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Please provide a copy of the referenced paper.

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CHAPTER 9

Regulation of electric power in Canada

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Introduction

The electricity grid in Canada is composed of generation facilities owned by 11 major companies organized primarily along provincial lines. Tables 9-1 and 9-2 provide data by province for 1993–94 on capacity and generation of energy by primary energy source.

The sources of power vary greatly across the provinces. In 1993, hydro generation represented 62% of electrical energy generated in Canada, hydro being near 100% in Quebec, Newfoundland, Manitoba, and British Columbia, 28% in Ontario, and less than 4% in Alberta. Nuclear facilities provided 17% of Canadian total electricity generated in 1993 but exist in only three provinces – New Brunswick and Quebec (35% and 3% respectively) and Ontario (52%). The choice of the nuclear option in Ontario is examined later. Conventional thermal generation represented 21% of Canadian sources.

The growth of electricity demand has over the years been highly correlated with the growth in gross domestic product, the two tracking each other fairly closely over the course of business cycles. Canadians are very intensive users of energy in general and electricity in particular. Climate and geography have been important contributing factors as has been the historically low price of electricity. The latter is not only a result of the availability of major hydraulic resources but also because public utilities, which dominate in Canada, do not pay corporate income taxes and are able to borrow at favourable rates. The real average price of electricity, which was 4.25 1991 Canadian ¢/kWh in 1970, increased during the mid-1970s as new facilities came on line, particularly nuclear facilities in Ontario. In 1991, the price of electricity was about 5.2 Canadian ¢/kWh – about 60% of which is attributable to generation, 15% to

From a paper presented at the American Economic Association meetings, Anaheim, California, January 6, 1993. The authors would like to thank Anthony Frayne and Nicholas Sisto for assistance with data.

Table 9-1. *Generating capacity, winter 1993–1994 (MW)*

	Hydro	Steam	Nuclear	Internal combustion	Combustion turbine	Unspecified	Total
Newfoundland	6,597	507	—	73	192	—	7,369
Prince Edward Is.	—	65	—	10	39	—	114
Nova Scotia	390	1,708	—	—	222	—	2,320
New Brunswick	934	2,181	635	5	531	10	4,296
Quebec	28,955	625	675	56	886	67	31,264
Ontario	7,240	11,258	14,164	9	998	—	33,669
Manitoba	4,934	347	—	18	—	—	5,308
Saskatchewan	847	1,852	—	2	137	—	2,837
Alberta	819	6,945	—	46	465	11	8,286
British Columbia	10,687	550	—	69	151	167	11,624
Yukon	78	—	—	57	—	—	135
Northwest Terr.	48	—	—	170	26	—	244
Canada	61,538	26,038	15,474	514	3,646	255	107,466

Source: Electric Power Statistics, Capability and Load, 1993, Statistics Canada – Catalogue 57-204.

Table 9-2. *Energy made available, 1993 (GWh)*

	Newfoundland	Prince Edward Island	NovaScotia	New Brunswick	Quebec	Ontario
Hydro	39,193	—	884	3,057	150,048	40,693
Steam	1,581	52	8,787	6,751	36	22,123
Nuclear	—	—	—	5,323	4,807	78,498
Internal combustion	77	—	11	—	250	3
Combustion turbine	–2	7	33	23	25	2,072
Total	40,849	59	9,715	15,154	155,166	143,389
Receipts:						
United States	—	—	—	123	684	2,765
Provinces	—	731	255	1,518	30,192	1,579
Deliveries:						
Firm – United States	—	—	—	1,518	8,092	244
Firm – Provinces	29,942	—	—	359	1,129	7
Nonfirm – United States	—	—	—	359	4,916	6,913
Nonfirm – Provinces	—	—	41	668	1,003	217
Total available	10,907	790	9,929	13,891	170,902	140,352
Nonfirm deliveries within Province	—	—	—	—	100	—
Losses:						
United States	—	—	—	24	500	—
Provinces	552	—	—	62	70	—
Firm energy available	10,355	790	9,929	13,805	170,232	140,352

Source: Electric Power Statistics, Capability and Load, 1993, Statistics Canada – Catalogue 57-204.

Table 9-2 *(cont.). Energy made available, 1993 (GWh)*

	Manitoba	Saskatchewan	Alberta	British Columbia	Yukon	Northwest Territories	Canada
Hydro	26,891	4,051	1,808	53,174	289	260	320,348
Steam	241	11,099	44,261	6,224	—	—	101,155
Nuclear	—	—	—	—	—	—	88,628
Internal combustion	27	56	20	69	48	233	794
Combustion turbine	—	6	2,275	193	—	96	4,728
Total	27,159	15,212	48,364	59,660	337	589	515,653
Receipts:							
United States	196	147	2	3,633	—	—	7,550
Provinces	925	1,411	683	1,842	—	—	—
Deliveries:							
Firm – United States	3,466	—	—	1,889	—	—	15,209
Firm – Provinces	188	6	1	21	—	—	—
Nonfirm – United States	3,893	229	—	3,362	—	—	19,672
Nonfirm – Provinces	2,130	1,314	1,858	251	—	—	—
Total available	18,603	15,221	47,190	59,612	337	589	488,322
Nonfirm deliveries within Province	—	—	891	225	—	—	1,216
Losses:							
United States	611	—	—	148	—	—	1,283
Provinces	177	—	—	17	—	—	—
Firm energy available	17,815	15,221	46,299	59,222	337	589	485,823

Source: Electric Power Statistics, Capability and Load, 1993, Statistics Canada – Catalogue 57-204.

