LIFELINE RATES FOR ELECTRICITY AND NATURAL GAS

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EXECUTIVE SUMMARY

This report considers the compatibility of lifeline proposals with the principles of sound utility rate design. According to these principles, utility rate structure must be designed (1) to recover enough revenues to equal total costs, including the cost of a fair rate of return on investment, (2) to encourage all economically justified use of utility service and discourage wasteful use, and (3) to distribute the burden of meeting the revenue requirement fairly among utility customers. These objectives are called the revenue requirement, the optimum use, and the fair apportionment objectives, respectively.

Lifeline is a general name for a variety of rate reform proposals intended to accomplish several purposes with a single change in rate structure. These purposes are to reduce utility rates for essential residential needs, to help the poor, to promote conservation, and to apply marginal cost pricing to utility rates. The various lifeline proposals differ in their ability to achieve these purposes and also differ in their compatibility with the principles of sound rate design. The variety of lifeline plans complicates the analysis.

Any lifeline proposal is compatible with the revenue requirement, provided revenues lost on lifeline sales are recovered by increasing the price of other sales.

The compatibility of lifeline with optimum use depends on the particular lifeline proposal and on the circumstances of the utility company for which it is proposed. For Ohio natural gas utilities, the cost of additional gas is greater than the average cost of current supplies. Under these conditions, a two block rate structure with the tail block priced higher than the front block, which we call the two-level lifeline rate structure, can be more compatible with optimum use than the declining block rate stuctures widely used by Ohio gas companies. Compatibility depends on an economically correct choice of rates and block sizes.

For electric utilities, time-of-day pricing (TDP) with no blocks is most compatible with optimum use. The metering devices needed to implement TDP for residential customers are not yet available at an economical price, but this situation may change in the near future. In the meantime, a block-type rate structure must be used. Its shape should be determined by whether expanding electricity production will raise or lower the cost of electricity. If the cost of additional electricity, marginal cost, is greater than the historic average cost, a two-level lifeline rate structure is more compatible with optimum use than a declining structure.

Although a particular lifeline proposal may be compatible with optimum use under present conditions, lifeline legislation is not compatible with optimum use if it requires the implementation of that proposal at all future times even though present conditions may have changed. Our conclusions regarding the compatibility of the two-level rate structure with optimum use could be changed by the availability of economical TDP meters, the deregulation of natural gas prices or other circumstances. Optimum use is achieved by changing the rate structure with changing conditions. Legislation which permanently specifies the details of utility rate design is therefore to be avoided.

The compatibility of lifeline with the fair apportionment objective of rate design depends on the particular lifeline plan and the chosen standard of fairness, as well as the customer characteristics of the particular utility. Lifeline proposals may be broadly categorized as either flat rate or inverted rate proposals, and as proposals which either hold residential revenues constant or support lifeline by increasing the revenues derived from nonresidential sales. Those who believe that fairness requires that rates be related to costs would favor a flat rate with a separate minimum charge, but would not favor inverted rates; and they would consider it fair to reduce residential revenues only to the extent that residential customers pay no more or less than their fairly allocated share of total utility costs. Those who believe everyone should pay the same rate regardless of costs favor flat rates and oppose inverted rates, and favor reducing the average price of residential sales until it equals the average price of nonresidential sales. Others believe that it is unfair to raise rates significantly for customers who invested in utility consuming appliances and machinery under a reasonable expectation that rates would not increase significantly. This idea of fairness can be applied not only to support lifeline rates for the operation of essential appliances but also to oppose a substantial rate increase for large-volume users under lifeline. Still another standard of fairness requires that utility rates should depend on the customer's ability to pay. Most lifeline proposals are supported because of a belief that lifeline will result in lower rates for the poor, who are small-volume users, and higher rates for the wealthy, high-volume users. This belief is justified for electricity users, but among natural gas users in Ohio it appears that the poor consume no less, and possibly more, natural gas than the nonpoor. Lifeline for electricity can be supported on the basis of favoring the poor, but lifeline for natural gas cannot.

Fairness arguments can be made either for or against the various proposals. We find that each of the arguments has some merit, but that because of the conflicting arguments a decision to adopt a lifeline proposal cannot be made on the basis of fairness alone.

This analysis of the compatibility of lifeline with the principles of rate design leads to the following conclusions:

1. For a utility company with a regulated rate of return, a lifeline rate structure can be better justified on the basis of economic efficiency than a declining block rate structure, provided (a) current marginal cost is greater than historic average cost, (b) the lifeline block length covers only essential use, and (c) the tail block price for each rate schedule equals the marginal cost for that customer class.

2. Although lifeline may be preferrable to declining blocks at the present time, this may not be so in the future, and lifeline may not be the best current alternative to declining blocks. Statutory adoption of lifeline could prevent the PUCO from adopting the rate structure which best serves the public interest. (A joint PUCO-OSU study is now investigating regulated rate structures and examining broader issues of rate design beyond the scope of this lifeline study.)

3. It is not possible to draw a firm conclusion regarding the equitableness of lifeline not only because of the great variety of lifeline proposals, but also because of the variety of standards used for determining fairness.

4. Alternatives to lifeline, such as energy stamps, weatherization programs, and time-of-day pricing, may be more effective than lifeline in satisfying the lifeline objectives.

5. If lifeline legislation is enacted, the above conclusion notwithstanding, three amendments to the current Ohio bill (Sub. H.B.583) should be considered:

   i) The lowest rate offered to each customer class should be related to the cost of serving each class.

   ii) Specification of the lifeline length for natural gas should allow for monthly variations in use due to weather. The length currently specified (30 mcf) approximates essential use only during the coldest months.

iii) Specification of the lifeline length for electricity should distinguish between households with and without electric water heaters. For households in the latter category, 300 kWh is a better estimate of essential monthly use than 500 kWh.

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CHAPTER 1

INTRODUCTION

Recently the Ohio legislature has taken up consideration of bills to provide "lifeline" rates for some utility service. Lifeline rates are designed to provide essential amounts of utility service to residential customers at a relatively low rate. Since the lifeline method of setting utility rates would be a departure from historically accepted methods, the Public Utilities Commission of Ohio (PUCO) has requested this study to consider the impact of lifeline on the public interest.

This report considers the criteria to be used in judging the effectiveness of any rate design proposal in promoting the public interest and analyzes lifeline proposals according to these criteria. Utility rate structure is traditionally judged according to how well it meets three basic purposes. We begin by comparing these purposes with the purposes which advocates of lifeline intend it to accomplish.

Traditional Purposes of Utility Rate Design

A summary of the guidelines to be followed in setting utility rates is presented here. A more detailed discussion is presented in Appendix A.

It is generally recognized that utility rates should be designed (1) to recover exactly enough revenues to cover total costs, including the "cost" of providing a fair return on capital investment, (2) to promote optimum use, that is, to encourage all economically justified use of the utility service and discourage wasteful use, and (3) to charge each customer a fair rate for the service received. These purposes are referred to as the revenue requirement, the optimum use and the fair apportionment objectives, respectively.

It is not possible for any one rate structure to satisfy fully all three purposes. Practical rate design requires a compromise to achieve each of these purposes to some significant degree.

The Purposes of Lifeline Rates

The purposes which the advocates of various lifeline rates intend to accomplish will be considered so as to assess the extent to which these purposes are compatible with the traditional purposes of utility rate design. Although a few specific lifeline plans have been proposed in Ohio, a survey of lifeline laws and bills in other states shows a great variety of lifeline plans. The plans are intended to accomplish different, sometimes conflicting, purposes.

A review of lifeline legislation, testimony and articles from around the nation shows that advocates of lifeline intend it to achieve one or more of four basic purposes, namely, (1) to provide everyone with essential utility service at a low rate, (2) to ease the financial burden of rising utility rates for low income consumers, (3) to promote conservation, and (4) to include marginal cost pricing in utility rate design. The arguments generally given in favor of these purposes are summarized here, and do not necessarily reflect the opinions of the authors of this report.

Lower Rates for Everyone

Utility services have become a necessary part of modern life. As an obvious example, it is no longer feasible for most people to gather firewood from the forest to provide for heating, cooking and lighting in their homes. A refrigerator is now a necessity, and to a certain extent a telephone is also. Water and sewage services are essential. Some advocates of lifeline contend that in today's world everyone is entitled to essential amounts of utility service at a rate lower than the rate for nonessential use.

Lower Rates for the Poor

The rapidly rising rates of some utilities have made it a financial burden in many low income households to pay for essential needs. Even those who reduce their utility usage to a minimum still often feel the burden because the <u>highest</u> rates are charged to residential customers for the first amount of service used. Some lifeline advocates feel that even if lifeline rates are extended to all households, lifeline would particularly benefit the poor because the poor are low volume users of utilities and because the savings realized with lifeline rates make up a larger fraction of their income.

Others feel that lifeline rates should be extended only to the poor. Extending a moderately low rate to everyone would only dilute the potential beneficial impact of lifeline on the poor who should instead receive a very low rate for essential use or even for all use. The success of lifeline, these advocates contend, depends on the extent to which it helps the poor and does not help the nonpoor.

Conservation

Utility rates for electricity and gas are now set according to a declining block structure which means the more you use, the lower your rate. The declining block structure was encouraged in the past, in part because it led to a growth in system sales, and the economies of scale resulting from growth were beneficial to all the utility's customers. Today the value of system growth is questionable. Aside from the fact that many believe that economies of scale are no longer attainable in the electric industry, growth in sales for electric and gas utilities tends to oppose conservation of energy and protection of the environment. To promote conservation, say some advocates of lifeline, we must turn away from a rate structure which promotes growth and turn to a rate structure based on the principle: the more you use, the higher your rate. Utilities should provide essential services at the lowest rate and charge higher rates for nonessential uses. Such a rate structure would give customers an incentive to reduce their nonessential energy consumption.

Marginal Cost Pricing

Economists favor setting utility rates according to principles which take account of marginal cost. Many lifeline advocates believe that application of such principles would lead to a lifeline rate structure. At least one advocate of a lifeline rate structure has based his arguments for lifeline solely on economic principles. Economist and utility rate consultant, Dr. Eugene P. Coyle, testifying before the California Public Utilities Commission,[1] attempted to show that for the particular case before the Commission at that time, accepted principles of sound rate design would lead to a two block rate structure for residential electric service with the front block priced lower than the tail block. The essence of his argument is that in cases where growth in utility sales tends to increase the average cost of service, the price of those sales which cause the growth should be higher than the average price for the service. Not all sales can be charged the higher

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[1] "Rate Design Proposed for Pacific Gas and Electric Co.," App. No. A 54279, Nov. 18, 1974.

price, however, because the utility would then recover revenues in excess of its costs (including the "cost" of providing a fair rate of return on its investment). To the extent that growth occurs in tail block sales, while front block sales for essential services remain relatively constant regardless of price, the tail block price should be higher than average and the front block price should be lower than average. The resulting rate structure is essentially a lifeline rate structure.

It is important to realize that the appeal of lifeline to its advocates rests on the apparent ability of a single new rate structure to achieve several purposes seen as desirable. If lifeline is conceived of as a single purpose proposal, for example, a proposal to help the poor, then one may possibly argue that there are more efficient ways of helping the poor than with lifeline rates. However, supporters of lifeline may still favor the proposal because they see it as providing at least some help for the poor while achieving other desirable purposes. Hence, the several purposes of lifeline must be considered in evaluating the proposal or in designing a particular rate structure to implement the proposal.

In this report, we relate the purposes of lifeline to the purposes traditionally served by rate structure. We shall examine the compatibility of lifeline with the revenue requirement objective, the optimum use objective, and the fair apportionment objective of utility rate design. We shall not be concerned with determining the rate structure most compatible with these objectives, and so we do not examine such issues as customer charges, fuel adjustment clauses, and curtailment plans. Other OSU studies are currently examining these issues.

CHAPTER 2

THE VARIETY OF LIFELINE PROPOSALS

Any lifeline proposal is designed to provide essential utility services at a relatively low rate. But a great variety of utility rate structures can be devised for meeting this goal, and the compatibility of lifeline with the rate design criteria depends on the particular lifeline proposal. To see how lifeline proposals may differ, we begin by looking at the essential features of some proposed lifeline legislation from around the nation.

Examples of Proposed Lifeline Legislation

The Ohio House of Representatives is considering HB583 to provide for a lifeline rate structure for electricity and natural gas. The current amended version of the bill requires that the first 500 kilowatt-hours (kWh) of electric service to residential customers be provided at the lowest rate. For all-electric households this provision applies to the first 2500 kWh during the heating season. For natural gas the lowest rate must apply to the first 30 mcf of residential gas every month.

In Wisconsin, Assembly Bill 287 proposes that "any public utility furnishing residential service may not levy any charge for the first 500 kilowatt-hours furnished per month to any residential customer."

Maine has set up a demonstration lifeline program to provide the first 500 kWh at 3¢/kWh to residents 62 years and older who meet certain low income requirements. The rate cannot be increased by adding a fixed customer charge to the utility bill.

California's Assembly Bill 167 directs the California

PUC to designate a lifeline volume of gas and quantity of electricity specifically to cover heating, lighting, cooking and refrigeration. This lifeline "length" must be different for different categories of customers according to what extent their appliances require electricity and gas, according to their geographic location and according to the season of the year. The rate charged for lifeline service must be no greater than the rate in effect on January 1, 1976, and no increase in the rate is allowed until the average system rate increases by 25%.

Many other lifeline plans have been proposed as bills before the state legislatures, and several have been signed into law. Provisions vary widely among these plans. In considering the merits of the lifeline concept we must therefore be clear about which specific lifeline proposal is considered.

The Critical Questions

Proposals may differ according to which utilities are covered, which customers receive the lifeline rate, the amount of service to be covered, the price to be charged for the lifeline service, and the manner of making up for lost revenues. Moreover, lifeline plans may differ according to the purpose to be served and the method to be used in determining these matters. The various proposals can differ, then, according to how they answer the following critical questions.

Which Utilities Should Be Covered?

Public utilities include electricity, natural gas, telephone, water and sewer. Lifeline advocates usually propose lifeline rates either for electricity only or for electricity and natural gas. This is because electricity and gas are energy utilities, and the cost of energy has been rising rapidly, creating a financial burden. Also, many lifeline advocates are also interested in energy conservation. However, the argument that everyone is entitled to essential services at a low rate can be made for all utilities. Nevertheless, because of the limited time available for this study and because of the current legislative interest in the energy utilities, we confine our analysis to gas and electric service. At the risk of belaboring the obvious, we point out here that these utilities should be examined separately in considering whether a lifeline plan should be adopted.

It should be recognized that lifeline rates may apply only to those service areas over which PUCO has jurisdiction because under the home rule provision of the Ohio constitution incorporated areas have the right to negotiate their own rate schedules with utility companies.

Who Should Benefit from Lifeline Rates?

Some lifeline advocates believe that all residential customers are entitled to lifeline rates while others believe that only the poor should be served by lifeline. Still others want to offer lifeline only to elderly people on low, fixed incomes. Conservation advocates recommend increasing rates with increasing use for all customers, not only residential customers.

What Should Be the Length of the Lifeline Block?

Regardless of who receives lifeline rates, all lifeline advocates agree that at least "essential" utility service should be available to lifeline recipients at a low rate. But determining the amount of service which is essential is at best difficult. For example, the essential amounts of electricity and gas are different for a family in an all-electric home than for a family which heats with gas and has a gas-operated water heater, range and dryer. For the first family the essential amount of electricity is large and no amount of gas is essential.

The essential amount of electricity for the other family is small since lighting and refrigeration require relatively small amounts of electric power, but their need for gas is probably above average. A possible solution to this problem is to relate the lifeline length for electricity to that for gas: if one is greater, the other is shorter. Aside from the possible administrative difficulty of this plan, there remains the question of how to set these lengths fairly for those who heat with oil, coal, or liquid petroleum gas (LPG).

The essential amount of gas or electricity is also different for the single person in a one-bedroom apartment than for a large family in a four-bedroom home. Each represents a single household for billing purposes, and would receive a single lifeline length under most lifeline plans. However, not only are their heating requirements different, but also their need for cooking, refrigeration, lighting, and water heating. The large family may exceed the lifeline length and pay heavily for their "excess" use even though the essential use <u>per person in the household</u> may be much less than for the single person.

The amount of utility service needed for heating the household depends on several factors. The size of the home has already been mentioned, but the amount of insulation, weather stripping and the use of storm windows and doors is also important. For those who rent, these may be factors over which they have no control. Another factor affecting the need for utility heating is the month of the year. Most lifeline proposals specify a monthly, essential amount of service without taking into account that the essential amount will vary from one month to the next. Moreover, the need for utility service can vary with geographic location. Hence it is extremely difficult to determine an "average" essential amount of gas and electricity that has any meaningful relation to the monthly needs of Ohio customers.

This difficulty is illustrated in Table 2-1, which presents an estimated range of monthly essential use of gas and electric utilities in Ohio. We believe that most households will have an essential use in the ranges given, though certainly the essential amounts for some households will fall outside this range.

Table 2-1 Estimated Monthly Essential Use of Electric and Gas Utilities in Ohio*

	Typical January		Typical July	
	Range	Average	Range	Average
Electricity	(kWh)	(kWh)	(kWh)	(kWh)
All electric homes	2500-4700	3600	500-700	600
Water Heating & other	500-700	600	500-700	600
Other uses only	200-400	300	200-400	300
Gas	(mcf)	(mcf)	(mcf)	(mcf)
Average household	20-40	30	4-6	5

*Based on OSU engineering estimates from a variety of sources.

What Should Be the Charge for Lifeline Service?

Lifeline legislation may take one of several alternative approaches to determining the charge for lifeline service. Many lifeline bills in other states specify the rate; for example, the lifeline rate for electric service in the Maine plan must be 3 cents per kWh. Under this approach, it is necessary to choose a lifeline rate somewhere between the limits of free service and the current rate. The question of whether to apply the fuel clause adjustment to the lifeline rate must be addressed. Also, the possibility of allowing two (or more) rate blocks within the lifeline length should be considered.

Another approach is to require that the rates for lifeline service be no greater than they were (or will be) on a specified date. This approach does not require lifeline rates to be lower than other rates and allows a block structure within the lifeline length if it existed on the specified date. Alternatively, there is the approach followed by Ohio's HB583 requiring that no other block be priced lower than the lifeline block.

<u>What Should Be the Lifeline Break-Even Point?</u>

We introduce at this point a concept often overlooked in lifeline literature but which we believe has considerable importance. This concept of the break-even point is illustrated by the example in Table 2-2. The rates were chosen so as to keep the example simple.

Table 2-2 Illustration of the Break-even Point*

	Before Lifeline			After Lifeline		
USAGE (kWh)	Rate (¢/kWh)	Charge ($)	Bill ($)	Rate (¢/kWh)	Charge ($)	Bill ($)
100	5	5	5	2	2	2
200	4	4	9	2	2	4
300	4	4	13	2	2	6
400	3	3	16	2	2	8
500	3	3	19	5	5	13
600	2	2	21	5	5	18
700	2	2	23	5	5	23
800	2	2	25	5	5	28

* The table contains sample customer bills. Revenues, which should be the same before and after lifeline, depend on the frequency of occurrence of bills, but the bill totals shown here need not be equal.

This example deals with replacing a declining block rate structure for electric service with a two block lifeline rate structure. Before lifeline rates were put into effect, the old rate schedule was 5¢/kWh for the first 100 kWh, 4¢/kWh for the next 200 kWh (up to 300 kWh), 3¢/kWh for the next 200 kWh (up to 500 kWh), and 2¢/kWh for all further usage. Under this pre-lifeline rate structure, the charge for the first 100 kWh was $5; the charge for the next 100 kWh was $4, making a total bill of $9 for the first 200 kWh; and so on. Under lifeline rates, the rate is 2¢/kWh for the first 400 kWh and 5¢/kWh for all additional kWh's.

In this example the bill for the lifeline length (400 kWh) is $8, whereas it was $16 before lifeline. Even those who consume more than the lifeline length still realize savings, however. For example, at 600 kWh, the lifeline bill is $18 but was $21 before lifeline. However, at 700 kWh the bill is the <u>same</u> after lifeline and before lifeline, $23. We call 700 kWh the <u>break-even point</u> for this lifeline plan. For usage above the break-even point, consumers have higher bills under lifeline than before. For example, at a usage of 800 kWh, the lifeline bill is $28 whereas it was $25 under the old rate schedule.

We point out that in terms of reducing utility bills and encouraging conservation, properly choosing the break-even point may be at least as important as choosing the lifeline length and rate. Where the break-even point lies depends on the method of revenue recovery chosen.

