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Preliminary Recommendations
for First Phase
HMLP Development Facilitation Program

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Recommendations

for First Phase

HMLP Development Facilitation Program

1 - INTRODUCTION

The Town of Hull is currently in a difficult situation. Large amounts of real estate development, very much desired by the Town, are currently in planning stages. The infrastructure to support that development, particularly in terms of electirc power, does not currently exist. Furthermore, the lack of professional planning staff in town bodies, including the Planning Board and the Hull Municipal Light Plant (HMLP), greatly complicates such tasks as anticipating future needs and planning for infrastructure improvements.

The HMLP faces three particular problems in fulfilling its part in facilitating development and system expansion. First, there are inflexible time constraints on resolving some of the present supply problems, since several solutions would involve lengthy negotiation, planning, design, permitting, and construction activities. Second, there are serious financial constraints on expansion, due to the cost of some of the proposed solutions, the credit rating of the Town, and HMLP's relatively small reserves compared to the size of the problems. Third, there is considerable uncertainty in all aspects of the system expansion: the amount of new development, the intensity of its electricity use, the timing of the development, the cost of distribution and transmission upgrades, Hingham's actions on transmission development, NEPCo's willingness to upgrade its facilities to serve Hull, and the time required to complete the improvements, especially on the transmission system.

This report starts by examining the size of the potential challenge to HMLP's ability to support peak loads, the capital cost of required upgrading, and the annual cost burden due to system growth. It then considers possible solutions to some of the problems posed by rapid system expansion, to facilitate development in the Town without creating financial burdens for present or future customers of the HMLP.

It is important to remember that this analysis is preliminary in nature. The staffing problems within the Town, and the high degree of uncertainty in many of the input parameters, has precluded the development of definitive solutions to most of the problems HMLP will face over the next year. Except for a few actions of a critical nature, major decisions will require further analysis of the scope of the problems and of the potential for various solutions.

2 - LOAD GROWTH POTENTIAL

Based on conversations with Judy Greenberg of the Hull Planning Board, our preliminary base-case estimate is that 1500 new condominium units could be added to Hull's housing stock over the next few years. This figure exceeds the number of units for which firm plans exist, but is far from the conceivable maximum. The 1500 unit estimate may prove to be understated for several reasons, including that it:

- assumes that the proposed height restrictions are passed,
- omits any development of the MGM property,
- neglects the load of commercial facilities associated with, or encouraged by, the condo developments, and
- assumes no development on the harbor islands HMLP might be expected to serve.

The level of development may also prove to be somewhat smaller than the level assumed here, or that level may be spread over many years.

If the 1500 condos come on line as all-electric units, using resistance heating and standard construction techniques, each of them might very well consume 20,000 kWh and require 10 kW at the time of the winter peak. Development of electric heating load on this scale would virtually assure that the winter peak would become the annual peak, and that the winter peak would determine the extent of necessary transmission investments and commitments. Overall, this level of heating load would approximately double HMLP's energy sales, but would triple its peak load, to some 22,000 kW.

The energy and demand projections are subject to some uncertainty, even beyond the problems of estimating the number of units and determining whether they will all be electrically heated. The energy use, but not the peak demand, would be significantly lower in those units which used heat pumps instead of resistance heating. Both energy and peak load for space heating use are very sensitive to the arrangement of the units (condos clustered in large buildings will require significantly less space heating energy than those in semi-attached townhouses, or in narrow towers), to the percentage of external walls which are glass, and to the insulation and infiltration levels of the structure. Appendix A presents our estimates of space heating energy use and demand on peak for a variety of building arrangements.

Condos which are not electrically heated, but which rely on electricity for all other uses, would each be expected to consume about 9000 kWh annually, while adding about 2 kW to the peak. Of this load, uncontrolled water heating contributes roughly 4000 kWh and 1 kW of peak demand.[1] About half of the remainder results from electric ranges and dryers. Thus, the load increase due to 1500 condos is about 3 MW if all energy uses except space heating are electric, down to less than a megawatt if none of the competitive uses are electric. Table 2.1 lists the individual and aggregate effects on HMLP sales and load for various levels of electrical intensity.

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1. Water heaters may be controlled by time clocks, which switch off the bottom elements for prescribed hours of each day, or by direct utility load control, which shuts off the bottom elements as needed. In any case, the top element stays on, allowing some electric use if the supply of hot water in the tank is exhausted during the controlled period. While other appliances can be conrolled to some extent, water heaters are particularly suitable, since they are large energy users and provide inherent storage.

3 - POTENTIAL COST CONSEQUENCES

There are four types of capacity which must be added, and related costs which must be incurred, to accommodate an increase in load:

1. generation,
2. transmission to Rockland Street substation in Hingham,
3. transmission/distribution from Rockland Street to Hull,
4. distribution within Hull.

The following subsections consider each of these cost categories.

3.1 - Generation

Depending on the extent of the load growth experienced in Hull,[2] additional load will reduce the amounts of energy and capacity Hull can sell, or will increase the amounts of energy and capacity Hull must buy. The market clearing price for these commodities is difficult to predict with any precision, given the

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2. Other factors, such as whether Seabrook 1 is completed, will also have roles in determining whether Hull has excessive, adequate, or insufficient generation capacity entitlements.

large number of presently unknown factors -- fuel prices, New England load growth, Hydro Quebec contracts, Seabrook completion, small power producer rates and development -- which will influence the market. In any case, the cost of generation is determined by the market, and not whether Hull is buying or selling.

Overall, it seems reasonable to estimate the cost of intermediate-term contract power (in the range of 10 - 15 years) at about 8 cents for baseload power. Low load factor power supply will be more expensive: we may represent this differential as a capacity charge for demand in excess of that required at a load factor of about 60%, or 5000 hours use for each kW of peak load. MMWEC projects that the cost of peaking capacity will remain at the present value of about $20/kw-yr until the early 1990's, when a New England capacity shortage will force the price up to the cost of new peakers, in the range of $150/kW-yr. Table 3.1 lists MMWEC's projections, and levelizes the projected capacity cost over the fifteen-year period. The levelized value is $50/kW-year.

