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COMMONWEALTH OF MASSACHUSETTS
ENERGY FACILITIES SITING COUNCIL

RE:	EASTERN UTILITIES ASSOCIATES DECEMBER 31, 1977 SUPPLEMENT TO ITS LONG-RANGE DEMAND AND ENERGY FORECAST, E.F.S.C. NO. 78-33

TESTIMONY OF PAUL CHERNICK ON BEHALF OF THE ATTORNEY GENERAL OF MASSACHUSETTS

FRANCIS X. BELLOTTI
ATTORNEY GENERAL

By: Michael B. Meyer
Assistant Attorney General
Utility Division
Public Protection Bureau
One Ashburton Place
Boston, Massachusetts 02108
(617) 727-1085

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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, Boston, Massachusetts, 02108.

Q: Please describe briefly your professional education and experience.

A: I received a S.B. degree from the Massachusetts Institute of Technology in June, 1974 in Civil Engineering and a S.M. degree from the same school in February, 1978 in 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 Sigma Xi. I am the author of Optimal Pricing for Peak Loads and Joint Production: Theory and Applications to Diverse Conditions, Report 77-1, Technology and Policy Program, Massachusetts Institute of Technology. During my graduate education, I was the teaching assistant for courses in systems analysis, for which I prepared course notes and taught classes in regression and other topics in modeling. My resume is attached to the end of this testimony as Appendix A.

Q: Have you ever testified as an expert witness?

A: Yes. I testified before the Energy Facilities Siting Council and the Massachusetts Department of Public

Utilities in the joint proceeding on Boston Edison's forecast, docketed by the E.F.S.C. as 78-12 and by the D.P.U. as 19494, Phase I. My testimony covered appliance penetration and saturation, elasticity, effects of price on peak loads, and a variety of modelling issues. I also testified before the E.F.S.C. in proceeding 78-17, on Northeast Utilities' forecast, for which I reviewed model structure, inputs, assumptions, and documentation for virtually all major sections of NU's sales forecasting methodology: the economic/demographic model, the residential model, the commercial model, and the industrial model.

Q: What materials did you review in preparing this testimony?

A: I studied the Long-Range Forecast of Electric Power Needs and Requirements 1976-1985 for the EUA system, submitted to the E.F.S.C. on May 1, 1976; the First Supplement to that forecast, submitted December 31, 1976; the Second Supplement of December 31, 1977; portions of various EUA company returns to the Federal Power Commission and the Massachusetts Department of Public Utilities; and EUA's responses to the information requests of the Attorney General and E.F.S.C. staff.

Q: On what matters will you be testifying?

A: I will discuss each major sales class forecast - residential, commercial, and industrial - in turn, followed by the peak forecast.

Q: What aspects of the residential forecast will you discuss?

A: I will consider issues related to demography, housing stock, customer counts, new customer consumption, electric space heat penetration, existing customer consumption, "Unforeseen Appliances", and price effects.

Q: Is EUA's overall approach to residential forecasting appropriate?

A: EUA's basic residential methodology represents a reasonable beginning framework for a small company. In fact, this aspect of the methodology is considerably more sophisticated than that employed by such larger companies as NEGEA, NEES, and MMWEC. The residential model is similar to those of BECO, NU, and NEPOOL; while EUA's approach is in a few instances superior, these other models include several important considerations which are omitted by EUA. Unfortunately, EUA has not improved its residential methodology to correct the numerous deficiencies noted below; the lack of progress over three forecasts is distressing.

Q: How sophisticated is EUA's demographic analysis?

A: EUA appears to utilize state and regional population projections and some sort of time trend of household size to derive future residential customer counts. The use of exogenous population forecasts would appear to be

reasonable, under the current circumstances. It is probably unrealistic to expect EUA to forecast population independently, given the small size of its service territories and the potential impact of migration. This is one aspect of forecasting for which regional cooperation may be useful on the county level. (The issue of coordination with other utilities will be considered again in my discussion of the industrial forecast.)

