

Higher than expected electricity consumption in recent years and increasing objections to capacity expansion on environmental grounds have led Québec's government-owned electric utility, Hydro-Québec, to launch an innovative program to reduce peak period residential electric heating demand. When the outside temperature drops below -12°C , customers who have opted for the program are charged 10¢/kWh for their electricity (substantially above the 4.46¢/kWh paid by normal residential customers) and they are automatically switched to a non-electric heating source, whereas above -12°C they pay 2.75¢/kWh for all uses. A cost-benefit analysis of this dual-energy program finds that if, as Hydro-Québec forecasts, 150,000 residential customers were to opt for the program, they would benefit by \$19.0 million per year, while the utility and government would lose \$21.6 million and \$1.6 million respectively, with a total net loss to Québec society of \$4.25 million a year.

Au cours des dernières années, la consommation d'électricité a été plus élevée que prévue. Ce fait, auquel s'ajoutent de nouvelles préoccupations environnementales au sujet de l'addition de capacité de production, a incité Hydro-Québec à faire appel à des programmes et à des structures de prix conçus pour freiner la croissance de la demande d'électricité, surtout en période de pointe. La société d'État de la province de Québec a mis sur pied un programme innovateur afin de réduire la demande résidentielle d'électricité pour des fins de chauffage durant la période de pointe. Lorsque la température descend sous -12°C , les clients ayant opté pour ce programme voient le prix de l'électricité augmenter à 10¢/kWh et doivent alors utiliser une autre source de chauffage. Au dessus de -12°C , ce prix est de 2.75¢/kWh peu importe l'usage. Ce dernier prix est inférieur au prix payé par les clients résidentiels réguliers, soit 4.46¢/kWh. Nous effectuons dans cet article une analyse bénéfices-coûts de ce programme. Nos résultats montrent que si, comme Hydro-Québec le prévoit, 150,000 clients résidentiels choisissent ce programme, alors ils feront globalement un bénéfice de \$19.0 millions par année tandis que la société d'État et le gouvernement perdront \$21.6 millions et \$1.6 million respectivement. La perte nette totale pour la société québécoise dans son ensemble sera de \$4.25 millions par année.

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The Residential Dual-Energy Program of Hydro-Québec: An Economic Analysis

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Introduction

Higher-than-expected electricity consumption in recent years¹ has led to upward pressure on Hydro-Québec's reserve margin. At the same time, increasing concern over capacity expansion, itself motivated by concern for the natural environment, has stimulated interest in programs and tariff structures designed to slow electricity demand growth and to shift demand away from peak periods. In this context, Québec's government-owned electric utility launched an innovative program in 1987 to reduce the demand for residential electric heating during peak periods. The innovative feature of this dual-energy program is its direct link with temperature.

To place the program in perspective, we first examine briefly Hydro-Québec's current situation. In 1989, Hydro-Québec sold 127.8 TWh of electricity within its mandated territory and 9.7 TWh on the export market. It had access to 30,570 MW (including 5428 MW from Churchill Falls in Labrador on a long term contract). Of this total, 94.3% came from hydro power. Peak pro-

1/ Over the last five years (1984-89), Hydro-Québec's forecast annual demand growth was 4.4%, while actual demand increased at 6.4% per year.

duction for 1989 reached 27,044 MW (Hydro-Québec, 1989). The residential sector accounted for 47.6 TWh, including 20.8 TWh used for heating purposes, according to Hydro-Québec's estimates (Hydro-Québec, 1990a). Residential electric heating is a peaking phenomenon, since temperature and economic activities join together to boost electricity demand periodically. For example, in 1987 January sales to the residential sector as a whole exceeded July sales by 150%.²