3.2 - Transmission

Transmission costs are probably the most difficult category to project, since they are so dependent on the actions of the Hingham Light Board and possibly of NEPCo, as well. Transmission is also the most difficult type of capacity to expand on an expeditied basis, due to the planning, engineering, permitting, and construction activities which are required: expanding Hull's transmission capacity will also require negotiation with at least one other utility, and possibly two others.

At this point, it appears likely, but by no means certain, that Hingham will soon settle on a transmission plan which it will pursue actively. The two leading contenders appear to be:

1. a 115 kV line which would replace approximately half of the Hull transmission lines, as they pass through Hingham, and which would terminate at a new substation at Union Street, which would provide 13.8 kV service, through the remainder of the Hull line, to HMLP, (the "new line" option) or

2. a very short 115 kV connection from NEPCo's East Weymouth susbstation to a new substation just inside Hingham, feeding all Hingham loads and removing all Hingham load from the Hull lines, which would remain as is (the "short line" option).

The first solution would require Hull's approval, and therefore would require the negotiation of a transmission service agreement between the two towns. Hingham's original proposal would have allowed Hingham to charge Hull for a substantial portion of the cost of the system, which was greatly in excess of Hull's needs and which was designed to solve several of Hingham's distribution problems (in addition to the shared transmission constraints). In essence, Hingham would have earned a profit on its services to HMLP, which would have underwritten the cost of the line. When HMLP offered a counter-proposal designed to limit HMLP's costs to the portions of the system relevant to HMLP's requirements, Hingham terminated the negotiations on cost sharing, and has since pursued the second solution. Hingham has indicated that it does not expect the original plan to be viable unless Hull subsidizes the project to a considerable extent. The first transmission option is unlikely to be revived unless HMLP needs large amounts of transmission capacity in a hurry, and is willing to pay a much larger share of the total project cost.

The first option may take several years to complete. Thus far, Hingham has been unsuccessful in resolving the transmission planning issue; the proposed line and substation would require the approval of the Energy Facilities Siting Council; and the proposed route would pose serious environmental issues. Hingham may eventually overcome the opposition, both within the town and before the EFSC, but this process will be time consuming. Utilities much larger than Hingham have required years for EFSC approval in disputed cases. It would not be prudent to expect the new substation to be in service before 1989.

The second option is a little easier to evaluate, but still involves several types of uncertainty. If Hingham gets off of the Hull transmission lines, several possibilities open up for

Hull. So long as the winter load stays below about 14 MW,[3] the existing capacity on the line would be sufficient, with some maintenance of poles and fixtures. NEPCo would presumably continue billing Hull at the present rate of $0.73/kW-month of entitlements (which should be about 1.25 times peak load), of which $0.12 covers transmission to East Weymouth, and the other $0.61 pays for the cost of the Hull line itself.[4] It is possible that a lease could be arranged for the line, since Hull would be the only user. This may be less expensive than paying the current $0.61/kW-month, or higher future rates. In any case, Hull should be able to take delivery of power at East Weymouth, reducing the NEPCo loss surcharge from 2.5% to 1%, plus actual losses in the Hull line.

If the load on the Hull line grows back to 14 MW or more, the town would once again be in its present position: the existing Hull line will not supply firm power, since the loss of either line at peak will result in the overloading of the second line. RW Beck has estimated that reconductoring less than half of the Hull line to bring its capacity to about 35 MW would cost $850,000.[5] RW Beck also believes that increasing load beyond 18 MW would require the expansion of transformer capacity at East

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3. The comparable summer peak would be about 11 MW, since the lines overheat more easily in hot weather.

4. NEPCo has filed for an increase in its subtransmission rate, further increasing the charge for the Hull line.

5. Preliminary EFSC Filing, 1/3/85, pages 17-18, and 52.

Weymouth, at a cost of approximately \$120,000/MW.[6] It appears that both of these costs would be paid by NEPCo, and charged to HMLP. NEPCo might be willing to finance the improvements, which would reduce HMLP's cash requirements, but would increase the annual cost.

The short line option might resolve the transmission constraint somewhat sooner than the new line option, since both permitting and construction should be considerably simpler. EFSC approval is probably not required, the area affected is much smaller, and most of the land is already owned by the town of Hingham. However, it appears that Hingham has only recently considered this option seriously, and that the design process has just started. Another bottleneck may arise in the planned conversion of the Hingham distribution system to 13.8 kV, which is one of Hingham's major motivations for its interest in the 115 kV supply arrangements. It seems that most of the distribution system is not yet prepared for the voltage conversion, and it is not clear that Hingham will want to transfer its existing 4 kV circuits to the new substation.[7] Thus, while it is conceivable that the new substation could be in service by 1987, Hingham might well concentrate on relieving its supply problems in South

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6. Ibid.

7. The 4 kV solution would require new temporary transformation, longer 4 kV lines, and larger conductors than the 13.8 kV system, and would result in higher losses and lower service voltages than the 13.8 kV system. Hull's distribution system has operated exclusively at 13.8 kV for many years.

Hingham, leaving considerable amounts of its load on the Hull line for another year or so.

3.3 - Rockland Street to Hull

The Hull 23 kV transmission line ends at the Rockland Street substation in Hingham, where two aging 10 MVA autotransformers step the voltage down to the 13.8 kV level of the HMLP distribution system. Substantial load growth will require the expansion of the capacity of both the tranformation and the 13.8 kV lines into Hull. The cost of such expansion has not been estimated.