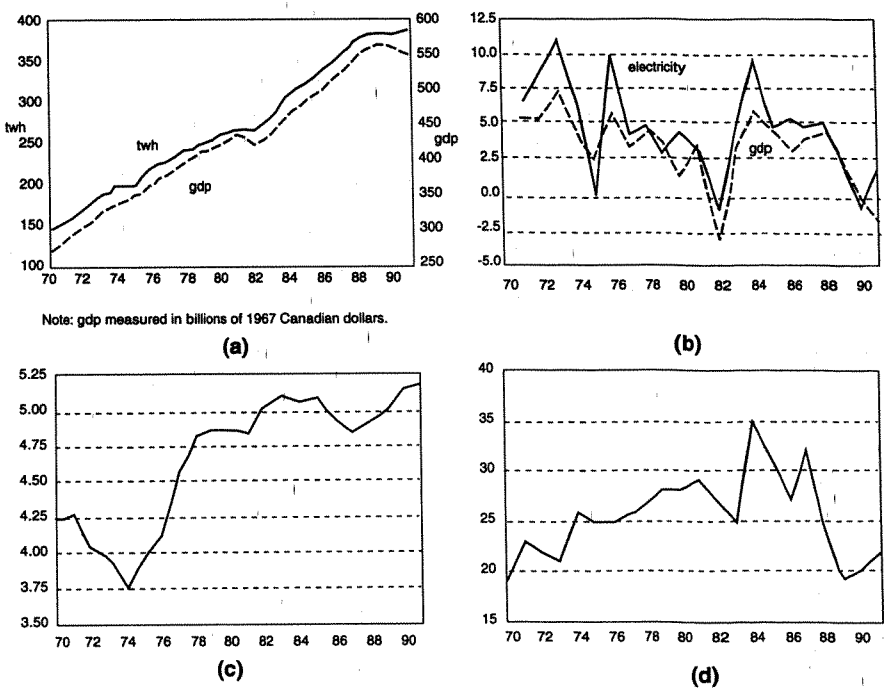

Figure 9-1. (a) Electricity consumption vs. GDP – Canada; (b) change in electricity consumption vs. change in GDP (percentage); (c) real price of electricity – Canada (1991 Canadian ¢/kWh); (d) reserve margin – Canada (percentage). Sources of data: electricity consumption and price of electricity: National Energy Board (1990, pages 38–9); reserve margins, Energy Mines and Resources (1970–1992); Canadian GDP: *Short Term Economic Outlook, Fall Review,* Ontario Hydro, October 1992.

transmission, and 25% to distribution.[1] Reserve margins increased from 20% in 1970 to a peak of 35% in 1985 as projects, begun during a period of faster growth, came on line during a period of moderating load growth. Electricity demand, which was growing at 6% per year during the 1970s, slowed to 4% growth per year during the 1980s. See Figures 9-1 (a) to 9-1 (b).

The regulation of electricity in Canada is largely a provincial matter.[2] Under

[1] Adjusting for exchange rates prevailing at the time these figures correspond to 4 US ¢/kWh in 1970 and 4.5 US ¢/kWh in 1991.

[2] "Under the *Constitution Act,* legislative authority over management of national resources, and the generation, transmission, and distribution of electricity, rests primarily with the provinces. The provinces have jurisdiction over generating facilities within their borders and over intraprovincial transmission grids. This mandate of the National Energy Board (NEB) with regard to electricity supply is restricted under the *NEB Act* mainly to regulation of exports and to facilities related to international and designated interprovincial transmission lines." National Energy Board, *Inter-Utility Trade Review: Inter-Utility Cooperation,* 1992, p. i.

the *British North America Act* of 1867, the federal government has jurisdiction over interprovincial and international trade. However, the federal government has not attempted to exercise this jurisdiction over interprovincial electricity trade, nor has it attempted to coerce an interconnected electricity grid.[3] Federal jurisdiction over electricity exports relies on a 1907 Act – *The Exportation of Power and Fluids and Importation of Gas Act.* The National Energy Board (NEB) established in 1959 oversees electricity trade (as well as oil and natural gas) and certifies international transmission lines. Interprovincial transmission lines are not regulated by this Board "except in cases designated by the Governor-in-Council."[4] The amount of interprovincial transfers among Canadian provinces is low. In 1991 interprovincial transfers represented only 8% of primary and secondary supply. In 1974 the corresponding value was even lower. These values, although small, exaggerate interprovincial movements; 90% of interregional electricity movements are accounted for by shipments from Labrador to Quebec, the legacy of the 1960s contract to develop the Churchill Falls hydro project. Although the pattern of Canadian population density (80% of the population lives within 100 miles of the 2,700-mile-long U.S. border) helps to explain the lack of interprovincial transfers, a number of studies point to efficiency gains from greater coordination. The absence of federal authority is a prime reason for the minimal provincial interconnections.

