INFORMATION AND THE ELECTRIC ENERGY MARKET: THE NEED FOR THE AVAILABILITY OF PRICE INFORMATION TO ENCOURAGE CONSERVATION[1]

by

Ola A. Oyefusi, Ph.D.
Pubic Service Commission of the District of Columbia
450 Fifth Street, N.W., Washington D.C. 20001

Introduction: On average, a customer using utility services only has limited knowledge about the characteristics of the market in which the utility services are sold. Information necessary for making decisions about transactions involving the utilities and utility appliances are also often inadequate. This is contrary to an idealized market exchange which requires the buyers and the sellers to have full knowledge of the transaction-related data that are necessary for decision making. For example, buyers are expected to know the price and product characteristics offered by sellers. Sellers must be aware of product prices, wage rates, cost of inputs, interest rates, and other production related data, as well as information about the buyers.

An idealized model is often assumed because of its capability to yield optimal solutions. It is also often used as a benchmark against which real world markets and situations are measured. An example of an idealized model is perfect competition. The perfectly competitive system, by utilizing the information produced by prices, has the tendency to achieve efficient allocation of resources.[2]

However, this model differ from the structure of the market for electricity which, in most U.S. cities, has a natural monopolistic structure. In these natural monopoly markets, the economic and technical conditions of the market permit only one efficient enterprise.[3] In order to attain the efficiency goals of competition, and to avoid wasteful duplication in this markets, regulation is often used as a surrogate for competition.

As a real world example, the markets for electricity show a natural monopolistic structure in terms of the number of

---

[1]The views in this paper are the author's and do not necessarily reflect those of the Public service Commission of the District of Columbia.

[2]See Nicholson, W., Intermediate Microeconomics and Its Application, 1979, pp. 497 - 520.

[3]See Greer, D., Industrial Organization and Public Policy, 1980, p. 485.

effective producers of electricity. However, the elements of competition are present in other forms. For example, residential customers have access to natural gas and other alternative sources of energy for cooking, space heating, and air conditioning. Thus, perfect or adequate knowledge, a condition of perfect competition, is still relevant because the price information would enable the customers to make cross market comparisons and choose the cheapest source of energy available to satisfy their needs. For many energy users, this information is even more valuable when they have to decide whether or not to install an energy efficient appliance, a transaction that involves a larger initial sunk cost.

The relevance of the elements of perfect competition especially to a natural monopolistic market is expressed in their use as guides for allocating energy resources. The efficiency elements of perfect competition are absent because of the structural differences between the two types of markets. In perfect competition there are alternative sellers such that information that is not available from one firm is provided by others. Thus, in such a setting, it is a good strategy for sellers to make the buyers adequately informed about their product and price since there are no differential costs to buyers for switching their purchase to other sellers.[4]

With a natural monopoly, a structure observed in most electricity markets in the United States, transaction costs are present and are higher. An example of this cost is the cost to buyers of acquiring the relevant information in an exchange. In fact, the buyer's cost is greater and the seller often dictates and controls the terms of the exchange. As a result, an asymmetry is introduced when the greater transaction costs situation faced by buyers improves the sellers' bargaining position. "Asymmetric information," sometimes termed "Asymmetry of information" exists when a trading group has access to relevant information that is not available to other individuals participating in the same transaction. With such asymmetry, purchasers are either uninformed or ill-informed, and thus often make incorrect decisions about a transaction or pay more than they would have if they had the same information as the seller.[5]

---

[4]This conclusion is based on the premise that this is a zero-transaction cost environment. In reality, there are some transaction costs. However, the relevant issue at this instant is that transaction costs (e.g. switching costs) differ in one market type relative to another. As a general rule, competitive structures tend to cause lower switching costs than monopolies.

[5]For more discussion on the economics of information see, Akerloff, G., Quarterly Journal of Economics, 1970, 84:488-500; Grossman, S. and Stiglitz, J., American Economic Review, 1976, 66:246-253; and Rothschild, M., Journal of Political Economy, 1973, 81:1283-1308.

These private costs may transform into a substantial loss to the society. For example, when customer's willingness to purchase and pay is not exactly linked to costs because of the lack of information, the right levels of demand are not revealed. As a result, producers wrongly react (e.g. allocate resources inefficiently) by employing productive technologies that could be used elsewhere in a particular type of production. The opportunity cost of the misallocation of resources is that the quantity and quality of other socially beneficial goods are inadequate. If available at all, they will be too expensive, and so may be unaffordable.

<u>Significance of Price Information</u>: As indicated above, optimal decision by customers require knowledge of price. However, only in about half of the regulatory jurisdictions in the United States is the actual rate schedule (i.e. the price of electricity) shown on the monthly billing statements for residential customers. This implies that decisions about utility related transactions made by many customers in the nation are sub-optimal. As a result, resources are wasted, and transaction costs are high.

Ideally, paramount to any transaction is the ascertainment of the market price. Explicit display of the market price minimizes ignorance about the transaction and reduces the expected cost to buyers of making uninformed decisions. Hence, in the case of the market for electricity, the rate structure information is valuable. The value of displaying the rate information is measured by the amount by which being informed reduces the expected cost of transaction to the buyers (e.g. in terms of the monthly savings on the bill) and to the society (e.g. in terms of the efficient use of energy resources).

The implication in terms of the gain or loss to the society is even more important when there is a need to design rates that would discourage energy consumption and promote energy conservation. To reiterate, the information transmitted through price and non-price signals assists the customers in avoiding wrong decisions regarding the purchase of electricity. These signals give the customers the incentive to change their behavior and reduce energy usage when cost savings are apparent.

In addition, the reduction in energy consumption induced by the implied savings is crucial because it reduces the need by electric utilities to build new generating plants to meet customer requirements. Therefore, cost-based rate designs, which are practiced in some parts of the nation, should complement the market requirement for price information. Differential rates alone will not discourage usage when the energy is most costly to produce (e.g. during summer months). The rates, once designed, must be revealed to customers to achieve their purpose.