The Residential Dual-Energy Program was introduced to alleviate some of the pressure that residential electric heating puts on the utility's reserve margin. A residential user in a centrally heated detached house who adopts the dual-energy program is required to maintain two permanent sources of heat: electricity and an alternate source, usually oil). When the temperature drops below -12°C an automatic control device located outside the house switches the heating system from electricity to the other heating source.³ In these circumstances, the price of electricity is 10¢/kWh for non-heating uses; otherwise it is 2.75¢/kWh for all uses, including heating. Figure 1 illustrates Hydro-Québec's pricing structure for regular users and those under the dual-energy program.⁴

In addition, the utility provides a \$55 annual grant toward the maintenance of the oil heating system, while the total annual maintenance cost of such a system is estimated to be \$155. Out of 2,804,418 residential customers in 1989, 90,000 chose the dual-energy price regime. Hydro-Québec expects this number to increase to 150,000 by 1992.⁵

This paper presents an economic analysis of the dual-energy tariff schedule relative to the regular residential tariff. The analysis assumes that the 90,000 residential customers who already own a dual-energy heating system can operate it either as an all-electric system or as a dual-energy system. It is also assumed that, if the 60,000 residential customers who currently use an oil heating system wish to convert to the dual-energy program, they are able to do so without installing an electric base-board heating system.⁶

Our intent is to examine whether it is worth-

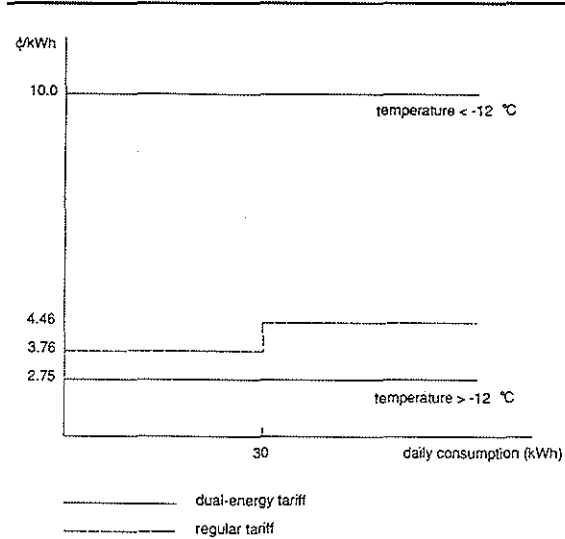


Figure 1: Regular and Dual-Energy Tariffs for Residential Customers (1989)

while to have 150,000 residential customers committed to the dual-energy heating system. The answer differs according to whose benefits and costs are considered. We consider in turn residential users, the utility, the government (as a tax collector), and society in general (the sum of the three groups). The analytical framework is bor-

2/ Energy, Mines, and Resources Canada (1990) Table 5.9A. From Table 2 below, it can be seen that January consumption exceeds July consumption by 350% for an all-electric house.

3/ The crossover point is -15°C in the northern area of the province.

4/ Both tariffs also include a daily fixed charge of 31.7¢ and electricity sales are subject to a 9% provincial sales tax. Heating oil is subject to the same sales tax. On January 1, 1991, the provincial government reduced the sales tax rate to 8% and the federal government introduced the Goods and Services Tax at 7%. These tax changes are not accounted for in this paper since it is based on information available up to 1989.

5/ See Hydro-Québec (1990a) p.A2.6. Customers using oil for home heating purposes form the target group for the Residential Dual-Energy Program. In 1989, they accounted for 10% of total residential market.

6/ The energy market shares for Québec residential home heating in 1989 are electricity (64%), dual-energy (7%), oil (11%), natural gas (17%) and others (6%). Source: Hydro-Québec (1990 a), p. A 2.4.

rowed from standard cost-benefit analysis with a view to determining the incentives for each of the three groups to support such a program.

Our perspective is on the long run: we will consider what would happen if 150,000 customers (90,000 current users and 60,000 new ones) were to opt permanently for the dual-energy program under conditions as of the end of 1989. We focus on the economic analysis in the narrow sense, i.e., on what happens to consumers' economic well-being, to Hydro-Québec's profits, and to the government sales tax account. Electricity planning, development and production involves many other dimensions, such as reliability of supply, investment irreversibility and externalities. These issues are not considered here.