On the other hand, the time-trending of household size is not a particularly valuable or reliable technique. Age-specific population projections and headship rates, for which forecasts are generally available (see NEPOOL p. D-2)[1/], can be used to derive household number in a more sophisticated and realistic manner than EUA's method.

In addition, the basis of EUA's time-trending is questionable. For both Blackstone and Fall River, the curves EUA fitted to the historical data underestimate household size for every year since 1970 (including 1970 for Blackstone). This is apparently because the family size trends are flattening out in EUA's service territories faster than the selected functional form can follow it. For example, for Blackstone, average family size fell by .97% annually from 1945 to 1965, but only .17% annual from 1965 to 1978.

1/References to NEPOOL are to the Report on a Model for Long-Range Forecasting of Electric Energy and Demand, June 30, 1977.

Regression of Fall River data for 1965 to 1978, using EUA's functional form, yields the equation

$$\text{average household size} = \frac{\text{Year}}{.33034 \times \text{year} - 1.4465}$$

where year = 0 in 1900

Correcting for the 1978 starting point, this trend projects an average household size of 3.1602 for Fall River in 1988, decreasing residential households to 45938 in that year and reducing the number of new customers in the decade by a third.

EUA's explanation of the household-size forecast for Brockton indicates that some round-about and subjective method was utilized (IR AG-4). The forecast would certainly benefit from a more analytical approach to household size.

Unfortunately, neither EUA nor the other forecasts mentioned above have found a way to deal with the decreased appliance saturations, penetrations, and electric consumption[2/] which would result from smaller household size. Until the necessary data is gathered and analyzed (presumably by a larger entity than EUA), EUA's projected decrease of family size by 3.4% is somewhat

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2/Except see NEPOOL, p. G-23, which indicates that electric water heat consumption, for example, would decrease 2% in response to a 3.4% decrease in family size.

problematical, since these other unrecognized effects will tend to counter-balance the increase in household number.

Q: Does EUA deal appropriately with issues related to housing stock?

A: Not at all. EUA does not disaggregate housing stock in any way. In contrast, most enumerative residential models separate households by housing type (such as single-family, multi-family and mobile) and some also estimate second residences. Since appliance penetrations and consumption may vary widely between housing type, this omission may seriously distort the forecast, unless future housing stock is very similar to the current stock.

Q: What are your comments on the residential customer counts?

A: There are two factors, both relating to Fall River, which raise questions concerning the accuracy of the customer counts reported. One is the shift of customers from residential to commercial classification in 1976. This would be quite appropriate if the customers in question are indeed schools and churches which had erroneously been classified as residential users. However, it is unclear whether base use, penetrations, and the like have been adjusted to reflect the revised historical data. Nor is it clear whether the distinctions between classes are properly maintained for any or all of the three retail companies; in fact, Fall River's 1976 Annual Report to the FPC (p. 414) lists about 5% of the commercial/industrial sales as "House Heating", which sounds like a residential use.

Secondly, according to p. 414 of Fall River's 1976 report to the FPC, the 44263 residential "customers" for that year include 1490 meters for off-peak water heaters in households which are already counted in Domestic or Home Heating service. The propriety of forecasting water heaters as if they were households is questionable at best, since it results in inflated household forecasts, faster increases in base use, double-penetrations (both a house and its water heater may be assigned a dryer, for example), exaggerated saturation increases (the number of existing "households" is larger, so a .6% increase in freezer saturation, for example, is calculated on a larger base), and so on.

It should be noted that the various customer categories established for billing, internal accounting, the D.P.U. and the F.P.C. are not generally consistent with one another or with the needs of forecasters. Therefore, both the company forecaster and the outside reviewer are in the position of attempting to reconcile apparently contradictory information. The forecaster would appear to be in a far better position than the reviewer to determine whether apartments are being counted as commercial sales, whether water heaters are counted as households, and the like; it is therefore vital that the forecaster resolve such issues. In EUA's forecast, there is little or no discussion of how sales and customer count were established

for each class; I can not really determine whether these adjustments were conducted properly.

