primarily electric) (enduse monitored)	1982/83 NAC	21,287	5,929	21
	1983/84 NAC	20,962	5,090	
	1984/85 NAC	20,427	5,106	
	1985/86 NAC	18,316	4,932	
	1986/87 NAC	18,892	5,260	
	1987/88 NAC	19,796	5,346	
	1st Year dNAC	-2,971	3,911	
	2nd Year dNAC	-2,395	4,045	
	3rd Year dNAC	-1,491	4,436	
All participants (mixed fuel uses) (not monitored)	1982/83 NAC	16,592	7,484	1,041
	1983/84 NAC	16,411	7,486	
	1984/85 NAC	15,493	6,909	
	1985/86 NAC	14,987	6,870	
	1986/87 NAC	14,906	6,898	
	1987/88 NAC	15,631	7,508	
	1st Year dNAC	-1,604	4,368	
	2nd Year dNAC	-1,685	4,657	
	3rd Year dNAC	-961	5,314	

Group	Variable	Mean	Standard Deviation	n
Single-family homes (mixed fuel uses) (not monitored)	1982/83 NAC	18,601	7,380	642
	1983/84 NAC	18,396	7,381	
	1984/85 NAC	17,131	6,837	
	1985/86 NAC	16,816	6,702	
	1986/87 NAC	16,778	6,795	
	1987/88 NAC	17,565	7,643	
	1st Year dNAC	-1,786	4,736	
	2nd Year dNAC	-1,824	5,022	
	3rd Year dNAC	-1,036	5,665	
Single-family homes (primarily electric) (not monitored)	1982/83 NAC	21,148	7,058	106
	1983/84 NAC	20,999	6,696	
	1984/85 NAC	18,872	6,452	
	1985/86 NAC	18,463	6,088	
	1986/87 NAC	18,695	6,054	
	1987/88 NAC	19,812	6,681	
	1st Year dNAC	-2,686	3,709	
	2nd Year dNAC	-2,453	4,054	
	3rd Year dNAC	-1,336	4,595	
Mobile homes (mixed fuel uses)	1982/83 NAC	17,461	5,883	186
	1983/84 NAC	17,233	5,923	
	1984/85 NAC	16,793	5,812	
	1985/86 NAC	16,027	5,187	
	1986/87 NAC	16,002	5,228	
	1987/88 NAC	16,952	5,900	
	1st Year dNAC	-1,434	4,321	
	2nd Year dNAC	-1,459	4,951	
	3rd Year dNAC	-508	5,656	
Mobile homes (primarily electric)	1982/83 NAC	18,474	4,899	46
	1983/84 NAC	18,324	5,139	
	1984/85 NAC	18,160	4,963	
	1985/86 NAC	17,564	4,645	
	1986/87 NAC	17,967	4,704	
	1987/88 NAC	19,240	5,028	
	1st Year dNAC	-910	2,942	
	2nd Year dNAC	-507	3,050	
	3rd Year dNAC	+766	3,334	

