NON-HEATING ELECTRIC USE AND CONSERVATION POTENTIAL AMONG ENERGY ASSISTANCE PROGRAM RECIPIENTS IN MINNEAPOLIS

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ABSTRACT

Low income energy programs in Minneapolis have focused on gas used for space and water heating. After high electric bills were found in one program, Northern States Power Company and the City of Minneapolis undertook a joint study of electric use among Energy Assistance Program (EAP) recipients.

EAP recipients have fewer major electric appliances than the general population. Large differences were found for air conditioners, dehumidifiers, dishwashers, clothes washers and ranges, while saturations were essentially the same in the two groups for freezers, supplementary heaters, waterbed heaters, dryers and televisions.

EAP recipients are similar to the general population in both the mean and range of their electric use. About half the variation in use within EAP households can be explained by a regression model of demographics and appliances. The rest is probably caused by variations in energy use behaviors or appliance performance. However, exploratory monitoring of refrigerators, the highest use appliance common in Minneapolis EAP households, did not find anomalously high use.

The electric bill as a percent of income is four times as great for EAP households as for the general population, and many recipients are in arrears or feel they cannot afford their bills.

Substantial fractions of the EAP population do not know how the electric company determines their bill, and in ranking the relative use of appliances, EAP households did not do better than if they had guessed at random. More than 60% feel there is nothing further they could do to reduce electric use.

As a result of these findings, a program is being developed to serve the upper quartile of EAP electric customers (bills over $38/month). The program will emphasize behavioral conservation following social psychological principles. It also includes a site-specific appliance audit.

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INTRODUCTION

Minneapolis residential dwellings generally have much higher gas expenses than electric expenses. As a result, residential electric energy conservation has received much less individual and government attention in the years since the energy crisis. However, Minneapolis Energy Office staff encountered surprisingly high electric bills while conducting a pilot program for Energy Assistance Program recipients in single-family homes in the fall of 1984. This group had electric use averaging 640 kWh per month ($555 per year), considerably higher than the 400 kWh per month estimated by Northern States Power (NSP) staff for the typical single-family home in Minneapolis. A few studies elsewhere had also shown that electric use in low income households equals or exceeds that in other households when normalized for house size or number of occupants (Brown and Rollinson, 1985, Pacific Gas and Electric, 1983, Vine and Reyes, 1987).

After reviewing the pilot project results, the City and NSP agreed that more complete information was needed on the electric use of Minneapolis' 16,000 Energy Assistance Program* (EAP) recipients. A joint research project was undertaken, funded by NSP with in-kind services from the Minneapolis Energy Office and the Minneapolis Community Action Agency. The goals of this project were to determine the extent of high electric use in the Minneapolis EAP population, and which subsets of this population are affected; and to make a preliminary assessment of reasons for the high use and of affordability issues.

METHODOLOGY

A sample of 953 EAP recipients was drawn progressively over the first six months of the eight month 1985-86 EAP application period. The EAP application form provided basic demographic data. NSP was able to compile some electric data for most households, though the number of months of data varied

* The Low Income Home Energy Assistance Program (LIHEAP, but in this paper simply EAP) is the federal program funded through Health and Human Services to provide assistance on fuel bills to low income households in the U.S. In Minnesota, eligibility is generally set at 135% of federal poverty guidelines. The disbursement in Minneapolis is about $6 million annually.

from none to a full year. The EAP electric data were drawn from a period with heating and cooling degree-day totals very similar to the weather for the comparison group data period.

Telephone interviews were conducted by a survey research consultant to collect data on appliances, demographics, knowledge of household electric bills and of factors affecting the bill, perceptions of utility and assistance program practices, and affordability. A stratified random subsample of 479 was drawn from the overall sample of 953, and interviews were completed for 81% of this subsample, including households without telephones that were interviewed face to face. This high response rate was very important in assuring that results derived from the phone survey accurately represent the overall EAP population. A pilot site survey was conducted in 89 households, stratified toward high users, to verify appliance saturations and collect more detailed data on the age, condition and use of these appliances.

The primary study group is the 388 households with complete telephone surveys. The survey group was stratified to overrepresent those with a complete year of electric data in order to provide a larger subsample for regressions relating electric use to appliances, demographics, and so on. Therefore, to use the survey group to represent the entire EAP population, it was necessary to weight it to remove the sampling stratification. The **weighted survey group** was compared with the overall sample of 953 and with the entire 1985-86 EAP population on all available characteristics from EAP data and was not statistically different on any of them. It is, therefore, a reliable sample for estimating the characteristics of the overall EAP population (other than electric use).