A similar sentiment was expressed during the District of Columbia Formal Case No. 905 by PEPCO witness Mayberry:

> By setting the highest prices in the period of peak demand in the summer, when it is most costly to produce electricity, customers are encouraged to reduce consumption when cost savings, both of capacity and energy, are greatest.[6]

PEPCO's intent is to design rate schedules that send proper price signals about actual energy costs to customers and also encourage conservation. However, the inducement to conserve energy and the cost savings implied may not be achieved if the appropriate price signals are not revealed to the customers on their monthly bills. Without the right signals, electric utility customers may be unable to make the correct decisions concerning energy consumption and implementation of energy efficiency and conservation measures.

A further argument can be proposed. According to economist Alfred Kahn,[7] the efficient allocation of resources, which is the premise upon which the cost-driven rate design proposal is based, requires setting rates that are consistent with the true costs of providing the service. However, this principle must not conflict with the other important market condition which requires effective knowledge by buyers and sellers. Cost driven rates will not achieve effective conservation unless they are fully known to the customers.

Even if the rate reflects marginal costs, and is capable of transmitting proper signals, its value would be diminished and the desired efficiency goal would not be achieved when the appropriate rate structure is not available at the key decision making times such as when a bill is paid by the customers and at the start of a new billing cycle. This proposal is even more essential for transactions involving the sale and use of electric energy for the following reason. Unlike other types of products (e.g. shoes) which can be returned if the qualities were inadequate or the quantities were excessive electric energy, once used, cannot be returned to the utility company for any reason. Customers use it first, and then pay for it later. The only recourse a customer may have in this case is if a billing error is made by the company. Problems regarding quality and quantity can only be corrected for future usage, not on prior usage. Therefore, the utility customers must be fully, and not partially, informed about the actual rates to ensure the desired consumption behavior and encourage conservation.

---

[6]The Potomac Electric Power Company (PEPCO) is the supplier of electricity in the District of Columbia.

[7]Alfred Kahn, Economics of Regulation, (1988), p.65.

An intermediate implication is that displaying the actual rate structure on residential customer's bills impacts the accurate estimation of the price elasticity of demand and its use for rate design purposes and forecasting future energy demand. Price elasticity of demand is a measure of consumer behavior, e.g., the responsiveness of quantity demanded (i.e., consumption) to changes in price. It presumes therefore the consumer is aware of the price and decides how much to consume with this factor in mind. When the consumer does not know the price (actual rate), then the consumption behavior may not be appropriate and any price elasticity of demand measure based on such quantity demanded would be incorrect.

For example, there is evidence in the literature that the price elasticity estimates are not reliable. One of the reasons it may be difficult to obtain accurate elasticity measures is because of the absence of a linkage in the customer's mind between the actual prices they are paying and the amount of electricity they are consuming.

A complement to the rate structure information that would be equally valuable to customers purchasing electric energy is the next meter reading date. Revealing the date of the next meter reading will enable the utility's customers to ascertain the accuracy of the meter readings. Combined with information about the rate structure under which the service is being rendered, the customer is assisted in checking the accuracy of the energy charge presented on the bill.

In addition, the customer is assisted in ascertaining the actual billing month which is often confused with the calendar month. The ascertainment of the actual billing cycle reduces confusion by enabling the customers to plan the inception of their conservation efforts to coincide with the beginning of a billing cycle. As a result, the true impact of the conservation programs will be known even though meters may not be read on the scheduled date.[8] A one day differential should not create any significant problem relative to the benefits derived from this information.

Practicality of Displaying the Rate Structure, Average versus Actual Rate: A survey of all regulatory commissions in the United States shows that several utilities display detailed rate information (including the rate schedule) on the monthly bills for residential customers.[9] The survey findings are summarized in Figure 1 which contains a pie chart

---

[8]Usually, meters are read one day prior or one day after the scheduled meter reading date.

[9]The survey was conducted by telephone in January/February, 1992.

showing the proportion of states responding either "Yes" or "Nc to the following survey question(s):

> Do utilities in your state include on the monthly bill the rate structure under which service is being rendered?

If the response was a "Yes,"

> Is this a statutory requirement by your Commission?

Utilities in about half the states provide rate structures on t monthly bills for residential service. More specifically, out the fifty states and the District of Columbia, twenty-one (41%) responded "Yes, required by Commission;" four (8%) responded "Yes, but not required by Commission;" and twenty-four (47%) answered "No, not required by Commission" to the survey questions. Two states (4%), California and West Virginia, did not respond to the survey requests.

The survey also gathered data on the types of rate structures f electric utilities across the United States. Out of the 19 states providing their billing samples from which these data we compiled, twelve (63%) use flat rates; five (26%) use the inverted rates; one (5%) has declining rates; and one (5%) alsc has time of use rates. That is, about 37% of the states use at least a form of non-flat rates (inverted, declining, time of us for which the display of actual rate structure is important to transmit proper price information. In these cases, surrogates (e.g. average rates) cannot be used to represent the actual rates.

The average rate information is not appropriate, especially whe a customer faces an inverted rate structure, for two reasons. First, it provides the customers with a misleading and false price signal. That is, it suggests every kilowatt hour of ener is being billed at the same price. When the rate structure is inverted or declining, this is not the case. For example, in D the residential rate structure is inverted; that is a kwh below the 400 kwh level is billed at one rate; above 400 kwh is bille at a much higher rate. Thus, use of average rate information o bills would not reveal to customers the proper cost of the ener they use, nor would it achieve the conservation incentive.

