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UTILITY PAYMENT PLAN CHOICE: IMPLICATIONS FOR ENERGY CONSUMPTION

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Abstract

The purpose of this study was to explore the relationship between levelized utility billing and energy consumption. The focus of the article is on the relationship of energy consumption to house size and location by utility payment plan choice. The sample included 496 electric utility consumers choosing either the average monthly payment (AMP) plan or consumers on a regular payment plan (non-AMP). The major finding indicates that energy consumption by AMP customers is greater than for non-AMP households, even though house size was not significantly different. There was not a significant difference in total energy usage between urban and rural residents; however, summer consumption was significantly higher for urban AMP residents. These findings raise questions regarding energy consumption and the need for additional in-depth study of policy implications.

Introduction

Energy usage in the U.S. increased sharply in the 1950s and 1960s and leveled off after the 1973 oil crisis. Since 1986, energy use has risen to record levels. In 1989, energy consumption reached 80 quadrillion BTU's of usage for the first time (Melville, 1991). Likewise, the reliance on foreign oil is increasing. From 1973 to 1986, the U.S. gross national product grew 36% with no increase in energy usage. Oil import levels peaked in 1977 at 46.4%. Imports dropped to 28% in 1982 through energy conservation efforts and sharp price increases. In 1990, dependence on foreign oil reached over 50%, an all time high (Wilson & Morrill, 1991). The continuing Middle East situation and the proposed taxation on fuels by the Clinton Administration reflects the need to be aware of the impact of energy consumption on the cost to the consumer.

U.S. families were challenged financially by increasing energy prices from the late 1970s through the 1980s. In the past decade, residential energy costs have gone from being rather insignificant for the micro-economy to becoming a major household budget item (Prindle & Reid, 1988). In 1984-85, the nation's 86 million households spent $97 billion on residential energy, or an average of $1,123 per household (Energy Information Administration [EIA], 1987). Between April, 1984, and March, 1985, 21.9 million households, which had annual family incomes less than $10,000, spent from $469 to $750 annually for electricity alone. According to the Department of Energy, the price of electricity rose approximately 60% between 1979 and 1986 (EIA, 1988).

The increasing cost of energy affects life-styles and housing affordability for all households, but drastically impacts disadvantaged or limited income households. Warriner (1981) found that the elderly use approximately one-third less electricity on the average than non-elderly; however, they paid proportionally more of their annual incomes for their electric usage than non-elderly households. Additionally, 81% of the elderly's electrical consumption was used to achieve essential needs related to lighting, refrigeration, heating, water heating, and cooling, whereas non-elderly households only committed 54% of their electrical consumption to essential needs (Warriner, 1981).

According to federal guidelines, homeowners who spend more than 30% of their income for total housing costs (mortgage principle, interest, utilities, taxes, and maintenance)

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have homes which are not affordable. Part of the affordability question centers on energy costs for heating and cooling which accounts for the largest housing expense after mortgage or rental payments. The National Consumer Law Center revealed that in 1983, approximately 20% of a middle-income family's average housing costs were for energy. In contrast, a low-income family spent on the average more than one-third of their housing costs for energy bills. The cost of energy is felt most severely by elderly and rural households who pay larger portions of their income for energy. These disadvantaged households also lived in less thermally efficient dwellings that reduce management options for this segment of society (National Consumer Law Center, 1989).

In an attempt to respond to these housing costs that include energy, many policies have been introduced at federal, state, and local levels. A variety of house weatherization and energy education programs were developed to assist households in managing the increasing energy costs. In the early 1980s, utility companies introduced the levelized billing plan. The major purpose of this plan was to assist limited and fixed income families in budgeting utility expenses by averaging the cost for the year (McDermott, Guldman, Pflster, & Kumari, 1980). There has been little or no evaluation of this billing program relative to household energy use.