Characterizing the electric use of the overall EAP population was complicated by the fact that complete electric data were not available for the entire group. Of necessity, detailed analysis focused on the **core** group that had 12 months of electric data and complete telephone interview data. Analyses showed that the electric use distribution of this group approximates the distribution of the weighted survey group quite well, particularly within individual dwelling types (Hewett et al., 1987).

The comparison group used to represent the general population was taken from NSP's 1983 Home Use Study (HUS) data base (Knutson, 1983). The HUS study started with a stratified random sample of all residential customers with at least 11 months of electric data. About 70% of the sample responded to a survey mailed by NSP, which covered demographics, appliances and conservation actions. Residential electric use in NSP's system has not shown any pronounced trends that would make this 1983 sample unsuitable as a 1986 comparison group. The subsample of 132 within Minneapolis alone was not large enough for our purposes, but tests determined the Minneapolis and St. Paul subsamples to be sufficiently similar to be combined to create a larger comparison group of 282. This sample was reweighted to remove stratification by customer type (gas, electric, and combination) and dwelling type, and is our best approximation of NSP's overall Minneapolis-St. Paul electric customer use.

DEMOGRAPHIC CHARACTERISTICS

The EAP group has many demographic characteristics consistent with other studies of the low income population in Minneapolis (although this does not imply that the EAP group is necessarily representative of all low income households), but it is quite different from the HUS group (see Table I). EAP households are less likely to live in single-family homes and less than half as likely to own their own homes. They have somewhat larger families on average, are more likely to have a female head of household, have less formal education, and have five times the proportion of racial minorities. The average EAP income is less than a third of the average HUS income, and less than a third of EAP households have any member who is employed. EAP has substantially fewer senior citizens.*

APPLIANCE SATURATIONS

Major appliances are a key factor in electric use and also an important determinant of programmatic conservation options. Appliance saturations tend to be correlated with dwelling type. Often, single-family homes show the highest saturations, followed by plexes (see Table I for definition) and then apartments, although some appliances show other patterns. Because the EAP and HUS groups differ significantly in the mix of dwelling types, comparisons of overall appliance saturations for the two groups are confounded by dwelling type effects. Table II presents comparative data overall and by dwelling type.

On average, the EAP group has fewer major electric appliances than the HUS group. The biggest differences were found for air conditioners, dehumidifiers, dishwashers, clothes washers, and electric ranges. Modest differences were found in second refrigerators. No significant differences were found in the saturations of freezers, supplementary electric space heaters, waterbed heaters, microwave ovens**, electric clothes dryers, or televisions. Self-reported primary electric space heating and electric water heating were found to be unreliable based on the site visits, but saturations are low in both groups.

Freezers and second refrigerators are among the highest use discretionary appliances. For the EAP group, crosstabulations showed that freezers are strongly correlated with family size for plexes and apartments but not significantly for single-family homes, while second refrigerators are not correlated with family size overall or within dwelling types.

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* This may be because senior citizens living in subsidized high rise buildings are not eligible to receive EAP payments. It could also reflect some uncorrected response bias in the HUS sample, or a difference in the extent to which seniors and non-seniors make use of assistance programs.

** Updated appliance data for NSP's entire system suggest that 1986 HUS saturations of microwave ovens probably are substantially greater than EAP saturations. On a systemwide level, no other HUS saturations showed significant changes from 1983 to 1986.

ELECTRIC USE DISTRIBUTIONS AND MODELS

The distribution of electric use in the EAP core group is quite similar to that in the HUS group within single-family homes ($0.5 < p < 0.9$, not significant) and plexes ($p > 0.9$, not significant) (Table III and Figure 1). The general similarities of the mean and distribution of use appear to be due in part to compensatory differences in the detailed patterns of use. For example, EAP households have more family members but fewer appliances than HUS households, and higher use by EAP non-seniors (compared to HUS) is offset by lower use by EAP seniors (Hewett et al, 1987).

EAP use is about one third higher than HUS use in apartments and this difference is statistically significant ($0.001 < p < 0.01$). Some of the difference is accounted for by the fact that this dwelling type has the largest proportional difference in family size (2.2 members for EAP vs 1.4 for HUS) and some by the fact that small EAP households in apartments use more electricity than small HUS households in apartments do.