<u>How Should Lost Revenues be Recovered?</u>

The PUCO has the legal obligation to set rates which provide a fair rate of return on utility investment. Such rates are in effect now for all utilities. If lifeline legislation reduces the revenues received for sales in the front rate block, the lost revenues must be made up from other sources. Most lifeline legislation does not specify the method of revenue recovery, but the effect of lifeline on the public interest may well depend critically on which method is adopted. Suppose the lifeline rate applies only to the front residential block. Assuming that revenues from residential customers now match the costs which the utility company incurs in serving these customers, then the lost revenues could reasonably be recovered wholly from the remaining residential blocks. This may lead to a substantial rate increase for large volume residential customers. Alternately, the burden of supporting lifeline could be spread evenly (or unevenly) among all the company's customers. Or the lost revenues could be recovered wholly from the commercial and industrial sectors. Another possibility is that the legislature may decide that lifeline assistance is a social welfare program and no one group (the utility's non-lifeline customers) should be required to subsidize it. The lifeline legislation could provide that the lost revenues be made up from the state treasury.

Even if it is determined that a certain class of customer should make up the lost revenues, there remains the question of how to distribute the rate increase among the rate blocks for that class. For example, suppose the lost revenues are to be recovered from the remaining residential blocks. This could be done in several ways, as shown in Figure 2-1. Figure 2-1(a) shows an increasing block rate structure. The first block is the lifeline block, for which the lowest rate is charged. As customers use more of the service, the rate progressively increases. Probably this structure would be favored by conservationists. Figure 2-1 (b) shows a two-part rate structure for which there is a single rate for all usage beyond the lifeline usage. This type of structure is popularly associated with lifeline. We call it the two-level rate structure. Assume now that the currently used declining block

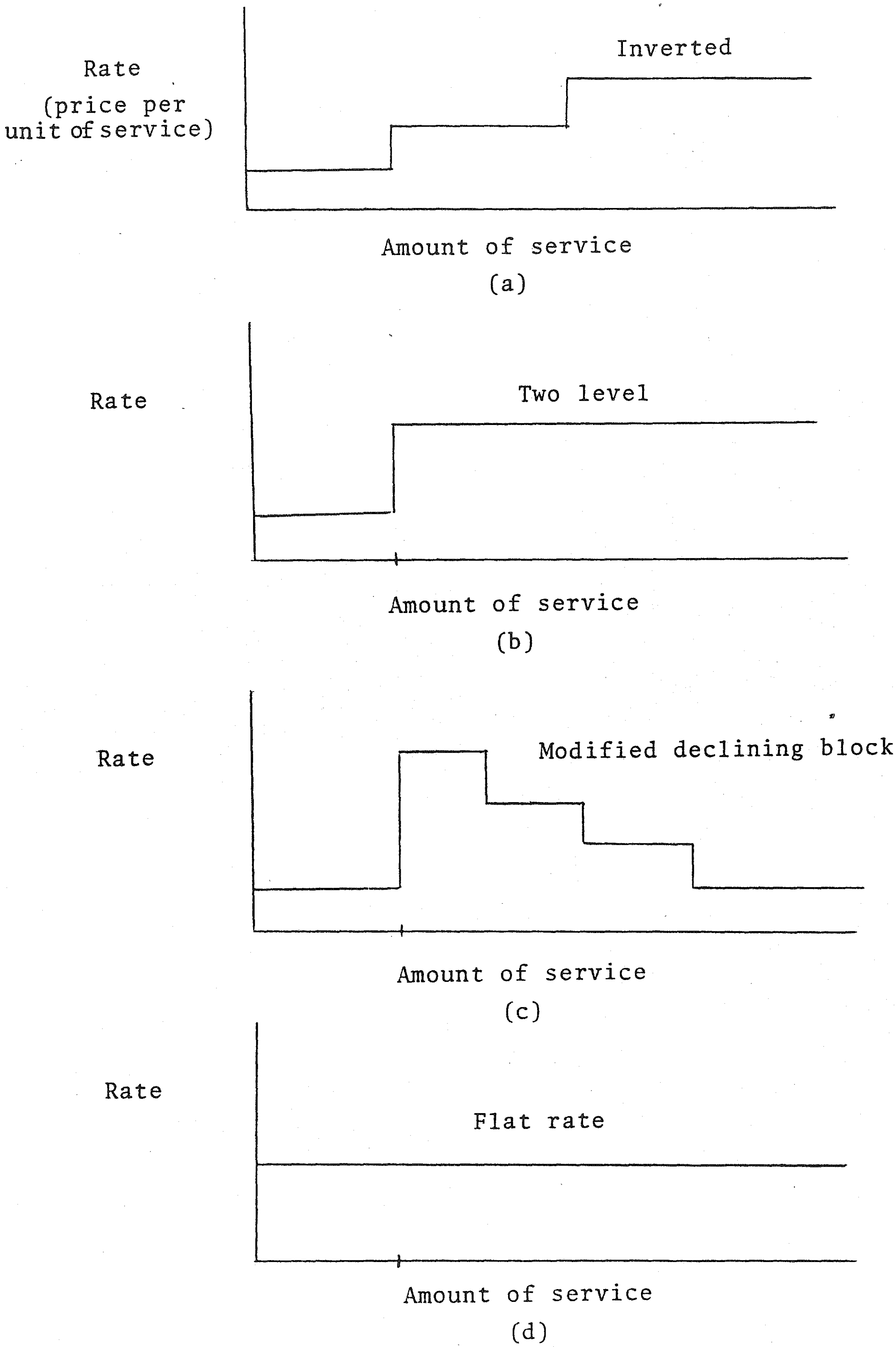

Figure 2-1 Various Lifeline Rate Structures

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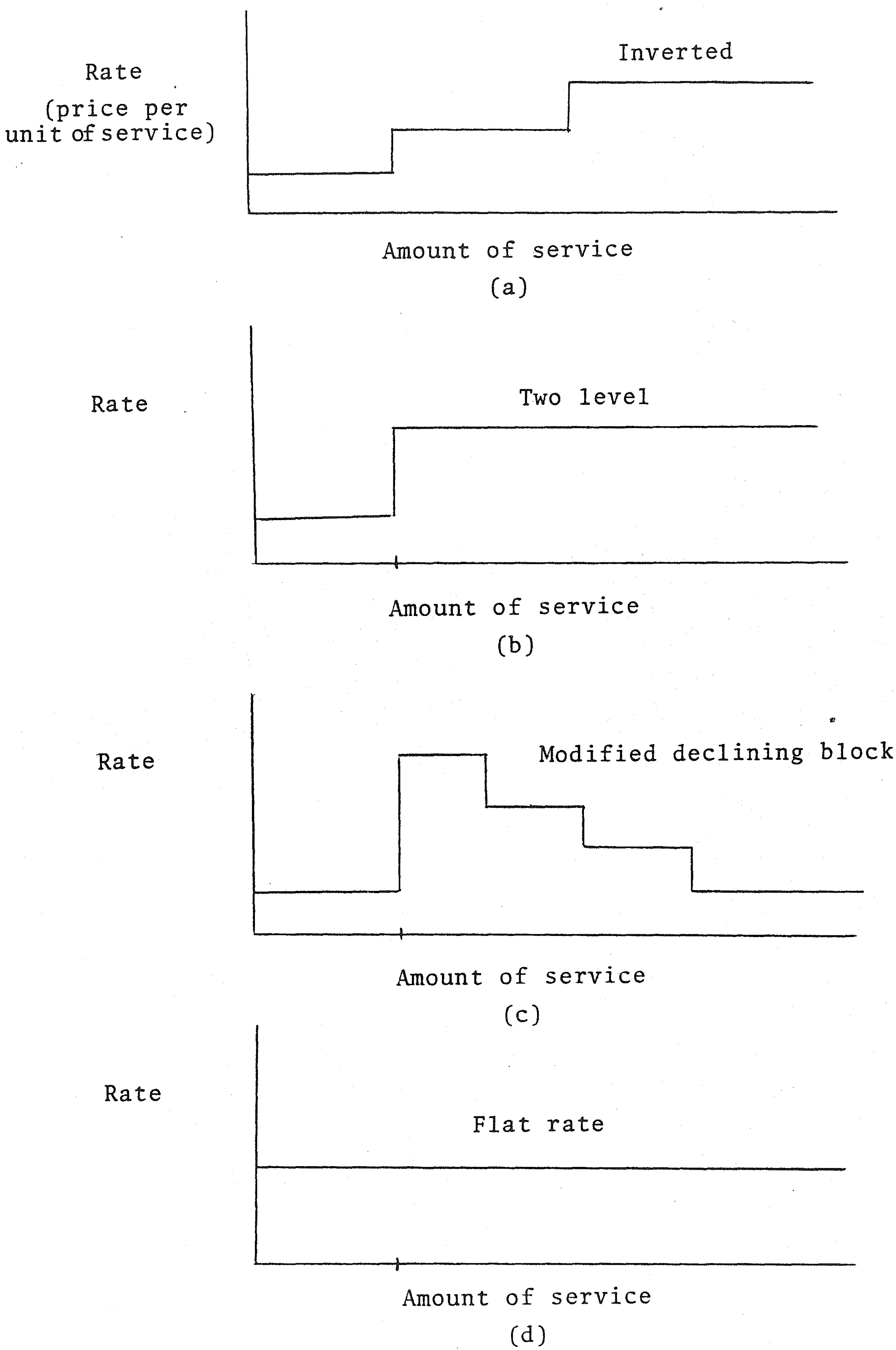

Figure 2-1 Various Lifeline Rate Structures

CHAPTER 3

LIFELINE AND THE REVENUE REQUIREMENT

The revenue requirement criterion evaluates utility rates according to their ability to generate sufficient revenue to cover total costs. Total costs include the cost of providing a fair rate of return on investment.

A great variety of revenue recovery plans can accomplish this objective because it is concerned only with <u>total</u> revenues and not with the distribution of revenue sources. For example, all customers could be provided with free utility service and the costs could be borne by the state. Or all customers (residential, commercial and industrial) earning over $30,000 a year could be charged rates in proportion to income with all remaining customers getting free service. Of course, these example revenue recovery plans may not satisfy the other criteria for sound rate design, but as long as total revenues collected equal total costs incurred, the revenue requirement criterion is satisfied.

Consider the case where no costs are borne by the state.[1] All sales could be priced at average cost, or some sales could be priced below average cost and others above. In the latter case the extra revenues from the sales above average cost must be sufficient to offset the "lost" revenues on sales below average cost. Any rate structure which accomplished this satisfies the revenue requirement.

<u>Any lifeline plan which provides for recovery of revenues lost in switching over to the plan will satisfy the revenue requirement</u>. If the rate for the lifeline block is below average cost, then the rates for at least some nonlifeline blocks must be above average cost. If the

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1 In some European countries, state-owned utility rates are set according to marginal cost pricing principles to promote optimum use. The state then makes up for insufficient revenue or collects excess revenues.

lifeline block occurs in residential schedules only, the nonlifeline blocks may include blocks on nonresidential rate schedules. If the rate for the lifeline block is significantly below average cost or if a large volume of sales occurs in the lifeline block, then to make up for "lost" revenues the nonlifeline blocks must include a large volume of sales or must be priced significantly above average cost.

In changing from a declining block rate structure to a lifeline rate structure, a transition problem may occur. To understand the problem, consider what happens when a utility applies for a change in rates. During the rate case, the utility's costs and revenues are examined for a recent 12-month period, called the test year. If it is shown that revenues do not equal costs (again including the cost of a fair rate of return) under the present rate schedule, a new rate schedule is proposed. It must be shown that if the proposed rate schedule had been in effect during the test year then revenues would have equaled costs. The assumption is that the sales in each rate block would have been the same under the proposed rate schedule as under the old one. When the new rates for each rate block are adjusted only slightly from the old rates this assumption is fairly valid. However, in changing from a declining block structure to a lifeline structure it may not be a valid assumption. If lifeline results in increased consumption among those already using less than the lifeline length, revenues "lost" in the lifeline block may be less than anticipated. And if lifeline results in reduced consumption in the nonlifeline blocks, revenues recovered from these blocks may also be less than anticipated. Hence, unless changes in consumption are anticipated in switching over to a lifeline rate structure, the revenue requirement may not be satisfied. If it is not, then a series of frequent rate cases may be needed to adjust the lifeline rates until the volume of sales in each block has stabilized. Although we consider this transition problem very important, it does not alter our conclusion that a lifeline rate structure can be designed to satisfy the revenue requirement.

Various lifeline plans will differ with regard to the severity of the transition problem, as shown in Figure 3-1. Because it introduces the minimum change from existing rate structure, the modified declining block example should result in the least severe transition problem. In the case of the flat rate example which has a single rate equal to average cost, the problem would be more serious. Because it introduces the greatest change from existing rate structure, the transition problem is expected to be most serious for the two-level rate example.

Another potential problem related to the revenue requirement involves the uncertainty of recovering enough revenues to meet total costs, and may be called the revenue uncertainty problem. Sales of electricity and gas fluctuate in volume from month to month and from year to year depending in part upon weather conditions. Because the "average" customer purchases from the front blocks every month, the fluctuation results in more variation in the volume of sale in the tail blocks. When front block rates are high and tail block rates are low, a large fraction of total monthly revenues are consistently recovered from front block sales. A small fraction of total revenues, recovered from tail block sales, is subject to uncertainty. On the other hand, when the rates for the front and tail blocks are reversed, a larger fraction of total monthly revenues is subject to uncertainty. Referring again to Figure 3-1, we see that the severity of the revenue uncertainty problem increases in going from the modified declining block example to the flat rate example, and again to the two-level rate example. Nevertheless, the

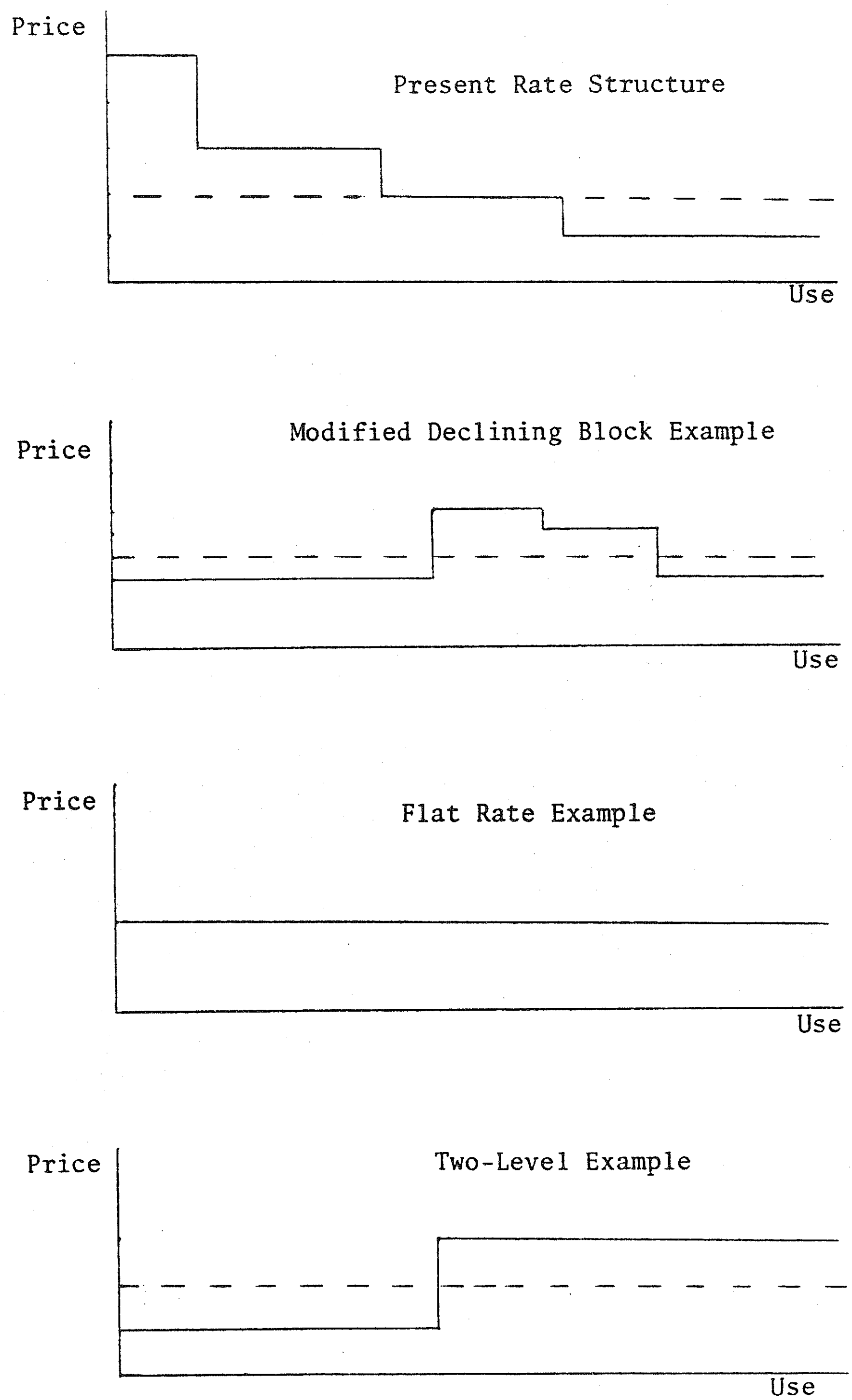

Figure 3-1. Example Rate Structures

fluctuation of revenues with sales need not rule out the use of lifeline rates. As long as the variations average out to the correct revenue requirement, no overriding problem is foreseen, provided that short-term cash flow problems do not become so severe that additional and otherwise unnecessary rate hearings must be held.

In summary, the revenue requirement criterion alone does not lead us either to favor or to reject a lifeline rate structure, and does not help us to choose among the many possible lifeline plans. However, the practical difficulties resulting from the transition problem and the revenue uncertainty problem are less with the modified declining block structure and more with the two-level structure.

CHAPTER 4

LIFELINE AND OPTIMUM USE

Optimum use is achieved when all economically justified use of a product occurs and no economically wasteful use occurs. Optimum use is best achieved for utilities by setting price equal to marginal cost. The reasons why marginal cost pricing produces optimum use are discussed in Appendix A. This chapter examines the extent to which lifeline is compatible with the marginal cost method of setting rates, but is not concerned with determining the single best rate structure for regulated utilities. A joint OSU-PUCO research group is currently studying this issue.

A lifeline proposal is more compatible with the optimum use criterion than current rate structures if it tends to bring rates more into line with a marginal cost pricing strategy. This is one purpose of lifeline intended by at least some lifeline advocates.

The intention of promoting conservation by means of lifeline rates can be an expression of the traditional optimum use purpose of rate design. This is true provided conservation is understood to mean eliminating all wasteful utility use without eliminating any economically justified use. For example, to institute an artifically high price for electricity, such as one dollar per kWh, in the name of conservation would eliminate most justified electric use as well as all wasteful use. Artificially raising prices to promote conservation of energy is opposed to optimum use. An artifical price in this case is a price higher than the long run marginal cost of energy.[1] The price of energy should rise automatically if energy is hard to obtain, because long run marginal cost will increase. Hence, we oppose such artificial use of utility rates to encourage energy conservation. However raising utility rates to the level of marginal cost

[1] In theory this could include the social costs associated with pollution.

has a conservation effect consistent with optimum use. Designing rates to achieve conservation in this way is recommended.

A Feasible Pricing Strategy for Utilities

Marginal cost pricing results in optimum use because it gives consumers the most accurate price signal regarding the additional cost of providing additional service. The price of every unit sold should equal the cost of providing one additional unit. But marginal cost pricing does not satisfy the revenue requirement of regulated public utilities when all sales are priced at marginal cost. If current marginal cost exceeds historic average cost then marginal cost pricing will yield too much revenue. A feasible solution is to set price equal to marginal cost for tail block sales in order to provide an economically correct price signal and adjust the price of front block sales to meet the revenue requirement. The size of the front block can be chosen to cover essential use. In this way most consumers making decisions about additional consumption will face a price equal to marginal cost, and so receive the correct economic price signal.

This strategy is illustrated in Tables 4-1 and 4-2 for two cases. In each case, the total revenues must be $500, and the average price must be $500 ÷ 300 units = $1.67 per unit. This is also the average cost. In the first case, assume the marginal cost is $1 per unit, which is less than historic average cost. Price is set equal to the

Table 4-1 Current Marginal Cost
Less Than Historic Average Cost

	Volume of Sales	Unit Price	Revenues
Tail Block Sales	200 units	$1	$200
Front Block Sales	100 units	$3	$300
Total	300 units	--	$500

the marginal cost for tail block sales because these sales respond best to economic price signals. The volume of such sales is 200 units, producing revenue of $200.

