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COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF PUBLIC UTILITES

Western Massachusetts Electric Company)	D.P.U. 588

TESTIMONY OF PAUL CHERNICK FOR THE ATTORNEY GENERAL

Volume I: Text

FRANCIS X. BELLOTTI
ATTORNEY GENERAL

By: Robert L. Dewees, Jr.
Assistant Attorney General
Utilities Division
Public Protection Bureau
One Ashburton Place
Boston, MA

Date May, 1981

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Q: Mr. Chernick, would you please state your name, position, and office address.

A: My name is Paul Chernick. I am employed by the Attorney General as a Utility Rate Analyst. My office is at One Ashburton Place, 19th floor, Bostn, Massachusetts 02108.

Q: Please describe briefly you professional education and experience.

A: I received a S.B. degree from the Massachusetts Institute of Technology in June, 1974 from the Civil Engineering Department, and a S.M. degree from the same school in February, 1978 inb Technology and Policy. I have been elected to membership in the civil engineering honorary society Chi Epsilon, to membership in the engineering honorary society Tau Beta Pi, and to associate membership in the research honorary society Tau Beta Pi, and to associate membership in the research honorary society Sigma Xi. I am the author of <u>Optimal Pricing for Peak Loads and Joint Production: Theory and Applications to Diverse Conditions, Report</u> 77-1, Technology and Policy Program, Massachusetts Institute of Technology. During my graduate education, I was the teaching assistant for courses in systems analysis. I have served as a consultant to the National Consumer Law Center for two projects: teaching part of a short course in rate design and time-of-use rates, and assisting in preparation for an electric time-of-use rate design case. I have also served as a consultant to the Northease Solar Energy Center on rates for cogenerations and small power producers.

Q: Have your testified previously as an expert witness?

A: Yes. I have testified jointly with Susan Geller before the Massachusetts Energy Facilities Siting Council and the Massachusetts Department of Public Utilities in the joint proceeding concerning Boston Edison's forecast, docketed by the E.F.S.C. as 78-12 and by the D.P.U. 19494, Phase I. I have also testified jointly with Susan Geller in Phase II of D.P.U. 19494, concerning Boston Edison's relationship to NEPOOL. I also testified before the E.F.S.C. in proceeding 78-17, on the 1978 forecast of Northeast Utilities; in E.F.S.C. 78-33 on the 1978 forecast and E.F.S.C. 79-33 on the 1979 forecast and supply plan of Eastern Utilities Associates; jointly with Susan Geller before the Atomic Safety and Licensing Board in Boston Edison Co., et al., Pilgrim Nuclear Generating Station No. 2, Docket No. 50-471 concerning the "need for power"; in D.P.U. 20055 regarding the 1979 forecasts of EUA and Fitchburg Gas and Electric, the cost of power from the Seabrook nuclear plant, and alternatives to Seabrook purchases; in D.P.U. 20248 on the cost of Seabrook power; in D.P.U. 200 on Massachusetts Electric Company's rate design and conservation initiatives; in D.P.U. 243 on Eastern Edison's rate design; in PUCT 3298, on Gulf States Utilities' Texas retail rate design; in E.F.S.C. 79-1 on

MMWEC's 1979 supply plan; in D.P.U. 472 on the allocation of the costs of the Residential Conservation Service; and in D.P.U. 535 on rates for small power producers. I have also submitted prefiled testimony on NU's 1980 forecast in E.F.S.C. 80-17 and prefiled joint testimony with Ms. Geller in the Boston Edison time-of-use rate design case, D.P.U. 19845, but have not yet testified.

Q: Please describe the subject matter and purpose of your testimony.

A: My testimony is in two parts. The first section deals with the changes in rate design proposed by Dr. Overcast. I will explain why I believe those changes are appropriate.

The second section deals with a number of issues involving conservation and alternative energy. I will discuss certain of WMECo's terms and conditions which should be changed, and explain why WMECo's activities promoting the use of electricity should be terminated. I will also discuss the limitations of the Northeast Utilities Conservation Program for the Eighties and Nineties (NUCPEN).

Q: Why will you discuss NUCPEN?

A: NUCPEN is a step in the right direction for NU and for New England. Because it represents an advance in the regional concept of conservation planning, it will undoubtedly be held up as a model for the majority of utilities which have not recognized the importance of utility conservation programs. Therefore, it is important to understand the weaknesses of NUCPEN, as well as its strengths.

RATE DESIGN

Q: Do you believe that the changes that WMECo has proposed in its rate structures are improvements?

A: Yes. I believe that the proposed changes will make WMECo's rates more efficient and more equitable. Furthermore, the transition to cost-based rates will be considerably easier, if the starting point is the proposed rate structure, rather than the existing structure.

Q: What are the significant features of the proposed charges?

A: There are three general improvements in the new rates. The rate structures have been simplified, the tail blocks have been increased and the rates flattened, and the promotional commercial heating rate has been eliminated.

Q: How have the rate structures been simplified?

A: An energy block has been eliminated from the declining-block structure of each of three rates: Schedule 10-regular, Schedule 10-water heating, and Schedule 20. One long-hours-use inducement block has been removed from Schedule 20, and two such blocks from Schedule 35. Finally, the entire commercial space-heating rate, Schedule 21, which has a total of six energy blocks, has been eliminated.

Q: What are the advantages of simplified rate structures?

A: Simplified rate structures facilitate customer evaluation of conservation cost-effectiveness. Also, the introduction in D.P.U. 20110 of more complex pricing provisions, such as time-of-day rates, interruptible rates, seasonal differentials, lifeline blocks, and load management incentives, will be more difficult if the rates for basic services are already complicated. Thus, much of the simplification proposed by WMECo in this case is likely to be required in D.P.U. 20110.

Q: Is there any advantage to simplifying the rates in this proceeding, rather than waiting until D.P.U. 20110?

A: Yes. The implementation of D.P.U. 20110 will probably result in many changes in customers' bills. If the simplification of basic rates can be accomplished before D.P.U. 20110, it will be easier for customers to understand the impact on their billings of the changes which result from D.P.U. 20110, whether these are revenue reallocations, inverted block rates or seasonal differentials, and to evaluate the advisability of optional rate forms (e.g., TOU or interruptibles), conservation options, and load management programs.

Q: Please describe how the tail blocks have been increased and the rates flattened in WMECo's proposed structure.

A: Table 1 shows that tail block energy prices for each of the non-TOU rates under the old rate structure and under WMECo's proposal. The proposed rates' tail blocks exceed those for existing rates by -3% to 47%, with a simple average of about 20%. Only for Schedule 20 regular use does the tail block decline. This is understandable, Tail blocks ¢/kwh

Rate	Existing Rates	Proposed Rates	% Increase(2)
10	3.741	4.605	11
20 regular	6.921	6.610	-3
200-400 hrs.	1.496	2.700	22
400 + hrs.	.561	2.700	47
21 regular (1)	4.770	6.610	21
200 + hrs.	1.871	2,700	14
night use	1.122	2.700	31
23	2.058	3.935	31
24	7.856	8.080	2
35 regular	1.683	2.403	13
200 - 300 hrs.	1.496	2.408	17
300 - 400 hrs.	1.029	2.408	27
400 + hrs.	0.561	1.800	27
transmission	0.533	1.700	26

Table 1 Tail block Energy Rates under the existing structure with an 87.05% surcharge and under the proposed rates

Note: (1) Assumes customer transfered to Rate 20
(2) Including 4¢ fuel charge

since this rate is also absorbing the old Schedule 21 regular use rates, which is considerably lower than the Schedule 20 regular rate.