Our main result is that, if 150,000 residential customers were to opt for the dual-energy program, they would gain \$19.0 million per year while the producer and government would lose \$21.6 million and \$1.6 million respectively. The total net loss for Québec society as a whole would be \$4.25 million per year. The loss is quite small and it is sensitive to the price of crude oil, which influences both the price of home heating oil and the operating cost of electricity-producing gas turbines. In this study, we rely on the average 1989 world oil price of US \$18.55/barrel (EMR Canada, 1990, Table 7.1A).

1. The Residential Customer

In this section we determine the incentives faced by residential customers when choosing between the dual-energy tariff and the regular tariff. These incentives are measured not only in terms of electricity bills but also in terms of consumer surplus, the most widely used measure of consumers' benefits.⁷ The behaviour of residential users is very important because their decisions determine how much electricity is produced, when to produce it, the associated revenue and cost to Hydro-Québec and the sales tax collected by the government.

To assess the changes in electricity consumption by a residential customer who chooses the dual-energy program over the regular tariff, we

Table 1: Hours Partition for the Year

Period	Hours	Number of Hours
Peak	December, January, & February (first fifteen days) from 16h00 to 20h00	330
Intermediate	November to April, (excluding peak hours)	4014
Base	May to October	4416
Total		8760

Source: Hydro-Québec (1978).

require information on hourly electricity demands, for both heating and non-heating purposes, as functions of price and temperature. Unfortunately such information is not readily available. Hence simplifying, though realistic, assumptions have been made to reduce the task to manageable proportions. The first assumption is that every hour of the year is assigned to one of the three subsets presented in Table 1. This partition is borrowed directly from Hydro-Québec (1978). The peak period includes hours when capacity is above 80% of peak demand. An immediate implication is that 20% of capacity is operating 330 hours or less per year. The dual-energy program is aimed at reducing this narrow peak.

Table 2 reproduces information taken from Hydro-Québec (1987) on monthly electricity consumption by use for a typical house, when the temperature is above or below -12°C, and on the average number of hours per month when the temperature drops below -12°C. It is assumed that hourly consumption for heating and non-heating uses is the same for every hour during which the temperature is below the -12°C thresh-

7/ Electricity bills measure changes in out-of-pocket expenses. Consumer surplus measures willingness to pay as revealed by consumer demand, which takes into account the inverse relationship between price and quantity demanded. The consumer surplus is the area beneath the traditional demand curve above the price paid. See Willig (1976) for a discussion of consumer surplus as a measure of economic welfare.

Table 2: Weather Condition and Electricity Consumption in an All-Electric House

Month	Heating (kWh)			Non-Heating (kWh)			Total	Number of Hours		
	< -12°C	> -12°C	Sub-Total	< -12°C	> -12°C	Sub-Total		< -12°C	> -12°C	Total
January	1,907	1,062	2,969	658	542	1,200	4,169	407.7	336.3	744
February	1,375	1,212	2,587	479	671	1,150	3,737	280.2	391.8	672
March	292	1,907	2,199	130	870	1,000	3,199	96.7	647.3	744
April	0	1,410	1,410	4	996	1,000	2,410	2.9	717.1	720
May	0	726	726	0	950	950	1,676	0.0	744.0	744
June	0	239	239	0	850	850	1,089	0.0	720.0	720
July	0	73	73	0	850	850	923	0.0	744.0	744
August	0	153	153	0	900	900	1,053	0.0	744.0	744
September	0	528	528	0	950	950	1,478	0.0	720.0	720
October	0	1,104	1,104	0	950	950	2,054	0.0	744.0	744
November	38	1,693	1,731	18	982	1,000	2,731	13.0	707.0	720
December	1,109	1,526	2,635	358	742	1,100	3,735	241.8	502.2	744
Annual	4,721	11,633	16,354	1,647	10,253	11,900	28,254	1,042.3	7,717.7	8,760

Source: Hydro-Québec (1987).

old within a particular month for both peak and intermediate hours. The same assumption is made when the temperature is above the threshold. These assumptions allow us to associate with each hour of the year an electricity consumption level that takes into account the type of use and the temperature criterion.