It has previously been proposed that, instead of building additional parallel facilities, it would be more desirable to continue the 23 kV line past Rockland Street, to a new substation in the center of Hull.[8] Undergrounding the new line and dividing the distribution system into four separate circuits would provide greater supply security, particularly in terms of resisting storm damage. Raising the voltage on the line from Rockland to the town would also reduce losses, which increase as the square of current, and which will therefore rise with the growth of load in Hull. Don Newton costed out this proposal at about $1.5 million a couple of years ago. It would be more expensive today, due to

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8. Major new loads, such as the Paragon Park development, might be served directly from the 23 kV system, avoiding one level of tranformation and the primary distribution system.

both inflation and load growth, but some investments would be required within the near future to improve voltage regulation, recloser condition, and other aspects of service quality.[9] Overall, the $1.5 million appears to be a reasonable estimate of the net investment required to serve loads near the present level. The line and substation capacity would probably have to be increased to accommodate loads near the base case: we have allowed an additional $250,000 for loads over 14 MW.

Construction would require approximately one year from financing to operation.

3.4 - Distribution

Incremental distribution investments are very sensitive to the size, location, density, and type of new loads, and therefore only rough aggregate estimates are possible. At the end of 1984, Hull's gross book distribution plant investment (excluding streetlights) was $3,435,000, which is about $680/customer, or about $478/kW. These figures are much smaller than present costs, because the original costs are representative of equipment prices and labor rates at the time of construction of the system, not today's higher costs.

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9. Mr. Newton's estimate also included some reconductoring of the existing Hull transmission lines. Since the RW Beck estimate included reconductoring only to the Bull Run substation, most of reconductoring allowance in the Rockland-Hull study would still be required.

The average age of the Hull distribution plant appears to be about 11 years (a typical utility value). This estimate is based on the fact that the depreciated 1984 cost of the system was $2,316,000, 33% less than the original cost: 11 years of depreciation at 3% would produce the 33% differnece between original and depreciated costs. Over the last 11 years, the costs of distribution equipment have more than doubled: the Handy-Whitman distribution cost index increased by more than 130% from 1972 to 1983, for example. Thus, the replacement cost for the distribution system would be at least twice the book cost, or roughly $1500/customer and $1100/kW.

New all-electric condominiums would be larger loads than the average existing HMLP customer (this average includes commercial customers), but would be more densely sited and would have the use of some of the existing infrastructure, such as poles. It is therefore difficult to translate the $900 - $1500 average investment figure to an incremental investment figure. Table 3.2 presents estimates of incremental distribution investment from various investor-owned utilities in New England, restated in 1986 dollars. Overall, an estimate of $300 per customer, plus $40 per kW demand, appears reasonable, or perhaps somewhat optimistic.

3.5 - Cost and Schedule Summary

Table 3.3 restates the cost assumptions and derives investment requirements, annual costs, and cents/kWh charges for four cases:

1. load growth to 14 MW, Hingham off the Hull line,

2. load growth to 14 MW, Hingham builds new 115 kV line,

3. load growth to 22 MW, Hingham off the Hull line, and

4. load growth to 22 MW, Hingham builds new 115 kV line,

all for 10 kW all-electric condominiums. Depending on the case, the investment required is $3 to $7 million, or $350 to $550/kW. Including obligations to NEP (or possibly to Hingham), and for peaking capacity, increases the effective commitment to $700 - $900/kW of added load, some of which may be required as advance payments. The cost of serving the load would be approximately 14 to 15¢/kWh, compared to 1984 revenues of 9.6¢/kWh for the all-electric rate A-2.

Any expansion in load while both Hingham and Hull are served by the existing Hull 1 and 2 lines will result in further deterioration in service quality. Significant increases in the capacity available on the lines are unlikely until Hingham makes a decision, and either purchases and upgrades the lines, or else gets its load off the lines. Either option might take two to four years.[10] In any case, the supply constraint from Rockland

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10. A third option, requesting NEP to significantly upgrade the lines, may be somewhat faster, but may not add enough capacity to accommodate load growth on the scale anticipated in the base case.

Street precludes growth beyond about a 10 MW peak demand. Relieving this constraint would require at least a year: additional design to accommodate base case load growth would add to the time requirement, and the final design should probably await resolution of the transmission issues with Hingham, which would add an indeterminate delay.

4 - EFFECTS ON NEW CUSTOMERS

The use of electricity for heating, especially in resistance applications, can have severe financial and economic effects on ratepayers, and indirectly on the Town of Hull. At the present electric heating rate, a 20000 kWh customer would pay $1900 annually in electric bills, for a unit of perhaps 1100 ft^2. Electricity at 9.5 ¢/kWh is equivalent in price to oil at $2.80/gallon, burned in a fairly efficient (80%) boiler. High electric bills, in addition to being burdensome for future customers, will also reduce the resale value of the condos, both directly (by reducing purchasers' buying power) and indirectly (by reducing the owners' ability to improve their units), and will therefore tend to depress the Town's tax base.

The effect of the electric bills on future customers is particularly unfair, to the extent that developers, rather than the customers, choose to build the condos as all-electric units.

The amount of electricity used in new units depends on both the uses to which electricity is applied[11] and the efficiency of the end uses. Heavy insulation, efficient windows, and other

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11. In order of decreasing importance, the most significant end use energy choices are for space heating, water heating, cooking, and clothes drying.

measures can greatly reduce the consumption of energy for space heating; similar efficiency measures are available for water heating, lighting, refrigeration, and most other uses. Thus, electric bills can be controlled by the choice of appliances, equipment, and building standards. Most of these choices are easier and less expensive when the building is under construction.

5 - RECOMMENDATIONS

5.1 - Hookup Fee

There are several reasons for the HMLP to impose a charge for connecting new load to the system. First, the costs of the system expansion are likely to increase rates for some time to come, unless the developers share in those costs. Second, financing the base case expansion would be difficult and burdensome for HMLP and the Town of Hull. Third, there are severe time constraints on the expansion, and measures which discourage contribution to peak demand will tend to increase the amount of development which may be accommodated. Fourth, hookup charges require developers to confront the costs they are imposing on the system and on their own customers, and to choose energy sources which reflect more than initial construction costs. Fifth, to the extent that hookup charges are combined with offsets for conservation and load management techniques, they can be used to encourage the efficient use of electricity.