Q: Does EUA forecast use by new customers in a reasonable manner?

A: The basic algorithm for new customers seems conceptually sound, but exhibits several practical flaws. The lack of a derivation for penetration and average use figures is one such weakness; at least a comparison with estimated current saturations and consumption would be appropriate. Of course, the efficiency improvements should be revised to the actual federal targets by appliance, and more stringent standards, such as those being enacted in California, should be anticipated during the 1980's. The failure to modify space heating average use to reflect smaller dwellings, better insulation, weather tightness, and generally better design is quite curious; for example, NU predicts a 30% decrease in the electric heating consumption for new houses between 1977 and 1987, and 18.2% for new apartments, in addition to some shift away from resistance heating to heat pumps and solar heating (NU, pp. 110-111).[3/] The same arguments would naturally apply to air-conditioning; winterization measures will reduce cooling requirements, as will smaller house size and such specific features as awnings, light-colored roofs and shading.

[3/] NU references are to Electrical Energy Demand 1978-1987, January 1, 1978.

Perhaps the most serious problem with the new customer methodology, however, is the handling of the "Base Use" consumption, which in EUA's nomenclature includes refrigerators, dishwashers, clothes washers, televisions, fossil-fuel heating auxiliaries, lighting, and miscellaneous. The first four categories are covered by federal efficiency standards. Table I applies the Federal standards to NEPOOL's estimates of refrigerator and TV usage in Massachusetts. In addition, clothes washers and dishwashers will use less hot water, and dishwashers will use less electricity for drying; the combined energy savings due to these latter improvements is projected to be comparable to those from refrigerators[4/] although the electric share of the savings will vary with the electric penetration of water heating. In any case, the efficiency standards should reduce Base Use by at least 20%. If Base Use for new customers is reduced by 10% in 1979 and 20% thereafter from EUA's estimates (which increase over time for some reason) the reduction in 1988 energy use for Brockton Edison is 12.5 GWH, about 1% of Brockton's residential energy (see Table II).

Q: Do EUA's electric heating penetrations appear reasonable?

A: Not really. Table III presents apparent penetration figures by company for 1971 to 1977; these numbers include conversions, changes in vacancy rates and the like, but

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[4/]Federal Register 7/15/77, p. 36649.

TABLE I

The Effect on Base Use of Federal Standards for Three Appliances

APPLIANCE	(1) % OF BASE	(2) FEDERAL EFFICIENCY IMPROVEMENT TARGET (%)	% BASE REDUCED
Refrigerator	38.8	28	10.9
Color TV	11.8	35	4.1
B/W TV	4.8	65	3.1
Total	55.4		18.1

Notes: (1) from NEPOOL, p. G-28, for 1975

(2) from Federal Register, 7/15/77, 4/11/78, and 10/12/78

(3) product of two preceding columns ÷ 100

TABLE II

The Effect of Federal Applicance Standards on New Base Use

YEAR	EUA BASE USE (kwh)	REDUCTION %	NEW CUSTOMER NUMBER	TOTAL ENERGY REDUCTION (kwh)
1979	3357	10	1379	463
1980	3480	20	1471	1023
1981	3606	20	1616	1165
1982	3738	20	1664	1244
1983	3874	20	1677	1299
1984	4015	20	1683	1351
1985	4161	20	1686	1403
1986	4312	20	1683	1451
1987	4469	20	1700	1519
1988	4632	20	1720	1593
TOTAL				12511

TABLE III

Apparent past electric heat penetration rates

			Blackstone	Brockton	Fall River
1971	a.	heating customers	42	93	132
	b.	total customers	1656	1626	488
	c.	apparent penetration %	2.5	5.7	27.0
1972	a.		90	362	154
	b.		707	2081	460
	c.		12.7	17.4	33.5
1973	a.		70	294	135
	b.		172	1581	333
	c.		40.7	18.6	40.5
1974	a.		128	609	42
	b.		292	1949	93
	c.		43.8	31.2	45.2
1975	a.		75	299	-34
	b.		230	1310	181
	c.		32.6	22.8	___
1976	a.		23	271	3
	b.		423	1406	213
	c.		5.4	19.2	1.4
1977	a.		48	198	6
	b.		580	1286	151
	c.		8.3	15.4	4.0

they offer a rough indication of the popularity of electric heat. Note that apparent penetration rose sharply from 1971 to 1974 and has been falling ever since. EUA predicts increases in electric penetrations to the levels of the early seventies; in the case of Brockton, the penetration forecast surpasses all historical values. Bear in mind that these comparisons are to historical values inflated by conversions, a gas shortage, and promotion by the utilities.