Residential Characteristics

Research in the late 1970s and early 1980s revealed many interesting findings related to housing and energy use. Ritchie, McDougall, and Claxton (1981) considered dwelling descriptors, demographic characteristics, and attitudinal values in relation to energy consumption. A major finding was that households living in larger dwellings consumed more energy. Newman and Day (1975) also found that a major portion of household consumption is circumscribed by the dwelling size. Warriner (1981) also found house size to have a positive relationship to energy consumption.

In studies linking housing size to energy consumption, several measures have been utilized: number of rooms, number of bedrooms, and square footage. A predominance of this research used number of rooms as a variable predicting household energy use, and few studies used actual house square footage. Morrison, Gladhart, Zuiches, Keith, Keege, and Long (1978) found a significantly positive relationship between the number of rooms in a dwelling and household energy consumption. Other researchers using number of rooms verified these findings (Wilder & Willenbord, 1975; Heslop, Moran, & Cousinea, 1981; Ritchie, et. al., 1981; and Gladhart, 1984).

Previous research using number of bedrooms found a significant positive influence on household energy consumption. Sierra Pacific Power Co. (1979), in a study of winter natural gas consumption, concluded there was a significant positive relation between number of bedrooms and bathrooms and energy use.

Jaffee, Houston, and Olshavsky (1982) used square footage as an independent variable and found floor space to be positively related to electricity consumption. Few studies have used actual square footage of a house as a predictor of household energy consumption. The difficulty in obtaining accurate square footage measurements may explain the lack of use of this measurement. Therefore, the number of rooms and/or number of bedrooms are used as a proxy variable.

Another variable which could contribute to household energy is location of residence. Unlike house size, few studies have analyzed whether dwelling location significantly affects energy cost. A study conducted by the U.S. Office of Technology Assessment (1979) indicated a slightly greater burden of energy costs on rural households when compared with urban households. Although this variable has not been considered in many previous studies, the significance of residential location should not be overlooked.

In summary, previous research has found housing characteristics, particularly house size, to be predictive of energy consumption patterns. Size of house is positively linked with energy consumption. However, the best method of measurement for determining house size has not been identified. Further study is also needed on the relationship between urban and rural households in terms of energy use.

Budget Billing

In response to the increasing cost of utility payments and fluctuations related to peak usage, a number of utility billing plans were implemented. The original purpose of these plans was to assist limited income families with budgeting for utility costs, although utility companies currently market the plans to middle class households (Henderson, 1979). The majority of the plans allow the consumer to budget a set amount monthly.

Average Monthly Payment (AMP) Plan, is a mathematical process of evenly dividing a customer's yearly utility cost over the previous 12-month billing period for a given energy source (McDermott, Guldman, Pfister, & Kumari, 1980). With the implementation of many independent utility bill averaging programs, the National Regulatory Institute, in a report to the U.S. Department of Energy, identified problems which were felt to be inherent with this alternative billing option. A major conclusion of the report was that "...the budget billing process may provide false cost signals to the consumer and result in over consumption during peak periods" (McDermott et al., 1980). Irrespective of these concerns, many utility companies, responding to consumer advocacy groups along with the commitment to serve the needs of the poor and elderly, initiated AMP plans. This billing practice is questioned because it may give the consumer false price cues because the amount paid does not reflect actual energy consumption and cost for the month.

To date, little research has been done to assess the impact of utility bill averaging along with household and housing characteristics on household energy use. Such research is needed to guide consumer decision making and housing policy. In as much as residential energy continues to be a major housing expense, it is critical that research continues to build on previous studies designed to determine significant factors related to household energy use and cost. Building on and testing the existing body of knowledge related to housing, household characteristics, and the use of household energy is an important research challenge for the 1990s.

Purpose and Objectives

This exploratory research study focuses on households choosing to average their household utility bills and those households not choosing this plan. Comparing these household groups will provide valuable insight regarding differences in household energy use as related to house size and household location. Further, the study is designed to provide additional insight regarding the best measurement of house size. Since house size is consistently used as a predictor of residential energy use, refinement of this measurement will make important contributions to housing and energy research.