Figure 1 shows base rate electric bills as a function of KWH consumption for the existing Schedule 10 and the proposed Schedule 10. Figure 2 provides the same information for the existing and proposed Schedule 10 with water heating. These figures illustrate two differences between the old and new rates: the new rates are flatter (more like straight lines in the graph) than the old rates, and the tail block charges are higher in the new rates.

Q: In making your comparisons, you assume an 87.05% surcharge on the existing rates. Does this imply an endorsement of the level of WMECo's requested rate increase?

A: No. I am not offering any testimony regarding overall rate levels. I am simply comparing the two alternatives WMECo has presented: a surcharge and a new rate design.

Q: What are the advantages of flattening rates and increasing tail blocks?

A: There are three general advantages. First, flattening rates redistributes revenue responsibility within a class in a manner which increases the tendency of the class to conserve energy. Under declining block rates, large customers face a lower average price than small users. Thus, the people with the most appliances, and hence with the greatest opportunity to conserve, have the least

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Figure 1

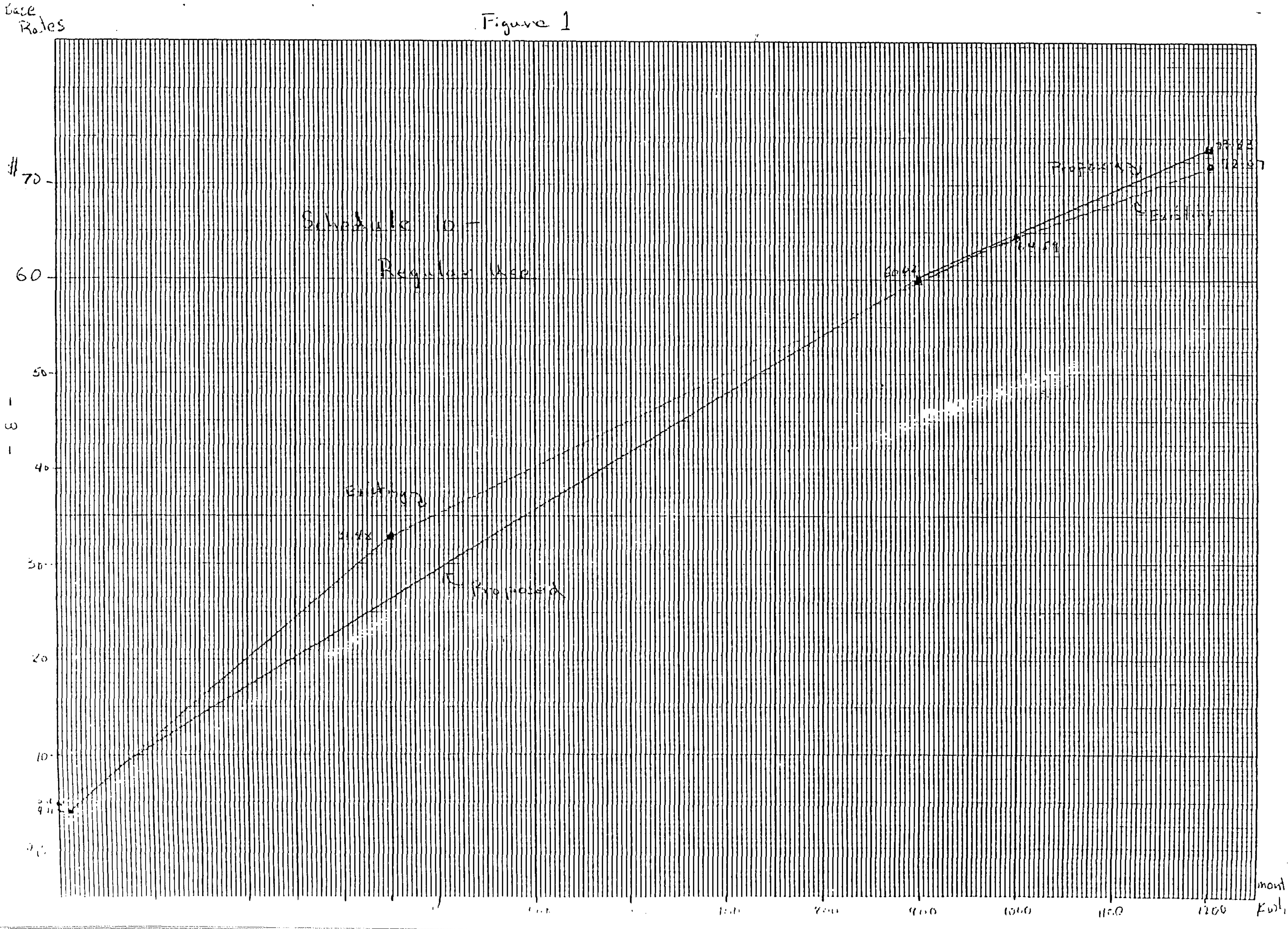

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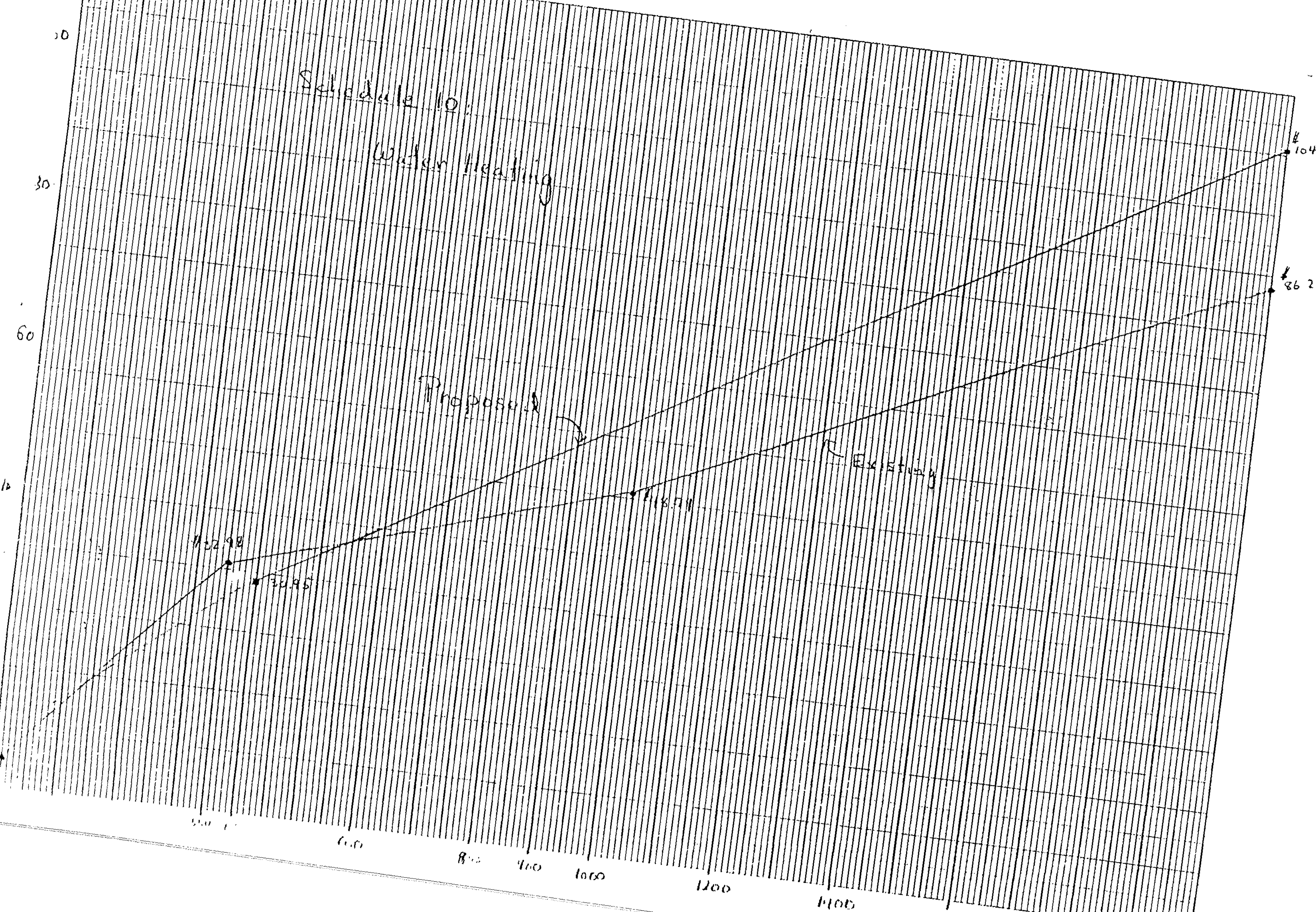
Figure 2



incentive to do so. Under flat rates, the costs are distributed more evenly into the bills of the larger customers.

Second, flatter rates would place more of the revenue paid by each customer into his/her largest bills, the ones over which the customer probably has the most control. For weather-sensitive classes (e.g., commercial with large air conditioning loads, electric heating customers), flat rates effectively increase the rates in high-use months, when insulation, temperature controls, and other conservation measures can be effective, while decreasing rates in the lower-use, off-peak months, when fewer promising conservation options are likely to exist.

Third, the flattening of rates gives the average customer more control over his bill. Under declining block rates, most customers will find that their marginal rate (the marginal rate is the rate paid for a few more KWH's or saved by using a few less KWH's) is considerably lower than the average price they pay per KWH. Therefore, the amount that customers can save by conserving, or the amount that they pay for extra use, is relatively small. The careful use of energy can be encouraged, and the customer can be given greater control over his bill, by increasing the marginal charges, that is, by flattening the rate structure.

This problem can easily be seen in WMECo's existing rate structure. The existing Schedules 20 and 21, for example, apply the higher price (12.16¢/kwh*) only to consumption under 150 kwh. Only 7.36% of the Schedule 21 bills in the bill frequency analysis were this small, and many of those bills were probably due to vacancies, erroneous estimates and the like. Therefore, the vast majority of customers will find that this block is intra-marginal (not near their marginal consumption) and beyond their control. Try as they might, they will not be able to reduce this part of the charge; no matter how profligate they are, they will not be charged 12.16¢ for any more KWH. Instead, on the existing rates, a large customer on Schedule 20 will save only 6.92¢ for each KWH he saves, a large Schedule 21 customer would save only 4.77¢ and high load-factor customers would save even less (as little as 0.56¢/kwh on Schedule 20 and 1.12¢/kwh on Schedule 21). This will tend to frustrate customers' efforts to control their bills, and limit their reward for conserving.