However, the average rate information may be used in some limit cases. The type of rate information that gives the proper signals depends on the rate schedule under which service is bei provided. For example, if a customer faces a flat rate schedul the average rate per kwh is equal to the actual rate per kwh at the point of usage along the rate block, and so average rates provide appropriate signals in that circumstance. Under a non-flat rate structure (e.g., the inverted block structure) the average rate will not equal the actual rate at a given point of usage. This difference is very crucial from a conservation standpoint.

The Inverted Rate Structure in DC: An Example: To further highlight the difference between the rate structure discussed above a graphical illustration is presented in Figure 2 which shows the average and actual cost per kwh for a residential customer in DC facing an inverted rate structure. As expected from a theoretical reasoning, the average rate line diverges from the actual rate line because of the variations in rates across the rate blocks.

The chart shows only two of the three rate blocks (the second and the tail blocks) of the inverted rate schedule. The first rate block has been omitted under the assumption that few customers use less than thirty kilowatt hours per month. In this graph, the average cost is represented by a U-shaped curve, which falls as energy consumption increases and then rises continuously as energy exceeds 400 kilowatt hours. This curve rises faster in the summer than in the winter, and the area between the two average cost curves reflect the 2.587 cents per kwh for seasonal differential due to the peak in energy demand in the summer.

The actual rate schedule is represented by an increasing step function. That is, a series of horizontal lines drawn at different rates and spanning different usage ranges. These steps which rise as energy usage exceeds 400 kwh represents a sudden rate change at that point. The steps are higher for the summer months than the winter months reflecting the peak in energy demand occurring in the summer. As stated above, the higher rate is expected to discourage customers from using too much energy at the time when it is most costly to produce.

There are four implications of the difference in the shapes of the two functions shown in Figure 2. First, as energy usage increases from 31 kwh, the average rate continues to fall even past the 400 kwh level when the actual rate has increased by a substantial amount. That is, the customers are not immediately aware of the rate change; this indicates a lag created by the lack of complete and timely price information. The summer rate change, for example, is reflected in the June bill for usage in the May billing month. However, at this time the customer is unaware of the higher incremental rate and continues to use energy as if the lower winter rates were still in effect. Thus a substantial amount of energy resources could be saved if customers were appropriately notified, ex ante, of the proposed seasonal rate change.[10]

---

[10]This suggestion is expected to complement the earlier proposal that the actual rate structure be displayed on monthly billing statements (the thrust of this paper) to provide proper price signals and encourage conservation.

Without the proper information the customer is left with the false perception that the rate he/she pays is lower than the actual rate, especially in the first summer billing month. In most cases, residential customers only feel the impact of the summer rate change with at least one month lag. Instead of possibly cutting energy consumption, had the customer received the proper signals, more energy is used because of false information.

Second, the three points on the average rate curves marked A, B, C in Figure 2 have the same average costs, but correspond to different total costs as measured by the area under the curves. To reiterate, this total cost differential for the same average rate of 6 cents per kwh is due not only to differences in kwh usage, but also to the rate change as usage exceeds 400 kwh, and to the seasonal rate block differential. Thus, approximating the actual rate structure with the average rate conceals and understates the true costs to customers of the energy they use.

Third, consider the two pairs of points D and F, E and G in Figure 2 which correspond to the same energy usage but yield different total costs. The costs are measured by the area bounded by the pair of points (D&F, E&G) under the step function. The substantial difference in this area from the area bounded under the average rate curve in the same region shows that the costs approximated by the average rate are less than the true energy costs to the customers (e.g. the area bounded by D&F, E&G). The real costs can only be revealed to customers by the actual rate schedule, and not by the average rate. Thus, the contemporaneous average rate does not produce the proper signal to induce the customer's conservation efforts.

The fourth implication is best presented with a different illustration in Figure 3. Suppose a rate change at 400 kwh is not necessary, and the horizontal line at 4.677 cents/kwh is extended by a dashed line. The area above the dashed line is the cost savings to the customer (1) if there were no rate differentials after 400 kwh usage (across rate blocks), or (2) if a rate block differential occurs but customers are able to maintain energy usage below 400 kwh level due to conservation efforts. The average rate information conceals the large jump in costs at 400 kwh level and makes it appear insignificant to the customer. This jump in cost across rate blocks is larger in the summer than in the winter for the reasons explained above.

Regarding (2) above, it is rare for average consumption to fall below the 400 kwh level. Examples of the actual average usage patterns (in 1991) of DC's basic residential customers, residential water heating customers, and residential water and space heating customers are shown in Figures 4, 5, 6, respectively. The actual usage patterns are marked by interior labels on the graphs. Asterisks (*) represent energy consumption in the summer, and pluses (+) represent energy consumption in the winter.[11]

The implication of this observation is that actual consumption often occurs in the tail block where energy cost per kwh is highest.[12] This observation is further reinforced by the proportions of monthly bills contributed by energy consumption within the different rate blocks of the inverted rate schedule. These data are compiled for basic residential customers, residential water heating customers, and residential water and space heating customers in Tables 1, 2, 3, respectively. The data for the summer months are shown in the shaded row to highlight the impacts of the seasonal rate differential.

These tables reveal two interesting inferences. First, the column labelled "Block 3" contains the tail block energy consumption as a percentage of the monthly bills. These data show that for the residential customers the largest proportion of the total bill for the summer months is incurred due to the tail block energy usage. This assertion holds also for residential water heating customers, and for the residential water and space heating customers (for both the summer and winter billing months). Thus, a great amount of resources could be saved if customers have the proper price signals and elicit effort to avoid usage in the tail block.

The second inference is derived from Blocks 3a and 3b which are produced by splitting the tail block (Block 3) to explain the effects of the rate differentials. Block 3b is the proportion of total cost the tail-block energy represents if billed at the second block's rate. Block 3a represents the proportion of the total bill that would be saved if consumption in the tail block were avoided (i.e. if the customer's usage does not exceed 400 kwh per month). The amount of savings depends on the type of customer and the billing month. For example, the cost saving is highest for the all-electric customers (32.52%) in February, 1991 and lowest for the regular residential customers (3.61%) in May, 1991. Such cost avoidance can only be induced if the detailed rate information which reveals the true cost of the tail block kwh is known to the customers.