It is thus provincial regulation that determines the operations of the Canadian electricity system. Table 9-3 provides information on the major electric utilities in Canada and the form of regulatory oversight. Two key features distinguish the Canadian system of electricity generation from that of the United States. First is the preponderance of publicly owned systems and second, the lack of statutory regulatory agency (SRA) supervision. In 1988, eight provincial publicly owned utilities accounted for 82% of total generated electricity (Nova Scotia Power was privatized in 1992). Of these eight major utilities, seven are totally vertically integrated.[5] The eighth – Ontario Hydro – which we deal with in detail, supplies wholesale power to over 300 municipally owned distribution utilities. Ontario Hydro is regulated in an unorthodox manner. Its new facilities needs are vetted by the provincial cabinet, and its rates are determined by the utility's board of directors after a public hearing before an SRA – the Ontario Energy Board, an agency that does not have the authority to set rates.

[3] The National Power Policy of 1963 encouraged connections between provinces as well as interconnections with the United States (see Economic Council of Canada, 1985, and NEB, 1992). In contrast telecommunications wholly within a province has been held to be a federal jurisdiction because the facilities can be used for interprovincial calling. This divergence between telecom and electricity is due to a difference in technologies, differences in the degree of interconnection, and the courts. A major telecom competitor, Unitel (formerly CNCP), sued for interconnection with the Alberta Government Telephone system in Alberta.

[4] See Ministry of Energy, Mines and Resources, Canada, 1988.

[5] In 1989 industrial companies produced 8% of Canadian electricity through self-generation.

Table 9-3. *Regulatory framework for the major electric utilities in Canada*

	Building new facilities							Rate setting	
	Owner-ship	Require-ment	Costs	Debt issue	Environmental impact	Nuclear plants	Exports	Recmmded. by:	Approved by:
Newfoundland and Labrador Hydro Commission	Public			C	C		F	NFLD Pub. Utils. Bd.	C
Newfoundland Light and Power Company	Private				C		F		NFLD Pub. Utils. Bd.
Maritime Electric Company	Private	B					F		Pr. Edwd Is. PUC
Nova Scotia Power Corporation	Private		B	C	C	F	F		Bd. of Comm. of Pub. Utils. of Nova Scotia
New Brunswick Electric Power Commission	Public	C		C	C		F/C		C
Hydro-Quebec	Public			C	C	F	F/C		Prlmntry. Comm.
Ontario Hydro	Public	C		C	C	F	F/C	Ont. Engy. Bd.	Ont. Hydro Bd of Dirs.
Maintoba Hydro Electric Board	Public			C			F/B	Mntba Pub. Utils. Bd.	C
Saskatchewan Power Corporation	Public			C	C		F		Sask. Pub. Utils. Rev. Comm.
Alberta Power Limited	Private	B			C		F		Albta PUB
Transalta Utilities Corp.	Private	B			C				Albta PUB
British Columbia Hydro and Power Authority	Public	B	B	C	C		F/B		B.C. Utils. Comm.

C = Provincial Cabinet
B = Provincial Utilities Board
F = Federal Government

1 Regulated by the Atomic Energy Control Board
2 Regulated by the National Energy Board

In this chapter, we concentrate on the growth and regulation of the second largest Canadian electricity utility – Ontario Hydro. The reasons for this emphasis on examining one utility are the unique features both of Ontario Hydro's generation mix and of the regulatory mechanisms established over the decades.

In 1950 100% of Ontario Hydro's generation was from hydro sources (hence its name). In 1972 thermal-electric generation, principally from coal, represented 63% of Ontario Hydro's capacity. Ontario Hydro's commercial nuclear program, designed around the unique Canadian nuclear technology (heavy-water based), began as a 2060 MW facility (4 by 515 MW reactors) completed in 1974 (at Pickering). A second facility of 3076 MW (4 by 769 MW) came into service in 1979 (at Bruce). A third facility came into service at the Pickering site between 1983 and 1985 (2064 MW, 4 by 516 MW). A fourth facility (at the Bruce site) came on stream between 1984 and 1987 (3440 MW, 4 by 860 MW).[6] A fifth facility was brought into service during the early 1990s (Darlington, 3524 MW, 4 by 881 MW) and was subject to construction delays, cost overruns, and commissioning problems. Today, nuclear power represents over 50% of output in Ontario, by far the highest reliance on nuclear power in North America.