In Table IV, I compare EUA's predicted heating conversions and penetrations for 1978 to the actual results for 1977. The prediction for the EUA system is about 40% higher than the actual number of new electric heating customers observed.

Q: Is EUA's methodology any better for existing customers?

A: No, not really. For example, conversion rates and saturation increases are expressed as a fraction of customers, rather than as a fraction of customers without the appliance (or the electric version). At best, this presentation is confusing to the reader. It is possible that EUA is confused as well, but since no derivation or historical data is provided for these factors, it is not clear whether the authors understood what they were doing. The causal mechanism underlying these penetrations into existing markets involves the purchase of the appliance by people who do not have it now, and it is difficult to see

TABLE IV

Comparison of 1977 actual increase in electric heating customers and prediction based on 1978 penetration and conversion

	Blackstone	Brockton	Fall River
New customers, 1977	580	1286	151
Predicted heating penetration rate 1978	.08	.15	.10
Predicted new heating customers, 1977	46	193	.5
Existing customers 1977	66123	85656	44263
Predicted heating conversion rate, 1978	.0005	.0005	.0005
Predicted existing customers converting to electric heat, 1977	33	43	22
Total predicted additional heating customers, 1977	79	236	37
Actual additional heating customers, 1977	48	198	6
% of error in prediction	65	19	517

how these factors can be forecast without both determining the number of households which might switch and estimating the fraction which will.

Secondly, EUA fails to recognize that old electric appliances will be replaced by new, more efficient appliances. For example, in 1980, EUA projects 10% replacement of water heaters. If the saturation of electric water heaters is 20% and the old units average 6000 kwh/year, the reduction in usage due to this turnover is (using Brockton as an example):

.10 x .20 x (6000 - 4874) = 22.5 kwh/year/customer

or about 2 GWH due to one appliance in one year. This correction should be made to the five listed appliances (space heating is a bit different) and to Base Use as well. If refrigerators are 38.8% of an average Base Use of 3,000 kwh for existing customers, if 10% of the refrigerators are replaced in each year and if the efficiency improvement is 28%, then in 1980, the reduction in usage due to refrigerator replacement is about

3000 x .388 x .10 x .28 = 32.6 kwh/customer

or about 3 GWH for that year (for Brockton). Note that this is about the size of EUA's projected Base Use increase for that year, which apparently reflects some sort of historical trend.

EUA's asserts that this error is "compensated for by an under-estimation with new customers", since some new customers bring some appliances with them. This factor is apt to be minor for several reasons. First of all, the number of new customers is relatively small, compared to the existing customer counts. Second, new customers are alleged to have very high penetration rates; unless only people who already have many appliances move to EUA's service territory, this indicates that most appliances will be new. Third, EUA assumes high Base Use for new customers, and applies no efficiency standards to Base Use; clearly, this is an over-estimation. Fourth, about a third of the customer increase is the result of decreased family size; these bifurcated families will not generally have appliances to take with them. Fifth, very few people carry water heaters or space heating systems when they relocate. Sixth, saturations of appliances and especially the electrical versions of ranges and dryers tend to be low in Boston Edison's service area, compared to EUA's new customers; people who have gas ranges (or rent an apartment with an electric range) will not have an electric range to bring with them.