---

[11]The data source is Formal Case No. 912, PEPCO (E)-6, page 1 of 19.

[12]The tail block charge has been changed (from 9.698 cents per kwh to 10.781 cents per kwh in the summer and from 7.111 cents per kwh to 9.698 cents per kwh in the winter) since the draft of this paper was written.

Conclusion: This paper has demonstrated that accurate price information (e.g. the rate schedule) is paramount for optimal decision making about transactions in the electric energy market. That is, explicit display of such transaction-related information, especially resulting in ascertaining the market price, eliminates ignorance about the transaction and reduces the expected (transaction) costs to buyers of making uninformed decisions. As a result, cost managing behavior by electric energy users is induced, reductions in wasteful energy consumption and resources is encouraged, and the need by electric utilities to build new generating plants to meet customer requirements is reduced.

Figure 1:

SURVEY OF BILLING FORMATS ACROSS UNITED STATES
Does Applicable Rate Schedule Appear on Monthly Bills?

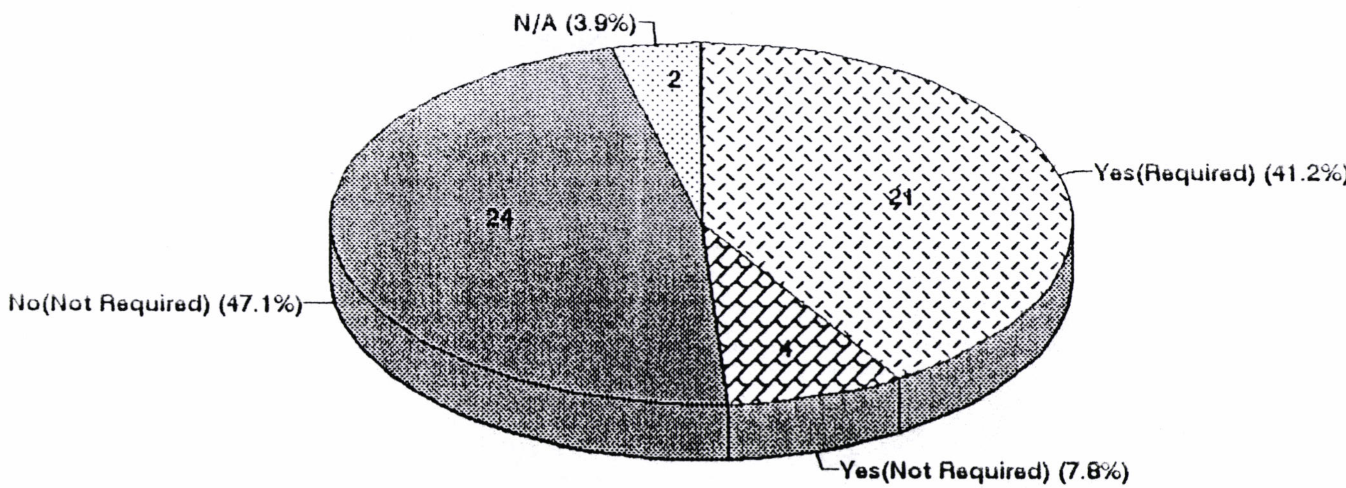
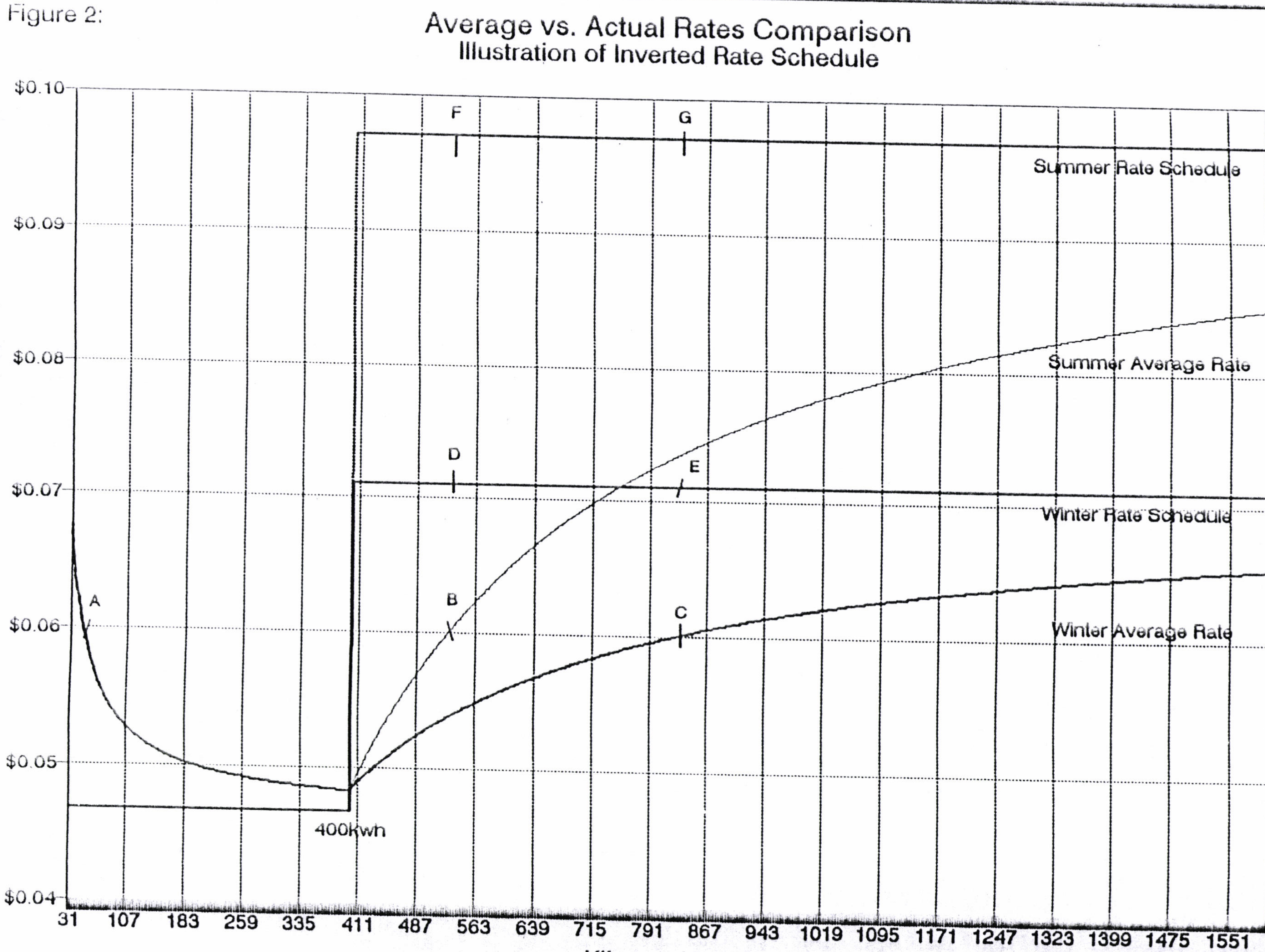