Group	Variable	Mean	Standard Deviation	n
Regional comparison group (Pacific customers)				
All comparison homes (mixed fuel uses)	1982/83 NAC	14,691	7,886	435
	1983/84 NAC	14,157	7,577	
	1984/85 NAC	13,973	7,311	
	1985/86 NAC	13,835	7,324	
	1986/87 NAC	14,081	7,808	
	1987/88 NAC	13,894	7,563	
	1st Year dNAC	-856	3,606	
	2nd Year dNAC	-610	4,073	
	3rd Year dNAC	-796	4,470	
By ft^2 category				
Less than 800 ft^2	1982/83 NAC	11,962	5,766	41
	1983/84 NAC	11,386	5,005	
	1984/85 NAC	10,778	4,646	
	1985/86 NAC	10,168	4,279	
	1986/87 NAC	10,098	5,249	
	1987/88 NAC	9,953	5,325	
	1st Year dNAC	-1,794	3,321	
	2nd Year dNAC	-1,864	4,506	
	3rd Year dNAC	-2,009	4,198	
800 to 1,200 ft^2	1982/83 NAC	13,612	6,473	109
	1983/84 NAC	13,105	5,926	
	1984/85 NAC	13,083	5,722	
	1985/86 NAC	13,082	5,667	
	1986/87 NAC	13,051	5,897	
	1987/88 NAC	13,189	6,181	
	1st Year dNAC	-530	3,236	
	2nd Year dNAC	-561	3,416	
	3rd Year dNAC	-423	4,078	
1,201 to 1,600 ft^2	1982/83 NAC	15,670	8,122	125
	1983/84 NAC	15,303	8,093	
	1984/85 NAC	15,068	7,607	
	1985/86 NAC	14,427	7,272	
	1986/87 NAC	14,726	7,924	
	1987/88 NAC	14,713	7,719	
	1st Year dNAC	-1,244	3,789	
	2nd Year dNAC	-944	4,170	
	3rd Year dNAC	-957	4,185	
1,601 to 2,000 ft^2	1982/83 NAC	16,460	8,455	66
	1983/84 NAC	15,514	8,593	
	1984/85 NAC	15,368	7,864	
	1985/86 NAC	15,650	8,083	
	1986/87 NAC	15,694	8,044	
	1987/88 NAC	15,187	7,392	
	1st Year dNAC	-810	3,381	
	2nd Year dNAC	-766	3,965	
	3rd Year dNAC	-1,272	5,490	

Group	Variable	Mean	Standard Deviation	n
2,001 to 2,400 ft^2	1982/83 NAC	16,012	8,445	31
	1983/84 NAC	15,893	7,890	
	1984/85 NAC	15,440	7,631	
	1985/86 NAC	15,814	7,858	
	1986/87 NAC	16,798	8,245	
	1987/88 NAC	16,613	8,307	
	1st Year dNAC	-199	4,952	
	2nd Year dNAC	786	5,449	
	3rd Year dNAC	600	5,514	
More than 2,400 ft^2	1982/83 NAC	18,275	12,140	24
	1983/84 NAC	18,044	10,797	
	1984/85 NAC	18,156	11,846	
	1985/86 NAC	19,324	11,788	
	1986/87 NAC	20,475	12,593	
	1987/88 NAC	19,011	11,920	
	1st Year dNAC	1,050	3,713	
	2nd Year dNAC	2,201	4,236	
	3rd Year dNAC	736	4,813	
Single-family homes (primarily electric)	1982/83 NAC	18,854	8,677	65
	1983/84 NAC	18,697	8,903	
	1984/85 NAC	18,213	8,559	
	1985/86 NAC	18,241	8,792	
	1986/87 NAC	18,827	9,010	
	1987/88 NAC	18,385	8,716	
	1st Year dNAC	-614	3.932	
	2nd Year dNAC	-28	4,136	
	3rd Year dNAC	-470	4,469	
Single-family homes (mixed fuel uses)	1982/83 NAC	14,533	7,374	339
	1983/84 NAC	14,176	7,101	
	1984/85 NAC	14,032	6,863	
	1985/86 NAC	13,981	7,206	
	1986/87 NAC	14,178	7,562	
	1987/88 NAC	13,994	7,309	
	1st Year dNAC	-552	3,583	
	2nd Year dNAC	-355	4,143	
	3rd Year dNAC	-539	4,492	
By ft^2 category				
Less than 800 ft^2	1982/83 NAC	11,615	6,180	21
	1983/84 NAC	11,017	5,009	
	1984/85 NAC	10,680	5,220	
	1985/86 NAC	10,095	4,962	
	1986/87 NAC	9,485	5,077	
	1987/88 NAC	9,843	5,242	
	1st Year dNAC	-1,520	3,648	
	2nd Year dNAC	-2,130	5,485	
	3rd Year dNAC	-1,772	5,184	