Third, the flat rate brings the price of using more power closer to the cost of producing more power. 1/

1/ All prices in this paragraph include an 87.05% surcharge and exclude fuel.

researchers have used statistical methods to measure customers' response to marginal price ans have found that this response is significant. These studies have estimated the elasticity of electric demand with respect to the marginal price of electricity by comparing electric use in areas with different marginal electric prices (cross-sectionally), by comparing electric use in one area as price changed over time (in a time series), or by combining cross-sectional and time-series data. A price elasticity is the percentage change in sales which is caused by a 1% increase in price. Thus, an eleasticity near zero implies little price response, while an elasticity with a large absolute value implies considerable price response. Negative elasticities imply that increased prices decrease sales, which is the expected result. Customers do not react instantaneously to a price increase. It takes time to change habits, insulate, replace appliances and so on. Therefore, short-run price elasticities (measured within a few months or a year of a price change) will be much smaller than elasticities which measure price effects in the long-run (ten or fifteen years). Unless otherwise noted, the elasticities I discuss below are long-run elasticities.

Taylor, Blattenberger, and Verleger (1977) developed two sets of elasticity models; relevant portions of their report appear in Appendix 1 to this testimony. The

According to WMECo's filing under §133 of PURPA (11/1/80), its marginal generation costs were 2.813¢/kwh off peak and 3.429¢/kwh on. Since 1979, fuel prices have increased dramatically. At West Springfield, January, 1981 purchases of #6 oil cost 105% more than the average price for 1979. If the price increases just 15% more by the middle of the rate year, the generation costs would be 6.632¢/kwh off-peak and 8.083¢/kwh on-peak. If the marginal energy losses in transmission and distribution as a percentage of sales are 12% off-peak and 25% on-peak, the costs at secondary would be 7.4¢ and 10.1¢, for an average of about 8.8¢/kwh. (These marginal loss estimates are quite modest. See Chernick and Geller, 1979, and MECo, 1978 for more detailed anlayses.) Due to the lower losses, high-voltage costs would be lower, around 8¢/kwh. Hence, with the fuel charge running approximately 4¢/kwh, energy charges of less than 4.8¢/kwh for secondary customers (and slightly less for primary customers) would not recover fuel costs alone. Transmission and distribution equipment costs would increase this figure.

The cost of Millstone 3 is quite uncertain, but it is not likely to be substantially cheaper than current marginal fuel costs. Cost estimates for the plant have reached $2.6 billion; at a 60% capacity factor and a 22% carrying charge, this is equivalent to 9.5¢/kwh, plus fuel, O & M, interim replacements, and decommissioning. While

Millstone 3 may turn out to be cheaper than the oil it replaces, its cost indicates that marginal energy costs cannot be expected to fall much in the near future, although they may stabilize.

As the preceding discussion has shown, both current fuel costs and future capacity costs are quite high. If rates do not provide incentives for conservation commensurate with these costs, customers will not expend the effort and capital for conservation which is justified by current and future oil prices and by the cost of utility alternatives to burning oil. In effect, customers would be receiving electricity which is not worth as much to the customers as it costs to generate.

Q: Do marginal energy charges actually affect energy use?