Combining all dwelling types yields mean use for the EAP core group (409 kWh/month) that is about 10% higher than for HUS (370 kWh/month)($0.5 < p < 0.10$, marginal). This difference stems about equally from the fact that the unweighted EAP core group has more plexes and fewer apartments than the HUS group and from the effect of the relatively large difference between EAP and HUS apartment dwellers. The mean use for the EAP weighted survey group imputed from a regression model is 389 kWh/month, somewhat closer to the overall HUS mean. Thus a representative sample of all EAP's does not show the same inflated use found in our 1984 pilot project mentioned earlier.

Multiple regression models were developed to determine how much of the variation in electric use from household to household can be explained by readily observed characteristics such as demographics and appliance saturations. It was hoped that we would be able to construct models which could explain much of the variation and which would have a useful degree of realism. Such models would allow us to compare EAP and HUS electric use in considerable detail. The best model we were able to develop for EAP included 9 of the 22 available demographic and appliance variables and captured about half of the total variation in use (Table IV). This model included three demographic variables which were still important predictors even after adding appliance information: family size, senior households, and dwelling type. Electric use increased by about 34 kWh per month per household member. Senior citizen households (all members 61 or older) used 105 kWh per month less than otherwise similar non-senior households. Families in single-family homes used 66 kWh per month more than otherwise similar families in plexes and apartments.

The model included three major electric appliances (refrigerators, freezers and stoves) and three lesser appliances (televisions, clothes washers and microwave ovens). Several plausible appliances expected to have higher use than the latter three, such as electric clothes dryers, supplementary space

heaters, and air conditioners, did not enter into the model. Exclusion of these could be occurring because the presence of an appliance does not adequately predict its likely contribution given the wide variations possible in the condition and amount of use of the appliance (for example, the site surveys showed households' normal use of electric dryers ranging from 1 to 22 loads per week). The monthly use coefficients for the appliance variables range from those that agree closely with NSP stock average figures (refrigerators, freezers) to those which appear to be within the broader range of possibilities (televisions, electric ranges) to those which are manifestly too high (clothes washers, microwave ovens). Both the inclusion of unexpected predictors and the occurrence of unrealistic coefficients could occur because these variables are "standing in" for some other, perhaps unmeasured, characteristic (e.g., microwave ovens are correlated with the presence of a number of other appliances and may be correlated with unmeasured attitudes or behaviors as well). An explanatory power of 40 to 60% appears to be the practical limit of analysis based on demographics and appliance presence alone without including more detailed, specific measures of how much each appliance is used in each household and what its features and condition are.

The regression model is useful in that it quantifies the importance of demographic variables when appliances are separately accounted for, it demonstrates the large component of use that is unexplained by demographics and appliance presence and that is presumably related to use habits and equipment differences, and it can be used to "impute" use when it is not available. However, since multiple regression analysis of the HUS group showed the same sort of mixture of expected and surprising variables and of realistic and unrealistic coefficient values, a variable by variable comparison of EAP and HUS regression models would be meaningless.

Further multiple regression was done using a single predicted use score (the sum of the stock average use values for each appliance present) instead of the 17 separate appliance variables, to try to include all appliances in our model and to reduce problems of particular appliances standing in for others or for unmeasured behavioral factors. In this model the predicted use score entered first and with an R^2 of 22%, demonstrating the importance of appliance presence in use, but the final model had an R^2 of only 41%, reinforcing the importance of unmeasured factors such as use habits and equipment condition in determining consumption.

AFFORDABILITY

The overall average monthly electric bill for the EAP core group is $27. Twenty-five percent have average bills of $38 or more, and 10% have bills of $49 or more (see Table V). While the average electric use of the EAP group is similar to that of the HUS group, this use is a heavier burden on EAP recipients as a percent of income. The median electric bill as a percent of income for EAP is 4.8%, compared to only 1.2% for the HUS group (Figure 2).

Seventy percent of EAP households reported that they were unable to pay all their bills on time at some point in the past 12 months. Of these, 76% said they were unable to pay their electric bill. Not surprisingly, missed bills increase as bill size increases. Twenty-four percent of those with average monthly electric bills less than $10 reported missing a bill, compared with 70% of those with average bills of $50 or more. For any given bill size, apartment dwellers have a noticeably higher rate of missed bills than single-family or plex dwellers.