Table 4-2 Current Marginal Cost
Greater Than Historic Average Cost

	Volume of Sales	Unit Price	Revenues
Tail Block Sales	200 units	$2	$400
Front Block Sales	100 units	$1	$100
Total	300 units	--	$500

Since $500 is required, $300 must be collected from the 100 units of front block sales. Hence, the price for front block sales must be $3 per unit. The advantage of this strategy is that the low price for tail block sales stimulates consumption. As long as marginal cost remains less than average cost, then increasing consumption results in a decreasing average cost. All consumers benefit from the decreasing average cost including those who consume mostly in the front block. This argument has been used in support of promotional rates, including declining block rates, designed to increase sales for regulated public utility service.

The case where current marginal cost is greater than historic average cost is illustrated in Table 4-2. Assuming marginal cost is $2, the revenue from 200 units of tail block sales is $400. In this case, only an additional $100 is required to meet the total revenue requirement of $500. The price for 100 units of front block sales must be $1 per unit. The high price for tail block sales tends to discourage growth which would raise the average price of all sales. If growth does occur, it is economically justified because those who cause the growth place a value on each additional unit purchased which is at least as great as the additional cost of providing the unit.

Let us see how this pricing strategy may be related to lifeline prices for Ohio electric and gas utility services.

Electricity

The marginal cost of electricity varies throughout the day. The marginal cost is high during peak hours because it consists of the cost of peaker fuel and the cost of additional plant for generation, transmission and distribution. Off the peak the marginal cost is much less. Therefore, marginal cost pricing requires time-of-day pricing(TDP) for electricity. With TDP there is no need for rate blocks; in the simplest case there would be only an on-peak rate and an off-peak rate. TDP appears to be the best practical rate design for promoting optimum use. This rate design has not been used in this country to any great extent for residential customers because of the cost of the meters required to implement TDP. However, economical TDP meters may be commercially available in the near future. The advantages of TDP are discussed further in Chapter 6.

Until TDP is instituted an alternate marginal cost pricing strategy could be applied to a block type rate structure to achieve a greater measure of optimum use than is currently achieved.

A two level rate structure for electricity, resembling lifeline, results from such a pricing strategy if long-run marginal cost, evaluated at current prices, is greater than historic average cost. In this case growth in demand can require building additional capacity. Growth in demand is due primarily to customer use extending further into the tail blocks.

Under these conditions, a reasonable pricing strategy leads to a two-block rate structure for electricity. The tail block price is set equal to the long-run marginal cost. The front block price is set at the level required for revenues to equal total costs. Two cases result depending on whether current marginal cost is greater or less than historic average cost, as shown in Figures 4-1(a) and (b).

In Figure 4-1(a) marginal cost is less than historic average cost so that the price for front block use must be greater than average cost to meet the revenue requirement. The opposite is true for Figure 4-1(b). This case is the two-level rate structure. However, in constructing this structure, one should not set the front block rate at an arbitrary, low level and adjust the tail block rate to meet the revenue requirement. Instead, one sets the tail block rate equal to marginal cost and adjusts the front block rate to meet the revenue requirement.

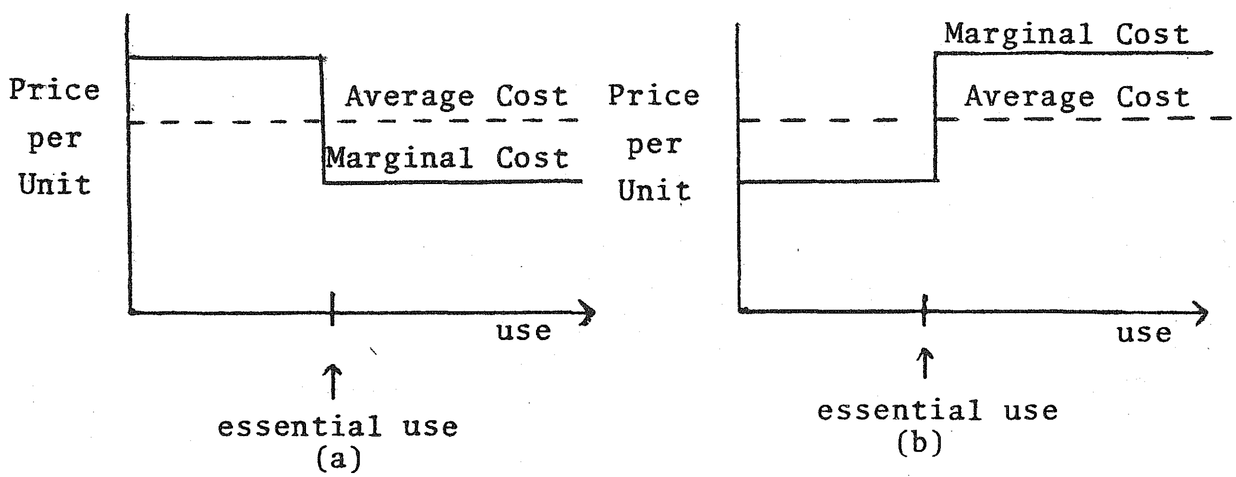

Figure 4-1. Versions of marginal cost pricing when (a) marginal cost is less than average cost, and (b) marginal cost is greater than average cost.

Therefore, in certain circumstances a lifeline rate structure, if properly constructed, will be more compatible with optimum use than the present declining blocks. In order to determine whether lifeline is compatible with optimum use for a particular electric utility, it is necessary to determine the long-run marginal cost of service for that utility and compare it with historic average cost.

However it is important to realize that, while this pricing strategy may achieve some greater degree of optimum use with present metering technology, a better strategy for optimum use is time-of-day pricing. Therefore any lifeline legislation should carefully avoid requiring that electricity be priced in blocks because TDP should be a blockless rate structure. The possible adoption of a reasonable pricing policy now should not preclude the adoption of a better pricing policy in the future.

Natural Gas

The natural gas situation differs from that for electricity primarily because the price of interstate natural gas is regulated by the Federal Power Commission (FPC). The regulated price is below the marginal cost of natural gas and below the price of alternatve fuels. As a result, the demand for regulated natural gas exceeds the supply. Hence a shortage of regulated natural gas exists and an administrative rationing program is required to allocate the supply. If the price were not federally regulated there would be no shortage because the higher unregulated price would reduce demand to the level of supply. The regulated price of gas is far below its true economic value and so economically inefficient consumption of gas is probable. One goal of administrative rationing is to allocate the gas supply in an efficient manner so that those who place a higher value on the gas receive a higher priority in the allocation plan. But as long as the price is artifically low the high priority customers may still consume more gas than they would if price rationing occurred.

The marginal cost of all new supplies of gas is much greater than the cost of historic supplies, and marginal cost is expected to increase in the future. Consumers must be made aware of the increasing marginal cost in the rate design if optimum use is to be achieved. Failure of the FPC to use an efficient pricing stategy in regulating the field price of gas, although it complicates the pricing strategy at the distribution level, does not preclude the use of an efficient pricing strategy at this level by the PUCO.

One such strategy is the marginal cost pricing strategy discussed above, that is, set the tail block price equal to marginal cost and adjust the front block price to meet the revenue requirement.

In spite of the possible objection that this pricing strategy does not achieve the same measure of optimum use as straight marginal cost pricing, it is clear that in today's natural gas market it promotes optimum use better than declining block rates. Hence, we find that a two-level rate structure for Ohio gas utilities with the tail block rate higher than the front block rate is compatible with the objective of promoting optimum use provided the rate levels are properly chosen.

Legislation and Optimum Use

When current marginal cost is greater than historic average cost, optimum use may be achieved in reasonable measure, consistent with the revenue requirement, by the two-level inverted rate structure. In this case the rate design for all customers, nonresidential as well as residential, should be inverted. When current marginal cost equals historic average cost optimum use dictates a flat rate, equal to marginal cost, for all customers.[3] When current marginal cost is less than historic average cost, optimum use may be achieved, while still satisfying the revenue requirement, by a two-level, declining block rate structure.

For electric rates these conclusions apply only as long as time-of-day pricing is not possible. TDP would achieve a greater degree of optimum use than any block

[3] The marginal cost may be different for different customers.

type rate structure.

We find that a two-level rate structure, which could be called a lifeline rate structure, can be compatible with optimum use for natural gas under present regulatory and economic circumstances. Also a two-level rate structure, like lifeline, might be compatible with optimum use for Ohio electric utilities depending on their economic and technological circumstances.

However, because these circumstances can change, the two-level rate structure may not be compatible with optimum use in the future. Under some circumstances declining block rates promote optimum use. Hence, the PUCO must have the prerogative of changing the rate structure with changing conditions. Therefore, for promoting optimum use, it is critical to avoid legislation which requires that a lifeline rate structure be used regardless of the economic, regulatory, and technological circumstances.

Ohio's proposed HB583 allows use of the two-level inverted rate structure and the flat rate, but does not allow use of the declining block rate. Although this bill may result in a rate structure compatible with optimum use under present economic circumstances, we believe that legislation should be designed to be lasting. Because the bill proposes to constrain rate design it may restrict the PUCO from implementing in the future the rate design most compatible with optimum use.

HB583 specifies the length of the lifeline blocks. This implies that a block type rate structure must be used in rate design, and may preclude the use of TDP, probably the most ecnomically efficient rate design for electricity.

Even if economic conditions would lead to an inverted rate structure, the lifeline lengths specified by HB583 are not compatible with optimum use because only essential use should receive the low rate. In spite of the difficulties, discussed in Chapter 2, of defining an average monthly essential use, we estimated (see Table 2-1) that average essential electric use is about 300 kWh per household each month for households without electric water heaters. In Ohio this includes 80% of all households. HB583 requires a lifeline length of 500 kWh. A low rate, below marginal cost, for such a long lifeline length encourages wasteful use of electric service. For natural gas HB583 sets a lifeline length of 30 mcf for every month. Referring again to Table 2-1, we see that the essential amount of gas averages roughly 30 mcf during the coldest months but averages only 5 mcf during the summer. Because HB583 requires that the lowest rate apply to the first 30 mcf every month wasteful use of natural gas is encouraged during most months. Hence, these provisions of HB583 are opposed to optimum use.

CHAPTER 5

LIFELINE AND FAIR APPORTIONMENT

The law requires that utility rates should be fair, but the fairness criterion is particulary difficult to apply because of disagreements about which standard of fairness to use.

At least four standards of fairness are commonly cited by advocates of various rate structures. These standards are introduced here and discussed in more detail in Appendix A:

1. good faith or reasonable expectation: it is fair to maintain low rates for customers who made capital investments based on past low rates;

2. notional equality: it is fair to charge the same price for every unit of service (regardless of differences in the cost of providing that service);

3. ability to pay: it is fair to vary rates according to each customer's ability to pay for the service; and

4. the compensation principle: it is fair to set rates for each customer according to the costs incurred in providing service to that customer.

Historically the compensation principle has been most often cited as the standard used for making utility rates fair. Lifeline advocates favor giving more weight to the other fairness standards.

Good Faith

Some lifeline advocates contend that fairness requires that everyone receive essential utility services at a low rate. This appears to be a version of the good faith standard of fairness. Over the years people have come to depend on utility services which in the past were offered at a low rate. In most homes, gas and electric heating devices have replaced the fireplace and the coal furnace. The refrigerator has replaced the icebox, and electric lights have replaced kerosene lamps. Now that people have invested in gas and electric appliances and become dependent on them, it is unfair that utility rates should be allowed to rise to high levels.

Table 5-1 shows how electricity and natural gas prices in Ohio varied from 1960 through 1974 for residential and other customers. For electricity, prices declined from 1960 to 1970 then increased after 1970. The largest increase occurred in 1974 when the price of coal for generating electricity nearly doubled over the previous year. For natural gas the prices were relatively stable during the 1960's and increased during the 1970's. Although precise figures are not yet available, the 1975 prices are known to be higher still, especially for natural gas. Even though prices have increased sharply in recent years, the average annual price increase, averaged over the past fifteen years, has been small. If the prices in Table 5-1 were converted to constant dollars, the average annual price increase could not be called a serious violation of good faith.

The argument that recent price increases have violated the good faith or reasonable expectation standard of fairness appears weak. Increases in residential prices have not occurred in order to decrease nonresidential prices. Prices have increased for all customers.

The good faith standard can be applied with greater force as an argument against lifeline. The adoption of lifeline rates may cause an abrupt and significant increase in price for large users, including large residential users. These are the users who have made the greatest capital investment in electric and gas operated appliances and machinery. Such customers may argue that adoption of lifeline is unfair to them.

Table 5-1 Ohio Average Prices of Electricity and Natural Gas By Sectors, 1960-1974. Source: Ohio Energy Profiles, OEEC

Year	Residential		Commercial		Large Users	
	Elec. ¢/kWh	Gas $/mcf	Elec. ¢/kWh	Gas $/mcf	Elec. ¢/kWh	Gas $/mcf
1960	2.56	.79	2.56	.79	.76	.53
1961	2.55	.80	2.50	.73	.76	.56
1962	2.57	.81	2.52	.73	.78	.56
1963	2.55	.82	2.47	.74	.78	.56
1964	2.50	.83	2.42	.74	.79	.56
1965	2.45	.86	2.24	.75	.80	.55
1966	2.40	.86	2.20	.75	.84	.55
1967	2.37	.86	2.17	.75	.85	.54
1968	2.32	.86	2.13	.74	.87	.52
1969	2.27	.87	2.10	.75	.88	.52
1970	2.27	.90	2.07	.77	.93	.57
1971	2.33	.98	2.17	.83	1.00	.61
1972	2.38	1.05	2.21	.89	1.01	.63
1973	2.43	1.11	2.26	.93	1.05	.70
1974	2.91	1.24	2.77	1.08	1.45	.81

The effect of lifeline on customers' electric and gas bills is discussed in Appendix B. The main features of this appendix are outlined here. The effects of lifeline on customers' bills depends on several features of the particular lifeline proposal. Most important among these features is whether residential rates are redesigned so as to keep the revenues collected from the residential sector the same as before lifeline, or whether lifeline is accompanied by a reduction in residential revenue recovery and an increase in the average price of nonresidential sales. We refer to these two cases as residential recovery and recovery from all ultimate customers, respectively.

Electricity

For electricity under residential recovery, high volume residential consumers of electricity are usually subjected to substantial bill increases. The amount of the increase depends on the lifeline rate structure, including the length and price of the lifeline block. To take a specific example, consider the low lifeline price of 1.5¢/kWh and a short lifeline length of 200 kWh. The bill for the 200 kWh customer is reduced from about $8 under present rates to $3. This results in a breakeven point of about 700 kWh; that is, everyone consuming less than 700 kWh per month has a lower bill. To keep total revenues constant everyone consuming more than 700 kWh must pay a higher bill. For example,the 1000 kWh customer pays about $4 more and the 2000 kWh customer pays $18 more every month. Maintaining the low lifeline price while extending the lifeline block length out to 500 kWh has a relatively minor effect on the breakeven point: it increases to about 780 kWh. But there is a major effect on the bills of high volume users. In this case the 1000 kWh customer pays $7 more and the 2000 kWh customer pays $38 more than he paid before.

For the case of recovery from all ultimate customers, the breakeven point, in most examples we considered, was about 2000 kWh and the increase in bill for larger residential users was generally a small fraction of their present bill. In the examples considered, the average price increase for all nonresidential sales was in the range of 0.25 to 0.40¢/kWh. A price increase of 0.40¢/kWh for large industrial users of electricity represents approximately a 25% increase over current electric bills. The impact of such an increase depends on the importance of electricity cost compared to total costs for a particular industry. For some companies the effect would be substantial.

In both cases of revenue recovery the flat rate provided for moderate savings for some residential users with a moderate surcharge on nonlifeline sales.

Natural Gas

The effect of lifeline on customers' natural gas bills cannot be easily summarized because of the many factors which influence the result. Even if a particular lifeline plan is specified, there are two major difficulties with specifying the effect of lifeline on customer monthly bills.

1. Residential natural gas usage varies greatly from month to month depending on the weather and so the effect of lifeline on the monthly bill depends on the month chosen and the weather for that month. January usage is typically about six times August usage. Since lifeline helps the low volume consumer, its effect may be to reduce bills for the months when bills are already low and increase bills for those months when bills are now the highest.

2. The ratio of nonresidential to residential sales varies greatly from month to month and from one company to another. In addition the amount of future curtailments of nonresidential sales is uncertain and varies from company to company; as a result past data for nonresidential sales is of little use for estimating future sales. Therefore it is not possible to determine with any precision the future effect of lifeline on a customer's bill for a "typical" company for a "typical" month in the case of recovery from all ultimate customers.

Nevertheless it is instructive to consider the effects of lifeline for the case of residential recovery. Any reasonable lifeline plan for natural gas must establish at least two lifeline lengths, one length each for the heating and nonheating seasons. Based on 1975 bill frequency data for an Ohio company we obtained results presented in Appendix B and summarized here.

For the case of residential recovery and a lifeline length of 3 mcf for the nonheating season a range of reasonable lifeline rates all resulted in a breakeven point of about 5 mcf. For the relatively low lifeline rate of $1.30 per mcf the bill for the 3 mcf user was reduced by half from about $6 to $3, whereas the bill for the large volume consumer, 10 mcf for the nonheating season, increased from about $17 to $24. With a lifeline length of 5 mcf and the same lifeline rate, the bill for the 5 mcf user decreases by $4, the breakeven point is just over 6 mcf, and the bill for the 10 mcf user increases by almost $12 per month. A lifeline length of 30 mcf is so large for the nonheating season that it would cover over 98% of all residential use. Any significant rate reduction on this use would result in an outlandish increase in the rate for remaining use, for the case of residential recovery.

During the heating season a longer lifeline length is required. The average essential use for the season should be below the average for the coldest month which is roughly 30 mcf per household. We considered lifeline lengths of 15 mcf and 25 mcf for the heating season. For a length of 15 mcf and a lifeline rate of $1.20 per mcf the breakeven point falls at 24 mcf and the bill increase for remaining sales is moderate. However for a lifeline length of 25 mcf and the same rate, the bills increase sharply for use over the breakeven amount of 30 mcf. For example the bill increases by $8 for the 33 mcf user and by $14 for the 36 mcf user.

The flat rate structure provides some savings to low volume users without imposing severe increases on high volume users.

In the case of recovery from all ultimate customers the increase in bills would be less, but the amount of the increase is difficult to estimate for the reasons discussed above.

Let us sum up the arguments based on the good faith standard of fairness. Although a weak argument can be presented by all customers that recent increases in utility bills for essential use is a violation of good faith, a stronger argument can be presented by the large users that a sudden and significant increase in their bills is a violation of good faith. In changing to a lifeline rate structure, the amount of increase in the bill of the large volume consumer depends on the particular lifeline plan. The increase is greater for the case where total residential revenues remain the same and less for the case where lifeline is supported by an increase in the price of sales to all customers. The impact of lifeline on the bills of high volume users is generally less severe under the flat rate version of lifeline.

Notional Equality

Some lifeline advocates support a particular lifeline plan, the flat rate. They invoke the notional-equality standard of fairness. Why, they ask, should residential customers pay more for each kilowatt-hour of electricity and each cubic foot of natural gas than industrial customers? And why should the first unit of electricity or gas purchased each month cost more than the thousandth unit? Why should essential service cost any more or any less than nonessential service? All units, they say, should be priced the same.

Those who believe in notional equality would favor two departures from current rate design. First the rate structure for any one sector, such as the residential, should be made flat. Second the average price for each sector should be the same.

The compatibility of lifeline with these changes depends on the particular lifeline plan. Some lifeline proposals require, or at least permit, a flat rate for the residential sector, while other proposals require that the price of the lifeline block be considerably below that of other blocks. The former lifeline proposals should be judged fair and the latter unfair according to the notional equality standard. Also according to this standard, lifeline proposals which provide for residential recovery of lost revenues do not improve the fairness of current rates because they preserve the difference in average price between sectors, shown in

Table 5-1. Proposals calling for recovery from all ultimate customers tend to reduce this difference and would be judged fair by those who believe in notional equality.

Ability to Pay

Many lifeline advocates believe that lifeline rates should be instituted to help the poor. They are invoking the ability to pay standard of fairness: although no one likes to see his utility bills rise to high levels, energy costs are going up and everyone should pay his fair share in so far as he is able. But the customer who is not able to pay the rising price of utility service must be allowed to receive at least essential service at a low rate he can afford.

These lifeline advocates assume that the poor generally use much smaller volumes of electricity and natural gas than the wealthy. The effect of lifeline, they believe, would be to reduce utility bills for the poor (small volume) consumer and increase bills for the wealthy (larger volume) consumer. We examine here the relationship between income and consumption of electricity and natural gas.

Electricity

Much of the support for lifeline rates for electricity is based on a belief that as income increases so does electricity consumption. This relationship has been disputed in a number of utility system studies. However, national data developed by the Ford Foundation Energy Policy Project and a survey of studies by the Federal Energy Administration support the contention that low income persons tend to use less electricity than those in higher income groups.[1]

A recent analysis of a high, a medium, and a low income residential area in Columbus also presents evidence to this effect. Table 5-2 details some of the findings.

