EQUITY AND EFFICIENCY IMPLICATIONS OF LIFELINE ELECTRIC RATES

John Byrne, Craig McDonnell,
Francis Tannian and Young-Doo Wang
Center for Energy and Urban Policy Research
University of Delaware

While recent decreases in oil prices will ease the impact of energy costs on households, the burdens borne by households will continue to be differentially distributed. The disparity in costs as a percent of income has been and will remain large especially in the case of electricity where substantial quantity discounts are still offered in most states to large residential users (usually middle and upper income). Lifeline electric rates have been advocated as a means of establishing greater equity in electricity cost burdens by assessing a "minimum" charge for a level of consumption estimated to be necessary to meet "basic" household electricity requirements (Pace, 1975: 2-3). A further advantage of lifeline rates could be a reduction in the number of bill payment delinquencies and service shut offs. Yet few states have adopted the lifeline rate option on the ground that it would establish prices at variance with utility costs of service and, as a result, would lead to inefficient consumer use of the service. Our analysis suggests that under certain conditions the reverse may actually be true: lifeline rates may substantially improve efficiency in the use of electricity but may only modestly affect equity (measured by household electricity costs as a percent of income or utility revenues).

The analysis is based upon data which combines responses to a household survey by a random sample of 224 Delaware residents with matched electricity billing records of respondents for the 24 months of the calendar period 1980-81. Weather effects on consumption were measured by dividing billed kWhs by the corresponding monthly cooling degree days recorded at the nearest national weather station. (We explain below why a lifeline rate is evaluated for summer periods only.)

INCOME AND ENERGY COSTS

The price shocks that occurred in world energy markets during the 1970s affected all areas of society. Fossil fuel prices rose 25.5 percent between 1970-73, 107 percent between 1973-75, 71.7 during 1975-79, and 44.1 percent between 1979 and 1980. In contrast, fossil fuel prices rose only 12 percent between 1960-1970 (U.S. Statistical Abstract, 1986). Fuel price increases were far greater than those occurring for non-energy goods and services during the same period.

Although important adjustments were made in all sectors, including the residential sector, certain household groups were especially hard pressed to adjust to changing energy conditions. Before the price shocks, the poor and elderly already devoted a larger share of their income to pay for energy services than did other income groups. After the price increases, this gap increased substantially, as energy costs rose faster than household income. Conservation has been difficult to achieve for many of these households because they must cope with older, less energy-efficient homes, appliances, furnaces, and limited financial resources to invest in energy-efficiency improvements. The result has been a general erosion of living standards for these groups. Some low-income and elderly households have been forced to choose between energy to heat and light their homes and other necessities, including food and transportation. In contrast to housing, food, health care and other social necessities, the U.S. has made few provisions for energy to be provided equitably to all households.

In 1984 19.6 million, or 23.4 percent of all households, had incomes of $10,000 or less. The dominant group in this category were households headed by individuals 65 or older (over 7,000,000). This figure represents 40 percent of all elderly households. In terms of numbers of individuals (rather than households), the low-income group was composed of 22 percent under 16 years of age, 17.5 percent between 16 and 21 years, and 12.5 percent were over 65 years old. Thus the low-income group is composed mainly of the young and the elderly in society.

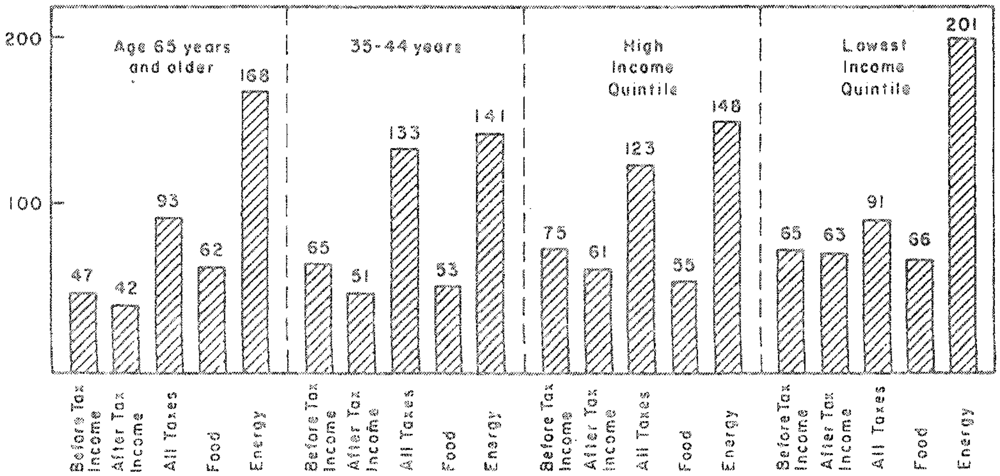
The Burden of High Energy Costs

Energy costs rose faster than other prices during the 1970s. As Table I indicates, price increases in major household fuels such as electricity, heating oil and piped natural gas outpaced other household items generally. How these increases compared to income changes and food costs during this time is illustrated below in Figure 1.