About 27% of the EAP sample were in arrears at the time their electric data were collected (defined as having $5 or more in their "60 day" arrears bin, the definition NSP uses for internal reports). By comparison, only 6.3% of NSP's Minneapolis Division customers were in arrears during the same time period, less than one quarter the EAP rate (Beyer, 1986). Indeed, it appears that EAP recipients account for the majority of customers in arrears. Again, arrears increased as average bill size increased (within the EAP core group that had complete electric data), with 10% of those with average bills less than $10 in arrears, compared to 36% of those with bills greater than $50. Even though bill size increases as dwelling size increases, single-family homes had the lowest rate of arrears (16% in the core group) and apartments the highest (33%). As with missed bills, apartments show higher rates of arrearages for any given bill size. Only 3% of senior households were in arrears, compared with 30% of non-seniors. This difference does not disappear when seniors' lower average bill size is taken into account. These data only give a picture of arrears status at the moment in time that the electric data printouts were made. This coincided with the time of year that NSP normally observes a peak in arrears, which would tend to suggest that these numbers are high. However, in an unknown and possibly large number of cases the EAP payment to NSP had already been received, which would make the above statistics low. Tracking of the arrears of a sample of EAP recipients over a one year cycle would be needed to get a more complete understanding of patterns of arrearages.

Being in arrears is associated statistically with a set of perceptions that suggest a low sense of personal efficacy. Discriminant analysis showed that households are more likely to be in arrears if they have taken no actions to reduce electric use, believe that there is nothing else they can do to reduce use, or feel that it is a waste of time to try to reduce their electric bill, all of which suggest a lack of a sense of control over use. They are also more likely to be in arrears if they believe NSP will not shut off those who do not pay or if they feel their bill is lower than in similar homes.

The unweighted average amount of arrears, for EAP households in arrears, is $101. Arrears amount increases with bill size, with the average amount being $20 for those with bills less than $10 per month and $187 for those with bills over $50 per month. Arrears amount does not vary significantly by dwelling type within a given bill size category.

Two-thirds of EAP recipients receive their EAP awards as a single payment. Only three percent of these go to NSP, with an average amount of $319. One third of EAP recipients receive two payments, and NSP receives one

of these 98% of the time, averaging about $100. Apartment dwellers are relatively less likely to have their EAP award sent to NSP and more likely to receive a direct payment. Since they could choose to use this in a discretionary way, this may explain in part their relatively high rates of arrears and arrears amounts for their bill size.

Thirty seven percent of EAP respondents believe that they cannot afford their electric bill, and 35% say that the cost of electricity concerns them a great deal. Sixty-nine percent say that is very difficult or somewhat difficult to find enough money to pay their electric bill. Fifty three percent feel that they need assistance in paying their electric bill, of whom more than half say their need is very serious or serious. All four of these measures of concern increase as bill size increases. Overall frequencies of these responses do not vary much across dwelling type, because apartment dwellers show a higher level of concern for a given bill size than single-family dwellers.

Fewer seniors than non-seniors feel that they cannot afford their bill. In detail, seniors with low or moderate bills are less likely to feel they cannot afford them than non-seniors with comparable bills, but seniors with high bills are more likely to feel they cannot afford them than non-seniors with comparable bills.

When people who said they could not afford their electric bills were asked how much they could afford to pay, the average response ranged from $30 for single-family houses to $28 for plexes and $19 for apartments. The averaged perceived need is between $8 and $24 per month, depending on whether respondents' estimates of what they could afford to pay are subtracted from their actual monthly bills or from their own estimates of their monthly bills.

KNOWLEDGE AND PERCEPTIONS

Knowledge and perceptions may influence energy use habits. Electric consumption might be influenced by lack of attention to one's bill amount, lack of normative information on how one's bill compares to others', lack of understanding of factors that affect the bill, or perceptions that nothing can be done about it or that there is no institutional incentive to do anything. This study included a brief exploration of these factors (see Hewett et al, 1987 for specific wording of questions).

For EAP recipients who have lived at their EAP address for at least 12 months, self-estimated bills are closely correlated with actual bills (R^2 = 62%, slope = 1) though slightly inflated (intercept = $5). Those who have lived at their address 5 to 11 months are less accurate and overestimate by more. Accuracy does not appear to vary with bill size, so that high users are as aware of their bill amount as low users. Arrears may be a factor in overestimations and could contribute to a perception of bills as unmanageably high. Those in the 5 to 11 month data group are nearly twice as likely to be

in arrears as those in the 12 month data group. They are also more likely to have had recent connection charges in their bill, and they of course have not experienced a complete year of bills at the current address.