A: There is considerable evidence that they do. Practically speaking, it is difficult to understand why customers would respond to intramarginal charges which are beyond their control, or fail to respond to marginal charges which actually vary with consumption. The same point may be made in more elegant theoretical terms by defining the customer's objectives mathematically and determining the consumer's optimal level of electric consumption; only the marginal price of electricity will affect the rational consumer's actions.

Empirical evidence is rather sparse on this issue, but the small amount available supports the theory. Several flow-adjustment models indicated that the effects of intra-marginal charges are not statistically significant (p. 5-4; the t-ratios are less than 2.0), while the marginal-charge elasticity is significant and is about -0.8 if a logarithmic equation is used, to about -5 if a linear model is assumed (p. 5-9). For the appliance stock models, the intra-marginal charge coefficients in the intensity equations average 26% of the marginal charge coefficients. The appliance saturation equations are of very poor statistical quality, but even so the marginal price is generally more important than the intra-marginal charge (pp. 6-7, 6-8). For all but two saturation equations, the fixed charge either has a positive sign (indicating that increased fixed charges <u>increase</u> saturation) or its coefficient is less significant than that of the marginal price. Combining the intensity and saturation equations, the authors develop marginal price elasticities for the appliance stock models of -0.46 to -0.90, with an average of -0.59. The appliance stock models are more ambitious than the flow-adjustment models and exhibit greater statistical problems, but they support the general result.

These results are also supported by a somewhat simplistic Boston Edison study (BECo, 1979), which found that residential KWH consumption is 75 times as sensitive to marginal price as to average price. The elasticity of use with respect to marginal price was calculated to be -0.0185; this is a very short-run elasticity, reflecting changes on the order of a few months, and is comparable to Taylor and Blattenberger's short-run elasticities for linear flow-adjustment models of -0.06 to -0.12.

Other studies have simply estimated elasticities for marginal price, without attempting to include average price or fixed charges.

Houthakker, Verleger, and Sheehan (1974) derived long-run marginal-price elasticity estimates of -1.0, -1.2, and -0.45, depending on the approximation of marginal price which was used. Houthakker (1978) later used a different definition of marginal price to derive elasticities for the country, the Northeast, New England, and Massachusetts; the long-run marginal elasticities ranged from -1.423 for the United States to -0.673 for the Northeast, with -0.756 for Massachusetts. Halvorsen (1975, 1976) estimated the coefficient of marginal price in several different ways, resulting in elasticities of -0.974 to -1.21 for residential use, -0.916 to -1.208 for commercial use, and -1.242 to -1.404 for national industrial use, all at a high level of significance (a result of -0.562 for commercial elasticity was less significant and was eliminated by the use of dummy variables for two states). Including the impacts of industrial location decisions, the statewide industrial elasticities would be -1.530 to -1.752. All of these studies are included in Appendix 1.

Q: How large a conservation impact would be expected from the proposed changes in rate design?

A. In the long term (that is, over the next 10-15 years), the total sales in each rate schedule will be lower by the ratio of the new marginal price to the old marginal price, raised to the long-term elasticity, all other things being equal. Table 2 shows these results for the proposed rates for customers in the tail blocks; for some small customers in Schedule 10 (less than 350 kwh), and smaller, low load-factor customers in Schedules 20 and 21, the opposite effect will occur to some extent. However, since the bulk of sales are to customers whose marginal price will increase, the overall impact should be to greatly increase conservation and reduce sales.

For Schedule 10 customers without controlled water heating, 26% of sales is to customers using under 350 kwh, whose marginal base rate will be 24% lower on the proposed rate than on the existing rate with an 87.05% surcharge; and 4% is to customers with bills between 900 kwh and 1000 kwh, whose marginal rate declines 5%. But 71% of sales is to the other customers over 350 kwh, whose marginal rates increase an average of 25%. Sales-weighted marginal rates increase by 10.5% for this subclass as a whole.

Nearly all (98.6%) of the Schedule 10 water-heating customers will have increased marginal base prices under the proposed rates, with a subclass average increase of

40.8%. Overall, Schedule 10 marginal base rates are 25.9% higher under the proposed rates, without any increase in the revenues to be collected from the class. In addition, the smaller customers probably have lower price elasticities, and their smaller price response would thus not offset that of the larger customers.

Rate		Price Ratio (1)	long-run elasticity assumed	% change in consumption
10		1.11	-0.8	- 8%
20	regular	0.97	-1.0	+ 3%
	200-400 hrs.	1.22	-1.0	-18%
	400 + hrs.	1.47	-1.0	-32%
21	regular	1.21	-1.0	-17%
	200 +hrs	1.14	-1.0	-12%
	night use	1.31	-1.0	-24%
23		1.31	-1.0	-24%
24		1.02	-1.0	- 2%
35	regular	1.13	-1.2	-14%
	200-300 hrs.	1.17	-1.2	-17%
	300-400 hrs.	1.27	-1.2	-25%
	400+ hrs	1.27	-1.2	-25%

Table 2: Long-term Impact of Proposed Rate Design on Comsumption by Tail-block Customers.

(1) from Table 1

Q: Which existing rates have tail blocks below the 4.8¢/kwh you have identified as a minimum reasonable value?

A: Existing Schedules 10, 20 (over 200 hours), 21 (over 200 hours), 23, and 35 (all blocks) are be well below 4.8¢/kwh in the tail block, and Schedule 21 (regular use) is close to the minimum, as shown in Table 1.

This problem is largely corrected in the proposed rates, except for Schedule 35, for which increases in energy charges are limited by the current revenue allocations, and for which many of the customers are served at higher voltage levels. Proposed Schedule 20 (over 400 hours) and Schedule 23 have tail blocks below 4.5¢/kwh, but these are partially or primarily off-peak rates, which should be compared to the off-peak floor of 3.4¢/kwh (7.4¢ off-peak marginal cost - 4¢ fuel charge). By this criterion, the tail block for Schedule 23 is adequate, and even the high-use tail block for Schedule 20 is more nearly adequate, and probably as great an improvement as can be expected in a single step.

Since these criteria are minimal values which exclude some costs, it is desirable to keep the tail blocks well above 4.8¢/kwh (3.4¢/kwh for off-peak uses). Therefore, if WMECo is allowed less than the full amount of its requested rate increase, the proposed rates should be adjusted to the revenue requirement by lowering customer charges, intra-marginal energy blocks, and demand charges, but not the proposed tail block charges. The tail block charges should be decreased only if continuity constraints or other equally significant concerns leave no other alternative.

Q: Why is it appropriate to close Schedule 21?

A: Schedule 21 is a promotional rate which offers low prices, even at a low load factor, for all usage by customers who heat electrically. Electricity is an extremely inefficient means for converting fossil fuels to space heating. Currently, the marginal electric supply in New England is essentially always oil, burned at heat rates between 9500 BTU/KWH and 20,000 BTU/KWH, or 17% to 36% efficiency. Combined with marginal losses between the generators and secondary customer meters of about 20% (consistent with the preceding discussion of marginal fuel costs), secondary end-use efficiency for oil-to-electric conversion is about 14% to 30%. The average system marginal heat rate is probably closer to the high-efficiency end of this range, say 11,000 or 12,000 BTU/KWH, for an average delivered efficiency of about 25%.