Appropriate hookup charges require a mechanism for estimating the contribution of new customers to sales and to peak load. The size of credits against the hookup charge for energy efficiency and load management measures in the building must be determined. It may also be useful to allow developers to offset their load contribution by financing efficiency improvements in existing buildings.

At this point, it would appear that a hookup charge on the order of $400/kW of peak load would be reasonable.

5.2 - Study Fee

There are many unresolved issues which require further exploration. These include

- more detailed assessment of the potential for load growth;
- the costing of
  * generation,
  * various transmission options,
  * various solutions to the Rockland - Hull constraint, and
  * distribution connections and upgrading within the town;
- detailed design for actions to relieve distribution constraints;
- development of a mechanism for estimating the electric use and peak demand contribution of various potential

developments;[12]

- development of conservation and load management credits to the hookup charge;

- investigation of the potential for efficiency improvements in existing electric uses in the Town;

- development of mandatory efficiency standards;

To ensure that development will not be delayed by the inability of HMLP to foresee events, evaluate problems, or identify solutions, a mechanism will be necessary to finance the continuing analysis of all of the issues listed above. These analyses can be financed by a nominal study fee on proposed new loads, such as $10/kVA of service drop or main breaker capacity. This fee would come to only $220 for a 100 amp service.

5.3 - Phasing Requirements

There are inflexible limits on load growth in the short term, imposed by various transmission and distribution bottlenecks, and by the need to negotiate solutions with Hingham and NEPCo. To ensure that those limits do not become limits on development, it is essential that the load per condominium unit (or other new

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construction) be restricted to the lowest feasible level. We therefore recommend that strict conservation standards be applied to new optional uses of electricity, particularly space heating and water heating. Specific interim standards would include the following requirements for electrically heated space:

- ceiling insulation of at least R50,
- wall and floor insulation of at least R35,
- triple glazing, with movable window insulation of at least R2.5,
- provision for addition of a wood stove, and
- infiltration of no more than 0.5 air changes per hour,

and the following requirements for electric water heating:

- effective water tank insulation value of R36 (equivalent to an efficient new tank with 9" of fiberglass wrap),
- pipe insulation of at least R10,
- low flow shower heads and faucet flow restrictors throughout, and
- installation of a heat pump water heater in non-electrically heated space.

Efficiency standards for electric dryers, refrigerators, and other appliances[13] which developers usually install should also be developed over the next few months. Since most of these standards can be borrowed from the standards in effect in California, which are available with lists of complying models, this can be a relatively modest effort for large benefits.

5.4 - Miscellaneous Recommendations

Hull's rate design does not reflect its current realities. The declining block features in most rates tend to encourage the increased use of electricity, which would only exacerbate HMLP's supply problems. The rates decline only slightly, however, so this is not a particularly crucial issue. More importantly, the discounts for space and water heating encourage new customers to use electricity for these major end uses, which are quite adequately served by natural gas. All of the promotional rates (A-1, A-2, and F) should be closed immediately to new customers: a new rate for controlled water heating should be developed, especially if it becomes clear that HMLP will become strongly winter-peaking.[14]

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13. In units which use electricity for water heating, clothes washers and dishwashers are of particular concern, since they use large quantities of water. Consideration should also be given to requiring the installation of microwave ovens wherever electric ranges are installed.

14. Summer peaks are frequently so broad, and equipment heating problems are so sensitive to daily heat build-up, that time clocks may have little value near summer peak conditions.

The new large condominium developments offer attractive sites for the location of cogeneration facilities, which would generally burn natural gas to produce both electricity and hot water for space and water heating. The high efficiency of this process makes it competitive almost anywhere in New England. Cogeneration would be particularly useful for HMLP, since it can provide generation within Hull, at fairly stable rates, owned or controlled by HMLP,[15] which does not require NEPCo transmission services, increased capacity on the Hull transmission line, new substation development, or any of the other costs and problems associated with purchasing power from outside the Town. If half of the base-case condominium development is provided with cogeneration systems for heat and hot water, as much as 2000 - 3000 kW of capacity could be made available, in addition to a 6750 kW reduction in load. HMLP should publish rates for purchase of cogenerated power, encourage real estate developers to consider such systems, and invite third-party proposals for new and existing properties.

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15. Either the condo developer or a specialized cogeneration developer may finance the system, to reduce the burden on HMLP. Over time, as its financial situation improves, HMLP may wish to buy out the developer.

TABLE 2.1: Load Effect of Condominium Additions

	Per Condo		Per 1500 Condos	
Energy Sources	Annual Load kWh	Peak kW	Annual Load MWh	Peak kW
1. All Electric	20,000	10	30,000	15,000
2. Non-Electric Space Heat	9,000	2	13,500	3,000
3. Non-Electric Space Heat Controlled Water Heat	9,000	1.2	13,500	1,800
4. Non-Electric Space Heat & Water Heat	5,000	1	7,500	1,500
5. Non-Electric Space Heat & Water Heat Gas Dryer & Range	2,500	0.5	3,750	750

TABLE 3.1: Marginal Peaker Capacity Costs

Power Year	Marginal Capacity Costs [1]	
	Current $/kW	Levelized
1986 /87	19.97	19.97
1987 /88	19.97	19.97
1988 /89	19.97	19.97
1989 /90	19.97	19.97
1990 /91	19.97	19.97
1991 /92	19.97	19.97
1992 /93	19.97	19.97
1993 /94	19.97	19.97
1994 /95	65.79	22.70
1995 /96	136.92	28.33
1996 /97	149.01	33.28
1997 /98	149.80	37.30
1998 /99	165.04	41.02
1999 /2000	179.58	44.44
2000 /01	192.18 [2]	47.55 [3]

Notes: 1. From Exh. 1, Response to EOER Data Request (1/28/85).
2. Extrapolated using 1995-99 growth rate.
3. Levelized at 15% interest, from 1986.