Specifically, the research hypotheses for this study include:

1. There is a significant difference between AMP and non-AMP households related to total residential energy use and seasonal residential energy use.
2. There is a significant correlation between measurement of house size for square footage, number of rooms, and number of bedrooms.
3. There is a positive relationship between house size (square footage, number of rooms, and number of bedrooms) and energy consumption for both AMP and non-AMP households.
4. There is a significant difference in household energy consumption between AMP and non-AMP households by location of residence (rural versus urban).

Definitions

The following definitions are used for this study:

AMP customers (averagers) have elected to use the average monthly payment plan.

AMP plan (budget billing) is the process of evenly distributing the total yearly utility costs or payments over 12 monthly billing periods.

Non-AMP customers (non-averagers) have chosen not to use the average monthly payment plan. Their monthly utility bills reflect actual consumption and charge for the billing period.

Rural defines the counties located outside the Standard Metropolitan Statistical Area (SMSA), (US. Census, 1980).

Urban describes the counties located within the SMSA (US. Census, 1980).

Methodology

Analysis of existing data provides the opportunity for comparative analysis of energy consumption by household. Although existing data can provide a conceptual context for future studies, such data can be restrictive in developing research questions and explaining results.

The data for this study were utility records for households served by a midwestern electric utility company. Supplemental data from tax records provided the housing characteristics for each household.

Sample

A 5% sample of AMP customers which equaled 300 households was randomly selected by the utility company. An equal number of customers was randomly selected from non-AMP customers for a total of 600 households. Both groups were over sampled to allow for the combining of the data bases.

Monthly utility bills were furnished for both AMP and non-AMP customers during December, 1987 to March, 1988. The bills included the kilowatt (KWH) usage and the monthly costs for each meter location. Additional data were obtained by converting the utility meter location to a legal property description to assess county property tax records for square footage.

In assessing the data, it was decided to eliminate customer's records if:

- utility costs and usage records were incomplete;
- the electricity meter served a mobile home, commercial property or public housing unit;
- the location of the meter was in the utility company service areas outside of the selected state;
- the meter location listing could not be translated into a legal description.

Of the total households, 496 records had complete utility data. The AMP records totalled 258 and the non-AMP records totalled 238. Of these, 330 records had house size measures data which was available from the county tax records. Although one third of the original sample was incomplete, the data available were deemed usable for the analysis.

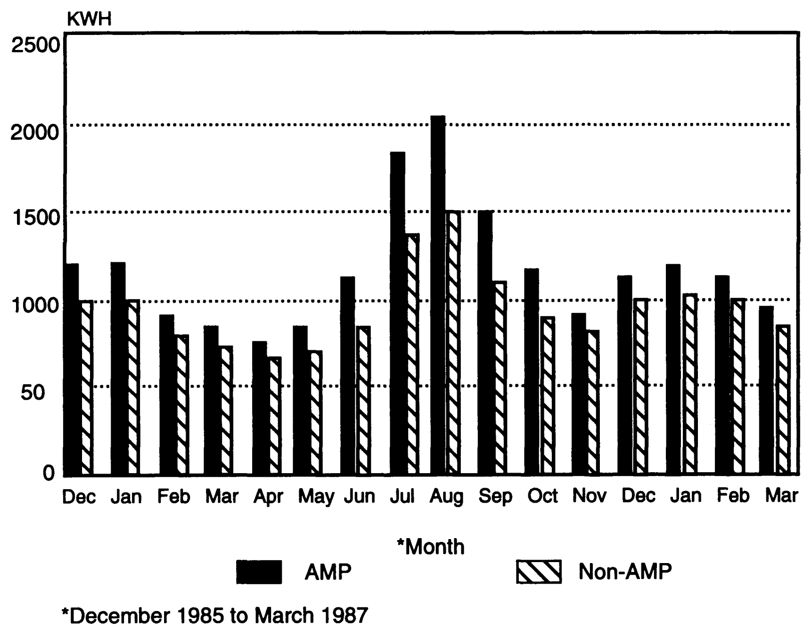
Analysis

Analysis of the data included the t-test to ascertain differences between types of users (AMP and non-AMP customers) and between location (urban and rural). Pearson correlation allowed for assessing the relationship between types of measurement for housing size (square footage, number of rooms, and number of bedrooms). Simple linear regression analysis was applied to predict the relationship between house size measures and energy consumption. The probability level of .05 was used for determining significance.