By way of contrast, Table 3 lists the annual fuel use efficiency reported by DOE for the most efficient furnace and for the sales-weighted average efficiency furnace of each type. The least efficient units listed (average 1978 gas furnaces) are 2.6 times as efficient as electric resistance heating, while the most efficient (the best 1978 oil boiler) is 3.4 times as efficient.

Type (2)	Average (3)	Best Commercially (4) Available
	%	%
Gas forced air	65	70
Gas boiler	65	75
Oil forced air	75	82(5)
Oil boiler	76	85

Table 3: DOE Data on Furnace Efficiency Levels (1)

(1) 1978 Annual Fuel Utilization Efficiency (AFUE);

(2) indoor location assumed;

(3) sales weighted AFUE, from Federal Register 6/30/80, P.44003; "Level 2 in 1981 corresponds to the SWEF in 1978";

(4) highest AFUE of any basic model commercially available in 1978;

(5) DOE estimate.

NU's 1980 forecast documentation (NU, 1980, p.45) indicates that all-electric heat pumps use 33% less electricity than resistance systems; this would raise theaverage end-use efficiency to about 37%. Direct fossil heating is still 1.8 to 2.3 times as efficient as all-electric heat pumps.

Electric space heating does have some efficiency advantages which are not included in the preceding calculations. Resistance heating can readily be controlled on a room-by-room basis, which reduces usage somewhat, but modern controls (such as multiple thermostat zones) on fossil-fueled heating systems limit the extent of resistance heating's superiority in this regard. All-electric heating systems are fueled primarily (perhaps 80-90%) with #6 oil, rather than the more expensive (both in dollars and in production energy inputs) #2 oil, since #6 is usually NEPOOL's marginal fuel. Electric heat pumps with fossil backup may use electricity much more efficiently than all-electric heat pumps, but it is not clear whether they will be superior to all-fossil heat pumps. The same is true for heat pumps with a ground water heat source. But in general, until New England is no longer dependent on oil to meet load in most hours (a condition NEPOOL apparently does not expect to occur until 1995, at the earliest), electric space heating will increase the use of oil and gas, as compared to the direct use of those fuels for space heating. Therefore, WMECo should not be encouraging electric space heating.

Q: In conclusion, do you support Dr. Overcast's rate design proposals?

A: Yes. I believe that each of the changes that Dr. Overcast has proposed represents an improvement in the rate structure.

Q: Do the rates proposed by Dr. Overcast constitute "conservation rates" in the sense in which that term has been used recently by the Office of Energy Resources and by th Governor?

A: No. The Energy Office's "Detailed Summary of the Governor's Plan to Stabilize Utility Costs" defined a conservation rate as one which "decreases the cost per kilowatt hour (kwh) for the minimum amount of basic residential use, the amount necessary to cover the essential needs in the household. The rate then increases the price per kwh for consumption in excess of this basic amount."

This definition describes an increasing-block (or inverted) rate structure, while most of Dr. Overcast's rates retain their declining-block nature. Specifically, proposed residential Schedule 10 has a tail block 1.508¢/kwh lower than the first block. However, the changes proposed by WMECo are consistent with the Energy Office's conception of how the conservation rates will be developed.

> Those customers using <u>less</u> electricity than the <u>basic</u> amount...would see a reduction in their electricity bills. Customers using <u>more</u> than the <u>basic</u> amount would pay a higher price per kwh for each kwh above the basic amount until, at some modest level of consumption, the customer would pay the same bill under the "conservation" rate as he presently pays (the "cross-over" point).
>
> Beyond the "cross-over" point, customers would pay more than they presently pay because the reduced price per kwh for the low lever of use is more than offset by the higher price per kwh for use above the established basic level.

As Figure 1 illustrates, WMECo's proposed rates move in the direction the Energy Office describes. Thus, despite disagreements on costing methodology, the nature of the ideal rate design, or the relative roles of cost and other factors in rate design, it seems that the proposed rate design constitutes an improvement over the existing design from the announced perspective of the Energy Office, as well as those of WMECo and the Attorney General.

CONSERVATION AND ALTERNATIVE ENERGY

Q: What aspects of conservation and alternative energy development will you be discussing?

A: I will discuss the following aspects of WMECo's conservation and alternative energy planning:

1. the influence of WMECo's terms and conditions on conservation and alternative energy;
2. the scope of the "Northeast Utilities Conservation Program for the 1980's and 1990's" (NUCPEN);
3. additional conservation opportunities in which NU has not yet expressed substantial interest; and
4. NU's promotional activities.

Q: How do WMECo's terms and conditions affect conservation incentives and alternative energy development?

A: These aspects of the terms and conditions fall in three groups: Schedule 10 limitations on renewable water heating, Schedule 35 limitations on cogeneration and small power production, and various Schedules' approaches to master-metering.

Q. What limitations on renewable water-heating are imposed by Schedule 10?

A. Schedule 10 currently limits availability of the off-peak water heating rate to situations in which it is "the sole supply of hot water service", thus excluding customers who also use solar, wood, waste heat (e.g., from refrigerators or air conditioners), or geothermal energy to heat water. Since the off-peak water heating rate is cheaper than the normal rate, this exclusion serves as a disincentive to customers who may be considering alternative energy sources. Under the existing ratio (with an 87% surcharge), a large residential customer would lose a discount of $15.80/month, or $189.67/year by installing a solar water heating panel, or any other supplementary source of hot water.

The proposed Schedule 10 corrects a portion of the problem, by extending the water heating rate to include solar water heating. The size of the discount is also reduced to $6.04 per month ($72.48 annually), so that the disincentive is smaller. However, the proposed Schedule 10 does add certain language requiring that the solar hot water system must be used "with a storage unit which meets the company's specifications," which is either redundant (if the specificatons are the same as for other controlled water-heating customers) or unnecessarily vague and restrictive (if some additional requirements will be placed on solar installations).

Q: How should the Schedule 10 language be modified to remove the disincentives to renewable water heating systems?

A: The language covering eligibility for the water heating rate should be changed to:

> where the customer has in regular use an electric water heater which meets the Company's requirements set forth herein and which is the sole source of energy (other than energy from renewable sources or waste) for domestic hot water service.

The "Water Heater Requirements" section should remain unchanged from the proposed rates, and should apply to all off-peak water heating installations, regardless of whether renewable sources are utilized.

Q: Will some water heating customers with renewable supplementary energy sources receive too large a discount under these provisions?

A: Since the controlled water heating rate discount varies with usage, a customer who uses little energy for water heating will tend to receive a smaller discount. A customer using less than 500 kwh/month will actually be worse off under the proposed Schedule 10 water heating rate, due to the $1.50 monthly charge for the timer.

In addition, most renewable energy sources will not replace more than half of the normal electric use of the water heater, and the contribution will tend to be at high-cost periods (winter evenings for wood stoves, hot summer days for solar, hot summer days and evenings for air conditioner heat recovery). Until TOU metering or separate off-peak metering is cost effective, the costs and disincentives resulting from attempting to limit the use of renewable energy sources greatly outweigh any benefits of such limits.