TABLE 3.2: Estimates of Marginal Distribution Investment (1986$)

Study	PRIMARY $1986/kW	SECONDARY $1986/kW	SECONDARY $1986/ Customer	PRIMARY $1986/ Customer
Fitchburg Gas & Electric 1984 Marginal Cost Study	$168.24	$307.59	$250.91	
Boston Edison DPU 1720, 1984	$123.01[1]	$298.66	$79.68	
Central Maine Power PURPA §133 Filing, 1982	$301.94[1]	$708.78	$916.80	$729.82[5]
Potomac Electric Power, Case 785, 1981 Rate Case	$489.06[1]	$1,608.82	$742.36	
Mass Electric DPU 84-240, 1985	$129.15	$215.25	$968.10[2] $469.35[3] $828.45[4]	

Notes: [1]No transformers; add about $73 for transformers. (from Fitchburg)
[2]Overhead.
[3]Overhead without poles.
[4]Underground.
[5]Includes Transformers and meters at secondary.

Source: Inflation data from: Handy-Whitman Bulletin No.118
Cost Trends Of Electric Utility Construction.
North Atlantic Region - Total Distribution Plant (Line 42).
After 1983, inflated by 5% per year.

TABLE 3.3 (A): Cost to Hull

CASE I

Number of Customers Added:	700
Demand on Peak per Customers	10 kW
Average Use:	20,000 kWh
Transmission Option:	23 kV - Hingham off the Hull Line
Load Growth to:	14,000 kW

COST CATEGORY:	Capital Cost	Annual Cost Total [1]	/kW-yr	Cents/ kWh [4]
Generation:				
base:				8.0
[5] peak:		$262,500	$38	1.9
Transmission,				
NEP to Rockland:				
NEP charges [2]:		$76,650	$11	0.5
Reconductor:	$800,000	$127,809	$18	0.9
Weymouth capacity:	$0	$0	$0	0.0
Rockland to Town:	$1,500,000	$239,642	$34	1.7
Distribution [3]:	$1,610,000	$257,216	$37	1.8
Total:	$3,910,000	$963,817	$138	14.9
Investment/kW	$559			
Commitment/kW	$862			

Notes: See Notes following Table 3.3 (D)

TABLE 3.3 (B): Cost to Hull

CASE II

Number of Customers Added:	700
Demand on Peak per Customers	10 kW
Average Use:	20,000 kWh
Transmission Option:	115 kV - new line owned by Hingham
Load Growth to:	14,000 kW

COST CATEGORY:	Capital Cost	Annual Cost Total [1]	Annual Cost /kW-yr	Cents/ kWh [4]
Generation:				
base:				8.0
[5] peak:		$262,500	$38	1.9
Transmission, NEP to Rockland:				
NEP charges [2]:		$12,600	$2	0.1
Hingham charges [6]:		$160,707	$23	1.1
Weymouth capacity:	-	-	-	-
Rockland to Town:	$1,500,000	$239,642	$34	1.7
Distribution [3]:	$1,610,000	$257,216	$37	1.8
Total:	$3,110,000	$932,665	$133	14.6
Investment/kW	$444			
Commitment/kW	$834			

TABLE 3.3 (C): Cost to Hull

CASE III

Number of Customers Added:	1500
Demand on Peak per Customers	10 kW
Average Use:	20,000 kWh
Transmission Option:	23 kV - Hingham off the Hull Line
Load Growth to:	22,000 kW

COST CATEGORY:	Capital Cost	Annual Total [1]	Cost /kW-yr	Cents/ kWh [4]
Generation:				
base:				8.0
[5] peak:		$562,500	$80	4.0
Transmission, NEP to Rockland:				
NEP charges [2]:		$164,250	$11	0.3
Reconductor:	$800,000	$127,809	$9	0.2
Weymouth capacity [7]:	$840,000	$134,200	$9	0.2
Rockland to Town [8]:	$1,750,000	$279,583	$19	0.5
Distribution [3]:	$3,450,000	$551,177	$37	0.9
Total:	$6,840,000	$1,819,518	$164	14.1
Investment/kW	$456			
Commitment/kW	$759			

Notes: See Notes following Table 3.3 (D)

TABLE 3.3 (D): Cost to Hull

CASE IV

Number of Customers Added:	1500
Demand on Peak per Customers	10 kW
Average Use:	20,000 kWh
Transmission Option:	115 kV - new line owned by Hingham
Load Growth to:	22,000 kW

COST CATEGORY:	Capital Cost	Annual Cost Total [1]	Annual Cost /kW-yr	Cents/ kWh [4]
Generation:				
base:				8.0
[5] peak:		$562,500	$38	1.9
Transmission, NEP to Rockland:				
NEP charges		$27,000	$2	0.1
Hingham Charges [9]:		$339,525	$23	1.1
Weymouth capacity:	-	-	-	-
Rockland to Town [8]:	$1,750,000	$279,583	$19	0.9
Distribution [3]:	$3,450,000	$551,177	$37	1.8
Total:	$5,200,000	$1,759,785	$117	13.8
Investment/kW	$347			
Commitment/kW	$734			

NOTES
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Notes to TABLES 3.3 (A) - 3.3 (D):

1. Capital Costs are annualized at Hull CRF.
2. (Load Growth) x (NEP $/kWh) x (reserve margin) x 12 = e.g., (14000-7000 kW) x .73 $/kWh x 1.25 x 12. In Cases II and IV, NEP rate is .12 $/kWh.
3. New Customers x $300/customer + New Load x $40/kW
4. Annual Cost per kW-yr / Average Use
5. Peak Generation ($/kW-yr) = (Peak Demand - Average Use/5000) x reserve margin x No. of Customers x Peaker Cost).
6. Assumes Hull pays (Hull load/(Hull+Hingham load)) = $594,000 (Hingham Cost, draft EFSC filing) where Hingham load = 23000 kW. Includes credit for NEP charges of 7000 kW. x 1.25 reserves x $0.61/kW-mn x 12.
7. Assumes $120,000/MW over 15 MW, from Hingham preliminary EFSC filing: $ for MVA, assuming 90% power factor.
8. $250,000 allowance added for additional transformation, and voltage control.
9. As in Note 6 above, except Hingham charges are multiplied by 1.5 to reflect Hingham's proposed profit margin, and Hingham's improved bargaining position.