To determine changes in electricity consumption resulting from price changes, information about price elasticities of demand is required. Since in the past Hydro-Québec has not instituted time of use pricing, there is no information of this sort available. Instead, we borrow price elasticity estimates from an earlier study in western Canada. To be conservative, rather low estimates are used: -0.10 for the peak, -0.25 for the intermediate, and -0.10 for the base period (Protti, 1980; Bernard, 1985).

It is assumed that price elasticities do not vary by use and within each period (peak, intermediate and base). The fairly low price elasticity estimates used here lead to underestimated consumer surplus gain when price is falling and overestimated consumer surplus loss when price is increasing. Since only 12% of total hours during the year are subject to price increases, with price decreases over the remaining hours, estimates of overall consumer surplus changes

are most probably biased downward.

The price elasticity estimates are assumed to account for the long-run reactions of consumers to the electricity prices associated with the dual-energy program relative to the regular tariff schedule. Since electricity provides essential services and since it represents a small share of consumers' total expenses, it could be argued that electricity price elasticities are likely to be quite low, if not zero. On the other hand, since consumers who opt for the dual-energy program are probably among those most likely to respond to that kind of price signal, their electricity consumption is likely to exhibit above average price responsiveness. In the absence of direct empirical evidence, the compromise between these two views was made in favour of low, but not zero, price elasticities of electricity demand.⁸

Figure 2 presents a graphical illustration of the three possible situations which the consumer faces under the dual-energy program. In part (a), we have the case of heating demand when the temperature is below -12°C. The initial electricity consumption Q_0 is completely wiped out and it

8/ Sensitivity analysis over a wider range of price elasticity estimates, although quite simple, would burden the presentation.