It is somewhat ironic that NU is proposing a program of grants to customers who install solar water heating (NUCPEN, p.40), while it is penalizing customers who are exploiting other renewables.

Q: How do the terms and conditions in Schedule 35 limit cogeneration and small power production?

A: There are two provisions which would prohibit or discourage qualifying facilities as defined by PURPA §210 and the FERC rules implementing that legislation.

First, applicability is limited to "the entire use of electricity at a single location"; this provision may be used to prohibit the use of Schedule 35 for any customer with any generation sources whatsoever. Qualifying facilities could then be required to take service under a less favorable rate, such as the Schedule 90 which WMECo proposed in response to the Commmission's order in DPU 18810. Schedule 90 imposes backup charges and high ratchets (up to 100%), which are not charged to non-generating Schedule 35 customers. Since that time, WMECo has proposed charges for "facilities rental" and "reservation demand" for qualifying facilities. Hence, this provision in Schedule 35 represents a form of rate discrimination against qualifying facilities, as compared to non-generating customers with the same load characteristics, and should be eliminated.

Second, the "Determination of Demand" section of Schedule 35 imposes a ratchet of 50% on the demand charges of all customers with demands under 2MW, except for "customers having a portion of their requirements furnished by their own hydro-generation", for which the ratchet is 75%. Again, this provision singles out qualifying facilities for special discriminatory treatment, which is not applied to identical non-generating loads.

Q: How should these problems be corrected?

A: The first sentence of the "Applicability" section of Schedule 35 should be amended to read:

> This rate is applicable only to the entire use of purchased electricity at a single location.

The portion of the sentence from the "Determination of Demand" section regarding hydropower which I quoted above should be deleted.

Q: Are there other WMECo terms and conditions which discriminate against qualifying facilities and impede their development?

A: Yes. Item 13 in the general "Terms and Conditions" reads:

> 13. The Company shall not be required to furnish electricity as a stand-by, or to supplement electricity for a Customer's source of electricity supply other than hydro-generation.

If enforced, this provision would allow WMECo to refuse to sell power to qualifying facilities. To remove the disincentive and discriminatory aspects of this provision, and to specify that qualifying facilities will be treated exactly as non-generating customers, the provision should be modified to read:

Consumers do seem to respond to direct metering. Federal Energy Administration figures (UCAN Manual of Conservation Measures, Conservation Paper #35) indicate that single-metered apartments use about 25% less energy than master-metered apartments; Boston Edison data (BECo, 1978) indicates that single-metered apartments use only about half the heating energy of master-metered units. A recent submetering conversion in New York appears to have reduced occupant electric consumption by 35% (Electrical Week, 6/2/80, p. 6). DOE (1980a) reports savings of 11-40% due to individual metering, with average reductions of about 20%. Appendix 2 contains the relevant portions of these reports.

Q: How should the terms and conditions be altered with respect to master-metering?

A: First, Schedules 20, 21, 27, and 35 should be modified to allow submetering in buildings controlled by the tenants (e.g., cooperatives, condominiums) and to allow check metering in any building in accordance with a lease[2/]

2/ Residential buildings subject to rent control should be excluded from check metering until procedures can be developed to ensure that conversion to check metering does not constitute an unauthorized rent increase. I do not believe that any municipalities in WMECo's service territory currently have rent control, so this exclusion would have no impact at this time.

13. The Company shall furnish electricity as a stand-by, and to supplement electricity for a Customer's source of electricity supply, under the same rates, terms, and conditions, as electricity furnished to a Customer with the same net load characteristics on the Company system.

Q: Which terms and conditions affect master-metering?

A: There are two sets of problems in the terms and conditions with regard to master-metering:

1. Schedules 20, 21, 27, and 35 prohibit resale; and
2. no Schedule prohibits new master-metering.

These situations should be remedied, so that new or renovated buildings cannot be master-metered, and so that existing master-metered buildings can be converted to individual meters.

Q: What are the advantages of preventing new master-metering installations and converting existing installations to individual meters?

A: The master-metered electricity user essentially faces a zero price of energy, and therefore has no incentive to use it wisely. Any connection between the behavior of the master-metered user and the costs to that user is quite tenuous. Under direct utility metering, submetering (in which the building pays the utility, and the occupants are billed by the building), or check-metering (in which the building bill is simply apportioned to the occupants in proportion to their KWH consumption) the electricity consumer can save money by saving energy.

Landlords should be allowed to charge each tenant on the basis of that tenant's KWH use, or where individual meters are not feasible, on the basis of the tenant's share of the floor space or connected load in the metered area.

To prevent new master-metering installations, none of the rate schedules should be applicable to multi-tenant buildings which connect to WMECo's system after January 1, 1983, or which receive building permits after January 1, 1982, unless:

1. each tenant's direct electrical use is metered by WMECo;
2. each tenant's direct electrical use is check-metered by the building owner/operator; or
3. where (1) and (2) are not practical due to movable walls and flexibility in space allocations between tenants, the tenant-occupied space is check-metered in areas of 10,000 sq. ft. or less.

Options (2) and (3) should be available only for non-residential buildings. Option (3) is clearly inferior to the other options, since the ultimate user of electricity will still often pay only a fraction of the price of eletricity used, but it is better than nothing. NU's 1979 demand forecast projected that new commercial buildings coming on line in 1983, for example, will use 29.2 KWH/sq. ft./year. (The 1980 forecast does not present this data, and the 1981 documentation is not yet available.) At this rate, the 10,000 sq. ft. areas specified in option 3 would use 292,000 KWH/year and presumably somewhat more if master-metered. If option 3 were considerably less effective than individual metering, and only saved 5-10% of the energy used by an average customer, it would still save 14,600-29,200 KWH/year, worth about $1100-$2200 to the customer under the proposed rates.[3/]

Thus, considerable metering investments, up to a few thousand dollars per meter, are cost justified.

Q: Do you consider it essential that the deficiencies you have identified in WMECo's terms and conditions be corrected in this case?

A: Since most of these deficiencies have existed for condiserable periods of time, a delay of a few months is probably not crucial. So long as the problems are corrected promptly, it is not of little consequence whether they are dealt with in this case, a special-purpose proceeding for WMECo, or a generic proceeding.

Q: Are the energy conservation goals of NUCPEN reasonable?

A: NU projects specific KWH savings for five types of end-use conservation programs: audits, street lighting efficiency improvements, ceiling insulation, solar water heating, and Operation Wrap-Up and Turn-Down. Of these, the audit programs are largely mandated and beyond NU's direct

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3/ For a Schedule 35 customer with 300 hours' use, less than 10MW demand, and a 4¢/KWH fuel charge. WMECo's savings and 1983 rates may differ from the proposed rates, but the differences are not material to this discussion.

control (although any efforts to expand and accelerate these programs are laudable) and the street lighting program appears to be largely business-as-usual. Determining the exact value of an appropriate incentive for ceiling insulation and solar water heating must await a careful analysis of NU's savings due to customer conservation; that is, a marginal cost study. Until the value of the programs to NU is determined, proper goals are difficult to assess. However, three aspects of NUCPEN's conservation programs appear to be inadequate:

1. The Maximum Ceiling Insulation level is too low.
2. The insulation level for the water heating Wrap-Up program is too low.
3. The projected participation in the Wrap-Up and Turn-Down programs is too low.