APPENDIX A:

Residential Electric Space Heating Loads

HMLP Development Facilitation Program

Preliminary Analysis

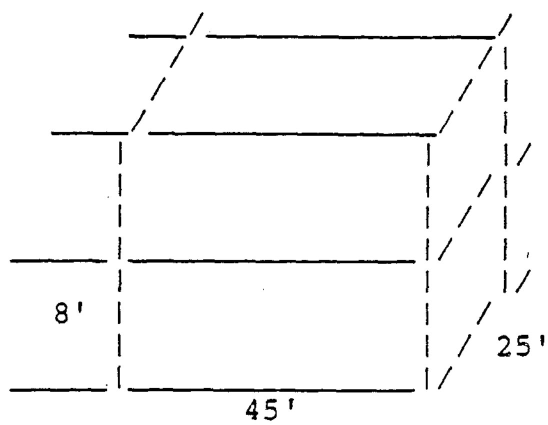
INPUTS:

Height (H)	8.0	ft
Length (L)	45.0	ft
Width (W)	25.0	ft
Total Area	1125.0	ft^2
Air Changes/Hour (ACH)	1.0	
Heating Degree Days (HDD)	5600	°F-days
Temperature at Peak (TP)	0.0	°F
Air Heat Value (EVA)	0.018	Btu/F/ft^3

Number of Stories:	6
Number in Length:	10
Number in Width:	2
Units:	120

Exposed Surfaces	D	R-Value
Ceiling (DC, RC)	0.17	25
Long Wall (L)	1.00	15
Short Wall (S)	0.10	15
Floor (F)	0.17	20
Window (W)		2

Window % of Wall 25.0%



(ft)

Conduction Losses	(Btu/°F/hour)
Ceiling	7.5
Walls	19.0
Floor	9.4
Window	47.5
TOTAL:	83.4
Air Infiltration Loss	162.0
TOTAL LOSSES:	245.4 Btu/°F/hour

Energy Use	9662.6 kWh
Peak Demand	4.5 kW

PUTS:

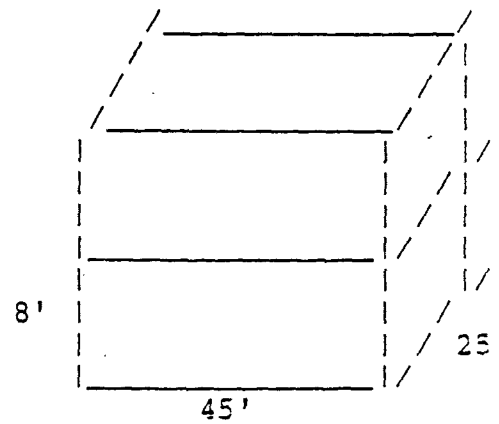
Height (H)	8.0 ft	Number of Stories:	10	
Length (L)	45.0 ft	Number in Length:	1	
Width (W)	25.0 ft	Number in Width:	2	
		Units:	20	
Total Area	1125.0 ft^2			

Exposed Surfaces	D	R-Value
Ceiling (DC, RC)	0.10	25
Long Wall (L)	1.00	15
Short Wall (S)	2.00	15
Floor (F)	0.10	20
Window (W)		2

Window % of Wall 50.0%

Air Changes/Hour (ACH)	1.0	
Heating Degree Days (HDD)	5600	°F-days
Temperature at Peak (TP)	0.0	°F
Air Heat Value (HVA)	0.018	ft^3-hr-°F/Btu

nduction Losses	(Btu/°F/hour)
eiling	4.5
alls	25.3
loor	5.6
indow	190.0
TAL:	225.5
ir Infiltration Loss	162.0
TAL LOSSES:	387.5 Btu/°F/hour



nergy Use 15257.7 kWh

eak Demand 7.2 kW

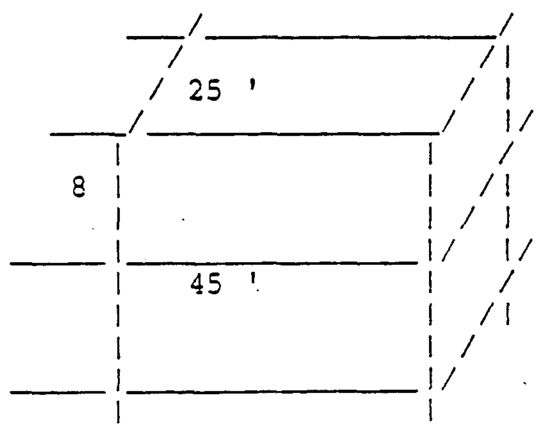
LL CONDOMINIUM HEAT FLOW

PUTS:

Height (H)	8.0	ft
Length (L)	45.0	ft
Width (W)	25.0	ft
Floor Area	1125.0	sq ft
Wall Area	1120.0	sq ft
Air Changes/Hour (ACH)	1.0	/hr
Heating Degree Days (HDD)	5600	F-days
Temperature at Peak (TP)	0.0	deg. F
Air Heat Capacity (HVA)	0.018	Btu/ft/F

Number of Stories:	6
Number in Length:	10
Number in Width:	2
Units:	120

Exposed Surfaces	D	R-Value
Ceiling (DC, RC)	0.17	25.0
Long Wall (L)	1.00	15.0
Short Wall (S)	0.20	15.0
Floor (F)	0.17	20.0
Window (W)		2.0
Window % of Wall	50.0%	



nduction Losses	(Btu/hr/ F)	
eiling	7.5	
'alls	13.3	
'loor	9.4	
/indow	100.0	
)TAL:	130.2	Btu/hr/ F
.r Infiltration Loss	162.0	Btu/hr/ F
)TAL LOSSES:	292.2	Btu/ F/hour