In addition to appliance efficiency, EUA also ignores the impacts of conservation in existing space heating, water heating, and air conditioning applications through such measures as insulation, weatherization, and

temperature set-backs. Surely, not all the walls, ceilings, floors, hot water pipes, and tanks in EUA's service areas are optimally insulated, nor have all customers installed heat traps, automatic set-back thermostats, water-saving shower heads, storm windows, and the like. Failure to account for these factors is a serious oversight. However, EUA seems to feel that conservation has gone as far as it can go, that it never had much impact, and will not have any in the future (see IR AG-12).

Q: What are your comments on the "Unforeseen Appliance" in the residential forecast?

A: EUA's "Unforeseen Appliance" category is quite an innovation in forecasting. I am disappointed that the forecast does not include an "Unforeseen Conservation" factor as well. After all, solar heating and hot water and passive cooling are much more technically and economically attractive then the electric car, which the "Unforeseen Appliance" is apparently modeled on. No evidence is presented to indicate that such an "Unforeseen Appliance" has ever appeared so rapidly, let alone that it is a regular decennial occurrence. Thus, in addition to increasing Base Use, EUA has thrown in a 19% saturation of a highly unlikely 4000 kwh/year appliance, which accounts for over a quarter of annual residential growth in EUA's Massachusetts service territory by 1988, and over a third in Rhode Island.

Q: How does EUA estimate the effects of electricity price on consumption?

A: EUA seems to ignore the effects of price increases, both historic and projected. This oversight is significant both because electric price is an important determinant of demand and because price impacts can be estimated quite easily and conveniently. Short-run and long-run elasticities have been estimated from various national and regional data sets by a large number of investigators; most studies are fairly consistent in deriving short-run residential elasticities in the -.1 to -.2 range, and long-run elasticities in the -1.0 to -1.2 range, although there is some spread around these figures. The large differences between the short-run and long-run effects indicate that much of the impact of the price increases of the early to middle 1970's are yet to be felt. EUA's response to IR AG-14 indicates a failure to understand these effects, especially lags and non-substitution price effects (efficiency, use, size, and purchase decisions).

Given the existing data base, local elasticity estimation is desirable but hardly essential; a small company, such as EUA, may simply apply elasticities representing the consensus of national or regional studies. The actual application of the elasticities can be quite

straightforward, and can be conducted independently of population, household, housing, and appliance models.[5/]

Q: Does this conclude your comments on EUA's residential model?

A: Yes.

Q: Is EUA's commercial methodology appropriate and reasonable?

A: EUA projects commercial sales as a fraction (sometimes greater than unity) of residential sales. This method has both advantages and disadvantages.

On the positive side, EUA's commercial methodology is relatively simple and straightforward in application. It also responds to both local population and residential conservation measures. On the negative side, the methodology requires a forecast of the residential/commercial ratio, is inversely proportional to household size, and does not reflect commercial conservation measures.

Q: What problems arise in forecasting the residential/commercial ratio?

A: First of all, it is not at all clear how this ratio was projected. Unless some uniform, consistent methodology is applied, the ratio forecast is essentially judgmental.

[5/]See the Testimony of Paul Chernick and Susan Geller in D.P.U. 19494 and E.F.S.C. 78-12, for two examples of price effect calculations.

Once the residential forecast is determined, a subjective forecast of the ratio is indistinguishable from a completely subjective forecast of commercial sales.

Secondly, this ratio is sensitive to the definition of rate classes, such as whether master-metered apartments are counted as residential or commercial sales. Unless the classes are properly distinguished, the ratio is meaningless. Page VIII-5 of the second supplement illustrates the impact on the ratio of the Fall River customer reclassification.

Q: What problems arise with the sensitivity of the commercial forecast to household size?

A: As noted above, the increase in per capita residential consumption forecasted by EUA is partly due to the decrease in family size. Since commercial sales are projected as a function of residential sales, this implies that greater commercial sales result from smaller family size. At least 3% of 1988 commercial sales would seem to originate in falling household size; actually, since new households use more electricity than existing households, and since declining household size generates new households, the impact must be substantially more than 3%.

It is not at all clear that commercial activity or electric use is more closely related to household number than to population; in fact, population is generally preferred as an explanatory variable, when the data is available.