Table I. Energy price increases: 1970-1980

Item	1970	1975	1979	1980
Consumer Price Index	116.3	161.2	217.4	246.8
Natural Gas	108.5	172.5	305.3	363.9
Heating Oil	109.3	230.6	416.8	579.7
Electricity	106.2	167.0	219.1	253.4

Source: Statistical Abstract of the United States 1986.



Sources: All data except tax payments taken from Consumer Expenditure Survey, Bulletin 2173, U.S. Bureau of Labor Statistics, Sept. 1983. Tax data for 1972 derived from Consumer Expenditure Survey Series: 1972-73, U.S. Bureau of Labor Statistics, Report 455-4, 1977. Tax data for 1981 derived from After-Tax Money Income Estimates of Households: 1982, Series p-23, No. 137.

Figure 1. A Comparison of Household Income Growth and Increased Costs of Major Items During the Period 1972-81 (Percent Increase)

For the period 1972 to 1981, energy prices rose faster for all households than did income, taxes or food prices. But energy costs rose disproportionately for the elderly and the poor, even after social transfers are included. Between 1972 and 1981 energy costs rose 168 percent for the elderly and 201 percent for the poor while after tax income for these two groups rose only 42 and 63 percent respectively. How this burden was distributed is shown in Table II. Energy costs before the price shocks of the 1970s were proportionately higher for households earning under $10,000 than those earning more than $10,000. This trend became more pronounced after the price shocks. Cooper et al. (1983) found that in the period between 1972-73, low-income households spent 11.0 percent of their household income for energy while lower middle-income households spent 5.2 percent and non-low-income households generally spent 2.5 percent. By 1981 these percentages had risen to 23.5 percent for low income households, 9.7 for lower middle-income households, and 3.5 percent for non-low-income households.

Table II. Energy costs as a percent of income

Income Category	1972-73	1979-80	1980-81
Low income	11.0	21.1	23.2
Lower Middle Income	5.2	8.9	9.7
Non-Lower Income	2.5	3.5	3.5

Source: Cooper et al., 1983: 82.

There are regional variations in these figures, but such differences are not nearly as significant as the widening differences by income class. Thus, Cooper et al. report the following:

> The lowest income households in the Northeast spent 28 percent of their income on energy, while those in the highest income category spent less than 3 percent of their income on household energy. In the North Central regions, the ratios were 23 percent and 2.5 percent respectively. The percentages in the South parallel the national average at a slightly lower level; the lowest income households spent about 19 percent of their income on energy while the highest spent less than 3 percent. In the West, the trend across income categories was the same although the percentages were smaller at all income levels. The lowest income households spent 13.4 percent of their income on energy while those in the highest income category spent only 1.3 percent (Cooper et al., 1983: 83).

In brief, low-income households have historically spent a higher proportion of their income for energy than non-low income households. This difference widened substantially after the energy price shocks of the 1970s as low-income households absorbed a *relative* increase in energy costs of approximately 150 percent (23.2/11.0 vs. 3.5/2.5).

Choosing Between Energy and Other Household Needs

The rising cost of energy relative to other goods put severe constraints and pressures on low-income and elderly household budgets and required choices between energy and other household necessities. These problems have been particularly acute among the elderly.

> If they are compelled to spend more of their income on energy in order to maintain basic heating and lighting needs, the elderly must make crucial adjustments in their lifestyles. [In a] 1980 survey conducted by the Gerontology Program at the University of Massachusetts...the following set of priorities were suggested as ways (the interviewed) senior citizens deal with energy costs: (1) undertaking conservation, or heating steps, (2) changes in living through a decline in the ability to purchase utilities, rent, transportation, and recreation, (3) increased fuel assistance, (4)

> changes in personal living arrangements ranging from closing off rooms, to taking in borders, to moving into less expensive housing, and (5) health and nutrition adaptations in the form of unbalanced meals, eating less and seeking additional medical aid (Solano and Sparling, 1985: 179).