Group	Variable	Mean	Standard Deviation	n
800 to 1,200 ft^2	1982/83 NAC	13,303	6,112	77
	1983/84 NAC	13,009	5,773	
	1984/85 NAC	12,912	5,581	
	1985/86 NAC	13,060	5,487	
	1986/87 NAC	12,993	5,896	
	1987/88 NAC	13,154	6,423	
	1st Year dNAC	-243	3,219	
	2nd Year dNAC	-309	3,255	
	3rd Year dNAC	-148	4,162	
1,201 to 1,600 ft^2	1982/83 NAC	14,912	6,792	105
	1983/84 NAC	14,798	6,705	
	1984/85 NAC	14,706	6,587	
	1985/86 NAC	14,135	6,642	
	1986/87 NAC	14,326	6,958	
	1987/88 NAC	14,115	6,719	
	1st Year dNAC	-777	3,626	
	2nd Year dNAC	-586	4,190	
	3rd Year dNAC	-797	4,285	
1,601 to 2,000 ft^2	1982/83 NAC	16,374	8,524	60
	1983/84 NAC	15,469	8,647	
	1984/85 NAC	15,416	8,005	
	1985/86 NAC	15,599	8,243	
	1986/87 NAC	15,484	8,178	
	1987/88 NAC	15,278	7,483	
	1st Year dNAC	-775	3,308	
	2nd Year dNAC	-891	3,720	
	3rd Year dNAC	-1,096	4,657	
2,001 to 2,400 ft^2	1982/83 NAC	16,106	8,573	30
	1983/84 NAC	16,073	7,960	
	1984/85 NAC	15,646	7,673	
	1985/86 NAC	16,081	7,848	
	1986/87 NAC	17,083	8,230	
	1987/88 NAC	16,880	8,313	
	1st Year dNAC	-25	4,940	
	2nd Year dNAC	977	5,435	
	3rd Year dNAC	774	5,522	
More than 2,400 ft^2	1982/83 NAC	16,932	9,717	21
	1983/84 NAC	16,670	8,416	
	1984/85 NAC	16,743	8,378	
	1985/86 NAC	18,379	10,648	
	1986/87 NAC	19,618	11,101	
	1987/88 NAC	18,122	10,531	
	1st Year dNAC	1,447	3,301	
	2nd Year dNAC	2,686	4,105	
	3rd Year dNAC	1,190	4,742	

Appendix C. KiloWatt-hour Data for Comparison Groups

Table C-1 shows the comparison group data which were used to calculate net Project savings.

Table C-1. KiloWatt-hour data

Sample	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	n
Bonneville area[a] (100% public, single-family, somefit)	NA	NA	22,100	22,100	NA	NA	1,192
Bonneville area[b] (80% public, single-family, somefit)	24,000	23,400	22,300	22,300[c]	22,300[d]	22,300[d]	280
Bonneville area[b] (80% public, single-family, goodfit)	26,200	25,700	24,500	24,500[c]	25,700[d]	25,000[d]	114
Private comparison[e] (mixed housing, somefit)	14,700	14,200	14,000	13,800	14,100	13,900	435
Private comparison[e] (mixed housing, goodfit)	16,100	15,400	15,300	15,200	15,600	15,400	221
Private comparison[e] (single-family, somefit)	14,500	14,200	14,000	14,000	14,200	14,000	339
Private comparison[e] (single-family goodfit)	18,900	18,700	18,200	18,200	18,800	18,400	65
Private comparison[e] (mobile home somefit)	17,600	16,600	16,000	15,100	15,800	16,000	43

All consumption figures rounded to nearest 100 kWh.
[a] Source: Horowitz, Bronfman, and Lerman (1987).
[b] Source: Goeltz, Hirst, and Trumble (1986).
[c] Estimated from Horowitz et al. data.
[d] Estimated from changes in customer rates (Appendix A).
[e] Source: Pacific billing records.

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