The regulation of rates and construction programs of Ontario Hydro has unique features. Ontario Hydro began in 1906 as a publicly owned transmission utility, connecting several private generating companies at Niagara Falls with a number of municipally owned distribution companies. Ontario Hydro bought out the private generators between 1914 and 1920 and expanded hydro capacity. The municipal distribution utilities, of which there are over 300, remain independent entities to this day. Ontario Hydro sets three rates – (1) the rate for wholesale power sold to the municipal distributors, (2) retail price schedules for electricity sold directly to rural customers, and (3) rates for large industrial customers tied to a transmission line. Retail rates for the vast majority of electricity users are set by the municipal distribution utilities and approved by Ontario Hydro.

Until 1974, no direct supervision of Ontario Hydro's rates (the wholesale rate and the retail rate schedules) existed. Beginning in 1974 (for the 1975 rate year), the Ontario Energy Board (OEB), which already set retail rates for natural gas distributors, was asked to examine Hydro's rates and make recommendations to Hydro and to the Ontario Provincial Cabinet. The OEB has no authority to set Ontario Hydro's rates and no authority over retail rates set by the municipal utilities, which in turn are regulated by Ontario Hydro. Municipal distributors, however, *are* responsible to their rate payers through elected commissions or through commissions appointed by locally elected officials.

[6] *Providing the Balance of Power,* Ontario Hydro's Demand Supply Plan Report, 1989, pp. 4–20.

In Ontario, regulatory supervision of the choice of technology, the amount of capacity, and the construction program is even more complex than rate setting. Numerous agencies are involved, both provincial and federal. However, no single supervisory or statutory regulatory agency is in charge. Instead, supervision of this crucial function rests on a standing committee and special committees of the provincial legislature, and ad hoc commissions set up to examine specific or general issues.

What explains this process and what are its impacts? The early expansion of public ownership was sold as "power at cost" and "power for the people." Public ownership per se was to ensure that the electricity producer acted in the public interest. We suggest that the theoretical economics literature can help to explain several characteristics of Ontario Hydro. In particular, the regulatory process in Ontario combined with asymmetric information, political uses of the firm, and a wage structure too compacted (in contrast to the suggestion made by Pint [1991]) contributed to overcapacity, emphasis on nuclear technology, and price shocks. The high reliance on nuclear power can be related to public ownership and political desires to base an industrial strategy and an economic development plan on the use of nuclear technology.

Cogeneration projects lag behind those in many U.S. jurisdictions. Demand-side management (DSM) was until recently to be promoted at a pace greater than that in the United States. We suggest that the nature of a publicly owned firm can help to explain these developments as well.

We also examine the current discussion to privatize Ontario Hydro and a number of alternatives – increased third-party access, and horizontal and vertical unbundling – whereby competition would be encouraged. However, an asset base of large nuclear plants, major hydro installations, aging thermal plants, and a set of smaller hydro and peaking plants does not make Ontario Hydro a difficult target for privatization.

Background and history

Early history of electricity in Canada

The rise of the electricity industry in Canada can be divided into two phases. The first phase started in 1880 and followed almost exactly the development of its U.S. counterpart.[7] In 1870 not a single horsepower of electricity was produced in Canada for lighting and manufacturing purposes, yet by 1880, 343 production units were in use. American investors and businessmen brought the new techniques to Canada. First arc and then incandescent lighting systems

[7] The Edison Electric Company was formed in the United States in 1878. In the same year, the American Electric and Illuminating Company, the first Canadian company in this sphere, was formed and a tiny generating plant was built in the retail business district of Montreal.

appeared in Canada, usually installed by the subsidiaries of American firms or by Canadian firms operating under license from the American patentees. Electric lighting systems were set up in smaller towns and villages. Around 1900, the introduction of larger-scale units and especially hydro stations made these small pioneer electrical works obsolete. The advent of the large hydroelectric station around the turn of the century rendered these pioneer electrical works obsolete. In Quebec, these enterprises were amalgamated into the Montreal Light, Heat and Power Company in the early years of the century, and into the Shawinigan Water and Power Company by World War I. Nevertheless, in Quebec some local enterprises escaped amalgamation. In Ontario, as will be detailed, economies of scale in the hydro development of the Niagara River led to a single firm.

Another factor was important in leading to the dominance of hydro power in this period. As electricity demand increased, so did dependence on coal from a foreign source – the United States. Ontario industry was experiencing a power shortage and increasing demand for cheap power in order to develop the manufacturing industries. Hard coal in Canada is found in the west in the Rocky Mountain foothills of Alberta, and in the east, in the Appalachian formations of Nova Scotia but not in Ontario. Neither source was economic for Ontario, even after the coming of railroads. As a result, Ontario became dependent on coal imported from Pennsylvania. In 1897 a two-month strike of 75,000 miners in Ohio, Pennsylvania, and West Virginia led to an American embargo against the export of coal to Canada. As a result, the price of coal in Ontario rose by a factor of three. A similar shock in the price of coal occurred in 1902.