Findings and Discussion

Total mean KWH usage by customers was 16,875 KWH (see Figure 1) per household. Total KWH usage indicated that during the study period, AMP customers (18,507 KWH) used over 3,400 KWH electricity more than the non-AMP customers (15,105 KWH) ($t=3.34$, $p=0.009$) (Table 1).

Figure 1. Mean usage by monthly billing period.



Seasonal electrical usage was assessed by formulating a mean for the October-March months (winter) and May-September months (summer). The highest electrical usage months were the summer months, which was not surprising given the number and intensity of cooling hours for the state. When comparing differences in usage by AMP and non-AMP customers, significant differences were found for the summer season (t=5.83, p=.0001) and winter season (t=1.95, p=.0517). AMP customers used over 851 KWH more electricity than did non-AMP customers during the winter months. Summer usage revealed a use of 1,890 more KWH of electricity for AMP customers. Mean square footage was not significantly different for AMP and non-AMP customers.

Table 1. Mean comparison between AMP and Non-AMP.

	AMP	Non AMP	T	P
Total KWH	18507.95	15105.13	-3.34	.009
Winter KWH	6272.89	5421.81	-1.95	.0517
Summer KWH	7368.57	5478.82	-5.83	.0001
Sq. footage	1349.30	1428.82	-0.74	.4594

Note: n(AMP) = 258
n(Non-AMP) = 238

Energy consumption research has typically used number of rooms as the variable representing house size. These measures may be adopted because room count is an easier and more accurate measure when the respondent recalls and provides the information. Square footage, number of rooms, and number of bedrooms were available in this study and provided the opportunity to compare actual size and size by proxy with energy consumption.

The mean square footage of the housing units in this study was 1,363, with a range of 405 to 7,385. The number of rooms per housing unit ranged from four to ten rooms, with a mean of 5.6.The number of bedrooms ranged from one to five with a mean of 2.9. Pearson's correlation analysis indicated that there was a positive correlation between square footage and both the number of rooms (r=.714, p=.0001) and the number of bedrooms (r=.554, p=.0001); and between number of rooms and number of bedrooms (r=.748, p=.001).

The relationship between house size and energy consumption was tested using a simple linear regression (Table 2). The predicted positive relationship between house size measures (square footage, number of rooms, and number of bedrooms) and energy consumption was significant for both AMP and non-AMP households. Regardless of the method of measurement, the house size was an important predictor of energy consumption for both AMP and non-AMP. The model for energy consumption was tested and compared using standardized beta (β) and model R^2. The results indicate that the square footage was a better measure to predict household energy consumption than number of rooms and number of bedrooms with a higher beta score (J3 (AMP)=.40, J3(non)=.49) and with a larger predictability (R^2 (AMP)=.15, R^2 (non)=.23) for both AMP and non-AMP.

Table 2. Relationship between house size measures and energy consumption.

		β	T	SE	R^2	F
AMP	Sq footage	.40	4.89	1.37	.15	23.93
	# or rooms	.38	4.68	540.67	.14	21.88
	# of bedrooms	.35	4.28	1050.11	.12	18.32
Non-AMP	Sq footage	.49	5.08	1.49	.23	25.77
	# of rooms	.47	4.80	559.15	.22	23.08
	# of bedrooms	.47	4.77	1040.77	.22	22.72

Note: All T-values and F-values are significant at P=.0001.

The comparison between AMP and non-AMP models showed an interesting result with greater energy consumption for AMP households than non-AMP households even though there was no significant difference for house size. Further study could determine customer differences that contribute to energy consumption and preference for payment plan. In assessing the differences in square footage of the residence between AMP and non-AMP households, the mean comparison indicates no significant differences exist. The non-AMP households lived in slightly larger housing (1429.82 mean square feet versus 1349.30 mean square feet), a difference of 80 square feet (Table 1).