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[1] Dorothy Newman and Dawn Day, The American Energy Consumer, Bollinger Pub. Co., Cambridge, Mass; 1975.

Table 5-2 Average Electricity Consumption in Selected Residential Areas of Columbus, Ohio

1974-1975	High Income Area	Medium Income Area	Low Income Area
August	1,029 kWh	579 kWh	437 kWh
September	1,021	516	427
October	673	415	352
November	609	421	338
December	740	529	427
January	873	522	424
February	716	493	414
March	794	465	404
April	649	415	370

However, looking only at the average consumption patterns partially masks a more complex set of data. If the entire range of electricity consumption by income group is considered, it can be seen that there is considerable overlap in the income-electricity consumption relationship. Table 5-3 shows that all income groups include both high and low usage customers. For example, 29.8% of households in the high income area consumed less than 620 kWh during July 1975, as did 63.3% of those in the middle income area, and 81.2% of low income area households. On the other hand, about 6% of the low income area residents consumed over 1,000 kWh. If a lifeline rate schedule with a breakeven point of approximately 620 kWh per month were adopted, it would financially help nearly 30% of the high income households and hurt nearly 20% of those in the low income area. This suggests that the correlation between income and electricity consumption, although present, is not a perfect one. Therefore, lifeline electric rates can be designed which reduce the

Table 5-3 Detailed Electricity Consumption in Selected Residential Areas of Columbus, Ohio, July 1975

Monthly Consumption	High Income Area (%)	Medium Income Area (%)	Low Income Area (%)
Under 100kWh	1.3	5.0	12.9
Under 400	16.4	39.7	61.5
Under 620	29.8	63.3	81.2
Under 1,000	53.0	84.3	93.7
Under 1,600	77.9	95.7	98.0
Under 2,500	94.0	99.4	99.3

Note: These data are for households which do not have electric space heaters.

financial burden on residential customers, especially the poor; but, depending on the breakeven point, lifeline rates will tend to hurt the minority of low income persons who are high usage electricity consumers, and who are therefore most in need of relief from recent rate increases.

Natural Gas

Although some national data supports the idea that natural gas consumption rises with income, the evidence is not as strong nor the relative increases as great as for electricity. Apparently almost all gas use by residential customers is for "essential" use: space heating, water heating, and cooking. This essential amount does not vary greatly with income.

Recent findings from an analysis using census tract data indicate that in Ohio a relationship may exist which is substantially different from the one for electricity. Poorer people as a group, according to this data, actually consume more natural gas than those in the middle income range. This apparent discrepancy between findings for the

U.S. and for Ohio is most likely explained by the greater need for space heating in Ohio, since Ohio is a relatively cold state. Characteristics of low-income housing such as inadequate insulation, leaky windows, and poorly maintained heating systems could cause poor families to have greater natural gas consumption than middle income families in better constructed homes. The estimated natural gas consumption-income relationship is given in Table 5-4. The minimum natural gas consumption was found to occur in the $13-14,000 income range. The combination of poor housing and the home-centered life-style of low income persons coupled with the larger homes of higher income persons appears to cause this result.

Table 5-4 Natural Gas Consumption Per Meter:* Selected Income Levels

Income	Consumption in "Typical January"
$ 8,000	39.1 mcf
12,000	35.8
16,000	35.2
20,000	39.2

*Typical average consumption per household in January in Ohio is about 30 mcf. The figures in the table include meters which serve several households.

Hence lifeline rates for natural gas are not likely to help the poor to any extent greater than they help the nonpoor, and could possibly hurt the poor, depending on where the break-even point falls.

To recapitulate, applying the ability to pay standard of fairness leads to the following conclusions. (1) For electricity lifeline will help more of the poor than it will hurt, although it may hurt the poor most in need

of help. Consequently, lifeline for electricity could be considered to have a net fairness under this standard.
(2) For natural gas lifeline is not likely to help the poor to any extent greater than it benefits middle and upper income groups, and could possibly hurt more of the poor than it helps depending on the particular lifeline plan. Therefore lifeline for natural gas can be considered either neutral with respect to fairness or unfair according to this standard depending on where the break-even point occurs.

Compensation Principle

This last fairness standard has been cited as the standard used in practice for making utility rates fair. According to this standard each customer's rates should be set as nearly as possible so as to compensate the company for the cost of providing the service. Rates should be different for customers requiring the company to incur different costs. For example, the large user who receives electricity at high transmission voltage makes no use of the company's distribution system. His rates should be lower because the company incurs no distribution costs in serving him.

To determine the cost of service the company must perform a cost of service analysis for groups of customers having similar cost characteristics, such as residential, commercial and industrial customers. Each class of customer requires a separate schedule of rates. However there is no uniquely correct way either to distribute all costs among the customer classes or to distribute the costs assigned to any one class among the rate blocks on its rate schedule. The company has the opportunity to choose a method of allocation which serves a purpose other than fair compensation, such as promoting sales or improving the load factor.

In Appendix C we discuss the fairness of the current declining block rate structures. The conclusion is that most residential gas rate schedules in Ohio consist of a declining block structure aimed at recovering a minimum customer charge and charging essentially a flat rate for additional consumption. This appears fair under the compensation principle. Electric utilities however have a declining demand charge on the higher consumption blocks. In the absence of data needed to make a sound determination, a flat demand charge appears to be more in accord with the compensation principle.

Although the compensation principle appears to favor flattening current rate structure for electricity, it would not lead to an inverted rate structure. The last unit of service sold to a given customer costs the company no more than the first. Therefore a lifeline plan with a front block rate lower than a later block rate is incompatible with the compensation principle. However a flat rate with a minimum customer charge is compatible with the compensation principle.

Ohio's HB583 allows a flat rate and does not disallow a minimum charge. However it does require that the front residential block rate be as low as the lowest rate offered to any other customer class. In the case of electricity, since the cost of the distribution system should not be borne by those customers receiving power at a high voltage, these customers should receive power at a lower price than residential customers, who require a costly distribution system. Hence this requirement of HB583 is incompatible with the compensation principle.

Summary of Fairness Arguments

Briefly recapitulating the evaluation of lifeline with respect to the fairness criterion, we found that the evaluation is complicated by the existence of various standards of fairness and the variety of lifeline proposals. In addition a plan judged fair for one utility may be unfair for another. Fairness arguments can be applied either for or against lifeline and fairness arguments can be made both for and against the various lifeline proposals.

The good faith standard on the whole argues against adoption of lifeline. The ability to pay criterion favors lifeline for electricity but not for natural gas. The notional equality standard favors a flat rate structure and favors having nonresidential customers share in the support of lifeline, but this standard does not favor a lifeline proposal offering a front block rate lower than other rates. The compensation principle, while it may support a flattening of present rate structure, is also opposed to a front block rate lower than other rates.

CHAPTER 6

ALTERNATIVES TO LIFELINE

In previous chapters the compatibility of lifeline with tradional purposes of utility rate design was examined and it was found that lifeline legislation may introduce undesirable constraints into utility rate design. In this chapter we examine some alternative programs which achieve some of the purposes intended by the advocates of lifeline without constraining rate design.

Limitations of Lifeline

To begin we briefly summarize some of the practical difficulties with lifeline which may not occur under alternate programs.

1. It is difficult to establish a single lifeline length for gas and for electricity which would apply fairly to all households. Part of the difficulty arises because appliances requiring gas in one household may operate on electricity in another. This is the appliance mix problem.
2. Although a lifeline bill can be designed to reduce the cost of gas and electricity during the winter heating season, no direct relief from high heating costs is afforded to consumers of non-regulated heating fuels such as oil, coal and liquefied petroleum gas (LPG).
3. Many lifeline plans would help the poor who are low volume users and hurt the poor who are high volume users of utility service.
4. The benefits of a lifeline plan would, it seems, not reach those renters whose utility service is included in the rent.
5. The degree of conservation achievable with

lifeline is uncertain partly because it depends on the extent to which a particular lifeline proposal might increase usage among low volume users.

6. A lifeline rate structure might result from applying marginal cost pricing principles for some companies but not for other companies offering the same utility service.
7. Because of the home rule provision of the Ohio constitution, lifeline legislation might possibly be effective only outside incorporated areas.

Alternate plans for achieving lifeline purposes may avoid some of these difficulties while encountering others. We have identified three alternate plans which could be implemented instead of, or possibly in combination with, a lifeline plan. These are an energy stamp program, a weatherization plan, and time-of-day pricing of electricity. Without cataloging the various versions of each plan, let us consider the general features of each.

Energy Stamps

Several proposals to help the poor could be discussed at this point. These include the negative income tax and increased welfare payments. The energy stamp program is discussed here, not because it is preferred by the authors but because it is an alternative proposal intended primarily to ease the financial burden of rising utility rates for the poor. The program would be analogous to the food stamp program. Eligibility requirement would be set and the stamps for paying energy bills would be given out by local agencies. Administration of the plan could be simplified if the eligibility were the same as for food stamps and if energy stamps were distributed by the food stamp agency.

In terms of helping the poor, this program has several distinct advantages over a lifeline program. It would help the poor directly and would not benefit the nonpoor. Because, as we have seen, some of the poor are large volume users of gas and electricity, they could receive financial relief from the energy stamp program which would probably not come from a lifeline program. The energy stamp plan avoids the lifeline difficulty of being unable to help the consumer who heats with oil, coal, or LPG: he can pay any fuel bill with energy stamps. It would not be necessary to deal with the problem of appliance mix. Renters whose rent includes utilities might be allowed to use energy stamps in partial payment of rent. The value of the energy stamps sold to a recipient could vary with his geographic location, with the month, or even with the recent weather. Therefore, in terms of easing the financial burden of rising utility costs for the poor, the energy stamp program seems to be superior to a lifeline plan.

Two major and serious disadvantages of energy stamps are the cost of administering the program and, as in the case of food stamps, the unlikelihood that the program would actually reach a large percentage of the target group. Also, the energy stamp plan tends to oppose the conservation effort. Reducing utility bills for the poor may possibly promote less efficient use of energy among the poor. In addition, the poor often live in older homes constructed before present insulation standards were set, and energy stamps may reduce their incentive to weatherize those homes.

Weatherization

A weatherization program is aimed primarily at achieving conservation of energy resources and lower utility bills by reducing the escape of heat from poorly insulated homes. It would assist the public in providing adequate housing insulation, weatherstripping and caulking, and storm windows and doors.

The weatherization program could be offered to all households or, like energy stamps, restricted to those below a specified income level. The program provides relief from high winter heating costs and summer cooling costs for those consumers in households needing weatherization. Costs are reduced whether the household is heated with gas, electricity, oil, coal or LPG. Some who benefit from a weatherization program may well realize annual savings many times the savings probable under a lifeline plan. However, creating incentives for weatherization of rented homes and apartments may be difficult. And of course the program does not help the consumer whose dwelling is already adequately insulated but who nevertheless still feels the need for relief from rising energy costs.

Conservation resulting from weatherization may lead to a loss in utility revenue and therefore to a petition for higher residential rates; but this is not necessarily the case. For example, conservation in gas-heated homes would allow more gas to be supplied to industrial customers now subject to curtailment. Total sales need not decline. Since gas is priced lower to industrial customers, the utility could offset the revenue loss either by raising rates for the smaller volume of residential sales or by raising the rates for these additional industrial sales.

A weatherization program, then, would have a positive conservation effect and a positive effect with regard to reducing energy costs for its recipients.

Time-Of-Day Pricing

Time-of-day pricing (TDP) has been proposed as the optimum rate design for electric utilities. Instead of charging different rates for different amounts of use, a TDP rate structure charges different rates at different times of the day. These times and rates could vary with the season. Briefly, the rationale for such a rate structure is that the marginal cost of a kilowatt-hour of electricity varies with the time of day and with the season. The need to build new electric plant capacity depends on the extent to which each customer demands service during the annual peak, that is, during the time of maximum system generation. The need to use expensive peaking units depends on the extent to which each customer demands service during the daily peak. To this extent the customer requires the company to incur extra expense and raises the average cost of a kilowatt-hour. The TDP rate structure charges more for a kWh demanded during a peak time and less for a kWh demanded during off-peak times.

TDP rate structures are not relevant for natural gas service because the cost of service does not vary significantly during the day.

Considerable enthusiasm for the TDP plan already exists among some leading economists and rate structure theorists, many of whom consider TDP the most needed step toward sound electric utility rate reform. Telephone utilities routinely use rates varying with the time of day. The main impediment to use of TDP by electric utilities has been the expense of the TDP meters, but the technology for inexpensively metering all residential customers with TDP meters may be on the horizon. The PUCO has been investigating TDP rate structures during the past year,[1] and adoption of a TDP rate structure by several state public utilities commissions around the nation in the near future is a distinct possibility. TDP achieves rate reform by matching the rate structure more closely with the marginal cost of service.

In addition, time-of-day pricing of electricity may also help to achieve the other purposes of lifeline.

Customers who need relief from the financial burden

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[1] A Final Report to the PUCO on <u>Evaluation of Metering and Related Technical Aspects for Implementing Improved Eelctric Utility Rate Structure</u>; OSU, Dept. of Mechanical Engineering; October 14, 1975.

of rising electric rates would have an incentive to switch their use of service to off-peak periods in order to reduce electric bills - provided there is sufficient public education about the benefits of switching. The more wealthy a customer, the more likely he is to be willing to pay the extra cost of on-peak service to avoid the inconvenience of changing his consumption patterns. If this is true, TDP may result in a natural difference in rates charged to the various income groups. On the average, the greater the difference in income between two customers, the greater the expected difference in the average rate charged. This occurs not because one consumer is forced to subsidize another, but because the poorer consumer may be willing to undergo more inconvenience by switching more of his use to off-peak periods.

Consider, for example, the use of air conditioners. Some Ohio electric utilities currently have a different residential schedule of rates for summer and winter service with the summer rates higher. This is because the annual peak occurs when the summer air conditioning load is greatest. The growing annual peak requires the building of greater plant capacity. The hottest summer days also have the highest daily peaks with greater use of peaking units. But air conditioners alone do not make a peak; their use is added onto normal commercial and industrial use, as well as residential cooking, washing, drying, and so on. Although much of the residential, non-air conditioning use could be deferred to off-peak periods, under present rate schedules there is no incentive to do so. There is no difference in rates between the daily peak and off-peak periods.

With TDP, those low income customers with no air conditioning would be able to obtain low electric rates by switching much of their electricity consumption off the air conditioning peak. Those among low income customers who do have air conditioning may be more willing than the higher income customers to forego its use during peak periods. Instead, they could choose to cool their homes before the peak period, closing curtains to retain the cool air during the peak period. The benefit for undergoing this inconvenience would be lower electric rates.

A better way to use off-peak energy for on-peak cooling exists, however, known as energy storage. If time-of-day pricing is introduced, we believe energy storage will become an effective, economical addition to home cooling systems, and also heating systems. Energy storage uses cheap, off-peak power to cool water which is stored in an insulated tank. During peak periods, the cooling equipment is automatically turned off; then cold water is pumped from the storage tank to the various rooms of the home in small tubes. Blowing air across these tubes cools the air entering the room.

An advantage of an energy storage system is that the same system can be used with time-of-day pricing in the winter to reduce electric heating costs. Water can be heated during the morning, the off-peak period, and used for heating during the evening, the peak period in the winter months.

Another version of time-of-day pricing which would reduce electric bills is interruptible service. Interruptible service is currently offered to residential customers by some smaller electric utilities (including at least one in Ohio) which purchase power from a larger utility company, and there are good reasons why large companies should also offer this service to their own residential customers. Under such a plan a customer could choose to have certain electric services, such as electric water heating, interruptible by the electric company, in return for lower service rates. The company might interrupt service whenever this would avoid a need to start up an expensive peaking unit. In this case also, the poorer customer is more likely to choose the inconvenience of interruptible service in order to reduce his electric bills.

Time-of-day pricing of electricity would also contribute to the conservation effort. TDP would reduce the use of peaker units and increase the use of base load units. Base load units are large steam plants consuming either coal or nuclear fuel to produce steam which runs the generator. Supplies of coal and nuclear fuel are relatively plentiful. Peakers, on the other hand, produce no steam but act as huge jet engines, burning oil and using the jet of hot exhaust gases to run the generator. Oil is expensive and in short supply. In addition, peakers burn oil inefficiently. It takes almost twice as much oil to produce a kilowatt-hour in a peaker as it would if the oil were burned in a steam plant. Hence, TDP, by reducing the usage of peakers, contributes to the conservation of scarce energy resources.

To sum up, time-of-day pricing of electricity would not only contribute to rate reform, but also would help reduce utility bills and achieve conservation. Time-of-day pricing of electricity is the only alternate plan which would achieve to some degree all the purposes of lifeline. It may possibly meet these goals more effectively than lifeline pricing. Although all residential customers would have to be refitted with TDP meters in order to implement a TDP rate structure, there is sufficient interest in this type of rate structure to expect that some electric utilities around the country may adopt it within the next several years.

Conclusions

This chapter has presented a brief overview of some other programs which could to some degree achieve the purposes for which lifeline is intended. The attractiveness of lifeline depends on how well alternate programs would succeed. This overview is not intended to be an in-depth analysis of these programs.

In providing everyone essential utility service at a reasonably low rate, none of the alternate plans rivals lifeline, although TDP may be partially successful, even if only for electric service. For helping the poor, a direct subsidy such as the energy stamp program appears in some ways superior to lifeline. An effective weatherization program would probably have greater conservation potential than lifeline, while TDP would tend somewhat to reduce electric utility consumption of oil in favor of more abundant fuels. TDP is a more efficient program for electric rate reform than lifeline, but is not applicable to natural gas.

CHAPTER 7

SUMMARY AND CONCLUSIONS

Lifeline is a general name for a variety of legislative proposals to change utility rate structure. These proposals are supported by lifeline advocates because of their apparent ability to accomplish several purposes: (1) to provide everyone with essential service at a low rate, (2) to help the poor, (3) to promote conservation, and (4) to apply marginal cost pricing theory to utility rate design.

Traditionally utility rates have served the public interest by accomplishing three purposes: (1) to meet the revenue requirement, (2) to promote economically optimum use, and (3) to charge customers a fair rate. These three purposes cannot be fully satisfied by any given rate structure. Practical rate design requires a compromise between competing purposes.

We found that the lifeline purposes are versions of the traditional rate design purposes. The statement that everyone is entitled to essential use at a low rate is equivalent to the statement that rates should be fair, according to the good faith standard of fairness. Helping the poor through rate design is the same as setting rates fairly according to an ability-to-pay standard of fairness. The intention of reasonably promoting conservation is part of the traditional purpose of promoting optimum use of utility service. Optimum use is best achieved by application of marginal cost pricing principles. Therefore the lifeline purposes are not new, only new expressions of traditional purposes. To design a sound rate structure these lifeline purposes must be balanced against each other and against other purposes, namely meeting the revenue requirement and setting rates fairly according to other standards of fairness, such as the compensation principle.

We found that lifeline is compatible with the revenue requirement, provided revenues lost on lifeline sales are collected by increasing the price of other sales.

The compatibility of lifeline with optimum use is not so clear cut. For natural gas, we found that under current supply and regulatory conditions a two-level rate structure, entirely consistent with lifeline, is justified on the basis of optimum use because current marginal cost is greater than historic average cost. For electricity the relation of current marginal cost to historic average cost is not known. When marginal cost is greater, a two-level lifeline rate structure is more compatible with optimum use than a declining block structure.

Even though a two-level, lifeline rate structure may be more compatible with optimum use under present conditions, these conditions may change in the future. The deregulation of natural gas, the lowering of the interest rate for capital, the availability of low cost time-of-day meters for electricity or other changes could alter the conclusions above. To achieve optimum use, it is essential that the PUCO have the prerogative of changing the rate structure with changing conditions. This requires that no legislation be passed which constrains rate structure for all utilities at all times without regard to their economic, regulatory and technological circumstances.

The compatibility of lifeline with fairness depends on the particular lifeline proposal, and the standard of fairness considered, as well as the particular utility industry. Fairness arguments generally favor flattening the present rate structure rather than inverting it. A flat rate with a separate minimum charge appears fair according to both the compensation principle and the notional equality standard of fairness. Inverted rates are unfair according to these two standards. The good faith standard of fairness can be applied to argue both for and against lifeline, but the stronger argument is the one against lifeline: a sudden and significant increase in rates for high volume users is unfair because they invested in gas and electric devices based on past low rates.

Only the ability to pay standard of fairness leads us to favor a front block rate lower than the rates for other blocks, at least for electricity. Low income households in Ohio use less electricity on the average than other households. So lifeline would help most of the poor. However, some of the poor use large quantities of electricity, and lifeline could increase electric bills for those most in need of relief from already high bills. The ability to pay standard does not support lifeline rates for natural gas. Low income users consume more natural gas on the average than middle income users. Hence, lifeline would not result in lower gas bills for the poor in particular, and could result in higher gas bills for the poor.