Only 37% of respondents were correct in their perception of whether their bill is higher, lower, or about the same as other households in the same type of dwelling with the same family size. Only 40% of those whose bills are higher than typical realize that they are. To the extent that increasing people's awareness of the norm can influence their behavior, the remaining 60% may offer an opportunity for programmatic intervention.

When asked how the electric company determines the amount of their monthly bill, 58% of EAP respondents correctly indicated the amount of use, but 30% said they did not know. In choosing the three highest users from a list of five common appliances, EAP households did not do significantly better than if they had guessed randomly. When asked open-endedly what factor affects the electric bill most, about 60% gave a somewhat reasonable response, while about 40% mentioned an unimportant appliance or did not know. These responses suggest that EAP recipients could benefit from information about electric use and how to reduce it.

Respondents' apparent sense of control over their electric use is mixed. Fifty-five percent reported that they had taken some action to reduce electric use in the past two years, though the most frequently reported action (45%) was simply reducing use of lights, and only 22% had reduced use of some other appliance. Only 38% feel that there is anything (else) they can do to reduce use. Twenty-seven percent agree that it is a waste of time to try to reduce their electric bills, and nearly half agree that some people have so many bills they can't pay that trying to save electricity won't help. These responses were not limited to respondents with small bills, for which they might be more reasonable, but rather were uniform with bill size. Sixty-nine percent feel that other people in their household would change their habits to use less electricity if they asked them to.

About a quarter of respondents who pay their own electric bill believe that the electric company will not shut off power for non-payment, and an equal number believe that people can avoid paying their bills by moving, perceptions that could tend to increase nonpayment or use. Eighty-two percent are aware that assistance is available to pay electric bills (many Minneapolis residents get EAP for gas only). Forty-four percent are aware that people can only get assistance if they have outstanding bills, and forty-eight percent know that the amount one can receive depends on the amount owed. These perceptions also could influence use or arrears.

The direct relationship of knowledge and perceptions to electric use was analyzed by conducting a factor analysis of these variables and using the resulting factors to try to explain differences between the actual use of each household and the use that would be expected from their demographic characteristics and appliance score. This analysis showed a significant but weak relation of knowledge and perceptions to use.

REFRIGERATOR STUDY

The role of appliance age, condition and efficiency in causing high bills is a key programmatic question. In the Minneapolis EAP population, refrigerators appeared to be the most important appliance to assess. Though electric central heating, water heating, and central air conditioning all use more electricity, they are uncommon in this population. Many other major appliances, such as space heaters, waterbed heaters, electric dryers and ranges, have energy consumption that is controlled primarily by usage patterns, whereas refrigerator (and freezer) consumption is strongly affected by equipment efficiency and condition. The cost to operate a refrigerator can vary considerably, from $50 to over $130 per year. However, exploratory monitoring of a small sample of 9 EAP refrigerators selected using criteria intended to pick out high use units did not give any indication that EAP refrigerators have anomalously high use. Only one of these refrigerators could be replaced with a payback of less than ten years, and none with a payback of less than five years.

SUMMARY AND DISCUSSION

Our overall findings regarding possible reasons for high use can be summarized as follows:

- Larger dwellings, larger families and non-senior families are associated with high use, and demographic models alone can account for about a quarter of the variation in electric use.

- The number of appliances present also accounts for about a quarter of the variation in use.

- Although appliance age, condition or efficiency may affect use, preliminary exploration of refrigerators did not show anomalous use and did not indicate reasonable paybacks for replacement in most cases. Refrigerators and freezers had been expected to be the most likely major appliance to be amenable to replacement, for reasons discussed above.

- The role of the amount that appliances are used or how they are used was not quantified in this study. However, regressions on demographics and appliances explain only about half of the variation in use and leave considerable room for such factors. Anecdotal data from the site visits and previous program experience indicate that these factors are probably very important determinants of use.

- Our analyses showed only a weak relationship of use to level of knowledge or perceptions of institutional practices, based on a small number of variables. However, the level of knowledge of factors affecting electric use was low for the EAP population as a whole.

In planning a program directed at high users, program staff should expect to find that many of their clients live in single-family homes, are larger families and are non-seniors. They will have somewhat higher saturations of many appliances than the general EAP population, particularly microwave ovens, freezers, clothes washers and televisions but also electric clothes dryers, waterbed heaters, dishwashers and second refrigerators (Table VI). They will have a higher level of concern and more arrears than the general EAP population, and about the same level of knowledge and perceptions.