Q: Please explain why the commercial forecast is not sensitive to conservation and price effects .

A: EUA forecasts increases in penetrations of electric heating and appliances, in both new and old dwellings, as well as increased Base Use and Unforeseen Appliance use. These effects more than counteract the limited residential conservation introduced by more efficient applicances (note that the residential model seriously underestimates the impact of efficiency standards, as described above). This represents a very limited view of the potential for commercial conservation from lighting reduction and replacement, more efficient appliances, improved ventilation systems, weatherization, and improved building design. With reference to the last point NU projects electricity savings of 35.6% in new construction due to the ASHRAE 90-75 standards (NU p. 154). I have testified elsewhere that this figure appears to be conservative (Testimony of Paul Chernick, E.F.S.C. 78-17, p. 22). Massachusetts is also changing lighting and ventilation standards for old and new buildings; the lighting code will require a 40% reduction in average commercial lighting levels.

Commercial establishments may have many of the same conservation technologies available to them as are available to residential customers, but with greater flexibility, expertise, incentives, opportunity, and regulatory pressure. In addition, large commercial

establishments have a conservation option not generally available to householders: cogeneration. This and other conservation measures may be encouraged by a variety of rate reforms, such as flat rates, peak-load pricing, and fair purchased-power and back-up-power rates for cogenerators. Therefore, assuming that commercial conservation will only be as great as residential conservation is very conservative. Assuming, as EUA apparently does, that conservation will be dominated by new electric uses is extremely unlikely.

Q: Can you determine from EUA's filing the extent of commercial conservation or price effects embodied in the forecast?

A: No, I can not. EUA fails to distinguish between changes in commercial activity (sales, floor space, employment, etc.) per household, historical energy use per unit of activity, electric penetration of the commercial energy market, and conservation. The forecast ratio (if one is used) should be derived from a quantitative analysis of all these factors; it is not clear that any of them were explicitly considered.

Q: What comments would you like to make on EUA's industrial forecast?

A: As filed, the industrial forecast is unreviewable. EUA generally has not provided or explained the historical data, the interview results, or the subsequent manipulations on these data and results. (The Brockton computation provided in IR AG-17 is not a linear

regression; it is so poorly documented as to be incomprehensible.) In any case, both historical growth rates and interview results have serious limitations as forecasting techniques.

Q: Please explain the limitations of historical growth rates for forecasting industrial sales.

A: Historical growth rates are deficient for forecasting for at least four reasons:

1. Future national (or even world) growth rates for output, shipments, employment, or value added in various industries may not be the same as past growth rates.

2. Local growth rates in the future may not bear the same relationship to national growth rates that they did in the past.

3. Technical change may alter historic relationships between industrial activity and electric consumption; e.g., conversion from vacuum tubes to integrated circuitry in both control equipment and products.

4. Increasing energy prices and rate reforms may further alter the ratio of output to electric use by encouraging more efficient equipment, greater care in the maintenence and use of equipment, cogeneration, etc.

Q: Why are interviews inappropriate for forecasting industrial electric consumption?

A: Again, there are several reasons:

1. It is not apparent that industrial customers make any concerted effort to realistically project the output, let alone the electric use, of particular facilities a decade in advance.

2. Forecasts which customers <u>do</u> prepare may be optimistic planning documents to facilitate growth under favorable conditions or to impress the home office with the plant manager's zeal.

3. Projections delivered to the utility may be tailored to the utility's expectations, either out of a general cooperative spirit or in hopes of such specific results as construction of new transmission facilities or special consideration in rates or service for a potentially significant customer. In particular, a customer is unlikely to mention major conservation or cogeneration plans as there is no reason to antagonize the utility earlier than necessary. This may be especially true when the utility is in a position to interfere with the project, e.g., Boston Edison's actions to halt MATEP. Similarly, customers may not wish to publicize plans to close a plant.

4. The results of the interview process may be manipulated in many ways by the utility, intentionally or unintentionally, including:

    a. the selection of companies to be interviewed,
    b. the interviewer's attitudes and comments,
    c. the phrasing and sequence of questions,
    d. the numerical interpretation of qualitative responses, and
    e. the weighting of results from various companies.