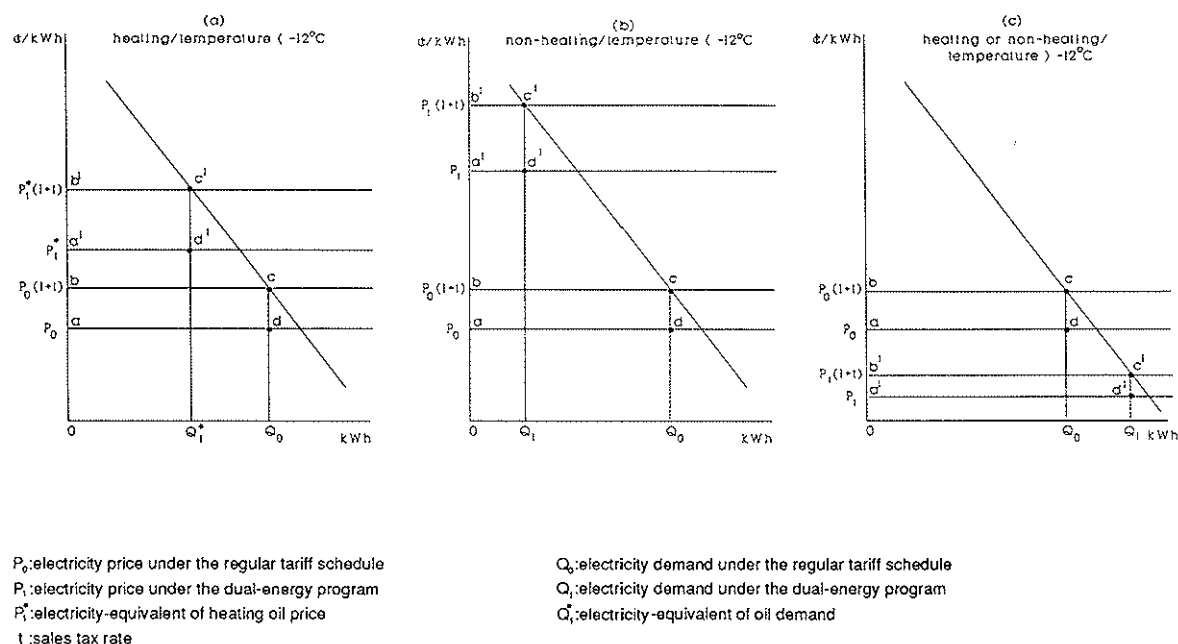


Figure 2: Electricity Demand Changes Induced by Price Changes

is replaced by an electricity equivalent of heating oil, Q_1^* . The quantity Q_1^* is less than Q_0 because the new price P_1^* is above the old price P_0 .⁹ Consumer expenses increase from $ObcQ_0$ to $Ob'c'Q_1^*$ since electricity demand is price inelastic. Consumer surplus falls by $bb'c'c$. Hydro-Québec's revenue goes from $OadQ_0$ to zero while government sales tax collection increases from $abcd$ to $a'b'c'd'$, again due to the price inelasticity of electricity demand for heating.

In part (b), we see that non-heating electricity demand is subject to a large price increase when the temperature falls below -12°C . As a result, electricity consumption falls from Q_0 to Q_1 and the associated consumer surplus loss is $bb'c'c$. Consumer expenses, Hydro-Québec's revenues, and sales tax collection all increase due to the price inelasticity of electricity demand. For heating and non-heating uses at temperatures above -12°C , the consumer benefits from an electricity price cut; the latter case is displayed in part (c). Electricity consumption increases together with consumer surplus, while the electricity bill decreases. This means lower revenues for Hydro-

Québec and for the government. This analysis of the price effect illustrates that out-of-pocket expenses are poor indicators of consumer incentives. In this case, the changes in consumer surplus are greater.

Before turning to the empirical results, three further observations should be made. First, according to Hydro-Québec (1987), 0.155 litres of heating oil provide the heating service equivalent of one kWh when the efficiency of the oil heating furnace is 60%. Based on an average price of 30.4¢/litre in 1989, the heating oil price is translated into a net of tax price of 4.72¢/kWh of electricity equivalent. Second, above the daily fixed charge, the regular residential electricity

9/ When the temperature drops below -12°C , the heating system changes automatically from electricity to heating oil. Under these circumstances, heating service is provided by oil. In order to make a graphical presentation of consumers' reaction to the underlying price change, oil heating service is translated into an electricity equivalent based on oil heating furnace efficiency of 60%. This is the electricity equivalent of heating oil service which is then used.

Table 3: Results for a Residential Consumer Using the Dual-Energy Tariff

Month	Δ Electricity Consumption (kWh)	Δ Electricity and Heating Oil Bills (\$)	Δ Consumer Surplus (\$)	Δ Hydro-Québec Revenue (\$)	Δ Sales Tax (\$)
January	-1,952	5.41	-15.63	-83.96	0.45
February	-1,345	-6.95	1.62	-70.44	-0.57
March	-66	-32.61	39.68	-43.51	-2.69
April	229	-30.96	39.92	-28.40	-2.56
May	129	-20.29	25.34	-18.62	-1.68
June	84	-10.93	14.21	-10.03	-0.90
July	50	-8.67	10.43	-7.96	-0.72
August	81	-10.11	13.28	-9.28	-0.83
September	113	-17.28	21.74	-15.86	-1.43
October	158	-26.47	32.66	-24.28	-2.19
November	213	-34.75	44.35	-33.65	-2.87
December	-1,014	-16.09	15.18	-66.47	-1.33
Sub-total	-3,320	-209.70	242.78	-412.46	-17.32
Heating Oil System Maintenance Cost		95.00	-95.00	-55.00	
Total	-3,320	-114.70	147.78	-467.46	-17.32