Based on this research, the City and NSP agreed that a substantial subset of the Minneapolis EAP population have bills high enough to be a financial burden and to suggest opportunities for reduction. A low cost pilot project to serve the top 25% percent of electric users within EAP is in progress. The pilot program is piggybacked on an existing EAP gas program that includes workshops, audits, house doctor visits and major weatherization.

Because relatively few technological interventions appear cost-effective, the program targets behavioral change, using concepts of social psychology such as specific, vivid information, emphasizing loss, modelling, overcoming barriers, commitments and goal setting and positive reinforcement Data on electric appliance consumption as a function of age, condition and use have been compiled to identify the most important target behaviors and to get the information needed to conduct electric audits. Physical electric interventions that could be made by the house doctors and other actions such as buying back second refrigerators are under consideration.

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Table I. Demographic characteristics of Energy Assistance Program group and Home Use Study group.

	Energy Assistance Program, 1986 (weighted survey group)				Home Use Study, 1983 (weighted survey group)			
	overall	single-family	plexes[1]	apts	overall	single-family	plexes[1]	apts
Dwelling								
dwelling type, %	100.0	38.8	32.0	29.1	100.0	55.2	14.8	30.0
own home, %	25.9	60.8	6.4	0.8	64.7	97.1	58.9	10.6
Household								
size, mean	2.7	2.8	3.1	2.2	2.3	2.7	2.6	1.4
size, std dev	1.8	1.9	1.9	1.4	1.4	1.4	1.4	0.8
senior[2], %	14.4	27.9	5.5	6.5	36.5	36.1	40.4	35.4
income < $8000, %	80.5	74.0	84.5	86.8	14.6	9.8	7.8	26.6
income ≥ $20,000, %	0.4	0.9	0.0	0.0	51.0	61.6	41.0	31.9
mean income, $	6,238	6,569	6,349	5,526	22,790	26,179	18,792	17,236
Head of Household								
not H.S. grad, %	39.2	42.9	36.7	37.5	15.6	19.9	7.2	11.4
college grad, %	6.5	5.3	8.6	5.2	42.9	41.7	40.5	46.6
female, %	73.4	72.7	80.8	65.9	49.6	42.2	42.4	67.1
minority, %	41.7	35.4	42.4	47.8	10.0[3]	n/a	n/a	n/a
handicapped, %	11.4	16.4	5.4	12.3	n/a	n/a	n/a	n/a

[1] "Plexes" are defined here to include townhouses and 2 to 4 unit multifamily buildings.
[2] all household members 61 or older (NSP definition)
[3] from 1980 US Census
n/a - not available

Table II. Appliance saturations of Energy Assistance Program group and Home Use Study group (percent).

	Energy Assistance Program, 1986 (weighted survey group)				Home Use Study, 1983 (weighted survey group)			
Appliance	overall	single-family	plexes	apts	overall	single-family	plexes	apts
air conditioning, all kinds	39.2*	47.4^{s}	33.7^{s}	37.7*	65.0	63.7	64.1	68.1
dishwasher	7.4*	11.4*	5.4^{ns}	3.5^{s}	27.9	38.7	10.3	16.7
electric range	15.1*	12.1*	12.8^{ns}	22.2*	36.6	39.1	20.7	51.2
dehumidifier	15.1*	21.2*	13.8*	8.7	48.0	57.7	49.5	29.8
clothes washer	54.2*	85.5*	48.5^{s}	16.5^{ns}	70.9	98.2	78.1	14.7
second refrig[1]	8.9*	13.9^{s}	8.4^{s}	2.6^{ns}	21.3	28.9	26.3	5.1
second refrig[1]	8.9^{s}	13.9^{ns}	8.4^{ns}	2.6^{ns}	14.2	20.9	17.9	0.3
freezer	24.2^{ns}	40.4^{ns}	20.8^{ns}	4.9^{ns}	30.5	44.7	31.1	4.3
electric clothes dryer[2]	16.3^{ns}	22.8^{ns}	19.9^{ns}	3.8^{ns}	19.6	26.8	16.3	7.2
electric suppl space heat	18.0^{ns}	21.5^{ns}	16.8^{ns}	13.3^{s}	13.8	17.3	20.2	4.2
waterbed heaters	10.0^{ns}	12.9^{ns}	11.4^{ns}	4.5^{ns}	7.5	7.5	10.3	6.0
microwave oven[3]	23.6^{ns}	35.0^{ns}	22.1^{ns}	9.5^{ns}	25.8	32.6	37.5	7.4
electric primary heat[4]	5.7^{ns}	1.6^{ns}	5.9^{ns}	14.9^{ns}	4.7	0.0	3.8	19.5
electric water heating[4]	7.0^{s}	7.2^{s}	8.1^{ns}	7.2^{ns}	2.9	1.6	0.0	11.3
TVs: none or one[5]	51.4^{ns}	38.1^{ns}	46.7^{ns}	74.0^{ns}	53.0	41.0	48.6	77.4
two	29.8	33.3	35.0	20.8	32.1	37.0	38.1	20.2
three or more	18.8	28.5	18.2	5.2	14.8	22.0	13.3	2.5