Of course, conservation is not widely available as an option to these households, especially low-income renters. With declining federal support for fuel assistance programs, these households are faced mainly with decisions that will have a direct impact upon their health and well-being. The elderly are particularly sensitive to lower temperatures in their homes and are especially vulnerable to hypothermia, as well as illnesses associated with changes in nutrition and diet. At least partly in response to social inequity in energy cost burdens and the health dangers posed by such inequity, federal policy encouraged states to consider lifeline electric rates which would enable all households to obtain service levels consonant with minimum health and well-being standards (Title I, Section 114(b) of the 1978 Public Utility Regulatory Policies Act).

ESTIMATING MINIMUM HOUSEHOLD ENERGY REQUIREMENTS

One issue in the implementation of lifeline rates is the question of how much electricity (or other kind of energy) is enough to satisfy basic family needs. While any reduction in energy costs would benefit low-income households, assistance must cover the basic needs or "lifeline" amount if energy-induced conditions of poverty are to be effectively addressed.

California is the only state to have enacted a broad lifeline rate policy providing for basic allowances of electricity and gas at lower than previous prices (for all residential users regardless of financial status). Under the Energy Lifeline Act of 1975, the California Public Utilities Commission was charged with determining the minimum needs for electricity and gas for lighting, cooking, refrigeration, water heating, and space heating. Section 1 of the California Act identifies lighting and heating as basic human rights and requires that they be available to all households at any affordable cost. It also stipulates that rates should be set so that consumers are able to purchase a basic amount of energy believed necessary for sustaining a "decent, though austere," standard of living. The California charge per kWh was established at a rate below the utility's cost of providing this basic amount of service, thereby furnishing a subsidy to those utility customers who purchase the minimum amount of energy. If production and delivery costs for gas or electricity increase substantially, the value of the gains to the needy and the burdens to the non-needy must also increase.

Unfortunately, "basic" or "essential" amounts of energy for all families cannot be easily determined. Problems include: (a) significant variations among users in terms of their housing characteristics, family sizes, appliance stocks, and weather conditions; and (b) technological shifts over time that alter the costs and supplies of all goods and services that can act as energy substitutes. Obviously, all residential energy consumers are not alike in their preferences, health conditions, appliance stocks, or ability to pay. Depending upon age and region, space heating or air conditioning can be a necessary item to maintain health. What constitutes a reasonable level of comfort depends upon the age of the individual, his or her health, clothing habits, and weather. Even if energy is used for the same purposes, households tend to use different amounts and different kinds of energy due to differences in housing size and structure.

Recognizing the impossibility of arriving at an invariant standard that would apply for all households and regions, sensible and reliable estimates can still be made of a minimum energy requirement. Minimal thresholds of energy use, assuming reasonable practices by consumers and relatively energy-efficient appliances, can be technically established. Once established, such thresholds can be changed with program experience. Utility commissions traditionally have lacked precise knowledge of all facets of changing supply and demand conditions and instead have relied upon rough averages of consumption rates, production costs and revenue growth in order to establish pricing structures. To hold the setting of minimum household energy requirements to a standard of precision above that used in rate setting is not very convincing. Certainly, a requirement that commissions adhere to some equity principle in setting rates is at least as feasible (and problematic) as the idea that ratemaking should observe an efficiency principle.

Estimation of the minimum energy requirement has raised difficult technical questions. Engineering estimates of appliance-specific consumption are typically made from laboratory data and, in some cases, end-use appliance metering records. The primary disadvantage of laboratory estimates is that they are unadjusted for regional climatic differences or variations in energy consuming behaviors. Direct appliance metering under varied use conditions is, of course, possible but it is much more complex and costly.

Statistical estimation of the minimum energy requirement is an alternative. A random sample of residential consumers were surveyed to obtain data on housing and household characteristics, accurate measures of energy use, and specific identification of electric appliances in use. These data can be utilized to empirically estimate "minimum amounts" for specific appliances through a conditional electric demand equation (Parti and Parti, 1980).