To sum up, for natural gas a two-level lifeline rate structure can be supported on the basis of optimum use as an improvement over declining block rates, but can be only weakly supported on the basis of fairness. For electricity, a two-level lifeline rate structure may be similarly supported on the basis of optimum use, depending on the relationship between current marginal cost and historic average cost, but cannot be strongly supported by most fairness standards, except the ability to pay standard.

CONCLUSIONS

1. For a utility company with a regulated rate of return, a lifeline rate structure can be better justified on the basis of economic efficiency than a declining block rate structure, provided (a) current marginal cost is greater than historic average cost, (b) the lifeline block length covers only essential use, and (c) the tail block price for each rate schedule equals the marginal cost for that customer class.

2. Although lifeline may be preferrable to declining blocks at the present time, this may not be so in the future, and lifeline may not be the best current alternative to declining blocks. Statutory adoption of lifeline could prevent the PUCO from adopting the rate structure which best serves the public interest. (A joint PUCO-OSU study is now investigating regulated rate structures and examining broader issues of rate design beyond the scope of this lifeline study.)

3. It is not possible to draw a firm conclusion regarding the equitableness of lifeline not only because of the great variety of lifeline proposals, but also because of the variety of standards used for determining fairness.

4. Alternatives to lifeline, such as energy stamps, weatherization programs, and time-of-day pricing, may be more effective than lifeline in satisfying the lifeline objectives.

5. If lifeline legislation is enacted, the above conclusion notwithstanding, three amendments to the current Ohio bill (Sub. H.B.583) should be considered:

   i) The lowest rate offered to each customer class should be related to the cost of serving each class.

   ii) Specifications of the lifeline length for natural gas should allow for monthly variations in use due to weather. The length currently specified (30 mcf) approximates essential use only during the coldest months.

   iii) Specification of the lifeline length for electricity should distinguish between households with and without electric water heaters. For households in the latter category, 300 kWh is a better estimate of essential monthly use than 500 kWh.

APPENDIX A

PRINCIPLES OF RATE DESIGN

In order to evaluate how consistent lifeline rates are with the principles of sound rate design, it is essential to develop an understanding of the criteria that are used in developing utility rates. This appendix examines in more detail criteria introduced in Chapter 1 used for judging rate structures. It is not our purpose here to present an exhaustive treatment of rate design principles and we concentrate on those concepts most relevant to lifeline analysis.

CRITERIA FOR SOUND RATE STRUCTURE

In his book, Principles of Public Utility Rates, James C. Bonbright distinguishes three primary criteria or objectives for a rate structure:[1]

(1) Revenue requirement: To meet revenue requirements necessary to attract capital and motivate the utility to provide the desired service.

(2) Optimum use or consumer rationing: To discourage wasteful use of utilities' services while promoting all use that is economically justified in view of the relationship between costs incurred and benefits received.

and (3) Fair apportionment: To distribute the burden of meeting revenue requirements fairly among beneficiaries of the service.

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1 James C. Bonbright, Principles of Public Utility Rates, Columbia University Press, New York, 1961. See in particular Chapter III, "The Role of Public Utilities Rates," p. 49, and Chapter XVI, "Criteria of Sound Rate Structure," p. 292.

In building a rate structure, each of these three criteria should be considered, but it is not possible to satisfy fully all criteria with any given rate structure. Conflicts arise between the different objectives. Thus any practical rate structure must be based on an artful compromise with regard to satisfying these criteria.

The Revenue Requirement Criterion

This is the most widely recognized and prominent function of public utility rates. Rates must be sufficient to provide a fair rate of return on investment and to attract the necessary capital for continued production and desired expansion.

The Optimum Use or Consumer Rationing Criterion

Rates should be set in such a way as to simulate, as nearly as possible, the rates which would be charged if the utility were competing with other utilities in a free market for the customer's business. The rates should compensate for the monopoly status granted to a single private firm by the state. Prices should be low enough to promote any economically justified use and high enough to discourage wasteful use.

Under free market conditions, this is achieved when competition forces all companies to set their prices equal to marginal costs. That is, the price of all units of the product (be it a cubic foot of natural gas or a kilowatt-hour of electricity) is set equal to the extra cost of producing one additional unit. Use is economically justified if the value of the product to the consumer is greater than marginal cost of producing it, and unjustified when less. Every customer is supposedly well enough aware of his own needs so that he is unwilling to pay more for a product than it is worth to him, and he is willing to purchase any product priced at or below its value to him. Consequently when price equals marginal cost all justified use occurs and no unjustified use occurs. Free market competition results in optimum use.

The Fair Apportionment Criterion

This criterion is difficult to apply because of the variety of standards of fairness. Bonbright distinguished four different standards of fairness that are applied in practice: (1) good faith or reasonable expectations, (2) notional-equality, (3) the compensation principle, and (4) ability to pay.[2] Briefly, these standards, along with some of Bonbright's critique are as follows:

(1) Good faith or reasonable expectation standard of fairness refers to what may be called a moral commitment to live up to previous commitments. Such standards are typically invoked by customers who wish to maintain low rates that they have become accustomed to. Suppose, for example, customers were led to buy electric appliances on the basis of low rates for large volume use. They might argue that since they were induced to make these purchases on the basis of expectation engendered by these rates that they should be able to maintain these rates even though conditions have changed. Bonbright points out, however, that, "As a matter of legal doctrine, such an argument has dubious standing in view of the generally accepted principle that public utility rates are subject to revision if and when they become 'unreasonable.'"[3]

(2) Notional-equality standard of fairness refers to the popular tendency to assert that uniform rates for the same kind of service (i.e., flat rate structure) are fair despite differences in the cost of delivery. In the present context the temptation to apply this standard may be great because even though the delivery costs to large industrial users at 340 kV and the

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2 Bonbright, op.cit., especially Chapter VIII, "Fairness Versus Functional Efficiency as Objectives of Rate Making Policy," p. 121.

3 Bonbright, op.cit., p. 129.

residential customers at 220 volts are quite different, the service they provide is the same.

(3) The compensation standard of fairness is based on the notion that the payment of the consumer to the producer should offset or counterbalance the cost incurred by the producer in delivering the service.

(4) Ability to pay standard of fairness is based on an egalitarian notion of social justice and is used to "support whatever deviations from cost can feasibly be applied in order to minimize burdens falling on those customers with lower incomes." Use of this standard essentially results in redistributing income and consequently represents what Bonbright refers to as a "quasi-tax." Bonbright further points out that, "The ability to pay principle cannot be carried beyond severe limits, since any attempt to do so would lead to a breakdown in the other functions of utility rates."[4]

This brief review of the various fairness standards is sufficient to indicate that it is possible to pick a fairness standard to support many different rate structures. For example, the good faith standard would require that low rates be maintained for customers already living in all-electric homes, but not necessarily for new customers in all-electric homes. On the other hand, the notional-equality standard would require the same rates for both. The fair compensation standard would require the same rates to be charged to two neighboring residential customers consuming comparable quantities of service. But the ability to pay standard of fairness would require that the wealthier customer pay higher rates than his poor neighbor.

This ability to stretch the fair apportionment criterion to support almost any alternative is one of the factors which no doubt motivated Bonbright's comment:

Today, despite the persistent use of the words

[4] Bonbright, op.cit., p. 60

> "fair" and "reasonable" as mere synonyms, no responsible writer or public service commissioner would attempt to develop or appraise rules for the determination of reasonable rates by sole reference to standards of fairness or equity.[5]

This summary of the three primary objectives of utility rates shows that there are many rate structures which can be justified from a single set of criteria. Full implementation of any one of these criteria conflicts with the implementation of the other two criteria, so that the development of a sound rate-making policy calls for a resort to wise compromise to minimize the conflict.

The revenue requirement criterion can be satisfied under any chosen standard of fairness because this requirement is concerned only with the total revenues recovered regardless of how much each customer pays. On the other hand, the optimum use criterion will not be satisfied if rates deviate too far from the compensation notion of fairness which looks at the cost of providing the service.

Most rate structure theorists agree that utility rates should be related to the cost of service. But there is considerable disagreement about how to determine that cost. Cost of service pricing of utility rates requires each customer to pay for those costs which he causes the utility to incur. It is intended to avoid undue discrimination in charging different rates to various customers.

One method of determining the cost of service to a particular customer is to add up all the costs which the utility would save if that customer were not served. This extra cost for the extra service is what economists call marginal cost. By setting utility prices equal to marginal costs, the "optimum use" objective of rates is best served.

But if revenues are collected from all customers when price is equal to marginal cost, the total revenues

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[5] Bonbright, op.cit., p. 122

do not necessarily equal total costs, including the cost of a fair rate of return. If total revenues do not equal total costs then setting rates in this way does not satisfy the revenue requirement objective.

An alternative method of determining the cost of service is to begin by insisting that total revenues equal total costs, and then to divide up all costs among all customers so that no costs are left over. While some costs can reasonably be assigned to some customers, remaining costs must be assigned without being unduly unreasonable. This is the fully allocated cost method of determining the cost of service.

In the remainder of this appendix we examine the advantages and disadvantages of each of these methods of determining the cost of service.

FULLY ALLOCATED COST METHOD

The fully allocated cost method seeks to apportion the revenues to be collected by the utility among its customers so as to recover the total cost of providing service. In order to do that, a cost of service analysis must be performed to determine how the incurred costs should be allocated. There is at present no unique and "right" manner in which to perform a cost of service analysis. There are, however, some guidelines for electric utilities which the National Association of Regulatory Utility Commissioners (NARUC) have issued in an attempt to make the procedure more standardized.[6] Even with these guidelines, the complexity of determining the cost of service to customers makes it impractical to follow through with this procedure to the point of determining block rates.

Total costs can be divided up in several ways. One such way is according to function: there are production

[6] John J. Doran, Fredrich M. Hopee, Robert Koger and William M. Lindsay, Electric Utility Cost Allocation Manual, National Association of Regulatory Utility Commissioners, Washington, D.C. (1973).

costs, transmission costs, distribution costs and administrative costs . Customers can be divided into categories, but it should be pointed out that there is no unique way of categorizing customers. Customers could be categorized by income, by distance from the nearest generating station, by being either urban or rural, or some other plan. Gas utilities often categorize customers as being either small users (residential and small commercial), large users (large commercial and most industrial), or very large users (large industrial). Electric utilities generally include among their customer categories industrial, commercial, residential with all-electric homes, residential with electric water heaters, and residential without electric water heaters. Then each customer category is allocated its share of the functionalized costs.

But not all costs are easily assigned to one of these functional categories. Administrative cost tends to become the catch-all category for costs not clearly assignable to one of the other categories, such as the cost of providing a return on investment. How, then, can administrative costs be fairly allocated among the customer categories?

In addition to dividing total costs by function, one can divide costs according to whether they are fixed or variable. Fixed costs are those incurred by the utility company regardless of how much of its service is sold. Variable costs increase as more of the service is sold. For electric utilities the variable costs are called energy costs, and these consist mostly of fuel costs. If one customer consumes twice as many kWh's as another, the utility burns twice as much fuel to supply him with service. Fixed costs can be divided into customer costs and demand costs. Customer costs are those costs which are found to vary with the number of customers regardless of the service consumption of each customer. For example, the company spends the same 13¢ postage on each customer to mail his monthly bill. Demand costs, or capacity costs, vary with the amount of service the company is able to deliver at any one time.

As an illustration of these costs, consider a simple hypothetical case. A small electric company exists solely to serve two customers. The utility delivers one million kWh's every month to an industrial customer who manufactures steel plates. The second customer is an amusement park, requiring three million kWh's a month for four months, and being shut down the rest of the year. Both customers would be charged the same annual customer cost and the same annual energy cost because both receive 12 million kWh's per year. However, the demand costs would have to be different. The steel company demands only one million kWh's per month while the amusement park demands three million kWh's per month. So the utility must build a generating plant and a transmission system with enough capacity to generate and to deliver four million kWh's per month. To cover the cost of providing this capacity, the utility must assess an annual demand charge to each customer. The demand charge for the amusement park should be three times the demand charge for the steel company.

Demand costs are the most complex to allocate and are considered the "nightmare of utility cost analysis." [7] Demand costs usually include the major portion depreciation, property taxes, and return on investment, together with a substantial part of the operating and maintenance expenses.

The fully allocated cost method has difficulty in assigning costs which do not clearly belong to any of the three cost categories: energy, demand, and customer. Consider, for example, the difficulty of allocating the annual maintenance cost of the secondary (low voltage) distribution system. At least a portion of this cost should be excluded from the demand-related costs because it does not vary with demand. Similarly, it does not

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[7] Bonbright, op. cit., p. 349

vary with the number of customers or with consumption of energy. So it cannot be justifiably placed in any of the three categories. This cost is an example of a cost which is not allocatable. Nevertheless, such a cost is typically allocated to the category of customer costs. Bonbright concludes: in order to maintain the assumption that "the sum of the parts equals the whole," the fully allocated cost analyst is "under impelling pressure to 'fudge' his cost apportionments by using the category of customer costs as a dumping ground for costs that he cannot plausibly impute to any of his other cost categories."[8]

The fully allocated cost method of determining cost of service is bound to succeed in meeting the revenue requirement. How well it satisfies the criterion for fairly apportioning costs is open to question, however. It purports to follow the compensation standard of fairness, but the impossibility of reasonably assigning all costs necessarily results in some "unreasonable" allocations. Hence the compensation standard cannot be fully adhered to. For those costs which are not allocatable, another standard must be used, either explicitly or implicitly, by the cost analyst to ensure that total costs are fully allocated.

The notional-equality standard could be applied so that all unallocated costs are divided evenly. But should they be divided evenly among all customers or divided evenly among all units of service sold? The first case amounts to assigning these costs to the customer cost category and results in a proportionally higher unit price to the small volume use. The second case makes the cost an energy cost even though the customer who doubles his comsumption from one month to the next in no way causes the company to incur any more of the unallocatable cost.

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[8] ibid., p. 349

Because some costs cannot be handled with a cost of service criterion, a value of service criterion could be used for allocation. This results in assessing the unallocatable costs to those who value the service enough to pay extra for it. Since use considered essential is valued most highly, this amounts to charging more for exsential use. Utilities may have an incentive to use this criterion in order to guarantee that the revenue requirement is met while at the same time minimizing the rate for nonessential use. Sales for nonessential use are more sensitive to price, and minimizing the rate promotes growth in sales.

An alternative criterion is the ability to pay. Unallocatable costs could be assigned to various customers in proportion to their ability to shoulder the financial burden.

To sum up, the extent to which the fully allocated cost method satisfies the fair apportionment objective of utility rates depends on a value judgment concerning (1) whether the compensation standard of fairness should be the primary standard of fairness, and, if so, (2) which fairness standard should be applied to those costs which cannot be allocated reasonably under the compensation standard.

Consider next how well the fully allocated cost system satisfies the optimum use objective of utility rates. We shall see that optimum use is obtained when price equals marginal cost. To the extent that prices set according to the fully allocated cost method differ from marginal cost prices, then to this same extent optimum use is not achieved.

Let us consider briefly why marginal cost pricing produces optimum use and what difficulties occur in practice when using this method of determining the cost of service.

MARGINAL COST PRICING

Two limitations of marginal cost pricing for achieving optimum use should be considered before we proceed. Marginal cost pricing is based on micro-economic theory, a theory well accepted by leading economists and useful for the purpose for which it is intended. It is limited, however, by that same purpose, which is to determine the optimum use of resources. Optimum use is measured by the willingness of consumers to pay for the use of the resource. The willingness to pay for resources of limited supply is determined by competitive bidding among all consumers in the free market. When rival companies compete in a free market to supply the demand for limited resources, a price equal to marginal cost results.

The first limitation of marginal cost pricing is that it makes no value judgment about the distribution of incomes. If one feels that income distribution is not optimum, then he will not agree that marginal cost pricing leads to "optimum use." Consider, for example, a consumer who is so poor that the cost of all <u>essential</u> goods and services is greater than his income. His lack of these goods and services does not reflect an unwillingness to pay the high prices but rather his inability to pay that price. If the term "optimum use" is used in a social equity sense instead of its strict economic sense, then "optimum use" could be achieved by incorporating the ability to pay into marginal cost pricing.

The second limitation of marginal cost pricing is that it provides for competitive bidding among today's customers only. At least one leading economist contends that this view is too narrow. Nicholas Georgescu-Roegen's opinion is summarized here:[9]

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[9] <u>Science</u>, Oct. 31, 1975

> Prices are only a parochial expression of value unless everyone concerned can bid - and future generations are excluded from today's market, which is why oil, for example, still sells for the merest fraction of its true value.

This suggests that the price of some resources should be higher than today's marginal cost in order to conserve a part of these resources for tomorrow's customers who will be willing to pay the higher cost. When "optimum use" encompasses this broader sense of equity, marginal cost pricing principles must be expanded to include the need for additional conservation.

Hence even if lifeline rates are not compatible with standard marginal cost pricing principles, lifeline may still be a rate structure which attains an expanded notion of "optimum use." Let us now examine the advantages and difficulties of applying marginal cost pricing principles to utility rate design.

We return to our hypothetical example, introduced in the previous section, of the electric utility serving the steel company and the amusement park. During the eight months of the year when the amusement park is closed, the system is producing only one million kWh's per month even though it is capable of producing energy at a rate of four million kWh's per month. Because a capability of three million kWh's monthly production lies idle, the system probably is not being used optimally.

In this case, the utility should encourage sales to new customers during the amusement park's off season. What should be the price of these new sales? An unregulated monopoly would try to obtain the best possible price by charging as much as the service is worth to these new customers provided that the additional revenue is at least enough to cover the extra cost of serving the new customers.

Let us now extend this example by imagining that the orignial utility meets competition from many identical utility companies, serving the same area and competing for new sales. Now instead of charging a price based on value of service to new customers, these utilities will each attempt to underbid the other, so that the price of service will fall until it approaches the extra cost of serving these new customers. This extra cost of supplying extra service is called marginal cost.

Consider the effect of competition on the price offered on old sales to old customers. All the companies will attempt to sell electricity to the steel company and the amusement park. They can make a profit by offering any price greater than the marginal cost because the extra revenues collected will be greater than the extra cost incurred. If these companies are truly identical, then they will have the same marginal cost. In perfect competition, the prices offered by each company will be set equal to marginal cost.

How does marginal cost pricing relate to the need to recover enough revenue to cover total costs? Consider Table A-1. The numbers were chosen not to be realistic but to provide for clarity of illustration. The table shows how costs change with various volumes of sale. Fixed costs, which include the interest on the capital cost of the plant, are constant. For a regulated utility, fixed costs include the cost of a fair rate of return on capital investment.

Table A-1

A Hypothetical Electric Company's Costs

Total Sales (millions of kWh's)	Fixed Costs ($ x thousand)	Variable Costs ($ x thousand)	Total Costs ($ x thousand)	Average Cost (¢/kWh)	Marginal Cost (¢/kWh)
0	10	0	10	- - -	- - -
1	10	20	30	3.00	2.00
2	10	30	40	2.00	1.00
3	10	50	60	2.00	2.00
4	10	80	90	2.25	3.00

Table A-2

A Hypothetical Electric Company's Revenues
When Price Equals Marginal Cost

Sales (millions of kWh's)	Price (¢/kWh)	Revenues ($ x thousand)	Total Costs ($ x thousand)	Profit (Loss) ($ x thousand)
1	2.0	20	30	(-10)
2	1.0	20	40	(-20)
3	2.0	60	60	0
4	3.0	120	90	30

Variable costs increase with sales, and so do total costs which are the sum of fixed and variable costs. Average costs are found by dividing total costs by total sales. Marginal cost is the extra cost of producing an extra quantity for sale.

For example, at a sales volume of two million kWh's, the fixed costs are \$10,000, the variable costs are \$30,000, and so the total costs are \$40,000. The average cost is \$40,000 ÷ two million kWh = 2¢/kWh. The marginal cost is the increase in total cost: whereas total cost was \$30,000 for one million kWh's, it increases to \$40,000 for two million kWh's, so the increase is \$10,000. This is the marginal cost of producing one extra block of kilowatt-hour sales, for the case where we have one million kWh's per block. Table A-1 expresses the marginal cost on a per kWh basis: \$10,000 ÷ one million kWh = 1¢/kWh.

Table A-1 shows several features generally found in most industries. As sales increase, economies of scale result in a low marginal cost; when marginal cost is less than average cost, increasing sales result in lowering the average cost. As sales continue to increase, however, decreasing returns to scale occur. For example, as plant capacity gets pushed to its limit maintenance costs may increase. Marginal cost may become greater than average cost, and increasing sales then will raise the average cost.