In fact, impartial interview or survey techniques are difficult to design and implement, even for impartial and well-trained social scientists.

5. If it is to be a reviewable public document, a forecast based on interviews must present a great deal of detail on the methodology for gathering, interpreting and processing the data, as well as summaries of the data collected and the sources. It would also be important for the utility to present forecasts both of industrial output (or activity) and of electricity consumption per unit of output. Providing this level of detail, even separately from the forecast document, may require considerable effort for a small utility. Reasonable levels of documentation also may create problems with confidentiality of individual customer plans; companies may either refuse to participate or come to view the survey as a public-relations forum.

Q: Are there any other problems in the forecast methodology?

A: EUA's limited statistical analysis was conducted on a data set from which certain data had been removed. That data represented industrial customers who have gone out of business. EUA is implicitly assuming that none of their current customers will go out of business in the future and, additionally, that all customers will grow (on the average) at the same rate as the successful customers of the previous decade. That analysis seems very optimistic.

Q: What alternative approaches might EUA pursue for forecasting industrial sales?

A: Two basic approaches occur to me; there may be other alternatives as well. As I see the situation, EUA can either carry out comprehensive industrial forecasts for each of its service territories, or participate in a regional forecasting effort.

Q: Please describe what a comprehensive industrial forecast methodology would entail.

A: Such a forecast would probably start with an exogenous forecast of national industrial activity by SIC. It would then be necessary to derive a local activity projection from the national projection by comparison of national to local levels of current and historical performance of the industry; of the costs and availability of raw materials, labor, financing, energy, land, and markets; and of such growth constraints or incentives as environmental regulation and governmental assistance. Such comparison may be statistical, analytical, and/or judgmental, so long as the methodology of the modification is adequately documented.

It is then necessary to estimate the electric energy consumption associated with the projected level of economic activity for each SIC. Again, several approaches can be taken, so long as technical change, price effects on the amount and type of energy use, and the tradeoffs between labor, energy, and capital are all captured.

Q: Is this approach feasible for a small utility company?

A: Probably not in full. As the current Northeast Utilities forecast illustrates, a thorough industrial model is quite complex. The Northeast model (which seems to follow NEPOOL's approach) uses an analytical economic module which attempts to follow the relationships between Connecticut production costs, industrial employment, unemployment rates, and labor migration (NU, pp. 21-37); estimates an econometric industrial power module relating past electricity use by SIC to national industrial production, Connecticut employment, conservation dummies, electricity price, labor price, and time (NU p. 169-171); and finally projects each SIC's electric use by inputing DRI production forecasts and NU's employment forecasts into the econometric power model (NU p. 171). A separate methodology was utilized for unclassified industrial sales.

Q: Is Northeast Utilities' model adequate for forecasting purposes?

A: Not really, although it is a good beginning. Much work remains to be done, especially in the economic module, before the methodology can be considered reliable. The same is apparently true for the NEPOOL model.

Q: Could a small utility be reasonably expected to implement a comprehensive industrial sales model?

A: They certainly could follow the basic format of a comprehensive model. While some of the "modelling" might be judgmental, it would still be advantageous to have

separate forecasts of national output growth, local output growth, and electric consumption. However, a better job could probably be done on a regional level.

Q: Please explain what a regional forecast would entail.

A: Essentially, it would be a comprehensive industrial forecast performed by a group of utilities, to model activity over a area which is large enough so that:

1. minor locational decisions by firms are unlikely to shift plants into or out of the study area; and
2. historical data will be available for the study area.

For example, NEPOOL is apparently gathering data and designing its model to operate for a state, a county, or a group of counties, largely to fit available data sets. For EUA, two logical regional study areas would then be the state of Rhode Island and southeast Massachusetts (Plymouth, Bristol, Barnstable, and Dukes Counties). The latter study area would involve only three private electric Companies (EUA, NEGEA, and NEES), and four municipals (North Attleboro, Mansfield, Taunton and Middleboro). A single forecast could be prepared for the area, drawing on the combined resources of the companies. Any errors committed in subsequently allocating forecast sales to the individual companies are not likely to be of any consequence for generation planning purposes, so long as the total forecast is accurate. The area forecast concept may also be fruitful for the residential sector and especially for the commercial sector.