Q: What ceiling insulation levels are appropriate?

A: Table 4 gives the optimal (cost-minimizing) insulation thickness for various climatic conditions for carrying charges of 14.55% (a 14% mortgage for 25 years) and of 20%. The optimal thickness is the point at which the savings from added insulation just equals its cost. The input values assumed are provided as notes to the table. The price of cellulose per pound is a current wholesale price; the homeowner's price will vary depending on how it is purchased. Once the decision has been made to install

Insulation Upgraded		For a 52 gallon tank			For a 82 gallon tank		
		Volume of Insulation	Annual Savings		Volume of Insulation	Annual Savings	
from	to	(cu. ft.)	DT=50 (Kwh)	DT=80 (Kwh)	(cu. ft.)	DT=50 (Kwh)	DT=80 (Kwh)
9"	10"	5.57	8.69	13.90	6.53	11.26	18.02
11"	12"	6.37	6.29*	10.01	7.39	8.14*	13.02
13"	14"	7.22	4.76	7.61*	8.30	6.16	9.85
14"	15"	7.66	4.19	6.71	8.77	5.43	8.68*

Table 5: Comparison of Cost and Savings from Waterheater Insulation

*analysed thickness for which marginal benefits closest to marginal costs at $.10/cu. ft-yr. and $.10/kwh

Assumptions: Fiberglass (R 3.2/in.) costs 50¢/cu. ft.; 20% carrying charge.
Size of Tanks: 52 gal. is 20" x 59.25", surface area = 28 sq. ft.
82 gal. is 24" x 63.25", surface area = 36.3 sq. ft.
Insulation applied to form cylinder around tank; affect on losses from bottom of tank ignored.
Losses: 52 gal. loses 3593 kwh/R at DT=50, 5749 kwh/R at DT=80.
82 gal. loses 4653 kwh/R at DT=50, 7445 kwh/R at DT=80.
Basic R value of tank = 6.

Heating Degree Days	Carrying Charge 14.55% R	14.55% inches	20% R	20% inches
6000	50.6	13.1	43.4	11.2
6500	52.6	13.7	45.1	11.7
7000	54.6	14.2	46.8	12.1
7500	56.5	14.7	48.5	12.6

Table 4: Optimal Ceiling R Values and Equivalent Inches of Cellulose Insulation

Assumptions:

Cellulos costs $5/30 lbs.
Applied at 3 lb/cu.ft
R value of cellulose is 3.7/inch.
R value of ceiling is 2.0: NU (1978) assumes 1.65.
Ignore effect of framing: since framing reduces the overall R of the first 6-8" of insulation, this assumption understates the value of added insulation.
Electricity Value = 10¢/kwh
Tax benefits excluded.

or increase insulation, the additional labor and equipment costs for blowing a few more inches should be negligible. Any underestimate in the insulation price is more than balanced by neglecting tax credits and by using the levelized marginal electric price over the life of the investment of just 10¢/KWH. Overall, the tabulated insulation levels are apt to be on the low side of optimal.

At a very high interest rate in the warmest portions of WMECo's service territory, NU's insulation target of R38 is nearly adequate. Thus, the owner of an existing home in Springfield, who is financing additional conservation with an expensive personal loan, may be well advised to limit ceiling insulation to NU's target level. For new construction in colder areas, such as Pittsfield, 40% more insulation is justified. Hence, NU should not be presenting R38 as an optimum, and should be encouraging much higher ceiling insulation levels, especially in new construction and in the colder portions of its service territory.

Q: What water heater insulation levels are appropriate, and how do they differ from NU's goals in Operation Wrap-Up and Turn-Down?

A: The optimal (cost-minimizing) amount of fiberglass to wrap around a water heater is about 12" to 15". The assumptions and analysis on which this conclusion is based are provided in Table 5. A water heater at a fairly low setting (120° F) in a fairly warm place (70° F average) would have a temperature differential (DT) of 50; a medium-temperature water heater (140^{O} F) in a cool place (60^{O} F) would have a DT of 80. These values are for conventional, modern water heaters with internal R values of about 6. DOE (1980b) found that the typical electric water heater manufactured in 1978 and early 1979 had 2 inches of low density fiberglass (R 2.7/inch). On older, less insulated water heaters an extra inch of fiberglass wrapping would be cost-effective; on the best foam-insulated new water heaters (R15 to R18), as much as three inches less insulation may be justified. Considering some factors I have neglected (increased losses from the larger surface, the difficulty of applying two layers of insulation), a single nine inch wrapping may be the most practical.

NU projects that wrapping water heaters will save 393 kwh to 441 kwh, depending on the temperature setting (NUCPEN, p.39). As shown in Table 6, this is equivalent to about 2" of additional insulation, not the 12" or 15" which are generally justified. By limiting the insulation level, NU is foregoing about 40% of the potential conservation from this source. For the 25,000 water heaters NU intends to wrap in the next two years (including those counted as part of the audit program results), an average extra 300 kwh reduction in annual losses would save 7.5 GWH, or 16800 barrels of oil per year, at 25% delivered efficiency and 6.1 million BTU/BBL.

		Annual Kwh Losses (1)			
		52 gal		82 gal	
Blanket Thickness (in.)	R Value	DT=50	DT=80	DT=50	DT=80
0	6	599	958	776	1243
2	12.4	290	464	375	601
6	25.2	143	228	158	295
9	34.8	103	165	134	214
12	44.4	81	129	105	168
15	54.0		106		138

Table 6: Water Heater Losses as Function of Tank Size, Temperature Differential, and Insulation Level

(1) Through top and sides only

Q: What is wrong with the participation targets for operation Wrap-Up and Turn-Down?

A: NU is projecting that 25,000 of its 234,000 unjacketed water heaters in Connecticut will be wrapped by 1982, and presents no plans beyond this point. Thus, less than 11% of this conservation resource would be realized. Since even the most efficient insulation scheme I propose would payback in less than one year, it is a pity to waste or delay the implementation of water heater insulation.

WMECo may not be able to undertake directly the prompt insulation of all the water heaters on its system, due to the labor requirements involved. If this is the case, WMECo may be able to accomplish the Wrap-Up process more rapidly and economically by providing materials, instructions, and some follow-up inspections to individual customers, local governments, CAP agencies, civic organizations' groups representing the elderly, low-income people and minorities, and other service delivery agencies.

Q: What potential conservation programs has NU neglected?

A: Judging from their omission from NUCPEN, it appears that NU has no plans to

1. promote the retrofitting of heat pumps to replace resistance electric heat;
2. finance cogeneration projects;
3. participate in converting mastered-metered buildings to individual metering or submetering; or

4. purchase or finance general conservation.