From 1900 to 1940, hydro project facilities in Quebec and Ontario accounted for approximately 80% of the total capacity of water power in Canada. With large power developments at Niagara Falls in the early years of the century, Ontario became the leading province in hydroelectricity, but its margin over Quebec was never large. For the period from 1931 to 1940, the per-capita output of hydroelectric energy in Quebec was higher than in any other Canadian province. Quebec accounted for about 40% of the Canadian central electric station capacity in 1926 and more than half of the Canadian total of installed hydroelectric capacity in 1956. Today, Quebec accounts for 47% of Canada's hydro capacity and 29% of all capacity. Ontario has 31% of total Canadian capacity but provided slightly less energy in 1993 than did Quebec.

Early history of Ontario Hydro

Niagara Falls, one of the seven natural wonders of the world, was seen as early as 1881 as an important source of hydroelectric power. In that year the first generating station was established on the U.S. side and used in an elec-

trolytic process for the manufacture of aluminum. The limiting factor in the first three decades was the inability to transport electricity over long distances. This was a greater problem in Ontario than in New York State because major users in the United States were at Buffalo only 20 miles away, whereas in Ontario the major potential users were in various towns and municipalities around the countryside, Toronto, by far the largest market, being 85 miles away. This geographic factor provides a partial explanation for the rise of public ownership in Ontario as contrasted to private ownership in New York State.

Development of the U.S. side of the Falls therefore preceded Canadian development. As a response to the uncontrolled development of the U.S. side, the Ontario legislature in 1885 passed an act "for the preservation of the natural scenery above Niagara Falls," which allowed for public control. In 1902 a group of municipalities endorsed a report that authorized municipal control over transmission as well as over the development of electrical energy itself. The report was introduced by the mayors of two of the largest communities in the province. Adam Beck from London, who became the principal driving force behind public ownership and the first chairman of Ontario Hydro, stated that the provincial government should be involved in "building and operating as a government work, a line for the transmission of electricity from Niagara Falls to the towns and cities" (Denison, 1960, p. 40). That same year saw passage of the *Power Bill,* which gave municipalities the right to acquire or construct works for the generation and distribution of electric or other power and energy.

In 1905 the new Conservative government issued an Order-In-Council, creating the Hydro-Electric Power Commission of the Province of Ontario with Adam Beck as chairman.

What is interesting for this analysis is that the Hydro-Electric Power Commission of Ontario reported to Chairman Beck and was not controlled to any significant degree. The first attempt at control was in 1911, when a bill was enacted to transfer control of the Hydro-Electric Commission to the Ontario Railways and Municipal Board. The bill never received a second reading. It remained on the order table, but nothing more was heard of it (Denison, 1960, p. 98).[8] Thus, Ontario Hydro remained unregulated by any public board. This does not mean that Ontario Hydro was autonomous because the legislature exercised ultimate authority.

Beck announced publicly that Ontario Hydro would not become a government department (Denison, 1960, p. 99). A key event that shaped the regula-

[8] Several reasons for the demise of this early attempt at regulation may be adduced. The municipalities feared strong provincial controls. The Liberal Party and a number of prominent members of the Conservative Party also were opposed to controls, fearing political manipulation.

tory environment was the establishment by Beck in February 1912 of the Ontario Municipal Electrical Association (OMEA), a body that is one of the predecessors of today's Municipal Electric Association. "One of the purposes of the new association was to make Hydro independent of political interference, and protect it from the inefficiency of political appointments, then not uncommon in Ontario" (Denison, 1960, pp. 99). The OMEA, whose members were the appointed delegates of the councils in Hydro municipalities, became a powerful lobby group.

It was not long before Ontario Hydro's regulatory authority was further broadened. Hydro was given the authority to regulate rates charged by municipal utilities, a feature that remains today, as well as to oversee their accounting practices and determine how they disposed of surplus earnings. In 1915, Hydro was empowered to perform all electrical inspections, again for the sake of consistency.

Private producers lobbied continuously to control the expansion of Ontario Hydro. In each case, public ownership won. "Power at Cost" became the rallying cry for public ownership. In 1917, following rapid growth in demand during World War I, Hydro was authorized to become a producer, purchased the Ontario Power Company's generating station at Niagara Falls (with a capacity of 135 MW) at a cost of $18.5 million, and at the same time embarked on the construction of a huge hydro facility.[9] In 1919, Ontario Hydro built what was at that time the world's largest hydro facility – 580,000 horsepower or 433 MW.[10] The total cost was $76 million – $20 million above estimates.

At the end of World War I, progress on the rural electrification program was considered unsatisfactory. The "Power at Cost" concept was seen as an impediment to this progress, in that customer density among the remote farms and hamlets was so low that those customers could not by themselves bear the cost of the required transmission line extensions.

Throughout the Depression, successive provincial governments found Ontario Hydro increasingly useful as a political tool. Rural Ontario still retained a considerable degree of political importance, and the provision of affordable electricity was viewed as one means of winning its support.