Figure 2:



Average vs. Actual Rates Comparison
Illustration of Inverted Rate Schedule
$0.10
$0.09
$0.08
$0.07
$0.06
$0.05
$0.04
31
107
183
259
335
411
487
563
639
715
791
867
943
1019
1095
1171
1247
1323
1399
1475
1551
400kwh
A
B
C
D
E
F
G
Summer Rate Schedule
Summer Average Rate
Winter Rate Schedule
Winter Average Rate

Figure 3:

Average vs. Actual Rates Comparison
Illustration of Inverted Rate Schedule

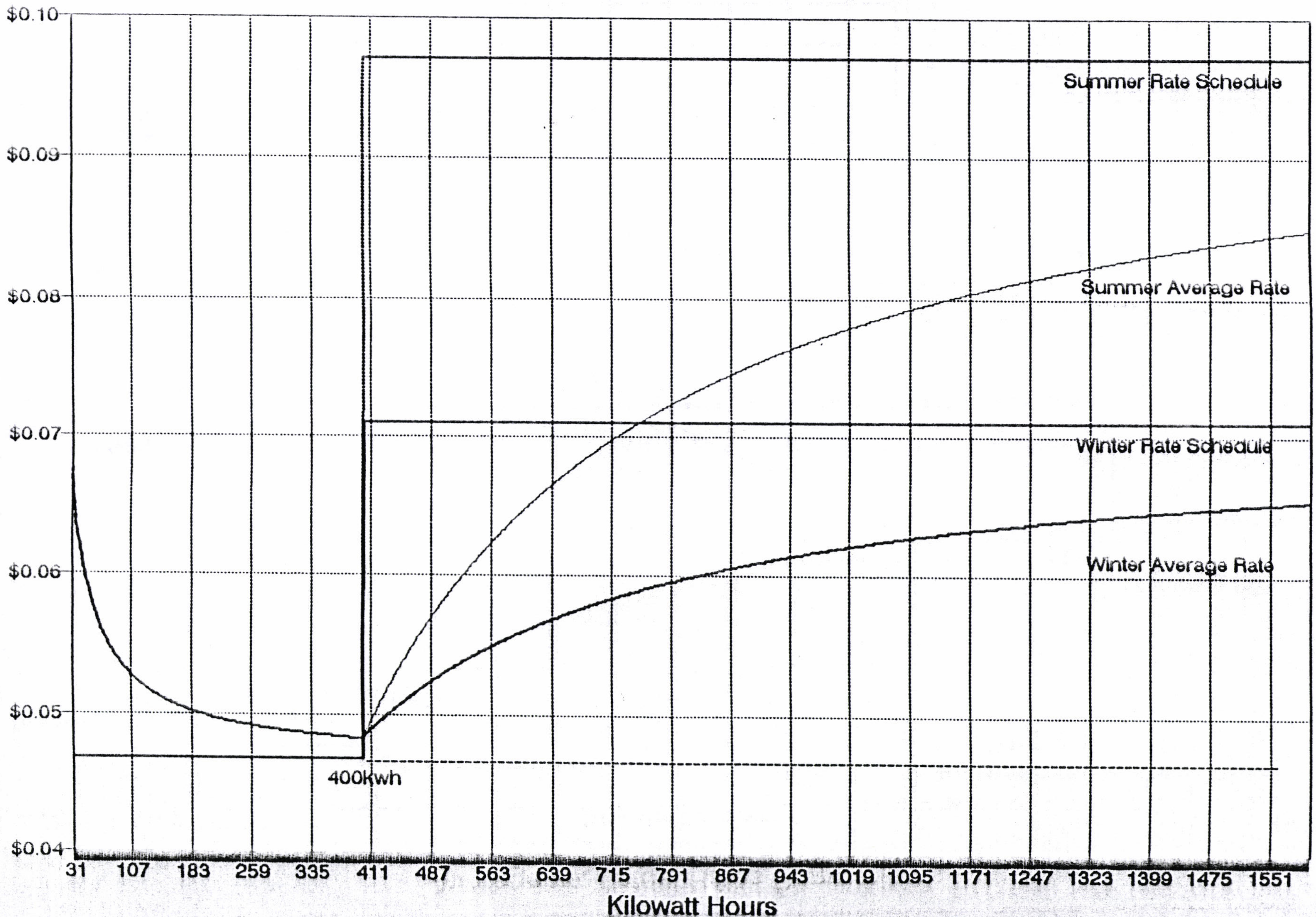


Figure 4:

Average vs. Actual Rates Comparison
Illustration of Inverted Rate Schedule

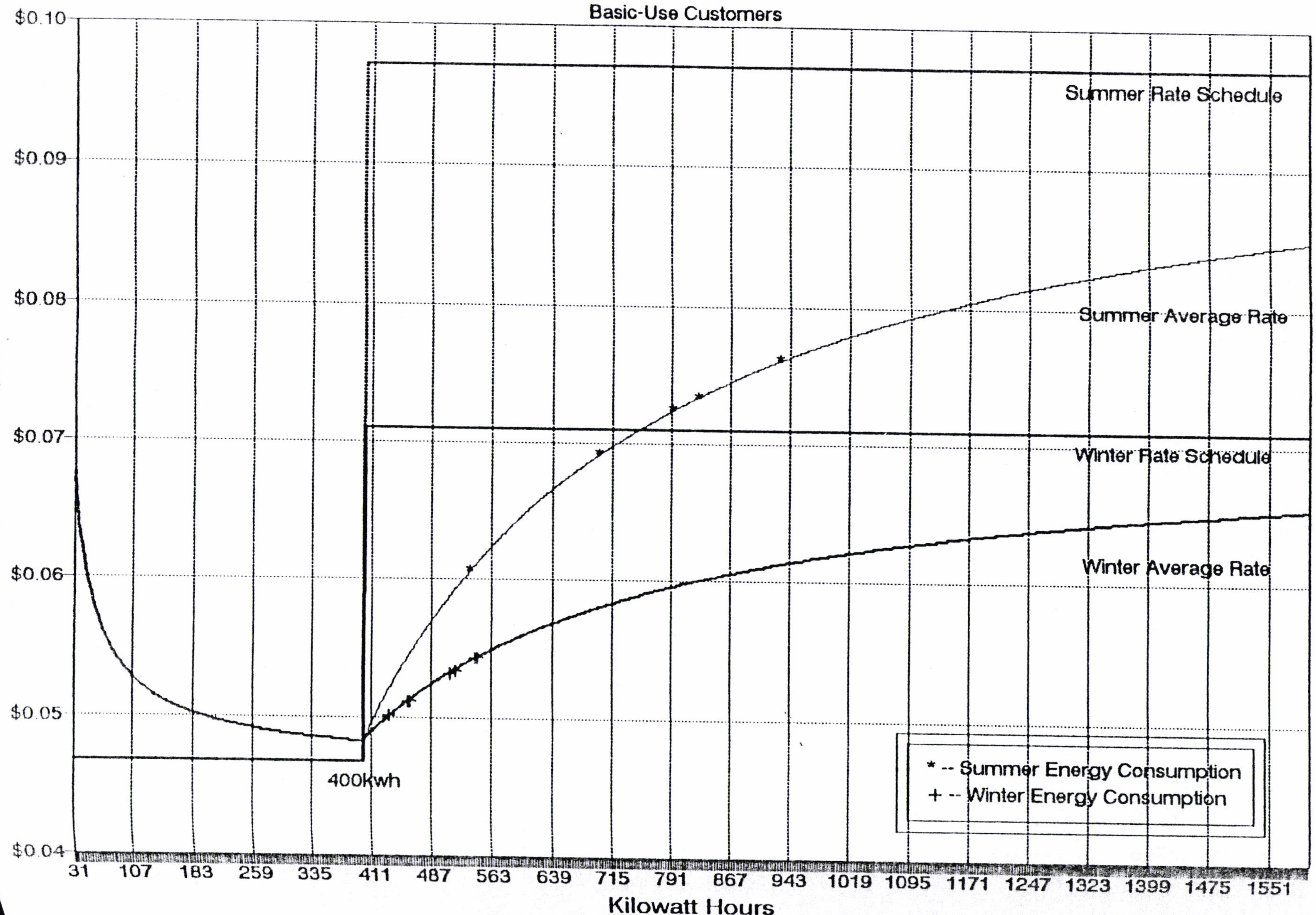


Figure 5:

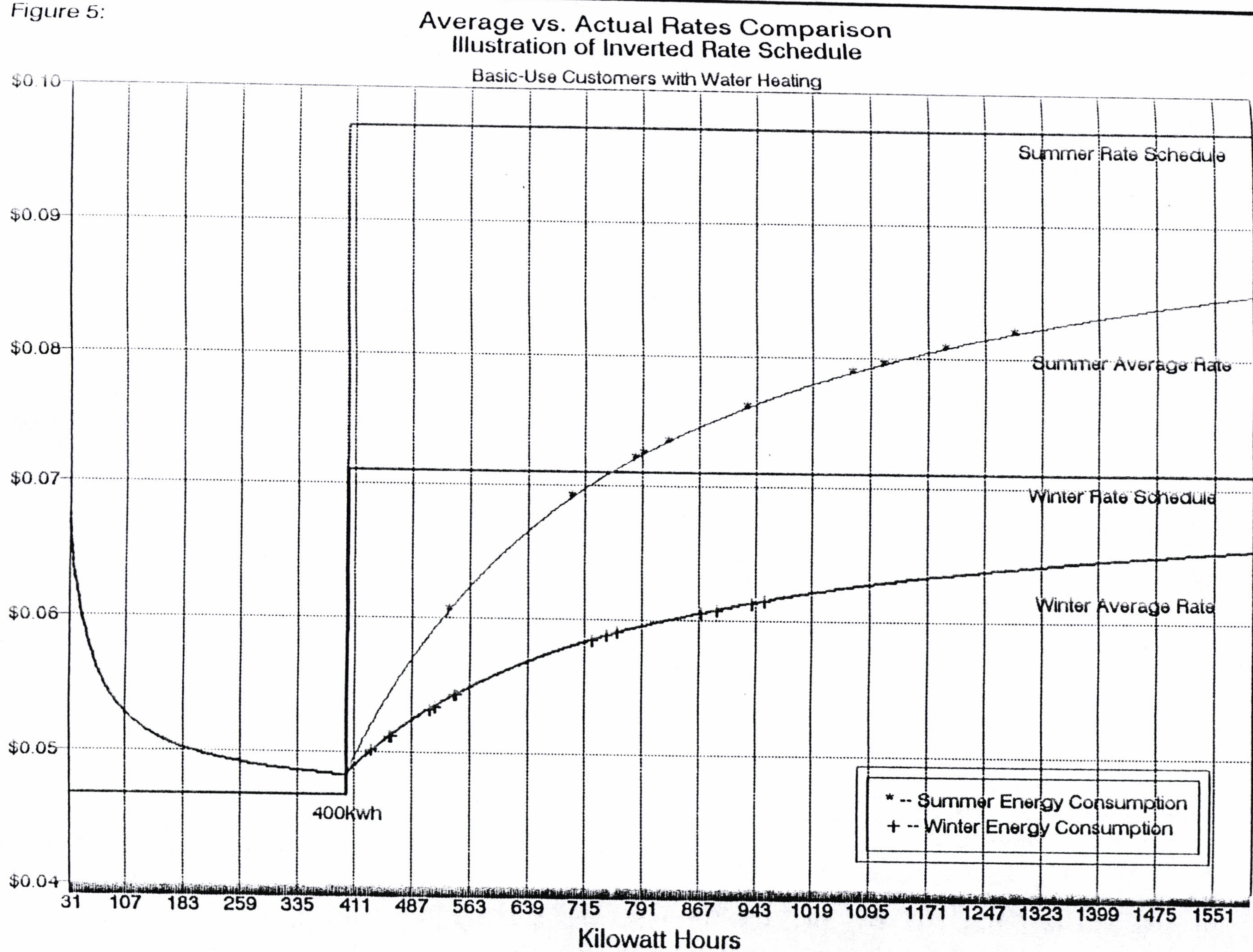

Average vs. Actual Rates Comparison
Illustration of Inverted Rate Schedule
Basic-Use Customers with Water Heating
$0.10
$0.09
$0.08
$0.07
$0.06
$0.05
$0.04
Summer Rate Schedule
Summer Average Rate
Winter Rate Schedule
Winter Average Rate
400kwh
* -- Summer Energy Consumption
+ -- Winter Energy Consumption
31
107
183
259
335
411
487
563
639
715
791
867
943
1019
1095
1171
1247
1323
1399
1475
1551
Kilowatt Hours

Figure 6:

Average vs. Actual Rates Comparison
Illustration of Inverted Rate Schedule

Basic-Use Customers with Water and Space Heating

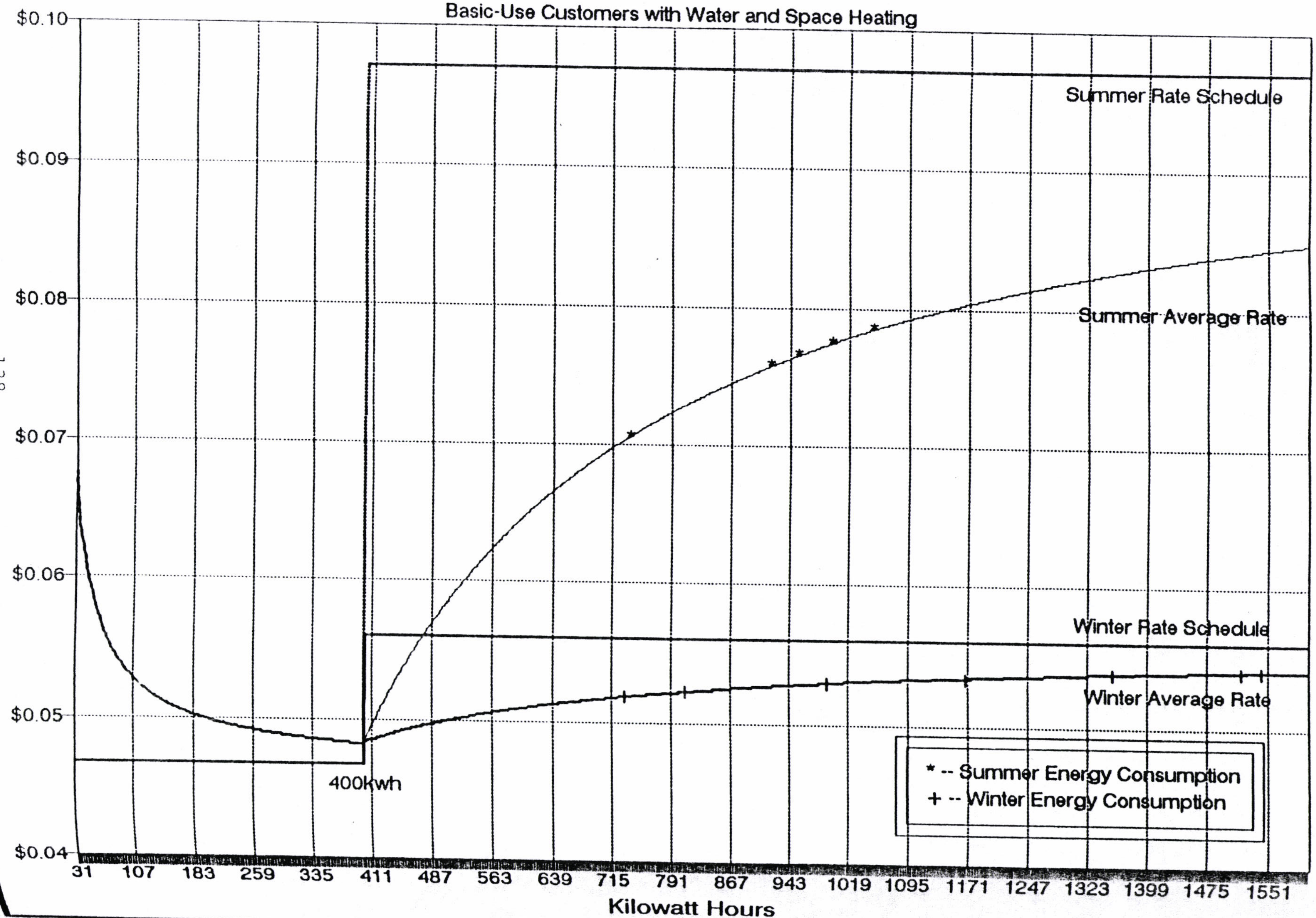


Table 1
Residential Monthly Bill
Basic-Use Customers

			Percent of Bill Within Rate Blocks					
Month	Average kwh*	Amount of Bill ($)*	Block 1	Block 2	Block 3	Other**	Block 3a	Block 3b
January	542	30.17	6.79%	57.35%	33.46%	2.39%	11.45%	22.01%
February	541	30.10	6.81%	57.49%	33.31%	2.40%	11.40%	21.91%
March	508	27.71	7.40%	62.45%	27.71%	2.44%	9.49%	18.23%
April	457	24.02	8.54%	72.05%	16.88%	2.54%	5.78%	11.10%
May	433	22.28	9.20%	77.67%	10.53%	2.59%	3.61%	6.93%
June	697	49.09	4.18%	35.25%	58.68%	1.89%	30.38%	28.30%
July	823	61.48	3.33%	28.15%	66.73%	1.78%	34.55%	32.18%
August	928	71.80	2.86%	24.10%	71.32%	1.72%	36.92%	34.39%
September	790	58.23	3.52%	29.72%	64.95%	1.81%	33.63%	31.32%
October	534	33.06	6.20%	52.34%	39.31%	2.15%	20.35%	18.96%
November	456	23.95	8.56%	72.27%	16.63%	2.54%	5.69%	10.94%
December	515	28.22	7.26%	61.32%	28.98%	2.43%	9.92%	19.06%

Key:
* -- Data Source = Formal Case No. 912, PEPCO (E)-6, page 1 of 19.
** -- Other includes charges for annual fuel rate adjustment at $0.0013333 per kWh.

Table 2
Residential Monthly Bill
Basic-Use Customers With Water Heating

			Percent of Bill Within Rate Blocks					
Month	Average kwh*	Amount of Bill ($)*	Block 1	Block 2	Block 3	Other**	Block 3a	Block 3b
January	953	59.95	3.42%	28.87%	65.60%	2.12%	22.45%	43.14%
February	935	58.65	3.50%	29.51%	64.87%	2.13%	22.20%	42.67%
March	888	55.24	3.71%	31.33%	62.82%	2.14%	21.50%	41.32%
April	756	45.68	4.49%	37.88%	55.42%	2.21%	18.97%	36.45%
May	724	43.36	4.73%	39.91%	53.14%	2.23%	18.19%	34.95%
June	1070	85.76	2.39%	20.18%	75.77%	1.66%	39.23%	36.54%
July	1192	97.75	2.10%	17.70%	78.57%	1.63%	40.68%	37.89%
August	1285	106.89	1.92%	16.19%	80.29%	1.60%	41.57%	38.72%
September	1111	89.79	2.28%	19.27%	76.79%	1.65%	39.76%	37.04%
October	780	57.25	3.58%	30.23%	64.37%	1.82%	33.33%	31.05%
November	744	44.81	4.58%	38.62%	54.59%	2.21%	18.69%	35.91%
December	868	53.79	3.81%	32.17%	61.87%	2.15%	21.18%	40.69%

Key:

* -- Data Source = Formal Case No. 912, PEPCO (E)-6, page 1 of 19.

** -- Other includes charges for annual fuel rate adjustment at $0.0013333 per kWh.

Table 3
Residential Monthly Bill
Basic-Use Customers With Water Heating and Space Heating

			Percent of Bill Within Rate Blocks					
Month	Average kwh*	Amount of Bill ($)*	Block 1	Block 2	Block 3	Other**	Block 3a	Block 3b
January	1517	84.05	2.44%	20.59%	74.57%	2.41%	12.41%	62.15%
February	1543	85.55	2.40%	20.23%	74.97%	2.40%	12.48%	62.49%
March	1353	74.63	2.75%	23.19%	71.65%	2.42%	11.93%	59.72%
April	989	53.72	3.82%	32.21%	61.52%	2.45%	10.24%	51.28%
May	730	38.84	5.28%	44.55%	47.67%	2.51%	7.93%	39.73%
June	916	70.62	2.90%	24.50%	70.86%	1.73%	36.69%	34.17%
July	995	78.39	2.62%	22.08%	73.62%	1.69%	38.11%	35.50%
August	1048	83.60	2.45%	20.70%	75.18%	1.67%	38.92%	36.25%
September	952	74.16	2.76%	23.34%	72.19%	1.71%	37.37%	34.81%
October	737	53.02	3.87%	32.64%	61.64%	1.85%	31.91%	29.73%
November	807	43.27	4.74%	40.00%	52.78%	2.49%	8.79%	43.99%
December	1167	63.95	3.21%	27.06%	67.30%	2.43%	11.20%	56.10%

Key:
* -- Data Source = Formal Case No. 912, PEPCO (E)-6, page 1 of 19.
** -- Other includes charges for annual fuel rate adjustment at $0.0013333 per kWh.