Q: Do you have any comments on EUA's peak forecast?

A: EUA's peak methodology appears to be deficient in two ways: the derivation of normalized load factors is not well documented, and numerous sources of load factor improvement are neglected.

Q: Please explain the inadequacies in the load factor normalization.

A: EUA refers, in the response to IR AG-27, to "normalized load factors in 1976", but these are not provided. Apparently, the load factors mentioned are not the 1975 base load factors listed on p.XI-1 of the May, 1976 filing, since the latter figures would project a 1988 unadjusted peak about 40 MW lower than EUA lists in IR AG-27. It is not at all clear how the 1976 base load factors were determined, nor how those values were determined to be more representative of future conditions than the 1975 factors. It is important to recognize that load factors are affected by weather and economic conditions throughout the year. Thus, a simple correction for peak-hour temperature does not necessarily establish an accurate base-line load factor.

Q: What sources of load factor improvement has EUA neglected?

A: There are three basic aspects: changes in appliance mix, broader load management, and voluntary reactions to time-of-use pricing. I will discuss these points individually.

First, EUA is predicting increased saturations of air conditioners and electric water heaters (presumably controlled) neither of which should contribute to the

winter peak. (Contrary to EUA's assertion, water heaters can be controlled to avoid the summer peak as well.) Thus, the changing appliance mix in the residential sector may tend to improve load factor.

Second, EUA considers only one type of load management in two customer classes. Other candidates for control include commercial display lighting, retrofit of currently uncontrolled water heaters in all classes, and some industrial and commercial processes (such as heating and chilling equipment).

Finally, in addition to controls imposed by the utility, customers will tend to switch activities out of the peak period to avoid peak rates. Again, this applies to all classes and may involve both rescheduling of activities (such as clothes drying) and greater care in those activities which continue to fall on peak.

Q: Do you have any comments on the forecast of sales for resale?

A: Yes. It seems important to ensure that the forecasts filed with the EFSC (and comparable agencies in other states) by various companies are consistent. Therefore, it is vital that each element of electric demand on sales be reported in one and only one forecast. To this end, total output or load should be reported exclusive of those figures which will be included in other forecasts. This category should include partial requirements customers (such as Middleboro and Newport) and such special situations as EUA's sales to

the Tiverton division of Narragansett Electric (unless NEES excludes these sales, which is not apparent from the current NEES forecast filing before the EFSC).

If the forecasts filed with the EFSC are to be useful in comprehending the New England load and capacity situation, those filings must be consistent with the NEPLAN forecasts. Presumably, NEPLAN excludes such duplication; the EFSC filings should also. As Boston Edison does in its current forecast, EUA may wish to report both "total" and "territory" figures.

Q: Do you have any concluding remarks?

A: Yes. As a general summary, I think it is fair to say that EUA's forecast is not up to the standard which could reasonably be expected from a company of its size. The residential model, while it represents a decent beginning, has serious defects which EUA could correct quite easily. The commercial model is very crude; again, a small additional effort could improve it considerably, although it would still be quite unsophisticated. In its current form, the industrial model is totally unreviewable; fairly straightforward disaggregation of the causal factors for industrial electric use would improve the forecast considerably. Finally, the peak forecast appears to be internally inconsistent and rather pessimistic.

On the other hand, it is only fair to note that EUA certainly has the clearest and most readable forecast layout of all those submitted to the EFSC. The tables in section II summarizing revisions of forecasts and growth rates, the population forecast tables, the tables of use by new and existing customers, the combination of the E-1 and E-2 Tables, and the addition of the "Total Residential" table and the electric heating saturation column are all quite helpful.

Q: Does this conclude your testimony?

A: Yes.