1 For HUS, first line is percent that have a second refrigerator, second line is percent that use it all the time. For EAP, both lines are percent that had one plugged in at the time of the interview.
2 HUS households are much more likely to own a dryer, but their proportion of electric dryers is lower.
3 See note in text.
4 These self reports are unreliable based on site visits.
5 Statistical comparisons are for the entire distribution of TV saturations.

* significant at 5% level with Bonferroni correction for number of tests.
m significant at 10% level with Bonferroni correction (marginal).
s significant at 5% level without correction (suggestive).
ns not significant at 5% uncorrected level.

Table III. Monthly electric use of Energy Assistance Program group and Home Use Study group.

	Energy Assistance Program, 1986 (unweighted core group) kWh				Home Use Study, 1983 (weighted survey group) kWh			
Statistic	overall	single-family	plexes	apts	overall	single-family	plexes	apts
maximum	1582	1582	1094	584	1936	1936	1530	879
90th percentile	730	755	687	390	656	734	711	333
75th percentile	555	622	525	337	483	575	490	248
50th percentile	354	435	357	254	339	402	352	154
25th percentile	249	261	271	162	202	315	250	113
minimum	66	66	77	79	26	27	101	26
mean	409.3	463.3	404.5	258.7	369.5	455.4	405.7	194.2
std dev	235.2	254.0	210.5	113.6	248.4	239.1	282.2	135.0

Table IV. Best stepwise multiple regression model (EAP core group).

variable	parameter value[1]	standard error	significance[2]	stock ave. value[3]	alternate est. use values[4]
(intercept)	-23.3	50.0	ns	(96.3?)	(highly var.)
TV count	36.0	13.0	**	10.4	10 - 37
family size	34.2	8.9	***	---	---
clothes washer	89.3	30.3	**	6.5	around 9
refrigerators	130.9	33.5	***	106.3	75 - 250
microwave	71.6	21.8	*	9.4	around 15
electric range	106.9	32.1	***	57.7	around 60
sep. freezer	74.3	28.8	*	87.5	100 - 147
senior	-104.9	34.6	**	---	---
sf home	66.2	27.1	*	---	---

1 parameter and standard error values are in kWh per month.

2 significance has been coded for easy visual comparison as **ns** (not significant)for $p>0.05$, * for $0.01<p<0.05$, ** for $0.001<p<0.01$, and *** for $p<0.001$.

3 stock average values provided by NSP Market Research Dept.

4 alternate ranges of expected use from an "Ask NSP" booklet, compiled from Edison Electric Institute data and other sources.

Table V. Monthly electric bills of Energy Assistance Program group and Home Use Study group.

	Energy Assistance Program, 1986 (unweighted core group)				Home Use Study, 1983 (weighted survey group)			
statistic	overall	single-family	plexes	apts	overall	single-family	plexes	apts
maximum	$91.24	$91.24	$71.63	$38.33	$115.38	$115.38	$91.19	$52.38
90th percentile	48.77	51.02	47.01	26.97	39.12	43.75	42.38	19.84
75th percentile	38.47	42.91	37.33	23.16	28.79	34.27	29.22	14.76
50th percentile	23.97	30.14	24.51	16.55	20.18	23.99	20.97	9.19
25th percentile	15.72	16.80	18.09	10.19	12.05	18.79	14.89	6.74
minimum	4.36	4.36	4.80	4.96	1.55	1.60	6.03	1.55
mean	27.47	31.04	27.39	17.21	22.02	27.14	24.18	11.57
std dev	15.77	16.78	14.47	8.31	14.81	14.25	16.82	8.04

HUS bills are based on average cost/kWh with customer charge rolled in.
The minimum values are thus artifically low.