The first three items are fairly self-explanatory, but a few observations are in order. NU appears to be promoting the heat pump primarily in the new housing market, and largely in competition with fossil fuel heating systems. As I demonstrated above, the heat pump is not generally an efficient means of heating space, compared to new oil and gas systems. However, the heat pump is an appropriate replacement or supplement to existing resistance heating. Based on estimates developed by NU (1978), a heat pump will save about 2700 kwh to 5000 kwh annually compared to resistance heating in a small house, for an investment of about $2255 (1977 prices assuming ductwork is already installed for central air conditioning). A solar water heater, which would generally be in the same price range, would save 3000 kwh annually (NUCPEN, p.41). Thus, a small incentive to existing electric heating customers to retrofit heat pumps appears to be as warranted as the solar water heating incentive.

NUCPEN (p.71) expresses the concern that some otherwise feasible cogeneration projects will not be developed because of "competing investment opportunities for would-be cogenerators". If cogeneration projects are not being developed due to capital availability constraints, WMECo should consider partial or complete financing of the cogeneration system. It would be wasteful not to develop cogeneration which is cost effective at WMECo's cost of capital and which would allow the rapid displacement of significant quantities of oil. The financing options which WMECo might consider include:

1. WMECo ownership of turbine-generators, powered by steam purchased from a customer's boiler;

2. WMECo ownership of a complete cogeneration system, selling waste heat to a customer; or

3. WMECo financing of customer-owner generation, in return for lower purchase rates.

Similarly, if building owners do not convert master-metered buildings to single meters or submeters, due to financial constraints or lack of expertise, WMECo should consider supplying funds or personnel for studies or implementation.

The purchase or financing of conservation can take a number of forms. NU's solar water heating and ceiling insulation incentive programs are examples of this genre. However, each program is limited to a particular application, and in neither case does the size of the incentive vary with the actual conservation achieved. Thus, increasing the insulation on a small house from R30 to R38 earns the same incentive as insulating a large house from R19 to R38, and a small, low efficiency solar water heater gets the same payment as a large efficient one. The excluded applications include a variety of solar and insulation options in electrically heated space (vertical solar air panels, sun spaces, window insulation, air lock entries, wood stoves); shading, ventilation, and ground water cooling in air conditioned spaces; heat recovery for water or space heating from air conditioning, refrigeration, and commercial cooking waste heat; increased building lighting efficiency. The omission of wall and window insulation programs is particularly curious, since NU's analysis of energy use in a prototypical house (NU 1978) found that, with R19 ceiling insulation, R11 wall insulation, and double glazing, 8% of the heat loss is through the ceiling, 30% through the walls, and 24% through the windows. For R38 ceiling and R19 walls, the proportions become 6% for ceilings, 26% for walls, and 33% for windows. Thus, NU's proposed ceiling insulation incentive is concentrated on an area of relatively high insulation and low heat loss. Much larger quantities of conservation are feasible from thicker walls (or walls insulated with higher-R materials), triple or quadruple glazing, or insulating shutters and shades, than from ceiling insulation. For NU's prototypical house, R8 insulating shutters in place for half the degree-days would save 2.5 times as much energy as increasing ceiling insulation from R19 to R38; even added storm windows would save about 2.4 times as much energy as would the added ceiling insulation.

The conservation assistance can be delivered by the utility directly to the customers, or indirectly through the sorts of agencies which I discussed above in reference to Operation Wrap-Up.

Q: How is WMECo promoting the use, rather than the conservation, of electricity?

A: WMECo, along with the other NU system companies, has been promoting electric space heating despite the inefficiencies of that end use. NUCPEN indicates that a promotional campaign on behalf of the electric car may be in preparation.

NU's promotional activities for electric space heating are succinctly described by its 1980 load forecasting documentation.

> During 1978 NU began an effort to clear up misunderstandings about the cost and overall economics of electric resistance heating. In an examination of life-cycle cost of selected space heating systems NU's Consumer Research section demonstrated that in terms of the total costs of owning and operating a space heating sustem in a prototypical dwelling (including installation, financing, taxes, maintenance) an electric resistance system was competitive with an oil-fired system... Electric resistance heating continues to be competitive on other than cost grounds because of its ease of installation, cleanliness, convenience and the possibility of economic installation of individual room controls. NU pointed out both the cost and the less tangible advantages of electric resistance heating in communications directed to the public in 1979. This effort at consumer education over time should create a somewhat better acceptance of electric heat among

homebuyers and renters if such systems are installed in dwellings of a certified high thermal efficiency. Penetration of new electric resistance heating systems is forecast to remain essentially stable during the forecast period, going from 14 percent for single-family houses in 1980 to 11 percent in 1989, and from 19 percent to 20 percent in the same period for multi-family dwellings. Penetration rates for electric heat pumps are, however, forecast to increase during the next ten years. (NU 1980, p.43).

NU's forecast assumes that the company will achieve "better acceptance of electric heat", increasing the fraction of new houses with some form of electric heat from 20% in 1980 to 45% in 1989, and the fraction of new apartments with electric heat from 30% to 53% in the same time frame.

Some of the literature on which NU's hopes for greater heating penetration depend are included as Appendix 3 to this testimony. The pamphlets quote a 1978 study (NU, 1978) which assumes, among other things, that the electric rates for electric heating customers will be lower (by about 27%) than those for other residential customers. This illustrates one of the disadvantages of promotional rates, such as Schedules 21 and the declining blocks in Schedule 10; inefficient systems, such as electric space heating, may be advantageous to customers who do not have to pay the full cost they impose on the utlity. As I explained above, electric heating uses much more fossil fuel than does direct fossil-fueled space heating; NU should not be promoting this and use through advertising, rates, or other incentives.

NUCPEN (p.57) includes a program for

> the acquisition and demonstration of the operational feasibility of a limited number of commercially available electric vehicles in suitable transportation fleet applications within the NU service territory.

An electric utility may have several legitimate interests in testing electric vehicles. It may wish to determine the cost-effectiveness of existing designs, to assist in forecasting future penetrations of electric vehicles. It may also wish to study the load shapes imposed by electric vehicles, for the purposes of load forecasting, rate design, and load management planning.

NU does not appear to be addressing the electric car in terms of anticipating its customers' actions and of preparing appropriate responses. Rather, in demonstrating the feasibility of electric vehicles, NU seems to be pushing the technology.

In the first half of this century, when technical progress and economies of scale allowed utilities to serve new loads (particularly off-peak loads) relatively inexpensively, the promotion of new electric uses may have been appropriate. Now, when added load increases the average cost of power, any utility effort to increase sales is a disservice to its customers. This is true whether the effort takes the form of declining block rates, or the promotion of electric space heating and vehicles.

Q: What is your overall assessment of NUCPEN?

A: NUCPEN is primarily a nuclear construction and coal conversion program, rather than a conservation program in the usual sense of the term. The end use conservation programs represent a broader approach to reducing energy use than has been undertaken by any other major New England utility. The Wrap-Up and Turn-Down program, in particular, has tremendous potential. Nonetheless, NUCPEN is still much less than NU could be doing to reduce customer requirements for expensive oil-generated electricity. NU has taken an important step in the right direction, but has not yet formulated a comprehensive program of energy conservation, cogeneration and small power production. Nor has it yet abandoned all of its efforts to increase the use of electricity.

Q: Does this complete your testimony?

A: Yes.

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