Table 3. Mean comparison between rural and urban

	Rural	Urban	T	P
Total KWH	16328.04	17022.07	.47	.6386
Winter KWH	5831.35	5873.41	.07	.9462
Summer KWH	5808.64	6637.20	2.04	.0420
Sq. footage	1661.66	1326.91	-1.45	.1525

Note: n(rural) = 105
n(Urban) = 391

In analyzing energy consumption in relation to location of residence, significant differences were found in summer consumption only (Table 3). Urban households (6,637 KWH) consume a significantly larger amount of electricity than rural households (5,808 KWH) during the summer months (t=2.04, p=.0420). No significant difference was found in total energy consumption and in winter energy consumption between rural and urban residents. However, in the urban area, AMP households consume significantly more energy than non-AMP households throughout the year (Table 4). This raises questions for further analysis to understand the energy consumption patterns in urban households. Analysis of square footage comparisons indicated no significant difference existed between AMP and non-AMP for both urban and rural (Table 3).

Table 4. Mean comparison between AMP and Non-AMP across locations.

	Rural				Urban			
	AMP	Non-AMP	T	P	AMP	Non-AMP	T	P
Total KWH	16818.86	16060.97	-.26	.7937	18790.74	14722.79	-3.84	.0001
Winter KWH	5890.86	5798.97	-.08	.9399	6336.85	5270.94	-2.33	.0205
Summer KWH	6433.22	5468.79	-1.24	.2179	7525.17	5482.84	-5.68	.0001
Sq. footage	1364.05	1989.05	1.33	.1981	1346.76	1297.00	-.72	.4764

n(AMP/Rural) = 37
n(Non-AMP/Rural) = 68
n(AMP/Urban) = 221
n(Non-AMP/Urban) = 170

Summary and Implications

The major finding indicates that energy consumption by AMP customers is greater than for non-AMP households, even though house size was not significantly different. There was not a significant difference in total energy usage between urban and rural residents; however, summer consumption was significantly higher for urban AMP residents.

Previous research has found that structural components have consistently surfaced as the leading explanatory variables in residential energy usage (McDougall, Claxton, Ritchie, & Anderson, 1981). The current research considers a behavioral aspect of energy consumption in addition to basic variables of house size and location.

Several variables, including billing type, house size measures, and residential location, revealed differences in energy consumption between AMP and non-AMP customers. Several questions arise from this study that pose the need for additional research. Does the price cue of non-AMP customers monthly consumption produce a signal that might affect energy usage whereas the real monthly cost is imbedded in the averaging for AMP customers? Do customers who choose alternative billing plans for their energy costs have higher energy use practices? How is life-style related to energy consumption for urban versus rural residences? An examination of heating and cooling equipment, inventory of household appliances, and fuel source data could provide further insight into impact of utility averaging on energy use. Additionally, analysis of behavioral practices and demographic characteristics of households would add a life-style dimension to the model of energy consumption.

Previous research indicates that there is a positive relationship between size of dwelling and energy usage (Ritchie, et al. 1981; Newman & Day, 1975; and Gladhart, 1984) and is consistent with the findings in this study for both AMP and non-AMP. However, in this study, although non-AMP households live in slightly larger houses, energy consumption was less for both winter and summer electrical usage. Given these findings, it appears there is a need for additional research to explore the relationship between billing plan selection and energy consumption.

The findings from this study differ in some respects from previous research studies for rural and urban household energy consumption. In this study, greater energy consumption of urban residents was found for summer with no difference in winter. This probably could be attributed to air conditioning load for the summer months. Hassoun and Hunt (1980) found no differences between energy consumption of rural and urban residences. However, Warriner (1981) found that rural residents consume more electricity than urban residents. Previous research has speculated that rural households may rely more on electricity in relation to their life-style than urban residents (Ruffin & Weinstein, 1979). Households located in both rural and urban areas may have other dwelling or life-style factors which influence electric consumption, such as: fuel source, heating and air conditioning equipment, and natural versus built environmental effects. Given the limitations of the data available, there was not an opportunity to explore or explain in depth the differences in energy consumption by location.