The effect on profits of setting price equal to marginal cost is illustrated in Table A-2 for the same company as in Table A-1. The revenues collected are found by multiplying sales times price. Profit, or loss, is found by subtracting total costs from revenues. A comparison of Tables A-1 and A-2 shows that with marginal cost pricing when marginal cost is less than average cost, the revenues do not cover costs. For example, with sales of two million kWh's, marginal cost is 1¢/kWh and average cost is 2¢/kWh; the company operates at a loss because total costs ($40,000) exceed revenues ($20,000). On the other hand, with marginal cost pricing, when marginal cost is greater than average cost, the revenues are in excess of cost. For example, with sales of four million kWh's, marginal cost is 3¢/kWh and average cost is 2.25¢/kWh; then revenues ($120,000) are greater than total costs ($90,000). A special case under marginal cost pricing is illustrated by sales of three million kWh's: when marginal cost equals average cost, the company's profit is zero. This is the ideal situation for a regulated public utility because the cost of a fair rate of return is already included in total costs and no revenues in excess of total costs should be collected.

In the competitive market, setting price equal to marginal cost results in the greatest profit or the minimum loss. When price equals marginal cost, any price decrease may result in increased sales but the company loses on the sales because the extra revenue does not cover the extra (marginal) cost of production. On the other hand, any price increase results in such a loss of sales to competitors that the resulting revenue (i.e., price times sales) is less than before. So revenue is maximized by marginal cost pricing whether or not revenue is less than costs. The company operating at a loss may be compelled to keep selling because it must pay the fixed costs even if there are no sales, and these fixed costs represent a loss: by maximizing revenue the company minimizes its losses. Hence in the free market the company achieves maximum benefit from marginal cost pricing.

Consumers also benefit from marginal cost pricing. To see this, return again to Table A-1. Suppose our example company is regulated and enjoys a monopoly position in a service area. The company may decide to meet its revenue requirement by setting price equal to average cost instead of marginal cost. At a sales volume of two million kWh's, the average price is 2¢/kWh. However, at this sales volume the company could produce extra kilowatt-hours at an extra (marginal) cost of only 1¢/kWh. Therefore, those customers who value the energy at a rate between 1¢/kWh and 2¢/kWh are excluded from receiving it. For example, the customer who is willing to pay up to 1.5¢/kWh for additional electricity will not receive it even though the company could produce extra electricity for a marginal cost of 1¢/kWh. Hence the capacity of the system is not being put to optimum use because not all economically justified use of the capacity occurs.

At a sales level of four million kWh's, our company's marginal cost (3¢/kWh) is greater than its average cost (2.25¢/kWh). Suppose the company is producing power near the limit of its capacity. By offering sales at a price equal to average cost, the company is encouraging sales which would not occur if the price were higher. When operating near capacity limits, it is possible that some customers who want extra power and who value it at more than 2.25¢/kWh may not be able to get as much as they want because of the demand for the service by those who value it at only 2.25¢/kWh. When it becomes necessary to ration the service, price rationing of consumer demand is the most beneficial from the economist's viewpoint. By raising the price to marginal cost (3¢/kWh), only those who value the power at this rate will buy it. In short, marginal cost pricing tends to discourage economically wasteful use of the service.

Setting price equal to average cost in a regulated company for the case where marginal cost is greater than average cost has another disadvantage. It may lead to unnecessarily frequent rate hearings. To see this, consider Table A-1 again for the case of four million kWh sales for which marginal cost (3.00¢/kWh) exceeds average cost (2.25¢/kWh). If the company agrees at a rate hearing to price sales at average cost, it collects the revenue, $90,000 (= 2.25¢/kWh x four million kWh), needed to cover total costs, $90,000. When growth in sales occurs, each additional kWh sold brings in only 2.25¢ but costs 3¢ to produce. So the company loses 0.75¢ on every extra kWh sold, and before long it must return to the regulatory agency with a request for a rate increase to cover these losses. Compounding the effect, more growth is likely to occur when the service is under-priced in the economic sense, that is, when price is below marginal cost.

In our hypothetical example, we have assumed that the utility has enough capacity to produce four million kWh's per month. In Table A-1, marginal cost was equal to increases in the variable cost. Marginal cost considered in this way for a system of fixed capacity is called short-run marginal cost. However, if the system is to grow in capacity to meet demand, then the fixed costs will also increase, over longer time periods, with an increase in sales. Then the marginal cost equals the sum of the increases in the variable costs and the increases in the fixed costs. Computed in this way, it is called long-run marginal cost.

There are practical difficulties with marginal cost pricing for regulated utilities' service. Under purely marginal cost pricing there are no rate blocks. All sales are priced at marginal cost. Then revenue may be greater or less than total costs. So with marginal cost pricing, the revenue requirement may not, very probably will not, be satisfied.

In addition, an electric company experiences constantly fluctuating short-run marginal costs primarily because the volume of sale varies throughout the day. As the demand for electricity increases during a typical morning, the utility brings on line its older, less efficient generating plants and also very inefficient peaking units which can quickly respond to quick changes in demand for power. Generating units are brought on line in order of increasing cost per kWh. The marginal cost per kWh increases with time during a typical morning. The short-run marginal cost, if determined very precisely, would be found to vary with time of day and with a different pattern of variation from day to day and especially from season to season. It is too difficult in practice to set price exactly equal to short-run marginal cost.

Long-run marginal cost is not subject to such rapid fluctuations. As system sales grow from year to year, the utility may decide that it is cheaper in the long run to build new plant capacity than to purchase power.[10] At times when demand approaches system capacity, the relevant marginal cost is the long-run marginal cost.

Long-run marginal cost pricing gives the consumer the correct economic signal about how much to invest in electrically powered goods. When long-run marginal cost is lower than average cost, it is because new plant capacity will have sufficient economies of scale or technological improvements so that the cost per kWh of electricity from the new plant will be lower than from the old. On the other hand, a long-run marginal cost higher than average cost means the cost of electricity from the new plant will be higher than from the old. Pricing electricity at long-run marginal cost gives consumers the correct price signal on the cost of system expansion. Consumers will then make correct choices about long-term investments in electrically powered devices. A low price encourages growth which lowers system average electric costs. A high price

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10 If the cost of producing power becomes greater than the cost of purchasing available power from a neighboring electric utility, then power is purchased. A utility may be forced to purchase power when demand approaches system capacity. Then the cost of purchased power is the relevant short-run marginal cost.

discourages growth which raises system average costs. With long-run marginal cost pricing, the economically "correct" amount of growth occurs: growth in capacity occurs only if consumers causing the growth place a value on the additional capacity at least as great as the cost of providing it. Consumers are given the opportunity to express their willingness to pay for new capacity if the price of sales, occuring when demand approaches system capacity, is set equal to the long-run marginal cost of new capacity. The difficulty of applying long-run marginal cost pricing in practice, however, is that estimates of future costs are subject to uncertainty.

APPENDIX B

THE EFFECT OF LIFELINE ON CUSTOMER BILLS

This appendix considers the effect of lifeline proposals for electricity and natural gas on consumers' utility bills. Electricity and natural gas are treated in separate sections. The method of calculation and the asumptions required to obtain the results are discussed first, and then the results are presented in tabular form. These results form the basis for some of the fairness arguments presented in Chapter 5.

Several assumptions are common to both sections. The first assumption was that the total revenues must remain the same before and after the institution of lifeline rates. The second was that the fuel adjustment applies to the lifeline block and therefore need not be included in the calculations because, although it would affect the amount of a customer's bill, it would not affect the change in his bill which would occur in switching from the present rate structure to lifeline rates. The last assumption was that there would be no changes in the consumption patterns of either the residential or the non-residential sectors when lifeline rates were instituted.

Calculations were carried out for two cases which we call the residential recovery case and the case of recovery from all ultimate customers. Residential recovery is the case in which the revenues recovered from residential sales remain the same when lifeline is enacted; that is, revenues lost through a price decrease on the front residential blocks are recovered by a price increase on the remaining residential blocks. In the case of recovery from all ultimate customers the lost revenues are recovered by a price increase on sales to all ultimate customers,[1] including the high volume residential customers.

Three example lifeline plans are considered in each case. These plans were introduced in Chapter 2 and illustrated in Figure 2-1. They are the modified declining block rate structure, the flat rate structure and the two-level rate structure.

Under the modified declining block example, present rate structure remains unchanged except for a rate reduction on the lifeline block and a surcharge on the nonlifeline blocks. The surcharge is determined by dividing the revenues lost on the lifeline block by (1) remaining residential sales, for the case of residential recovery, and (2) remaining sales to all ultimate customers, for the case of all ultimate customer recovery.

The flat rate is determined for residential recovery by dividing total residential revenues by total residential sales. Several reasonable methods of determining a flat rate for all ultimate customer recovery can be identified. The method used here was to divide total revenues on sales to all ultimate customers by the volume of such sales to obtain a flat residential rate. The cost to nonresidential customers is expressed as a surcharge determined by dividing the reduction in residential revenues by the volume of nonresidential sales.

In the case of the two-level rate structure several lifeline lengths and rates were examined and in each case the tail block price was set at the level necessary to meet the revenue requirement. For the case of residential recovery the revenue requirement was that residential revenues should not change. For the case of all ultimate customer recovery, several reasonable methods could have been used. We chose to set residential revenues at the

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[1] This includes all sales except sales for resale.

same level as in the case of the flat rate for all ultimate customer recovery.

There is at present only a rough uniformity among the residential rate schedules from one company to another and even among the several residential rate schedules for a single company. Consequently the effects of switching from a present rate schedule to a lifeline schedule, as presented here, while they can be considered typical, cannot be expected to apply precisely to all companies.

Electricity

Bill frequency data was analyzed for three Ohio electric companies, one each having a relatively large, intermediate and small ratio of nonresidential to residential load. Results for the three companies did not vary greatly from company to company, and the effect of differences in the load ratio was masked by the effect of differences in the companies' present residential rate schedules. The results for the company of intermediate ratio only are presented here.

In each case bill frequency data was used which was based on sales for August 1975 to residential customers without electric water heaters. These customers were served under a variety of rate schedules. A typical rate schedule was assumed to apply to all sales. These sales included most residential sales. In determining the surcharge on nonresidential sales, we made an adjustment for the fact that not all residential sales were included in the bill frequency data available to us in order to obtain a better estimate of that surcharge for the case where all residential customers were included.

The effect of lifeline on residential customers' electric bills is shown in the first three tables of this appendix. Because of the variety of lifeline proposals it is difficult to present the results succinctly. These tables present a sample of our results and show the effects of the important variables, namely the lifeline length, the lifeline rate and the method of revenue recovery. Ohio's proposed HB583 allows for any of the methods of revenue recovery presented in these tables. In HB583 the lifeline length for most residential sales is 500 kWh, and the requirement that the lifeline rate be the lowest offered to any customer means the lifeline rate would be about 1.5¢/kWh.

Table B-1 shows the change in bills with a modified declining block structure for the case of residential recovery. As the lifeline length varies from 200 kWh to 500 kWh with the same lifeline rate, the break-even point does not change greatly. The break-even point only moves from about 650 kWh to about 770 kWh. This occurs because the 700 kWh user receives an increasingly lower bill for his initial usage, but this is offset by an increasingly higher surcharge on his later usage. Consequently his bill remains about the same regardless of the lifeline length. However those who consume over 1000 kWh per month must pay a higher bill with a longer lifeline length because the dominant effect is that of the increasing surcharge. The effect of this lifeline method of revenue recovery on the 2500 kWh user for a lifeline length of 500 kWh and a lifeline rate of 1.5¢/kWh is to nearly double the customer's electric bill.

Table B-1 also shows the effect of changing the lifeline rate for a fixed lifeline length. Once again there is little effect on the break-even point. For a 500 kWh length as the rate varies from 1.5¢/kWh to 2.5¢/kWh, the break-even point remains between 700 and 800 kWh. The reason is that the decreasing savings on the first 500 kWh is offset by a decreasing surcharge on the remaining kWh's. However as the lifeline rate decreases the effect of the surcharge on the large volume consumer is to increase his bill significantly.

Table B-1 Changes in Residential Electricity Bills Under Modified Declining Block Rate Structure for Residential Recovery.*

Use (kWh)	Old Bill ($)	Bill Changes ($) for Various Lifeline Lengths (kWh) and Lifeline Rates (¢/kWh)					
		200 kWh @ 1.5¢/kWh	300 kWh @ 1.5¢/kWh	400 kWh @ 1.5¢/kWh	500 kWh @ 1.5¢/kWh	500 kWh @ 2 ¢/kWh	500 kWh @2.5¢/kWh
200	7.75	- 4.75	- 4.75	- 4.75	- 4.75	- 3.75	- 2.75
300	10.33	- 3.70	- 5.83	- 5.83	- 5.83	- 5.33	- 2.83
400	12.91	- 2.65	- 4.28	- 6.91	- 6.91	- 4.91	- 2.91
500	15.33	- 1.60	- 2.73	- 4.73	- 7.83	- 5.33	- 2.83
600	17.59	- .55	- 1.18	- 2.55	- 4.88	- 3.25	- 1.62
700	19.85	.50	.37	- .37	- 1.93	- 1.17	- .41
800	22.11	1.55	1.92	1.81	1.02	.91	.80
900	24.01	2.60	3.47	3.99	3.97	2.99	2.01
1000	25.91	3.65	5.02	6.17	6.92	5.07	3.22
1500	35.41	8.90	12.77	17.07	21,67	15.47	9.27
2000	44.91	14.15	20.52	27.97	36.42	25.87	15.32
2500	54.41	19.40	28.27	38.87	51.17	36.27	21.37

* The old bill is the residential bill for the given amount of use under a 1975 rate schedule excluding fuel adjustment revenues. The table shows the dollar increase, or decrease (-), in the bill under a lifeline rate schedule. Nonresidential bills are unchanged.

Table B-2 presents the same example for the case of all ultimate customer recovery. The same insensitivity of the break-even point to lifeline length and rate is apparent. However in this case the location of the break-even point is quite different. It is between 2100 and 2400 kWh. Almost all residential customers would receive lower electric bills in this case, regardless of the lifeline length and rate, because some revenues formerly collected from residential customers are now collected from nonresidential customers. The effect of increasing the lifeline length or of decreasing the lifeline rate is to increase the savings of most residential customers and to increase the surcharge on nonresidential sales. For example for a lifeline length of 500 kWh at 1.5¢/kWh, electric bills are reduced by about 50% for those consuming 500 kWh or less, and this includes about half of all residential consumers. On the other hand, the rates for all other sales are increased by 4 mills per kWh. This increase would raise the cost of sales to some small commercial customers above the cost of some residential sales and would raise the cost of electricity to large industries by about 25%.

Table B-3 presents bill changes under flat rates and under two-level rate structures. The two-level rate structure is not presented in detail because the results for this structure are very similar to those for the modified declining block structure: the bills are nearly the same and the insensitivity of the break-even point to variations in the lifeline length and rate is the same. The only significant difference is that the break-even point occurs earlier, at about 1500 kWh, for the case of all ultimate customer recovery.

For the flat rate with residential recovery bill changes are less than for the other rate structures.

Table B-2 Changes in Residential Electricity Bills Under Modified Declining Block Rate Structure for All Ultimate Customer Recovery*

Use (kWh)	Old Bill ($)	Bill Changes ($) for Various Lifeline Lengths (kWh) and Lifeline Rates (¢/kWh)					
		200 kWh @ 1.5¢/kWh	300 kWh @ 1.5¢/kWh	400 kWh @ 1.5¢/kWh	500 kWh @ 1.5¢/kWh	500 kWh @ 2 ¢/kWh	500 kWh @2.5¢/kWh
200	7.75	- 4.75	- 4.75	- 4.75	- 4.75	- 3.75	- 2.75
300	10.33	- 4.51	- 5.83	- 5.83	- 5.83	- 5.33	- 2.83
400	12.91	- 4.27	- 5.53	- 6.91	- 6.91	- 4.91	- 2.91
500	15.33	- 4.03	- 5.23	- 6.56	- 7.83	- 5.33	- 2.83
600	17.59	- 3.79	- 4,93	- 6.21	- 7.43	- 5.05	- 2.67
700	19.85	- 3.55	- 4.63	- 5.86	- 7.03	- 4.77	- 2.51
800	22.11	- 3.31	- 4.33	- 5.51	- 6.63	- 4,49	- 2.35
900	24.01	- 3.07	- 4.03	- 5.16	- 6.23	- 4,21	- 2.19
1000	25.91	- 2.83	- 3.73	- 4.81	- 5,83	- 3.93	- 2.03
1500	35.41	- 1.63	- 2.23	- 3.06	- 3.83	- 2.53	- 1.23
2000	44.91	- .43	- .73	- 1.31	- 1.83	- 1.13	- .43
2500	54.41	.77	.77	.44	.17	.27	.37
Surcharge on Nonresidential Sales (¢/kWh)		.24	.30	.35	.40	.28	.16

* The old bill is the residential bill for a given amount of use under a 1975 rate schedule excluding fuel adjustment revenues. The table shows the dollar increase, or decrease (-), in the bill under a lifeline rate schedule.

Table B-3 Changes in Residential Electricity Bills Under A Flat Rate Structure and A Two-Level Rate Structure for Both Residential Recovery (Res.Rec.) and All Ultimate Customer Recovery (A.U.C.Rec.). [1]

Use	Old Bill	Flat Rate Changes ($)		Two-Level Rate Structure Changes ($)			
		Res. Rec.	A.U.C. Rec. [2]	Res. Rec.		A.U.C. Rec.	
(kWh)	($)	All kWh @2.79¢/kWh	All kWh @2.09¢/kWh	200 kWh @ 1.5¢/kWh	500 kWh @ 1.5¢/kWh	200 kWh @ 1.5¢/kWh	500 kWh @ 1.5¢/kWh
200	7.75	- 2.17	- 3.57	- 4.75	- 4.75	- 4.75	- 4.75
300	10.33	- 1.96	- 4.06	- 3.98	- 5.83	- 4.98	- 5.83
400	12.91	- 1.75	- 4.55	- 3.21	- 6.91	- 5.21	- 6.91
500	15.33	- 1.38	- 4.88	- 2.28	- 7.83	- 5.28	- 7.83
600	17.59	- .85	- 5.05	- 1.19	- 5.06	- 5.19	- 6.97
700	19.85	- .32	- 5.22	- .10	- 2.29	- 5.10	- 6.11
800	22.11	.21	- 5.39	.99	.48	- 5.01	- 5.25
900	24.01	1.10	- 5.20	2.44	3.61	- 4.56	- 4.03
1000	25.91	1.99	- 5.01	3.89	6.74	- 4.11	- 2.81
1500	35.41	6.44	- 4.06	11.14	22.39	- 1.86	3.29
2000	44.91	10.89	- 3.11	18.39	38.04	.39	9.39
2500	54.41	15.34	- 2.16	25.64	53.69	2.64	15.49
Surcharge on Nonresidential Sales (¢/kWh)		0	.30	0	0	.30	.30

[1] The old bill is the residential bill for a given amount of use under a 1975 rate schedule excluding fuel adjustment revenues. The table shows the dollar increase, or decrease (-), in the bill under a lifeline rate schedule.

[2] The breakeven point in this example is 3637 kWh.

The break-even point is between 700 and 800 kWh as it was before, but the savings for those consuming under the break-even amount are more moderate and bill increases for large volume residential consumers are not so drastic. The 300 kWh user's bill is reduced by about 20% and the 2500 kWh user's bill is increased by only 30%. For the case of the flat rate with all ultimate customer recovery, virtually all residential customers receive lower bills and all nonresidential customers pay 3 mills per kWh more than they paid formerly.

Natural Gas

The analysis for natural gas was carried out in the same way as for electricity with three important exceptions. First, because of the uncertainty of the curtailment situation historical data on nonresidential sales cannot be used to predict reliably a surcharge for the case of all ultimate customer recovery. Therefore the effect of this lifeline example on residential customers' bills is also uncertain. In addition the ratio of residential to nonresidential sales varies greatly from company to company and from month to month, and hence requires a complicated analysis. In view of the uncertainty introduced by the curtailment situation, we decided that a complicated analysis was not justified. Therefore we did not treat the case of all ultimate customer recovery for natural gas.

Secondly, residential gas consumption changes greatly from month to month depending on the weather. Any reasonable lifeline proposal must at least distinguish essential use during the heating season from essential use during the nonheating season. A typical gas consumer may need, for example, 4 mcf in July, 15 mcf in November and 30 mcf in February. If the lifeline length is long all year, then almost all residential gas sold during the year is covered by lifeline rates and the resulting surcharge on other sales is huge. If the lifeline length is set at a monthly average value, 10 mcf for example, the result is to reduce already low summer bills and to increase already high winter bills. Therefore different lifeline lengths are needed for the heating and nonheating seasons. This alleviates the problem but does not eliminate it. Gas consumption varies enough even during the heating season so that the problems discussed above still occur if a single lifeline length is applied to the entire heating season.