Residential demand for electricity is a derived demand based on household appliance stocks and rates of utilization. Thus, electricity consumption can be measured in terms of the relationship between the stock of electricity-using appliances and the flow of energy through this stock. The demand for electric energy (E) is considered as a two-dimensional vector which is identified by a stock of electric appliances (A_i) and its utilization rate (U_i):

$$E_i = U_i A_i$$

$$E = \sum_{i=o}^{N} U_i A_i \tag{1}$$

E can be subdivided by the electricity consumed through a set of specified major electric appliances ($U_i A_i$) and through a set of unspecified appliances ($U_o A_o$):

$$E = U_o A_o + \sum_{i=1}^{N} U_i A_i \tag{2}$$

Present appliance stocks (A_i) are some function of a series of vectors (X) including income and prices in the current and previous periods ($-t_i$). The utilization of the existing appliances is assumed to be affected by housing and household energy-consuming characteristics (such as housing size and structure) which are represented by vectors (V_i).

$$A_i = f_i\ (X(-t_i))$$

$$U_i = f_i\ (V) \tag{3}$$

If Equation 3 is linear, then

$$U_i = b_i + \sum_{j=1}^{M} b_{ij}\ V_j \tag{4}$$

Using the conditional format, A_i is a dummy variable which takes on the value one for those households possessing the (i)th appliance and is zero otherwise. If the (i)th appliance is owned by households, then Equation 1 can be rewritten using Equation 4.

$$E_i = b_i\ (A_i) + \sum_{j=1}^{M} b_{ij}\ (V_j A_i)$$

$$E = \sum_{i=o}^{N} b_i\ (A_i) + \sum_{i=1}^{N} \sum_{j=1}^{M} b_{ij}\ (V_j A_i) \tag{5}$$

Equation 5 can be estimated using linear regression techniques. The coefficients of A_i and V_jA_i (b_i and b_{ij}) are the estimates of average energy usage of households indexed by their appliance stocks and housing and household characteristics. As a means of estimating minimum requirements, a 95 percent confidence interval is adopted for each of the estimated coefficients. Using billing records from a sample of 224 Delaware households, we estimated the coefficients (B), standard errors (SE), and lower level "minimums" (MIN B) as follows:

	B	SE	MIN B
Water heater	253.919	40.159	175.205
Cooking	183.999	35.226	114.955
Furnace	397.511	74.184	252.110
Air conditioning (wall or central units)	180.847	39.396	103.629
Single-family housing	392.519	47.036	300.328
Family size	153.094	32.552	89.292

The final step in establishing a Delaware minimum energy requirement was to disaggregate the above totals into individual estimates by major appliances. Using the lower confidence level estimates, the minimum energy requirement for specified appliance groups is given in Table III. Minor unspecified appliances such as lights, TV, refrigerator, and small electric appliances as used in any standard households are included in each combination. Equivalent figures for apartment dwellers can be calculated by subtracting 250-300 kWh from the single-family unit estimates. With several national estimates as points of reference (Byrne et al., 1981: 16-19), the empirically determined minimal amounts of energy consumption estimated for Delaware appear to be reliable.

Table III. Estimates of minimum energy requirements in Delaware by major appliances (monthly use)

	Single-Family Dwellers	
Major Appliance Combinations	Family of 2 or less	Family of more than 2
Water heating, cooking, and air conditioning	662 kWh (2.3)	751 kWh (2.6)
Space heating, cooking, and air conditioning	739 kWh (2.5)	828 kWh (2.8)
Water heating and air conditioning	547 kWh (1.9)	636 kWh (2.2)
Space heating and air conditioning	656 kWh (2.2)	713 kWh (2.4)
Cooking and air conditioning	487 kWh (1.7)	576 kWh (2.0)
Water heating and cooking	558 kWh (1.9)	648 kWh (2.2)
Space heating and cooking	635 kWh (2.7)	725 kWh (2.5)

Note: The figures in parentheses are million Btus.

Table III indicates that the minimum quantity per household to be supported in a Delaware lifeline rate program should not be less than 500 kWh per month. If the lifeline program took appliance combinations into account, then electric space heating households can be treated as a special sub-class. Due to the small number of such households in the sample, we did not attempt to estimate the conservation and equity effects of a lifeline rate program targetted for this sub-class.

CONSERVATION AND EQUITY EFFECTS OF LIFELINE RATES: A CASE STUDY

Based on a minimum requirement of 500 kWh, a lifeline rate was simulated and evaluated in terms of its efficiency and equity effects. For this evaluation, an electricity demand equation was estimated with two price elasticities: one for consumers with annual family incomes below $15,000 (hereinafter referred to as the lifeline group); and another for income earners over $15,000 (the non-lifeline group). A two-stage least-square specification was used to address the simultaneity problem between electricity consumption and price (see Byrne et al., 1985: 98). Estimates were restricted to the summer months for reasons explained below. The estimated equation has the following statistical characteristics:

$$\begin{array}{lcccccc} \text{SUMAC} & = & 14.371 & - & 0.522\ \text{SUMAP} & - & 0.440\ \text{LIFELINE} \\ & & (t= 0.703) & & (t= -0.502) & & (t= -0.982) \\ & + & 1.495\ \text{FSIZE} & - & 2.530\ \text{INFO} & + & 14.388\ \text{INCOME} \\ & & (t= 1.714) & & (t= -1.785) & & (t= 2.270) \end{array}$$