ıergy Use	11506.8	kWh
›ak Demand	5.4	kW

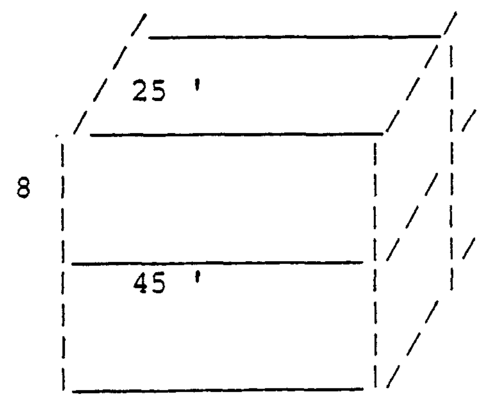
PUTS:

Height (H)	8.0	ft
Length (L)	45.0	ft
Width (W)	25.0	ft
Floor Area	1125.0	sq ft
Wall Area	1120.0	sq ft
Air Changes/Hour (ACH)	1.0	/hr
Heating Degree Days (HDD)	5600	F-days
Temperature at Peak (TP)	0.0	deg. F
Air Heat Capacity (EVA)	0.018	Btu/ft/F

Number of Stories:	10
Number in Length:	1
Number in Width:	2
Units:	20

Exposed Surfaces	D	R-Value
Ceiling (DC, RC)	0.10	25.0
Long Wall (L)	1.00	15.0
Short Wall (S)	2.00	15.0
Floor (F)	0.10	20.0
Window (W)		2.0

Window % of Wall 25.0%



›nduction Losses	(Btu/hr/ F)	
:eiling	4.5	
/alls	38.0	
'loor	5.6	
/indow	95.0	
)TAL:	143.1	Btu/hr/ F
ir Infiltration Loss	162.0	Btu/hr/ F
)TAL LOSSES:	305.1	Btu/ F/hour

nergy Use	12015.5	kWh
eak Demand	5.6	kW

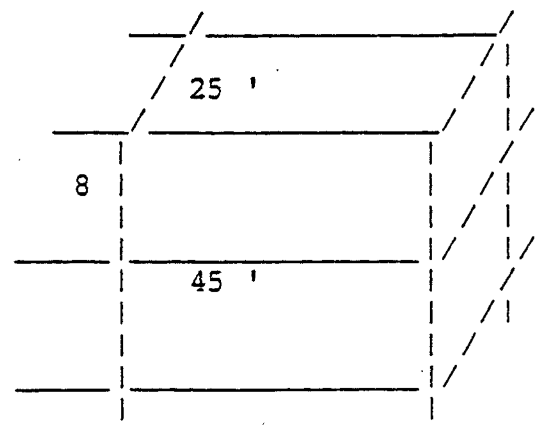
NPUTS:

Height (H)	8.0	ft
Length (L)	45.0	ft
Width (W)	25.0	ft
Floor Area	1125.0	sq ft
Wall Area	1120.0	sq ft
Air Changes/Hour (ACH)	1.0	/hr
Heating Degree Days (HDD)	5600	F-days
Temperature at Peak (TP)	0.0	deg. F
Air Heat Capacity (HVA)	0.018	Btu/ft/F

Number of Stories:	6
Number in Length:	10
Number in Width:	2
Units:	120

Exposed Surfaces	D	R-Value
Ceiling (DC, RC)	0.17	40.0
Long Wall (L)	1.00	30.0
Short Wall (S)	0.20	30.0
Floor (F)	0.17	30.0
Window (W)		10.0

Window % of Wall 50.0%



onduction Losses	(Btu/hr/ F)
Ceiling	4.7
Walls	6.7
Floor	6.3
Window	20.0
OTAL:	37.6 Btu/hr/ F
ir Infiltration Loss	162.0 Btu/hr/ F
OTAL LOSSES:	199.6 Btu/ F/hour

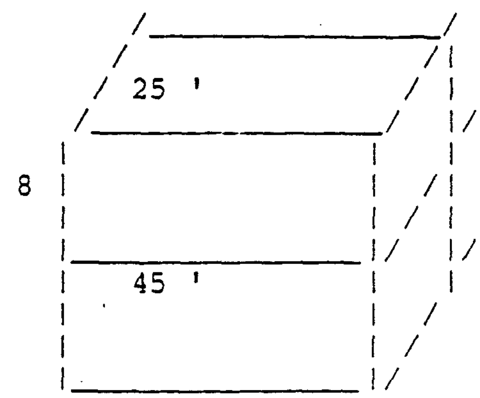
nergy Use	7860.2 kWh
eak Demand	3.7 kW

IPUTS:

Height (H)	8.0	ft
Length (L)	45.0	ft
Width (W)	25.0	ft
Floor Area	1125.0	sq ft
Wall Area	1120.0	sq ft
Air Changes/Hour (ACH)	1.0	/hr
Heating Degree Days (HDD)	5600	F-days
Temperature at Peak (TP)	0.0	deg. F
Air Heat Capacity (HVA)	0.018	Btu/ft/F

Number of Stories:	10
Number in Length:	1
Number in Width:	2
Units:	20

Exposed Surfaces	D	R-Value
Ceiling (DC, RC)	0.10	40.0
Long Wall (L)	1.00	30.0
Short Wall (S)	2.00	30.0
Floor (F)	0.10	30.0
Window (W)		10.0
Window % of Wall	25.0%	



onduction Losses	(Btu/hr/ F)	
Ceiling	2.8	
Walls	19.0	
Floor	3.8	
Window	19.0	
TOTAL:	44.6	Btu/hr/ F
Air Infiltration Loss	162.0	Btu/hr/ F
TOTAL LOSSES:	206.6	Btu/ F/hour

Energy Use	8134.2	KWh
Peak Demand	3.8	kW

COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF PUBLIC UTILITIES

Re: Complaint of Hull Municipal Lighting Plant for Adjudication to Determine the Validity of the Contribution-in-Aid-of-Construction Provision of its Development Facilitation Program	D.P.U. 87-19

AFFIDAVIT OF PAUL L. CHERNICK IN SUPPORT OF PETITION

PAUL L. CHERNICK being duly sworn, deposes and says as follows:

1. I am and have been since 1981 a consultant in the area of electric utilities. I have been a utility analyst since 1977, specializing in electric utility rates and supply planning. I am President and founder of the consulting firm, PLC, Inc. and have held that office since August, 1986. My business address is Suite 955, Ten Post Office Square, Boston, Massachusetts. A copy of my resume is attached hereto.