Third, because most natural gas rate schedules are flat, or essentially flat, beyond the first two or three mcf, the modified declining block and two-level rate structures are reduced to the same rate structure.

Results for this rate structure, now called the two-level structure, are presented in Table B-4 for the nonheating season and Table B-5 for the heating season. These tables confirm the relative insensitivity of the break-even point to the lifeline length and rate. Average household consumption is about 4 to 6 mcf during the summer and essential use could be estimated as 3 to 5 mcf. Because relatively few households consume more than 6 mcf, reducing the rate for essential use is equivalent to reducing the rate for most use and the resulting surcharge on the relatively small volume of sales over 6 mcf is substantial. For a lifeline length of 3 mcf, the effect of lifeline is to eliminate the customer charge on the front block and add a surcharge of about one dollar or more on the blocks beyond 3 mcf. Since relatively few households consume more than about 6 mcf, the effect is to shift the customer charge from the first 3 mcf to the next 3 mcf. However those few customers who consume large amounts of gas during the

Table B-4 Changes in Residential Natural Gas Bills Under the Two-Level Rate Structure for Residential Recovery in the Nonheating Season [1]

Use (mcf)	Old Bill ($)	Bill Changes ($) for Various Lifeline Lengths (mcf) and Lifeline Rates ($/mcf)					
		3 mcf @$1.00/mcf	3 mcf @$1.30/mcf	3 mcf @$1.50/mcf	5 mcf @$1.00/mcf	5 mcf @$1,30/mcf	5 mcf @$1.50/mcf
1.5	3.99	- 2.49	- 2.04	- 1.74	- 2.49	- 2.04	- 1.74
2.0	4.78	- 2.78	- 2.18	- 1.78	- 2.78	- 2.18	- 1.78
2.5	5.57	- 3.07	- 2.32	- 1.82	- 3.07	- 2.32	- 1.82
3.0	6.36	- 3.36	- 2.46	- 1.86	- 3.36	- 2.46	- 1.86
3.5	7.09	- 2.62	- 1.91	- 1.44	- 3.59	- 2.54	- 1.84
4.0	7.81	- 1.87	- 1.36	- 1.01	- 3.81	- 2.61	- 1.81
4.5	8.54	- 1.13	- .81	- .59	- 4.04	- 2.69	- 1.79
5.0	9.26	- .38	- .26	- .16	- 4.26	- 2.76	- 1.76
5.5	9.99	.37	.29	.27	- 2.68	- 1.67	- .99
6.0	10.71	1.11	.84	.69	- 1.10	- .57	- .22
7.0	12.16	2,60	1,94	1.54	2.06	1.62	1.32
8,0	13.61	4.09	3.04	2,39	5.22	3.81	2.86
9.0	15.06	5.58	4.14	3,24	8.38	6.00	4.40
10.0	16.51	7.07	5.24	4.09	11.54	8.19	5.94
20.0	31.01	21.97	16.24	12.59	43.14	30.09	21.34
30.0	45.51	36.87	27.24	21.09	74.74	51.99	36.74

[1] The old bill is the residential bill for a given amount of use under a 1975 rate schedule, excluding escalation under the purchased gas adjustment. The table shows the dollar increase, or decrease (-), in the bill under a lifeline rate schedule. These calculations are based on the assumption that total nonheating season revenue is unchanged.

Table B-5 Changes in Residential Natural Gas Bills Under the Two-Level Rate Structure for Residential Recovery in the Heating Season [1]

Use (mcf)	Old Bill ($)	Bill Changes ($) for Various Lifeline Length (mcf) and Lifeline Rates ($/mcf)					
		15 mcf @$1.00/mcf	15 mcf @$1.30/mcf	15 mcf @$1.50/mcf	25 mcf @$1.00/mcf	25 mcf @$1.30/mcf	25 mcf @$1.50/mcf
3	6.36	- 3.36	- 2.46	- 1.86	- 3.36	- 2.46	- 1.86
6	10.71	- 4.71	- 2.91	- 1.71	- 4.71	- 2.91	- 1.71
9	15.06	- 6.06	- 3.36	- 1.56	- 6.06	- 3.36	- 1.56
12	19.41	- 7.41	- 3.81	- 1.41	- 7.41	- 3.81	- 1.41
15	23.76	- 8.76	- 4.26	- 1.26	- 8.76	- 4.26	- 1.26
18	28.11	- 6.79	- 2.77	- .75	-10.11	- 4.71	- 1.11
21	32.46	- 2.82	- 1.28	- .24	-11.45	- 5.16	- .96
24	36.81	.15	.21	.27	-12.81	- 5.61	- .81
27	41.16	3.12	1.70	.78	- 7.00	- 2.84	- .08
30	45.51	6.09	3.19	1.29	2.39	1.54	.94
33	49.86	9.06	4.68	1.80	11.78	5.92	1.96
36	54.21	12.03	6.17	2.31	21.17	10.30	2.98
39	58.26	15.00	7.66	2.82	30.56	14.68	4.00
42	62.91	17.97	9.16	3.33	39.95	19.06	5.02
45	67.26	20.94	10.65	3.84	49.34	23.44	6.04
48	71.61	23.91	12.14	4.35	58.73	27.82	7.06
51	75.96	26.88	13.63	4.86	68.12	32.20	8.08

[1] The old bill is the residential bill for a given amount of use under a 1975 rate schedule, excluding escalation under the purchased gas adjustment. The table shows the dollar increase, or decrease (-), in the bill under a lifeline rate schedule. These calculations are based on the assumption that total heating season revenue is unchanged.

nonheating season must pay that surcharge on every mcf consumed. The result is a large bill increase for such customers. For a lifeline length of 5 mcf the billing increases for large volume consumers is even greater. The break-even point is about 6 mcf in this case. It is very close to the lifeline length because most sales are covered by the lifeline rate.

Table B-5 shows the effect on bills during the heating season for lifeline lengths of 15 mcf and 25 mcf. In the first case the break-even point is about 24 mcf and in the second case it is about 28 mcf. The break-even point occurs close to the lifeline length in the latter case because most residential consumption occurred within the lifeline block. (The data upon which these calculations are based was obtained from a gas company in southern Ohio.) Hence if the lifeline rate is low, the surcharge on high volume consumption is substantial.

Tables B-6 and B-7 show the effects of a flat rate for nonheating and heating seasons. We chose to set separate rates for each season so as to keep seasonal revenues unchanged. Since gas consumption is low during the nonheating season, most consumption is front block (customer cost) consumption and the rate is high. Therefore the flat rate for this season is higher than for the heating season where use extends to the lower priced tail block. For the nonheating season application of this relatively high flat rate results in significant, but not exorbitant, bill increases for the high volume user. For the heating season, the flat rate results in very little change in bill for most users. This is because gas rate schedules are flat, or almost flat, at the present time, except for the front block. Therefore during the season when gas usage extends far beyond the front block, there is little effect in changing from an almost flat schedule to a completely flat schedule.

Table B-6 Changes in Residential Gas Bills Under the Flat Rate for Residential Recovery for the Nonheating Season *

Use (mcf)	Old Bill ($)	Bill Changes ($) Flat Rate = $1.35/mcf
1.5	3.99	- 1.22
2.0	4.78	- 1.08
2.5	5.57	- .95
3.0	6.36	- .81
3.5	7.09	- .62
4.0	7.81	- .41
4.5	8.54	- .22
5.0	9.26	- .01
5.5	9.99	.19
6.0	10.71	.39
7.0	12.16	.79
8.0	13.61	1.19
9.0	15.06	1.59
10.0	16.51	1.99
20.0	31.01	5.99
30.0	45.51	9.99

Table B-7 Changes in Residential Gas Bills Under The Flat Rate for Residential Recovery for the Heating Season *

Use (mcf)	Old Bill ($)	Bill Changes ($) Flat Rate = $1.54/mcf
3	6.36	- 1.74
6	10.71	- 1.47
9	15.06	- 1.20
12	19.41	- .93
15	23.76	- .66
18	28.11	- .39
21	32.46	- .12
24	36.81	.15
27	41.16	.42
30	45.51	.69
33	49.86	.96
36	54.21	1.23
39	58.26	1.50
42	62.91	1.77
45	67.26	2.04
48	71.61	2.31
51	75.96	2.54

* The old bill is the residential bill for a given amount of use under a 1975 rate schedule, excluding escalation under the purchased gas adjustment. The table shows the dollar increase, or decrease (-), in the bill under a lifeline rate schedule. These calculations are based on the assumption that heating season revenue and nonheating season revenue are each unchanged.

APPENDIX C

THE FAIRNESS OF DECLINING BLOCK RATE STRUCTURES

The compensation standard of fairness is cited as the basis of present rate structures. Rates are based on the cost of service. However the cost of service can be determinded either by the fully allocated cost method or by the marginal cost pricing method. The two methods generally will not lead to the same rate design. In this appendix we apply the fully allocated cost method and attempt to see if it leads to a declining block rate structure in a fair manner. (Some terms used here were explained in Appendix A.)

Electricity

Under the fully allocated cost method, revenues must equal total costs. Total costs are divided by function into production, transmission, distribution and administrative costs. Each of these costs is divided by category into energy, demand and customer costs. Customers are divided into classes including industrial, commercial and one or more residential classes. Each customer class must pay for a fraction of the total costs. Assigning these costs to customer classes involves arbitrary allocation of some unallocatable costs. There is simply no unique, correct method. (The Cost Allocation Committee of the Engineering Committee of NARUC prepared a report in June 1955 which identified 16 different methods of allocating demand costs to customer classes.[1]) This raises the obvious question of whether something which cannot be done "correctly" can be done "fairly." But let us assume that a customer class has been fairly allocated a demand cost, a customer cost and an energy cost for which it is responsible. (We make this assumption not because the question raised is unimportant, but because

[1] J.J. Doran, et al., Cost Allocation Manual, NARUC, Washington, D.C., 1973, p. 53.

answering the question requires an analysis of rate design too complex to be included in this lifeline report.) How then can a rate schedule be devised for that customer class?

Suppose, for ease of illustration, that there are 1,000 customers in the class. If the total monthly customer cost assigned to the class is $3,000, and if all customers are sufficiently alike so that they made an equal contribution to the company's incurrence of customer costs, then each customer should pay a $3.00 customer charge per month.

The energy charge to each customer should clearly be proportional to his monthly use. In fact, the energy charge, which consists almost entirely of the fuel charge per kWh, should be nearly the same for every customer regardless of what class he belongs to.[2] If the energy charge is 1¢/kWh, then we can begin to build a rate structure with the flat energy charge shown in Figure C-1(a). If a customer uses 200 kWh in a given month, his energy charge is 200 kWh x 1¢/kWh = $2.00.

Now how can the $3.00 customer charge be added onto the flat energy rate? There is no "right" way to add on the customer charge on a per kWh basis. There could be an additional 30¢/kWh rate for the first 10 kWh, an additional 3¢/kWh rate for the first 100 kWh, or an additional 1¢/kWh rate for the first 300 kWh. The latter two cases are shown in Figures C-1(b) and (c).

None of these suggestions really solves the problem of converting a charge to a rate. For example, in the case shown in Figure C-1(b), anyone who uses less than 100 kWh will not pay the full customer charge. More of the customer charge can be collected on the first 50 kWh and less lost on the second from a customer consuming under 100 kWh's

[2] Not all customers should receive exactly the same energy charge because the energy charge also includes that portion of operation and maintenance expenses which increase with increased use. For example, low voltage transformers may need extra maintenance in proportion to the amount of energy they transmit. Industrial customers who receive energy at a high voltage do not use such transformers and should not be assessed an energy charge for their maintenance.

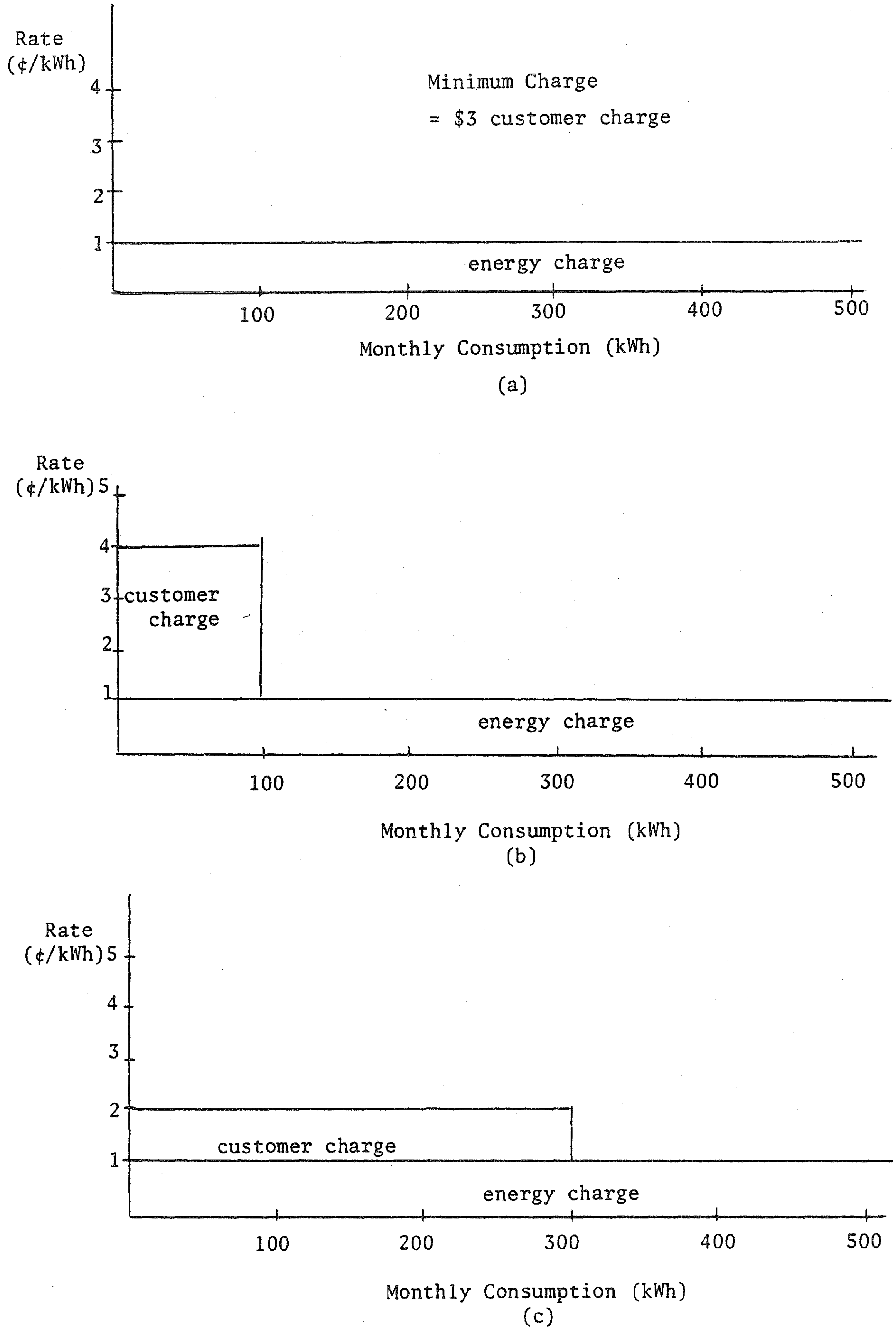

Figure C-1 Possible Distributions of the Customer Charge if the customer charge is divided into two blocks, as shown in Figure C-2. However, the full customer charge can be collected from all customers only if it is separated from the rate blocks, and assessed as a separate minimum charge regardless of use.[3] Nevertheless, many electric utilities build the customer charge into the rate schedule in a manner similar to that shown in Figure C-2.

The demand charge remains to be added. But again, since it is not an energy charge it cannot be "correctly" added as a rate per kWh. Remember that a demand charge for any customer should be in proportion to the amount of extra plant capacity the company must build to serve him. It should properly be related to the rate at which energy is consumed. For example, one customer's total use may consist of leaving a 100-watt lamp burning 24 hours a day for a month. His total use is about 72 kWh's per month. He consumes energy at a rate of 0.1 kilowatt-hours every hour. The company needs very little plant capacity to supply his energy need; to be specific, a capacity of 0.1 kilowatts is needed. A second customer may also consume 72 kWh's per month by using the whole 72 kWh's during a single hour. The company needs much more plant capacity to supply him than the first customer; his use requires a capacity of 72 kilowatts.

For this reason, industrial and large commercial customers normally have two meters: one to measure the energy consumed during the month and one to measure the maximum rate of energy consumption during the month. The second meter is called a demand meter, and the demand charge is based on this meter reading. Even this meter does not provide an exact measure of what the demand charge should truly be, however, because it does not

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[3] We have estimated the value of the customer charge for Ohio electric utilities. It is in the range $4 to $6 for all companies.

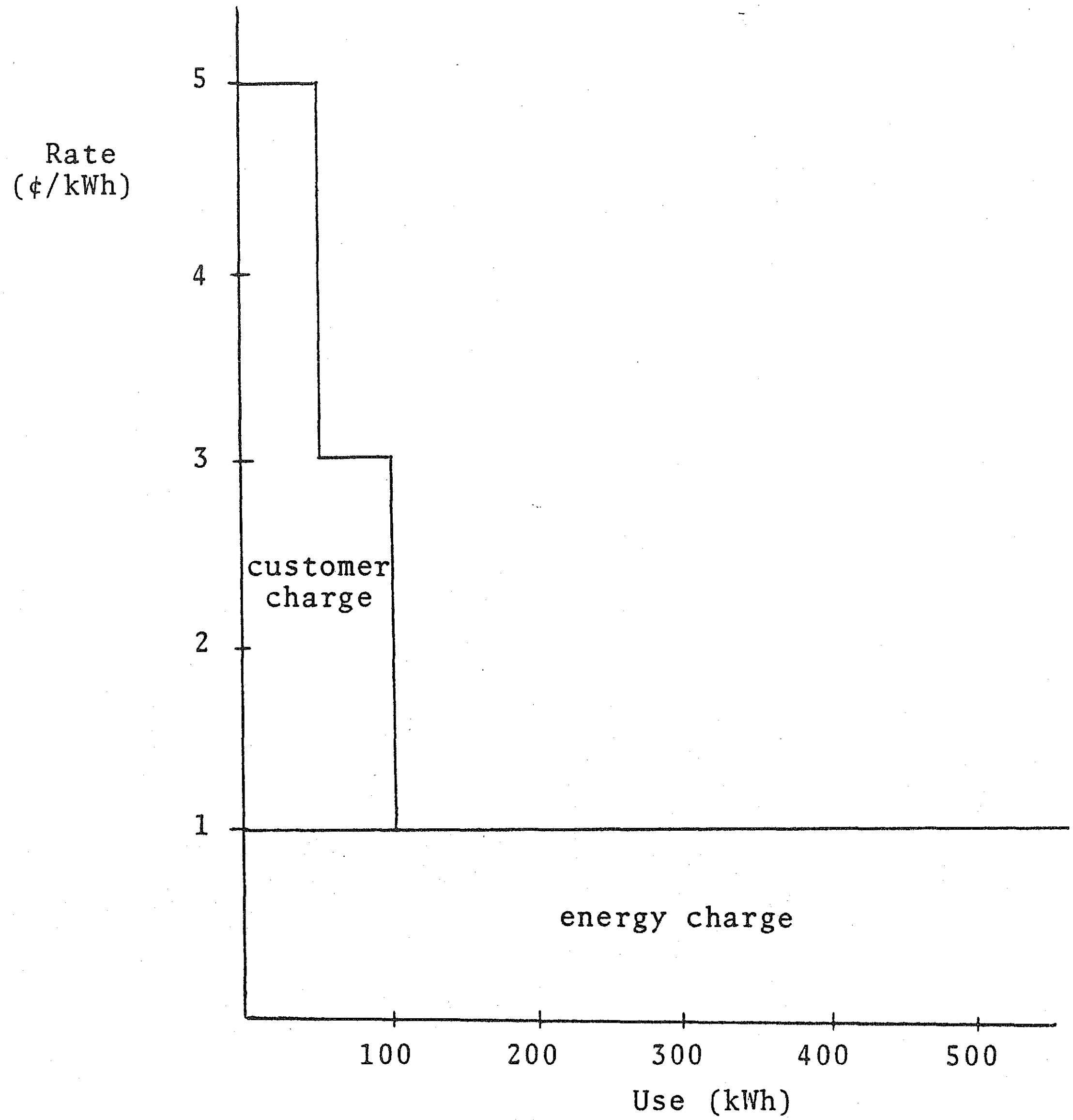


Figure C-2 Typical distribution of the customer charge

normally record the time at which maximum demand occurs. It is demand which occurs when the total system demand is near its maximum that determines the amount of plant capacity needed, and only this demand should properly be assessed a demand charge.