$R^2 = 0.19$ SE $= 20.68$ F $= 11.17$ N $= 224$

Where,

SUMAC	Percentage change in electricity consumption between the summer of 1980 and 1981 $((kWh_{81} - kWh_{80})/kWh_{80})$
SUMAP	Percentage change in average price of electricity between the summer of 1980 and 1981 $((AP_{81} - AP_{80})/AP_{80})$
LIFELINE	Lifeline elasticity variable: the product of average price and a dummy income variable with a value of 1 for households with incomes greater than $15,000 per year and 0 if household income is below $15,000
FSIZE	Family size: number of persons in the home
INFO	Electricity information index: value of 1 is given for correct response to each of the following questions: (i) knew approximate average price per kWh (ii) aware of fixed customer charge (iii) knew the peak use season (iv) knew about higher peak season rates
INCOME	Dummy variable based on 1980 annual family income: value of 0 if household income is below $15,000 and 1 if income is above $15,000.

While R^2 is modest, it is within the range obtained by others using two-stage least-square techniques (Byrne et al., 1985: 111).

Since SUMAC and SUMAP are entered into the equation as percentage changes, the coefficient of SUMAP represents a price elasticity and can be interpreted as the estimated percentage adjustment in consumption by the average household to a percentage change in price. The coefficient of LIFELINE becomes zero for those households who earned less than $15,000; and -0.44 for consumers with family incomes above $15,000. Therefore, the price elasticities for the lifeline and non-lifeline groups are -0.522 and -0.962, respectively. Consistent with the findings of other researchers, household electricity demand is only modestly elastic due to its characteristic as a "necessary good"; and low-income consumers exhibit the least elastic demand. This latter result is expected given the relatively low average consumption (400 kWhs in our sample compared to 982 kWhs among non-lifeline users) and narrow range of discretionary use for low-income households.

Average price was chosen over a marginal price approach in which the kWh charge in the last rate block is used with an average charge for lower blocks. The average price specification has tended to yield more stable estimates (Cicchetti and Smith, 1975) and has been argued by some as more appropriate because residential consumers in particular are seldom aware of rate structures used to figure electric bills (see, e.g., Wilder and Willenborg, 1975). Moreover, Halvorsen (1975) has shown that for standard demand models, elasticity terms derived from average electricity price data are mathematically identical to those obtained with marginal prices (see Byrne et al., 1984, for a discussion of this issue).

Whatever marginal price effect might exist is indirectly captured with the billing information index (INFO) included in the equation. In two studies of the role of information in electricity demand, we found that household knowledge of the rate structure varied greatly, but that informed households, *regardless* of income levels, tended to exhibit slower demand growth (Byrne et al., 1982 and 1984).

Finally, following standard practice (e.g., Bohi, 1981), family income and family size were incorporated into the estimating equation to separate their effects on demand growth from that of price.

The restriction of the estimate to summer consumption was dictated by a 1981 cost-of-service study performed by the state's major utility. In that study, it was argued that the cost of electricity supply was highest during the peak summer season and that supply in the off-peak winter period was still subject to scale economies of generation. Since a lifeline rate is a type of inverted rate (Neufeld and Watts, 1981) in which increased levels of consumption are priced at higher rates, it seems most appropriate to employ such a rate during periods when supply cost patterns correspond to the pricing assumptions of this rate structure. There are, of course, problems in basing rates strictly on utility costs of service (see, e.g., Kahn, 1970, vol. 1: 63-181; and 1971, vol. 2: 47-94) but this issue cannot be satisfactorily addressed here.

Efficiency Evaluation

Following Neufeld and Watts (1981), the efficiency effect of a lifeline rate was evaluated by comparing efficiency losses of existing rates and a lifeline alternative to a rate structure based on marginal costs. Regulators generally do not allow utilities to charge full marginal costs for fear that this would result in "excess revenues" over what would be available to competitive firms. Since utilities are state-granted monopolies, one purpose of regulation is purportedly to protect consumers from anticompetitive practices which might lead to excessive revenues. Putting aside the excess revenue issue, however, a marginal cost pricing standard allows different rate structures to be evaluated in terms of their assignment of supply costs to users whose demand levels and patterns invoke those costs.