Following World War II, Hydro engaged in an ambitious program to convert all electrical appliances in a 12,000-square-mile area in southern Ontario from 25 cycle to 60 cycle power. Work began in 1949 and took 15 years, at an estimated cost of $170 million to Ontario Hydro and $21 million to municipalities (Denison, 1960, p. 239). The actual cost to Ontario Hydro for the complete conversion operation was $352 million.

[9] This was authorized by way of a plebiscite held New Years Day, 1917.

[10] One horsepower equals 746 watts.

Developments in Quebec

Quebec developments were different. Until the 1930s, the hydroelectric industry in Quebec had been allowed to develop in an environment of unfettered private enterprise.

Social control by regulatory boards in Quebec had been minimal. A Public Utilities Commission was set up in 1909, which was renamed the Quebec Public Service Commission in 1920. The body exercised general supervision over electrical as well as all other utilities until 1934. In that year a Provincial Royal Commission was appointed to study the electrical industry, probably in an attempt to slough off public discontent associated with the Depression, which in part was taking the form of agitation for public ownership of electrical utilities. The commissioner advocated private ownership regulated by a permanent electricity commission. Consequently, the Quebec Electricity Commission was set up in December 1935 with very wide powers of inquiry and regulation and the old Public Service Commission was deprived of its jurisdiction over electrical utilities. This new commission (and its successors) collected statistical data and other information pertaining to the power companies, but its usefulness as an effective regulatory body has been very small, in part because it immediately became subject to political forces. The Quebec Electricity Commission of 1935 was replaced by the Provincial Electricity Board in 1937, which in turn was taken over in 1940 by a refurbished general utilities commission under the name of the Public Service Board.

In Quebec only a few municipally owned generating stations developed – 20 in 1921, 12 in 1928, and 16 in 1940 – but they were small and accounted for only an insignificant fraction of the total electrical output of the province. On occasion they were responsible for forcing rate reductions by the private companies, but on the whole the municipal stations were only a minor nuisance to private enterprise.

In 1944, however, the situation changed drastically. In that year the provincial government set up the Quebec Hydro Electric Commission, which took over ownership and operation of the Montreal Light, Heat, and Power Company. The issue was rates – the private firm refusing to lower announced rates. In 1963 the private generators were "provincialized." The developments in Ontario, the foreign (i.e., non-Francophone) control over electricity in Quebec and the existence of vast hydro potential in the remote North led to a public monopoly.

Impacts of regulatory forms in Ontario

Costs of generation and prices charged by Ontario Hydro followed three major phases, each linked to the transition from one major technology to an-

other. From 1908 to 1950, the system was hydraulic. As the size of the utility increased, the unit cost of production and supply decreased, although the cheaper hydro sites were developed first. Short-run marginal costs were very low. Thus, a declining block-rate structure and promotional efforts were likely efficient. In the early 1950s, coal-fired stations were introduced. These had two effects. The first was to raise average electricity costs, initially by 10% (Royal Commission on Electric Power Planning, 1980, p. 35). The second was to make electricity prices in Ontario a function of fuel costs for the first time. By 1970, thermal generation (mainly coal-fired) accounted for 60% of Ontario Hydro's energy production. Coal costs fell throughout the 1960s as oil prices also fell. Ontario Hydro added generation constantly, but demand grew even more quickly as a function of rapid economic growth and price decreases for electricity. Ontario Hydro continued to promote electricity use, even for uses with intrinsically low-load factors. The construction of the TransCanada natural gas pipeline in 1956 and the expansion of natural gas distribution through the 1960s provided a new and major source of interfuel competition. Thus, Hydro developed special rates encouraging the use of electricity for home heating purposes, water heating, and even a special low tariff for all-electric houses.

Between 1970 and 1973, the cost of coal rose 16% in real terms and real oil prices doubled. The construction program featured nuclear power, a technology in which the capital costs were clearly uncertain but in which fuel costs played a relatively minor role. Yet, in the 1970 to 1974 period, average-cost rather than marginal-cost pricing made real electricity rates fall, not increase. Locked into huge nuclear projects as demand growth slowed, Ontario Hydro came under major pressure to raise rates; public regulation, absent in the entire previous history of Ontario Hydro, began to emerge.

During the 1970s, regulatory scrutiny of Ontario Hydro intensified. Task Force Hydro, a quasi-independent ad hoc review body, completed five reports during 1972 and 1973. Perhaps its most important recommendation was that Hydro become a Crown corporation with a board of directors.[11] In addition, the Task Force recommended that an independent tribunal be set up to review Hydro rate proposals and rate-setting practices. The tribunal had only the power to make recommendations rather than to direct Hydro to undertake specific actions. The Task Force endorsed nuclear power but recommended that Hydro engage in a greater degree of contracting out. In 1974, consistent with the recommendations of the Task Force, Hydro became a corporation with a

[11] Crown corporations are wholly owned federal or provincial organizations that enjoy a greater degree of freedom from direct political control than government departments. They are usually structured in a manner similar to private enterprises but are typically not subject to the same incentives and market forces.

board of directors. It did not, however, become a Crown corporation, leaving the question of ownership unanswered.