tariff schedule has two levels, as shown in Figure 1. From Table 2, it can be seen that July is the only month when electricity consumption marginally fails to reach the second level. Here it is assumed that the consumer is always facing the higher price of the second part of the tariff at the margin. One implication is that attention has to be paid to the lower first level when one computes changes in consumer surplus, electricity bills, Hydro-Québec's revenues and sales tax revenue. Finally, heating system maintenance and repair costs are taken into consideration in this analysis, while installation expenses related to dual-energy heating systems are ignored for the 90,000 customers who already own one. However, the installation expenses have to be taken into consideration for the 60,000 users who still have to buy the dual-energy heating system. This point will be developed further below.

Based on the above information, Table 3 presents the monthly changes in electricity consumption, electricity and heating oil bills, consumer surplus, Hydro-Québec revenues, and sales tax revenues for a consumer who chooses the dual-energy tariff over the regular residential tariff. Net reduction of electricity consumption is 3320

kWh, or 12% of total annual consumption under the regular tariff. The largest decreases occur in January, February, and December. Net changes of electricity consumption per month have three components: (1) the transfer to oil when temperature is below -12°C ; (2) the effect of the electricity price rise on non-heating use under the same circumstances, and (3) the increase in all uses due to the price decrease when the temperature is above -12°C . Overall, the net reduction in total electricity consumption is less than the electricity displaced when the temperature is below -12°C , i.e. 3320 kWh versus 4721 kWh. Except for January, electricity and heating oil bills diminish in every month. The total reduction is \$209.70 per year; but when the customer's share of oil heating system maintenance cost (\$95) is taken into account, the net decrease is \$114.70 per year. The gain in consumer surplus is \$147.78 per year.

Most of the benefit occurs in months when heating is still required and the temperature is above -12°C , such as March, April, October, and November. Hydro-Québec loses revenue in every month because of the oil heating component when the temperature is below -12°C and because of demand price inelasticities when the

temperature is above this benchmark. Overall the utility loses \$467.46, which includes the \$55.00 grant, for each customer who chooses the dual-energy program. Similarly, the government suffers a sales tax reduction of \$17.32.

Since our perspective is long run, the added cost of installing a dual-energy heating system, rather than an all-electric one, must be taken into account for the 60,000 customers who currently own an oil heating system to be replaced by a dual-energy system. According to Hydro-Québec (1991), the added cost before sales tax of installing a dual-energy system over an all-electric one is \$1900. Hydro-Québec provides a \$1500 grant to customers who select the dual-energy program. Since our analysis of electricity demand and production is carried on an annual basis, these amounts have to be annualized over the useful life of the equipment, which is assumed to be 20 years. A 7.5% social rate of discount is used for that purpose.¹⁰ The annual equivalent amounts¹¹ per customer are \$136.87 for Hydro-Québec and \$52.10 for the customer, while the government receives \$15.60 in the form of sales tax on the purchase of the new heating system.

2. The Producer

Electricity cannot be stored on a large scale. For all practical purposes, it must be produced when required and the producer must have access to sufficient capacity to meet demand. Otherwise demand must be rationed.¹² Inventories cannot play a buffer role between demand and supply variations. Because electricity is an intermediate service, used with complementary equipment to produce services desired by users in the form of heat, light, motion and electrolysis, the demand for electricity depends on a large array of variables.

Over the course of a year, however, electricity demand displays regular cycles. The order of electricity demand levels per hour, from the highest to the lowest, yields the so-called load duration curve, as displayed in the upper part of Figure 3. The horizontal axis shows the number of hours in a year when capacity in kilowatts (kW) is equal to or above the level of demand,

which appears on the vertical axis. The integral under the curve yields total electricity demand (kWh) over the course of a year.