The marginal cost rate for summer residential use was taken from the utility cost-of-service study mentioned above which set the value at 9.4 cents per kWh. Consumption by the non-lifeline group was charged at this rate. The lifeline rate for low-income households was then solved by fixing utility revenues from the residential class at their summer 1981 levels and determining what kWh charge assessed to the lifeline group for consumption below 500 kWhs would generate the remaining revenue necessary to fulfill this constraint. This yielded a lifeline rate of 7.9 cents per kWh for monthly consumption below 500 kWhs by households with incomes less than $15,000. Consumption by the lifeline group above 500 kWhs is priced at marginal cost (i.e., 9.4 cents per kWh). In this way, a lifeline rate was constructed which, in keeping with the method proposed by Neufeld and Watts, is revenue-neutral and charges higher rates for increased consumption levels.

The rate structure in existence during 1981 resulted in the lifeline group paying an average price of 8.7 cents, while non-lifeline households paid 7.5 cents per kWh. The lower average price paid by non-lifeline households is the result of a monthly charge of $4.95 assessed all residents independent of consumption level. Since the non-lifeline group consumed electricity during the summer at more than twice the level of the lifeline group, the monthly charge acted as a volume discount for them.

Efficiency losses under the 1981 rate structure and the constructed lifeline alternative were measured as the shaded areas in Figures 2 and 3 based on the marginal cost standard of 9.4 cents per kWh. It was assumed that the demand curves for both groups are linear and continuous. The size of the shaded area can then be figured in two steps: first, using the arc elasticity formula, the level of service that would be demanded by each group at an average price of 9.4 cents is determined (given the estimated demand elasticities for each group); second, the difference in average bill payments for each group is then found and the efficiency loss is calculated. Using the arc elasticity formula and solving for Q_L, the demand level of the lifeline group under marginal cost pricing would be 384 kWhs per month. That is,

$$\frac{[(400\ kWh - Q_L)] \div [0.5(400\ kWh + Q_L)]}{[(\$0.094 - \$0.087)] \div [0.5(\$0.094 + \$0.087)]} = 0.522;$$

therefore,

$$Q_L = 384\ kWh.$$

For the non-lifeline group, the average monthly consumption under marginal cost pricing would be 790 kWhs:

$$\frac{[(982\ kWh - Q_N)] \div [0.5(982\ kWh + Q_N]}{[(\$0.094 - \$0.075)] \div [0.5(\$0.094 + \$0.075)]} = 0.962;$$

therefore,

$$Q_N = 790\ kWh.$$

The combined efficiency loss under the 1981 rate schedule is then:

$$0.5\ [(400\ kWh - 384\ kWh) \times (\$0.094 - \$0.087)] +$$
$$0.5\ [(982\ kWh - 790\ kWh) \times (\$0.094 - \$0.075)] =$$
$$\$1.88/household/summer\ month.$$

The efficiency loss due to excess demand (the combined shaded areas in Figure 2) is thus equal to $1.88 per household for each summer month. With the average household summer monthly bill equal to $66.90, this translates to a 3 percent demand subsidy. This subsidy is enjoyed almost entirely by the non-lifeline group; the efficiency loss for this group (d-e-f in Figure 2) accounts for 97 percent of the total loss.

Efficiency losses remain under the constructed lifeline rate because it is assumed that all units of summer electricity supply cost 9.4 cents per kWh. However, losses are greatly reduced under this rate structure to approximately $0.28 per household per month. This represents an 85 percent reduction in efficiency losses over existing rates. Because total residential revenues remain constant, the relative efficiency of the lifeline alternative is directly attributable to the proportionate elasticity adjustments of the two groups in response to prices that more closely reflect marginal costs. The average subsidy is substantially lower representing less than one-half of one percent ($0.28 ÷ $66.90) and is wholly enjoyed by the lifeline group (a-g-h in Figure 3).

Underlying the relative efficiency improvement are important shifts in consumption behavior by the lifeline and non-lifeline groups. Average peak season consumption by the former grows 5 percent to 421 kWhs as average price falls 9 percent (8.7 cents to 7.9 cents). In contrast, the non-lifeline group reduces its average peak season consumption by 20 percent (982 kWhs to 790 kWhs) in response to a 25 percent increase in its average kWh price (7.5 cents to 9.4 cents). The projected elasticity adjustment of the non-lifeline group, in particular, is substantial.