Table VI. Bill size class vs demographic measures and appliance saturations (percent).

demographic characteristic or appliance	low users	medium users	high users	contrast	
sf homes + plexes	67.1	78.4	97.4	p<.0001	***
owned dwellings	47.4	37.3	55.3	p=.0545	marg
senior citizens	40.8	20.6	10.5	p<.0001	***
family size (≥ 3)	13.2	44.1	64.5	p<.0001	***
family income:				p<.005	**
less than $5,000	39.5	23.5	10.5		
$5,000 to $8,000	32.9	39.2	34.2		
over $8,000	24.9	33.3	48.5		
elec clothes dryer	8.7	22.2	30.7	p=.0050	**
electric range	10.5	16.8	22.4	p=.1455	ns
microwave oven	10.5	28.4	50.7	p<.0001	***
dishwasher	1.3	12.9	14.9	p=.0097	**
dehumidifier	21.1	14.7	12.0	p=.2893	ns
car heater	3.9	12.9	12.2	p=.1098	marg
waterbed heater	2.6	12.7	18.4	p=.0080	**
freezer	16.0	22.5	55.4	p<.0001	***
clothes washer	53.3	65.3	88.0	p<.0001	***
central AC	6.7	9.8	9.2	p=.7512	ns
room AC (≥1)	42.1	40.2	40.8	p=.9672	ns
televisions (≥2)	39.5	50.0	81.1	p<.0001	***
elec supp space heat	22.4	16.7	19.7	p=.7589	ns
refrigerators (≥2)	7.9	6.9	21.1	p=.0106	*

Low users = lower 30%, bills less than $17.30 per month.
Medium users = middle 40%, bills $17.30 to $34.50 per month.
High users = upper 30%, bills more than $34.50 per month.

Fig 1. Average electric use per month.

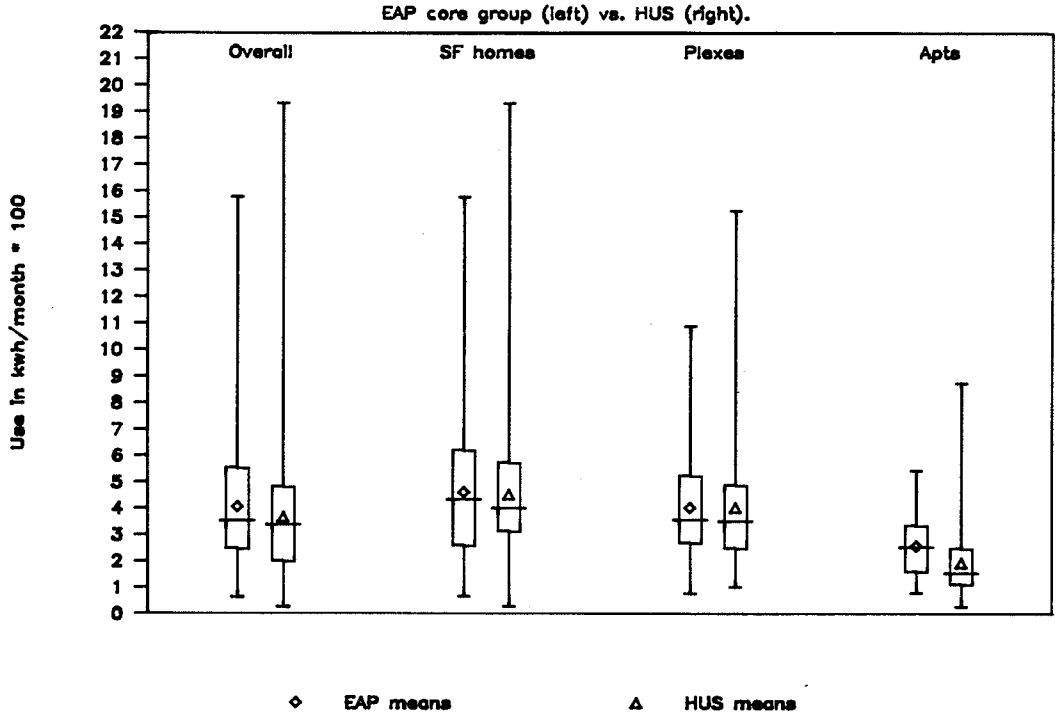

Fig 2. Use as a percent of income.