In 1974 the Ontario Energy Board was selected as the review tribunal that had been proposed by both the Task Force and the Advisory Committee. The Ontario Energy Board Act provided for recommendatory powers to the board. That same year the OEB held hearings into Hydro system expansion plans and advised the government not to authorize a number of proposed nuclear facilities. The OEB recommended that an outside report be prepared reviewing these issues and that the interests of the province might be better served by a thermal plant instead of Darlington.

The Select Committee of 1977–81 on Ontario Hydro Affairs was initiated to investigate a number of areas, including heavy-water plants under construction at Bruce, fuel contracts, and the need for future nuclear plants. During this period, major uranium contracts were being negotiated between Ontario Hydro and producers at Elliot Lake. The government argued that the contracts were in the public's best interest. The opposition held the opposite view.[12] In the end, Hydro entered into long-term cost-plus contracts with Rio Algom and Denison Mines. During the 1980s, the price of uranium plummeted as worldwide construction of nuclear plants ground to a halt. However, the price Ontario Hydro paid for uranium was decoupled from the world price. Thus, Hydro ended up overpaying for uranium supplies by hundred of millions of dollars during the 1980s.

By the early 1980s, 16 nuclear units were either in service or nearing completion at the Pickering and Bruce sites. Individual units were in the 515 to 860 MW range. In addition, construction of a fifth nuclear station consisting of four 881 MW units was in its early stages at the Darlington site. Demand growth, on the other hand, had fallen dramatically from 6 to about 3% per year. The Select Committee found that Hydro was overestimating load growth and a more appropriate planning number would be in the range of 2 to 3%. The need for the Darlington station was therefore in grave doubt, and the Select Committee recommended that Hydro cease letting contracts in connection with its construction until the government had made a positive determination that the project should proceed as planned. Nevertheless, the Committee acknowledged that the government might decide to continue with the project on the basis of other considerations such as provincial employment, continued sustenance of the nuclear industry, the replacement of less efficient fossil plants, and maintenance of a higher reserve margin in case of a sudden resurgence of load growth. Thus the Darlington project continued to limp along, with occasional delays and postponements and at ever-increasing cost.

[12] Indeed, the New Democratic Party held that Denison Mines' shares should have been bought out earlier when they were cheaper.

The electricity costing and pricing hearings held during the late 1970s reconfirmed average-cost pricing as the basis for rate setting. Marginal-cost pricing had been proposed based upon arguments of economic efficiency and as a way to reduce load growth. In the midst of the hearings, Hydro filed a new study indicating generation surpluses that would make marginal-cost pricing infeasible. The Board ultimately rejected marginal-cost pricing on the grounds that it would be too difficult to implement.

In 1980, after four years of investigations, the Porter Commission filed its final report. The Commission had investigated a broad number of areas and its recommendations were far-reaching. The Commission recommended the Hydro plan on the basis that load growth would not exceed 4% per year to the end of the century and that only one additional four-unit station after Darlington would be required over that time. (In fact, no additional stations have been built and the usefulness of Darlington is debatable.) It further recommended increased emphasis on conservation, greater study of health and safety issues related to nuclear power plants, and greater public participation in the hearing process.

In the mid-1980s, the Ontario government commissioned yet another study – the Nuclear Cost Inquiry. The study, submitted in January 1989, concluded that although Hydro's methodology for estimating the lifecycle costs of nuclear generation was appropriate, the final costs would likely be at the upper end of Hydro estimates. Noting the CANDU (Canadian Deuterium Uranium) reactors had been observed for only about half their expected lifetimes, the study indicated that operations, maintenance, and administration costs during the later years were likely being underestimated. The study also found that Hydro estimates of costs of alternatives (such as advanced fossil generation) had not received sufficient attention and recommended that Hydro give consideration to advanced coal-fired plants as alternatives to nuclear generation (Ontario Energy Board, 1975–94).

In 1987–88, the Hare Commission conducted a review of the safety of Hydro's nuclear reactors. It found that: "Ontario Hydro reactors are being operated safely and at high standards of technical performance. No significant adverse impact has been detected in either the work-force or the public. The risk of accidents serious enough to affect the public adversely can never be zero, but it is very remote" (*Providing the Balance of Power*, 1989, pp. 15–38).

From 1989 to 1992 Hydro underwent an aborted public review of a 25-year demand-supply plan, details of which follow.