In order to minimize metering costs (one of the customer costs) there are no demand meters for residential customers. It then becomes necessary to add the demand charge onto the rate schedule which we started to build in Figure C-2.

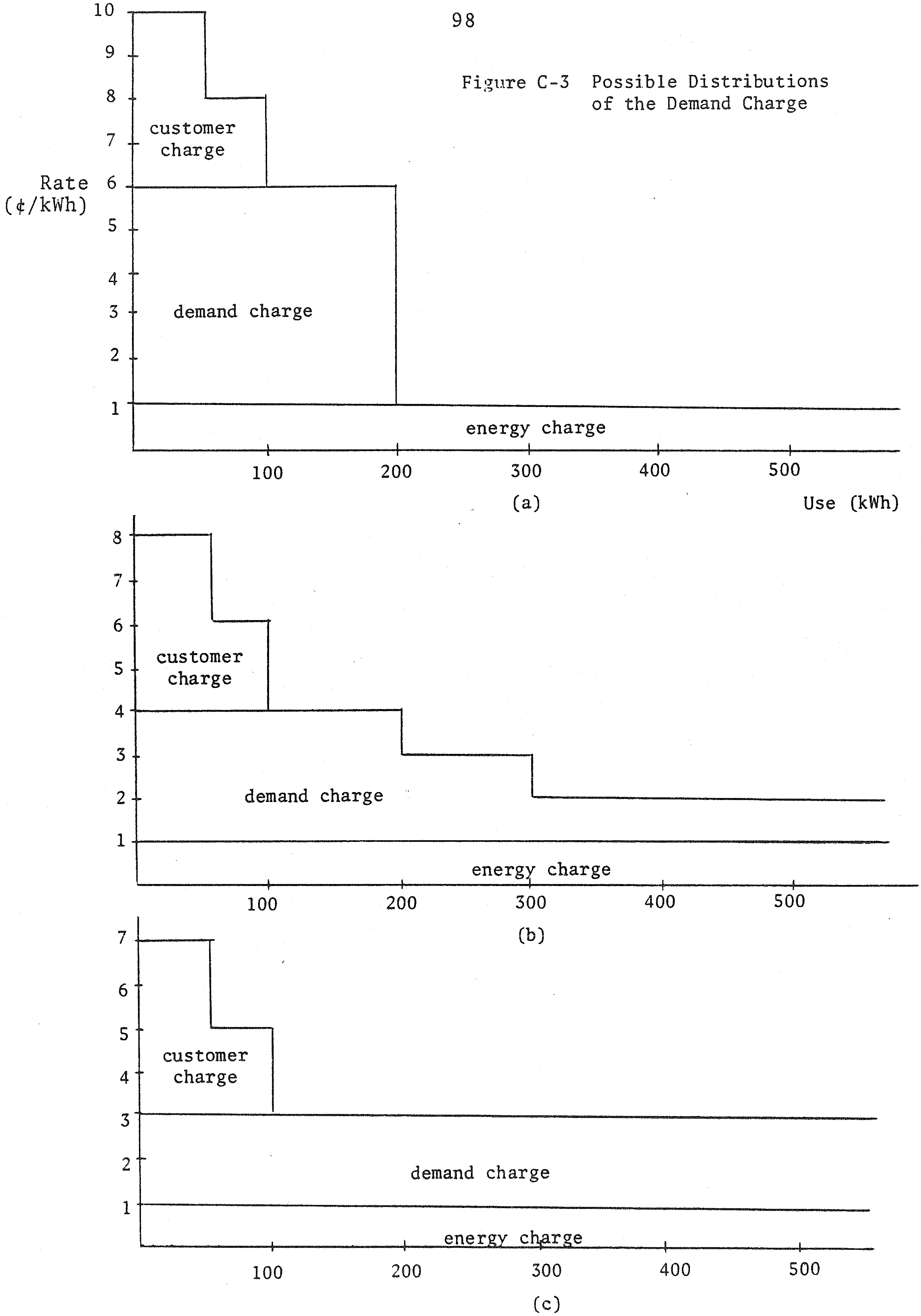
Suppose the demand charge for the customer class is $10,000. If there are 1,000 customers in the class, this averages out to $10 per customer. This charge could be added onto the first 200 kWh's as the customer charge was. This alternative is illustrated in Figure C-3(a). In this case, all customers pay the same demand charge, assuming they use at least 200 kWh's. However, on the average, the large volume user makes a larger contribution to demand than the small volume user. So some demand charge should be added onto all blocks, including the tail block.

How should the demand charge be distributed? Figures C-3(b) and (c) show two possible ways. Figure C-3(b) shows a demand charge distribution with more of the demand charge collected on the early blocks and less on later blocks. Figure C-2(c) assesses a flat demand charge. In case (b), the customer who consumes 500 kWh's pays a $10 demand charge, equal to the average demand charge for his class. Those consuming under 500 kWh's pay less than average; those consuming over 500 kWh's pay more. In case (c), the customer who consumes 500 kWh's also pays a $10 demand charge, but in this case the demand charge is proportional to use. Table C-1 shows how the demand charge varies with consumption for each of the cases (a), (b),

Table C-1. Demand Charges From Figure C-3

Usage (kWh)	Demand Charge		
	Case (a)	Case (b)	Case (c)
200	$10	$ 6	$ 4
300	10	8	6
400	10	9	8
500	10	10	10
600	10	11	12
700	10	12	14
800	10	13	16

Figure C-3 Possible Distributions of the Demand Charge



and (c) of Figure C-3. In each case, the 500 kWh user pays $10, the average demand charge. In case (a) the demand charge is fixed, in case (b) it increases slowly with increasing use, and in case(c) it doubles when use doubles. Case (b) is the declining block rate structure.

Writing in the Public Utilities Fortnightly,[4] Herbert B. Cohn, Vice-Chairman of the Board of American Electric Power, defends the use of the declining block rate structure. His argument is worth presenting in its entirety:

> Under this approach, the price per kilowatt-hour for the first block of kilowatt-hours is designed to cover both variable costs and a substantial part of customer and fixed costs; and the price per kilowatt-hour for the second and succeeding blocks is set at diminishing figures to cover variable costs and diminishing portions of customer and fixed costs to the point where the last block may cover only variable costs and a minimum of fixed costs. This approach of including a portion of fixed costs in the second and succeeding blocks recognizes that the demand created by the large use residential customer is generally greater than the demand of the small use customer.
>
> Since the customer and fixed costs for a given demand represent a constant figure, the greater the customer's usage in kilowatt-hours, the more widely these customer and fixed costs will be spread per kilowatt-hour. Accordingly, the larger user will pay less per kilowatt-hour than the smaller user. There is nothing unfair, improper, strange, or unique about this.
>
> Let us consider, for example, two residential customers who (to simplify the illustration) have similar peak requirements. Let us assume that the fixed and customer costs for each add up to about $50 a year, and that fuel costs represent an additional one cent per kilowatt-hour.
>
> Using these numbers, if one of the customers uses 2,000 kilowatt-hours and the second uses 20,000 kilowatt-hours, the cost of service to the first would be $50 plus 2,000 kilowatt-hours times

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[4] Herbert B. Cohn, Public Utilities Fortnightly, Dec. 18 , 1975; p. 21.

> one cent or \$20. This totals \$70 and works out to 3.5 cents per kilowatt-hour for the customer who uses 2,000 kilowatt-hours.
>
> The cost of service for the second customer would be \$50 plus 20,000 kilowatt-hours times one cent or \$200 for a total of \$250. This works out to 1.25 cents per kilowatt-hour or considerably less than one-half as much per kilowatt-hour as for the first customer.
>
> This difference in average price per kilowatt-hour is nothing more or less than a reflection of the difference in the respective costs of service. More specifically, it reflects a lower cost, and a lower price, per kilowatt-hour for the customer whose higher usage permits a distribution of the fixed costs over a much larger number of kilowatt-hours.

This argument is valid for the customer portion of fixed costs, but not valid for the demand portion of fixed costs. The argument begins by stating that not all fixed costs should be on the first block but should be distributed "at diminishing figures" over all blocks. This corresponds to the case illustrated in Figure C-3 (b) above. Although it is admitted that "the demand created by the large use residential customer is generally greater than the demand of the small use customer," this fact is ignored in the numerical example. The example assumes the special case of "two residential customers who (to simplify the illustration) have similar peak requirements," and who should, of course, then be responsible for the same fixed costs (demand charges). The example assumes at the beginning the conditions of case (a), that all customers should pay the same demand charge.

On the other hand, assume that the demand created by the 20,000 kWh customer is 10 times that amount created by the 2,000 kWh customer. This is not at all an unreasonable assumption: it means that at the time when the total system demand is near maximum, the first customer is consuming energy at a rate 10 times faster than the second customer. Certainly if one consumes 10 times as much energy as the other during equal time periods, then on the average he consumes energy 10 times as fast. The only uncertainty is whether he consumes energy 10 times as fast when the total system demand is near maximum. Given this assumption, then the demand charge for the first customer should be 10 times that for the second. If customer charges are billed as a separate minimum charge, then the remaining energy and demand charges are strictly proportional to use. Hence if demand is,on the average, proportional to monthly use, then case (c) above is more fair, on a cost of service basis, than case (b).

Let us carry Cohn's example one step further. The customer with an annual energy consumption of 20,000 kWh has an average demand of (20,000 kWh per year) ÷ (8,760 hours per year) = 2.3 kW. (Notice that energy has units of kilowatt-hours and demand has units of kilowatts.) The customer consuming 2,000 kWh yearly has an average demand of (2,000 kWh) ÷ (8,760 hours) = 0.23 kW. These are average demand figures: sometimes the customer's demand is above his average and sometimes it is below his average. For the purpose of determining the demand charge, the relevant demand is not the average demand or even the maximum demand. It is the customer's demand at the time when the total system demand approaches maximum. Of course, we cannot know for an individual customer what his demand is at that time. Nevertheless, we might make a common sense estimate for a typical low use and high use customer. The low use customer consumes an average of 167 kWh per month (2,000 kWh ÷ 12 months) for refrigeration, lighting, and a few other essential uses. It is probable that his use varies very little from month to month, or even from day to day, so that his daily demand is close to his average of 0.23 kW. The high use customer consumes an average of 1,670 kWh per month (20,000 kWh ÷ 12 months). In many cases (though certainly not in all cases) the high use customer is a high use customer because he has central air conditioning. He consumes less than 1,670 kWh's during most months and consumes in excess of 1,670 kWh's during the summer.[5] Then his demand is below 2.3 kW at most times and well in excess of 2.3 kW during the hottest days of the year. For electric utilities in Ohio, total system demand is greatest on the hottest days of the year. On such days, the low use customer maintains his average demand of 0.23 kW for essential use, but many high use customers have a demand well in excess of the 2.3 kW average. These customers should then pay a demand charge well in excess of 10 times the demand charge to the low use customer. If we must put this demand charge in a rate schedule on a per kWh basis, then a rate schedule of the type shown in Figure C-4 results. If the customer charge is removed from the rate schedule and assessed as a separate minimum charge, then the resulting rate schedule is a lifeline rate schedule, arrived at by applying the fully allocated cost method of determining the cost of service.

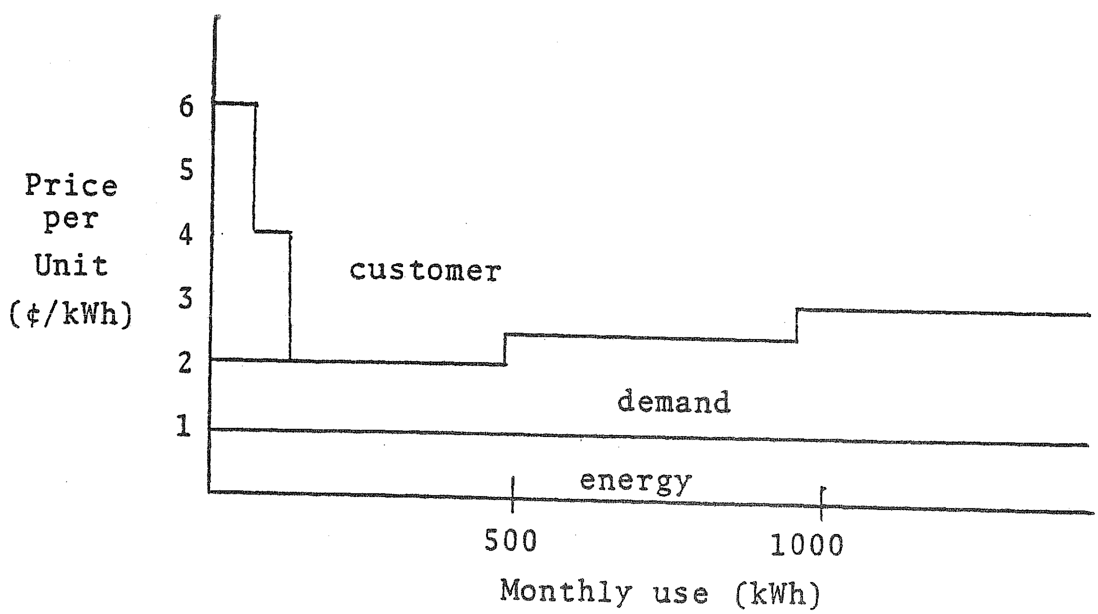

Figure C-4

[5] See the data in Table 5-2 for support of this argument.

This higher rate for tail block use should not apply to the all-electric home for winter space heating unless that home also contributes significantly to the summer air conditioning peak demand. This conclusion applies only if Ohio remains a state with a summer peak. There are indications that Ohio may have a winter peak in the future.

We have seen four methods of distributing demand costs. It is hard to argue on a firm basis that any one of these methods is more fair than the other in the absence of data relating monthly use to the amount of customer demand coincident with system peak. However, in the absence of such data we believe the flat demand rate should be presumed fairer.

We attempted to determine how Ohio electric utilities distribute demand and customer costs among the rate blocks on residential rate schedules. We began with a telephone survey of the rate analysts for all Ohio electric utilities. In most cases we were told that most of the customer charges are recovered in the first few blocks and some demand charges were included in all blocks, but that it is not possible to determine how much of the rate for each block was made up of demand and customer charges.

Declining block rates were instituted in the past, we believe, to promote sales and perhaps to minimize the revenue uncertainty problem discussed in Chapter 3. From our survey we gained the impression that current rate schedules result from adjusting the rates on old schedules just enough to meet new revenue requirements, but without regard to how customer and demand charges are exactly distributed.

Therefore, we have made our own estimates of the distribution of demand charges among the rate blocks for a typical Ohio electric utility. To do this, we took a current rate schedule and subtracted the energy charge from each block. The energy charge is approximated by assuming it is equal to the fuel charge per kWh at the time of the rate hearing which established the rate schedule in question. Customer charges were calculated by a method suggested by Doran.[6] Although exact numerical values for the demand charges on each block cannot be calculated without knowing how the customer charge is distributed across these blocks, we were able to determine with certainty that the demand charge per kWh decreases going from the front to the tail block.

In the absence of evidence showing that early block sales contribute any more to demand than later block sales, it is at least questionable whether a declining block demand charge is "fair" in any sense. If a flat demand charge were built into electricity rate schedules and customer charges were separated from the rate blocks and identified as a minimum charge, then the rate schedule would be flat. In terms of consistency with the fully allocated cost method of setting rates equal to the cost of service, the flat rate with a minimum charge appears to be no less fair, and may well be more fair, than the declining block rate. In addition, we have seen that in some cases a demand cost per kWh increasing with consumption may be justified on a cost of service basis.

Gas

For gas utilties, analysis of the fairness of declining block rates is less complex. Demand varies from heating season to nonheating season and is greatest in the heating season. But in the current curtailment situation there is no expectation that demand will result in a need to expand system capacity.

Typical residential declining block rate schedules in Ohio consist of a high rate (averaging $3 per mcf) for the first block where the length of the first block is

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[6] J.J. Doran, et al., Cost Allocation Manual, NARUC, Washington, D.C., 1973.

usually 2 mcf in length. For all residential use above 2 mcf, the rate is flat, or almost flat. The average use for gas is about 5 mcf during the nonheating season and about 25 mcf during the heating season. Hence for almost all customers the first block is equivalent to a minimum customer charge and remaining gas is purchased at an essentially flat rate.

In view of our discussion presented in the previous section, we find that this rate structure is fair according to the fully allocated cost method of determining the cost of service. It is worth recalling here, however, reservations about the fairness of the method itself, expressed in Appendix A.

APPENDIX D

OHIO'S LIFELINE BILL: SUB. H.B. 583

LSC 111 2800

111th General Assembly

Regular Session

1975-1976

Sub. H. B. 583

MR. Wilkowski

A BILL

To enact section 4905.341 of the Revised Code to create a special category of "lifeline" for residential electric and gas consumers.

BE IT ENACTED BY THE GENERAL ASSEMBLY OF THE STATE OF OHIO:

Section 1. That section 4905.341 of the Revised Code be enacted to read as follows:

Sec. 4905.341. AS USED IN THIS SECTION:

(A) "RESIDENTIAL CONSUMERS" ARE URBAN, SUBURBAN, AND RURAL PATRONS OF ELECTRIC LIGHT COMPANIES AND GAS AND NATURAL GAS COMPANIES INSOFAR AS THEIR NEEDS FOR ELECTRICITY AND GAS ARE LIMITED TO THEIR RESIDENCE.

(B) "TOTAL ELECTRIC DWELLING UNIT" IS A DWELLING UNIT WHICH IS HEATED FROM THE FIRST DAY OF NOVEMBER TO THE LAST DAY OF MARCH OF EACH YEAR PRINCIPALLY THROUGH THE USE OF ELECTRICITY.

(C) "MONTHLY BILLING PERIOD" IS THAT PERIOD OF TIME FOR WHICH AN ELECTRIC LIGHT COMPANY OR GAS OR NATURAL GAS COMPANY NORMALLY BILLS ITS RESIDENTIAL CONSUMERS. FOR THE PURPOSE OF DETERMINING THE QUANTITIES OF ELECTRICITY AND GAS TO WHICH THE LIFELINE RATE SHALL APPLY, ALL ELECTRIC LIGHT COMPANIES, GAS COMPANIES, AND NATURAL GAS COMPANIES SHALL HAVE TWELVE MONTHLY BILLING PERIODS IN EACH CALENDAR YEAR, ALL OF WHICH SHALL BE AS EQUAL IN LENGTH AS IS REASONABLY POSSIBLE. IF ANY PORTION OF A MONTHLY BILLING PERIOD FALLS ON OR AFTER THE FIRST DAY OF NOVEMBER AND ON OR BEFORE THE LAST DAY OF MARCH THAT ENTIRE MONTHLY BILLING PERIOD SHALL BE TREATED AS IF ALL OF IT WAS INCLUDED WITHIN THE PERIOD BEGINNING THE FIRST DAY OF NOVEMBER AND ENDING THE LAST DAY OF MARCH.

(D) "LIFELINE RATE" SHALL BE THE LOWEST UNIT RATE CHARGED TO ANY CUSTOMER OF AN ELECTRIC LIGHT COMPANY, A GAS COMPANY, AND A NATURAL GAS COMPANY IN ANY BLOCK OF ITS SCHEDULED RATE STRUCTURE.

(E) THE TERM "c.c.f." MEANS ONE HUNDRED CUBIC FEET.

EVERY RESIDENTIAL CONSUMER SHALL BE CHARGED A LIFELINE RATE FOR THE FOLLOWING QUANTITIES OF GAS AND ELECTRICITY:

(F) EXCEPT FOR TOTAL ELECTRIC DWELLING UNITS, THE FIRST FIVE HUNDRED KILOWATT HOURS OF ELECTRICITY USED DURING EACH MONTHLY BILLING PERIOD.

(G) FOR ALL TOTAL ELECTRIC DWELLING UNITS, THE FIRST TWO THOUSAND FIVE HUNDRED KILOWATT HOURS OF ELECTRICITY USED DURING EACH MONTHLY BILLING PERIOD BEGINNING THE FIRST DAY OF NOVEMBER

AND ENDING THE LAST DAY OF MARCH AND THE FIRST FIVE HUNDRED KILOWATT HOURS OF ELECTRICITY USED DURING EACH MONTHLY BILLING PERIOD BEGINNING THE FIRST DAY OF APRIL AND ENDING THE LAST DAY OF OCTOBER.

(H) THE FIRST THREE HUNDRED c.c.f. OF GAS IN ANY FORM USED DURING EACH MONTHLY BILLING PERIOD.

Section 2. Each electric light company and gas and natural gas company shall file with the Public Utilities Commission schedules revised in conformance with section 4905.341 of the Revised Code within thirty days after the effective date of this Act. The Commission shall order such reductions in existing schedules as are necessary under this Act within thirty days after such filing.

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