If the goal is to minimize total generation costs, the producer must choose from the available set of technologies the mix of equipment which offers the proper trade-offs between capacity costs and energy costs.¹³ Gas turbines are cheap to install; however, their operating costs, linked directly to the price of oil, are relatively high. At a hydro-electric power site, the producer combines generation capacity with the mechanical energy of falling water to produce electricity. Hydro sites have different characteristics which can hardly be summarized in a few general statements. They present different opportunities to install turbines (capacity) and to control water flows (energy). In general, sites with high capacity costs and low energy costs are developed to deliver base load electricity, while sites with lower capacity costs and higher energy costs provide peak and intermediate power. The lower part of Figure 3 shows total costs for a gas turbine and for two hypothetical hydro power sites, together with the range over which each type of equipment presents the least cost.¹⁴ During peak hours, i.e., up to H_p , gas turbines have an advantage due to their short period of use.

10/ For a justification, see Bernard and Chatel (1985). A cloud of uncertainty enshrouds estimates of "the" social rate of discount. In order to take this into account, it is common practice to perform a sensitivity analysis, which tends to burden the presentation. Here a choice has been made in favor of simplicity by choosing the mid-point over the commonly-used range of 5 to 10%.

11/ The annual equivalent amount is the constant annual amount, calculated over the useful life of the heating system (20 years), which has the same present value (at a 7.5% discount rate) as the initial amount.

12/ In recent years, electric utilities have developed interruptible sales programs, which allow the utilities to cut power to a customer with compensation in the form of rates lower than regular rates.

13/ For a general discussion of the cost minimizing choice for generation equipment, see the seminal paper of Anderson (1972).

14/ For a more detailed discussion, see Bernard and Chatel (1985).

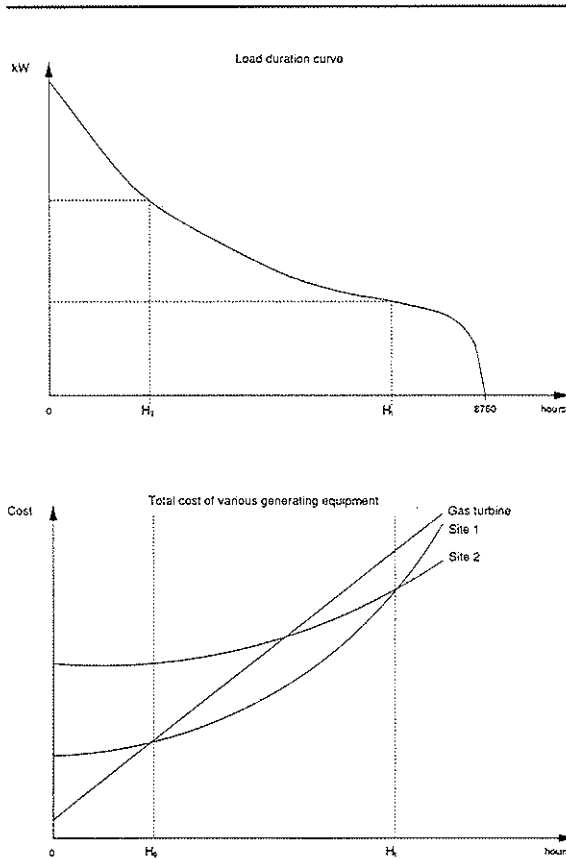


Figure 3: Gas Turbine vs. Hydro Turbine with On-Site Additional Hydraulic Power

This is followed by energy limited hydro power sites, where turbines are added at sites with fairly low capital cost and no change to dams and reservoirs. Finally, hydro power sites with high capacity costs and low energy costs are developed to serve the bottom of the load duration curve. Hydro sites 1 and 2 are examples of the last two types of sites.