Equity Evaluation

By one measure, the equity effect of the constructed lifeline rate is significant. Whereas 1981 rates allocated 97 percent of the price subsidy to households with incomes above $15,000, the lifeline alternative

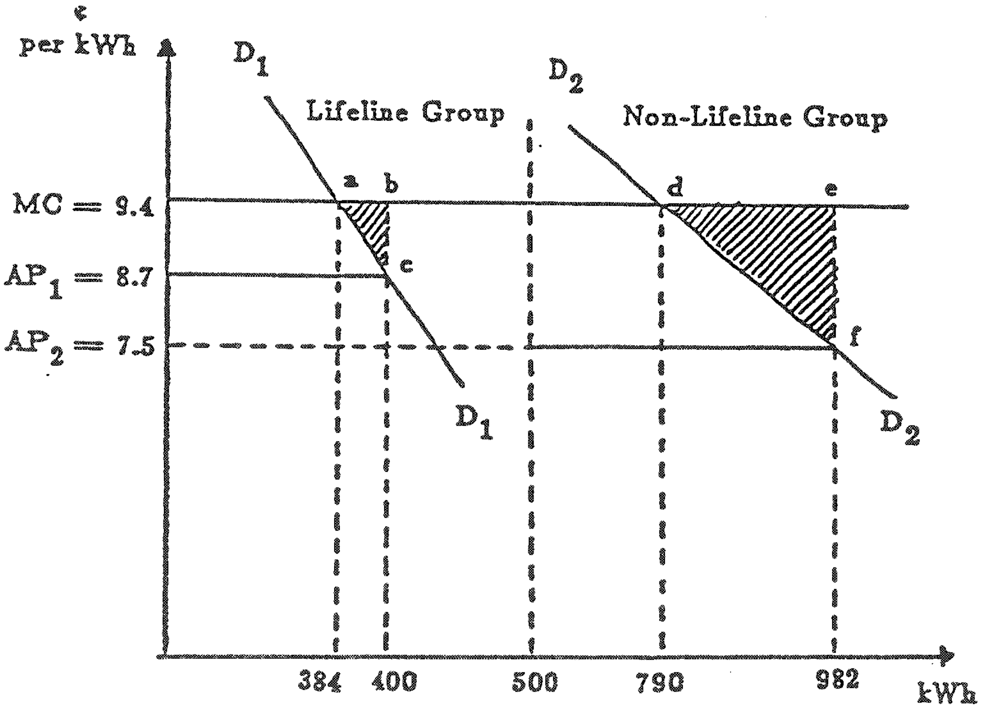


Figure 2. Efficiency Losses: 1981 Rate Structure

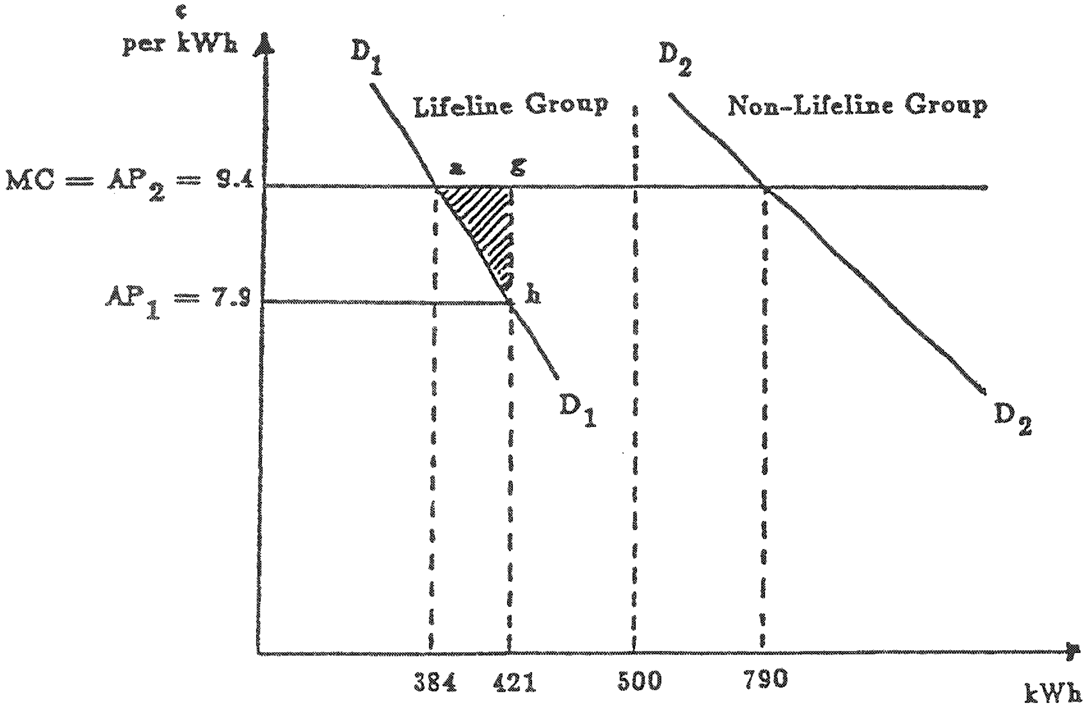


Figure 3. Efficiency Losses: Lifeline Rate Structure

provides a subsidy exclusively to low-income consumers and, furthermore, limits the extent of the subsidy to the first 500 kWhs of consumption. Insofar as rate policies will necessarily create a subsidy (a consequence of avoiding "excess revenues"), a fairer distribution of this benefit would seem to result under a lifeline rate.

However, when the equity effect of such a rate is measured as the relative income burden of the two groups, the impact turns out to be quite small. The average lifeline-eligible household stood to gain about $6.16 over the summer period of 1981 if the existing rate structure had been replaced by the constructed lifeline alternative. Conversely, non-lifeline households would lose $2.44 on average over the four-month summer period. These represent very small changes absolutely and as a proportion of income. Using the most recent *Consumer Expenditure Survey* (U.S. Bureau of Labor Statistics, 1985), the lifeline group would experience only a 0.22 percent decrease in the proportion of disposable income devoted to electric bill payments (from 4.91 percent to 4.69 percent). The non-lifeline group would increase its share of disposable income to pay electric only by 0.03 percent (from 3.9 percent to 3.93 percent).

When equity is measured by the relative share of utility revenues collected from the two groups, the effect of the constructed lifeline rate is still very small. The substitution of the lifeline alternative for the 1981 rate structure results in a redistribution of utility revenue shares of only 0.5 percent. Under the original rates, the lifeline group accounted for 9.1 percent of revenues collected from the residential class while their share falls to 8.6 percent with the adoption of the constructed lifeline rate (correspondingly, the share collected from the non-lifeline group increases from 90.9 percent to 91.4 percent).

CONCLUSION: EFFICIENCY, EQUITY AND REGULATORY OPPOSITION TO LIFELINE RATES

The social and health benefits derived from a lifeline rate policy depend first upon the level of the minimum energy requirement set in the policy. While establishing the appropriate requirement is conceptually and technically difficult, it is not the primary obstacle to the adoption of lifeline rates. Rather, regulatory debate has centered largely on efficiency and equity issues raised in pricing the minimum energy requirement. State utility commissions have resisted lifeline policies on allocative efficiency grounds and, to a lesser extent, on the belief that equity improvements would be captured mainly by middle and upper income groups.