2. Prior to founding PLC, Inc. I was employed as a research associate for the consulting firm, Analysis and Inference, Inc. of Boston.

3. I received a Bachelor of Science degree in Civil Engineering from the Massachusetts Institute of Technology in 1974 and a Master of Science degree in Technology and Policy from the Massachusetts Institute of Technology in 1978.

4. While serving as a utility analyst for the Massachusetts Attorney General I was involved in numerous aspects

of utility rate design, costing, load forecasting and evaluation of power supply options. My work involved, among other things, review and evaluation of electricity demand projections; consideration of the effects of rate design and cost allocations on conservation, efficiency, and equity; and the design of conservation programs.

5. During my tenure as a utility analyst and consultant I have testified before the Massachusetts Department of Public Utilities ("DPU" or "Department") on more than thirty-five occasions. This experience in combination with the knowledge acquired through my analytical and consulting work in the utility area make me extremely familiar with the rules, orders, policies and practices of the Department.

6. As a utility consultant I have advised a variety of clients on many different utility matters as set forth in my resume. One of my clients is Hull Municipal Lighting Plant ("HMLP") for whom I conducted a preliminary analysis for the first phase of the HMLP Development Facilitation Program ("DFP"). In December, 1986 I completed a supplemental analysis in which I derived the hook-up fee rates and estimation procedures for the first phase of the DFP. Both of these analyses have been filed with the Department in support of HMLP's General Terms and Conditions. See Exhibits G and O to HMLP's Petition for Adjudication and Memorandum in Support of Petition for Adjudication.

7. Because extensive condominium development was planned for the Town of Hull ("Hull"), I was requested by HMLP in 1985 to analyze the issues raised by such development. It was clear that the transmission capacity, distribution equipment and supply resources of the HMLP system as it existed in 1985 were unable to accommodate any significant load increase.

8. In my analysis which is entitled "Preliminary Recommendations for First Phase HMLP Development Facilitation Program," I examined the size of the potential challenge to HMLP's ability to support peak loads, the capital cost of required upgrading, and the annual cost burden due to system growth. I then considered possible solutions to some of the problems posed by rapid system expansion in order to facilitate development in Hull without creating financial burdens for HMLP's present or future customers. See Exhibit G.

9. My analysis made it clear that improvements to the existing system would take considerable time and money. The amount of time and money was dependent on how much electricity the proposed condominium units would require. The amount of electricity required to service the condominiums would vary depending on the style of building construction and the type of heating and hot water systems used in the units.

10. In my analysis I first calculated load growth potential by assuming that 1500 condominiums would be coming on line over a short time period as all-electric units using resistance heating and standard construction techniques. Under these circumstances

each unit may consume 20,000 kWh and require 10 kW at the time of winter peak for a total increase of 15,000 kW. This level of heating load could be expected to double HMLP's energy sales and triple its peak load to 22,000 kW. See Exhibit G at p. 3-4.

11. In contrast, my analysis found if the condominiums were not electrically heated but depended on electricity for all other uses they would be expected to consume about 9000 kWh annually and contribute some 2 kW to the peak which would be a total contribution of 3,000 kW. Finally, if the units did not rely on electricity for space heating or hot water the total contribution to peak would be less than 1,000 kW. See Exhibit G at p. 4-5.

12. Electricity use also varies depending on the arrangement of the condominium units. Therefore, my analysis estimated space heating energy use and demand on peak using a variety of building arrangements. See Exhibit G at p. 4.

13. Based on the information obtained in my analysis I was able to recommend that HMLP impose a hook-up charge for connecting new load to the system. I made this recommendation for the following reasons: (1) unless the developers share in the costs of the system expansion, such costs are likely to increase rates for some time to come; (2) financing the base case expansion would be difficult and burdensome for HMLP and Hull; (3) there are severe time constraints on the expansion of the HMLP transmission and distribution system and the resultant limit on short term capacity implies that measures which reduce contribution to peak demand per unit of development will tend to

increase the amount of development that can be accommodated; (4) hook-up charges require that developers confront the costs they are imposing on the system and on their own customers thereby giving them the incentive to select energy sources efficiently, considering costs beyond just the initial construction costs; and (5) hook-up charges when combined with offsets for conservation and load management techniques can be used to encourage the efficient use of electricity. See Exhibit G at p. 19.

14. By providing the developer with all the information as to the costs of electricity supply, the hook-up charge encourages the use of alternative space and water heating systems to the extent that they are economical. The DPU has expressly directed that electric companies implement programs designed to save electricity. By imposing a hook-up charge for connecting new load to the system HMLP has therefore acted in the public interest by furthering the DPU's policy of conservation and load management.

15. The hook-up charge is by its very nature a tariff. HMLP has determined that those desiring electrical service for new or expanded use must pay a charge as a condition for such service. Such a charge comports with the DPU's policy of using marginal cost in rate design. The hook-up charge assures that those increasing the load will pay the costs to HMLP associated with the load increase.

Paul L. Chernick

Subscribed and sworn to before me this 21st day of January, 1987.

Jeffrey M. Bernstein

My commission expires 5/4/90.