References

Energy Information Administration. (1987). *Energy facts 1987.* (DOE/EIA-0469[87]). Washington, DC: U.S. Government Printing Office.

Energy Information Administration. (1988). *Energy facts 1988.* (DOE/FIA-0469[88]). Washington, DC: U.S. Government Printing Office.

Gladhart, P.M. (1984). Interactions of price and household characteristics and residential energy conservation. *Housing and Society,* 11(3), 149-167.

Hassoun, V.S., & Hunt, F.E. (1980). Electric energy usage in the home: A predictive model. *Home Economics Research Journal,* 8, 252-260.

Henderson, L.J., Jr. (1979). Public utility regulations: The socioeconomic dimensions of reform. *Review of Black Political Economy,* 9, 260-275.

Heslop, L.A., Moran, L., & Cousineau, A. (1981). "Consciousness" in energy conservation behavior: An exploratory study. *Journal of Consumer Research,* 8, 299-305.

Jaffee, B.L., Houston, D.A., & Olshavsky, R.W. (1982). Residential electricity demand in rural areas: The role of conservation actions, engineering factors and economic variables. *The Journal of Consumer Affairs,* 16(1), 137-151.

McDermott, K.A., Guldman, J.M., Pfister, K.A., & Kumari, K.V. (1980). *Budget billing plans for electric and gas utilities: An analysis and some recommendations for change.* Columbus, OH: The National Regulatory Research Institute.

McDougall, G.H.G., Claxton, J.S., Ritchie, J.R.B., & Anderson, C.D. (1981). Consumer energy research: A review. *Journal of Consumer Research,* 8, 343-354.

Melville, K. (1991). *Energy options: Finding a solution to the power predicament.* Public Agenda Foundation. Dubuque, IA: Kendall/Hunt Publishing Company.

Morrison, B.M., Gladhart, P.M., Zuiches, J., Keith, J.G., Keefe, D. & Long, B.K. (1978). Energy and families: The crisis and the response. *Journal of Home Economics,* 70(4), 18-21.

National Consumer Law Center. (1989). *Energy and the poor -- the forgotten crisis.* Washington, DC: Author.

Newman, D., & Day, D. (1975). *The American Energy Consumer.* Cambridge, MA: Ballinger Publishing Co.

Prindle, W.R., & Reid, M.W. (1988, January 28). Energy efficiency: A key to affordable housing. In *Preparing for the energy challenges of the 1990s.* Washington, DC: The Alliance to Save Energy.

Ritchie, J.R.B., McDougall, G.H.G., & Claxton, J.P. (1981). Complexities of household energy consumption and conservation. *Journal of Consumer Research,* 8, 233-242.

Ruffin, M.D., & Weinstein, M.B. (1979). Energy in the farm house. *Home Economics Research Journal,* 8(1), 2-15.

Sierra Pacific Power Co. (1979). *Home energy survey: Electrical and gas analysis: Report No. 4.* Reno, NV: Author.

U.S. Bureau of Census. (1980). *The 1980 Census of the population: Characteristics of the population. Volume 1.* Washington, DC: Government Printing Office.

U.S. Office of Technology Assessment. (1979). *Residential energy conservation.* Washington, DC: Government Printing Office.

Warriner, G.K. (1981). Electrical consumption by the elderly: Policy implications. *Journal of Consumer Research,* 8, 258-264.

Wilder, R.P. & Willenborg, J.F. (1975). Residential demand for electricity: A consumer panel approach. *Southern Economic Journal,* 42(2), 212-217.

Wilson, A. & Morrill, J. (1991). *Consumer guide to home energy savings.* Berkeley, CA: American Council for an Energy-Efficient Economy.