Assuming an optimal order of generation equipment under the load duration curve, we can compute the marginal cost of providing one additional kWh for any hour over the year. The power losses, which are themselves related to consumption levels, are incorporated into the analysis. The end result of such calculations is displayed in Table 4;¹⁵ they are labelled marginal social costs since the social rate of discount underlies the annualization process of investment

Table 4: Electricity cost (1989 € / kWh)

Period	Marginal Social Cost
Peak	41.3
Intermediate	3.4
Base	1.8

expenses. We can see that there are huge differences between peak period marginal cost on the one hand and intermediate and base period marginal costs on the other. Capacity costs contribute a large share of total costs and, in the case of the peak period, they are spread over a few (330) hours.

Producer surplus which is used here to measure the effects of output changes on the utility, is defined as the difference between the price that the producer receives for output and the marginal social cost of providing the output. At this stage, we are interested in measuring the changes of producer surplus which result from the application of the Residential Dual-Energy Program. When a customer chooses the dual-energy program, he or she induces two types of change for the producer: first, some of the quantities are sold at different prices, and second, consumption levels, and hence output, are modified.

Figure 4 shows a graphical illustration of some changes of producer surplus with respect to demand for heating only. In part (a), it is seen that when the temperature drops below -12°C in the peak period, the producer surplus increase is $abcd$, since Q_0 units at marginal cost MC_p and price P_0 , are erased by the shift to heating oil. However, when the temperature is above -12°C in the peak period, as in part (b), the producer has an added loss $abcd$ on the quantity Q_0 previously provided, plus a new loss $defg$ on the added consumption $Q_1 - Q_0$ induced by the lower price.

Producer surplus changes associated with heating demand over the intermediate period are shown in parts (c) and (d). This analysis is straightforward with loss $abcd$ in the first case and $defg - abcd$ in the second case. Parts (c) and (d) of Figure 4 are also representative of the base

15/ A data appendix can be obtained from the authors.

Table 6: Overall Results (\$ thousands)

Description	Consumer Surplus	Producer Surplus	Sales Tax	Total
<u>All Consumers</u>				
January	-2,345	17,102	68	14,825
February	243	3,884	-85	4,042
March	5,952	-6,189	-404	-641
April	5,988	-5,430	-384	174
May	3,801	-2,163	-252	1,386
June	2,132	-1,730	-135	267
July	1,565	-1,328	-108	129
August	1,992	-2,586	-125	-719
September	3,261	-2,685	-215	361
October	4,899	-4,068	-329	502
November	6,653	-6,132	-431	90
December	2,277	6,131	-200	8,208
Sub-Total	36,418	-5,194	-2,600	28,624
Heating Oil System Maintenance Cost	-14,250	-8,250		-22,500
Sub-Total	22,168	-13,444	-2,600	6,124
<u>New Dual-Energy Program Participants (60,000)</u>				
Furnace Installation Cost	-3,126	-8,212	93	-10,402
Total	19,042	-21,656	-1,644	-4,258

year, while the producer and the government suffer losses of \$21.6 million and \$1.6 million respectively. Total net loss is \$4.26 million. Such a small loss could easily be erased if some key parameters were to change. Examples of such key parameters are heating oil prices, the social rate of discount, electricity demand elasticities, and heating oil system maintenance costs.

The small loss to society as a whole, combined with the results that both the utility and the government are net losers, leads to the prediction that the program may either be dropped altogether, or that some of its key parameters may be modified, when the current capacity and energy shortages faced by Hydro-Québec are relieved.¹⁶

Conclusion

In this paper, we presented the results of a standard cost-benefit analysis applied to Hydro-Québec's Residential Dual-Energy Program. This program is one of many currently being introduced in North America to reduce electricity demand growth or to transfer load away from the peak period. The usual qualifications of cost-benefit analysis apply (Harberger, 1971). Our main result is that the net loss to society is relatively small, while the consumer is the only winner.

16/ For a description of the current capacity and energy shortage in Québec, as well as some of the actions that Hydro-Québec is undertaking to bring the situation under control, see Hydro-Québec (1990b).

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