Obviously, the efficiency and equity effects of any rate policy, including one incorporating lifeline principles, will be determined by the actual price structure used. It is possible, however, to design lifeline rates which are substantially more efficient in the allocation of costs, providing that the marginal cost of electricity supply is not declining; and any subsidy can be restricted to low-income groups. In this sense, regulatory opposition to these rates as inefficient and mostly beneficial to non-low-income groups may be misplaced. From our analysis, there appears to be reason for concern about the *magnitude* of economic relief which can be provided via a lifeline rate. But in comparison to typical residential rate policies which offer some form of a volume discount, lifeline rates can certainly allocate marginal costs more equitably when they exceed average costs.

This leads us to speculate that regulatory opposition might stem from a different source. The pricing tradition in state regulatory policies has been to promote increased service levels. In the past, promotional rates have been rationalized by scale economy arguments that the marginal cost of electricity supply falls with increased production. This justification relies on an accounting regime which evaluates costs on the basis of utility expenditures. However, as has been pointed out (see, e.g., Kahn, 1970: 87-122), this regime does not accurately reflect marginal costs which concern future supply options and costs rather than past experience. Instead, this regime facilitates a "grow and build" strategy (Flavin. 1984) which seeks to expand electricity penetration of the energy market. With increasing marginal costs of traditional electric power supply in the 1970s, maintenance of this strategy requires increased subsidies to promote demand and/or price discrimination based on demand elasticities (less elastic demanders, such as low-income households, being charged relatively higher prices). The 1978 PURPA rules made the former more difficult and so utilities have sought to sustain policies which charge higher rates to small volume users who are usually inelastic demanders. Lifeline rates are in direct conflict with such an approach and, indeed, can be shown to be costly *within* a utility cost-of-service framework. Only if regulators abandon this framework can the efficiency and equity benefits of lifeline rates be fully evaluated.

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