Table 9-4 lists 17 major inquiries and legislative committee reports that have examined some aspect of Ontario Hydro's operations in the 1974–90 period. This would suggest a strict regulatory environment. In fact, we will give examples of important asymmetries in information between the firm and the supervisory organizations. Public ownership does not by itself induce com-

Table 9-4. *List of major special inquiry and legislative committee reports related to Ontario Hydro*

Year	Name of committee / title of report
1960	Royal Commission; Report on the Purchase of Lands by Hydro-Electric Power Commission of Ontario
1973	Select Committee on the Hydro Electric Power Commission of Ontario Hydro New Head Office Building (Hearings)
1973	Task Force Hydro (Committee on Government Productivity); Hydro in Ontario
1975	Ontario Environmental Hearing Board; Public Hearing on Ontario Hydro Bradley Georgetown 500 kv Transmission Line Right-of-Way between Point 33 near Colbeck and Point 95 near Limehouse
1976	Select Committee on inquiry into Hydro's Proposed Bulk Power Rates; A New Public Policy Direction for Ontario Hydro
1976–1980	Reports of the Royal Commission on Electricity Power Planning, Volumes 1–9
1980	Select Committee on Ontario Hydro Affairs; Final Report on the Safety of Ontario's Nuclear Reactors
1980	Select Committee on Ontario Hydro Affairs; Report on the Management of Nuclear Fuel Waste
1980	Select Committee on Ontario Hydro Affairs; Report on Proposed Uranium Contracts
1980	Select Committee on Ontario Hydro Affairs; Special Report on the Need for Electricity Capacity
1980	Select Committee on Ontario Hydro Affairs; Final Report on the Mining, Milling and Refining of Uranium in Ontario
1985	Select Committee on Energy; Report on Darlington Nuclear Generating Station
1986	Select Committee on Energy; Final Report on Toward a Balanced Electricity System
1987	Select Committee on Environment; Report on Acid Rain in Ontario
1989	Select Committee on Energy; Report on Ontario Hydro Draft Demand and Supply Planning Strategy
1990	Select Committee on Energy; Interim Report on Climate Change
1992	Environmental Assessment Board hearing into Ontario Hydro's 25-Year Demand/Supply Plan; no report

plete revelation of relevant information by managers. Furthermore, the regulatory/supervisory apparatus over Ontario Hydro does not minimize informational asymmetries. The use of Select Committees with changing membership and without a permanent secretariat does not ensure that full information is

built up and passed on. The division of responsibilities between rates (the OEB) and capacity (Select Committees and more recently the Environmental Assessment Board) also reduces the buildup of coherent information outside the firm. We suggest that these information asymmetries were partially responsible for choices made by the firm.

Regulation of a public utility under asymmetric information

Economics literature

In the sections that follow we discuss various aspects of Ontario Hydro in the context of the economics literature on regulation. Under the Power Corporations Act, Ontario Hydro is required to provide power at cost. Since regulation is not of a classic rate-of-return type, there is no reason to expect the bias toward capital from the classical Averch–Johnson effect. On the contrary, Pint (1991) suggests that in the presence of asymmetric information, government-owned firms are likely to be biased toward labour as a factor of production. In the case of Hydro, a case could be made for the proposition that it is biased toward *both* capital and labour and away from fuel. The nuclear technology, which is Hydro's principal technology, employs both massive amounts of capital and a large complement of highly specialized nuclear engineers, operators, and technicians.[13]

Pint's further prediction, that government-owned firms are likely to offer steeper compensation profiles to managers than private forms do, is also not borne out at Hydro: All Hydro employees are paid a significant premium relative to the private sector, but there is a compression of salaries at the top end. We discuss staffing levels and compensation later.

Various objective functions have been proposed for the regulated firm. Such objective functions have included producer surplus, consumer surplus, and worker surplus as well as benefits accruing to government. See, for example, Baron and Myerson (1982), Besanko (1985), Laffont and Tirole (1986), and Pint (1991).

In Ontario, significant surplus accrues to the consumer by virtue of average-cost pricing based on historical value of assets. Ontario Hydro ostensibly does not collect any producer surplus. However, we will argue that significant surplus has been appropriated by Ontario Hydro's labour force through premium salaries, an excessive labour force, and various employment benefits, in particular a high degree of job security and very generous severance packages

[13] For example, in 1991, about 50% of Hydro's revenue requirement consisted of interest and depreciation, about 30% was operations, maintenance, and administration, and less than 20% corresponded to fuel costs.

(though, in recent restructuring, its labour force has been reduced by over 25%). We will also argue that provincial governments have appropriated benefits by using Hydro as part of an industrial strategy as well as by implementing a number of nontransparent transfers through Hydro.

Selection of nuclear technology

With over 50% of its generation coming from nuclear sources, Ontario Hydro is among the most nuclear-intensive utilities in the world. The origins of nuclear energy in Canada go back to World War II. In 1942 it was decided that most of the personnel working on nuclear technology in Britain would be moved to Canada. The work in Canada was part of a tripartite agreement among Canada, the United States, and Britain. Wartime research in Canada focused on the development and design of nuclear reactors. In 1945, a reactor at Chalk River, Canada, achieved criticality – the first time a nuclear reactor was operated outside the United States. In 1952 discussions were initiated between the federal government and Ontario Hydro on the feasibility of nuclear generation for commercial purposes. In 1953 Atomic Energy of Canada Limited (AECL) was established as a federal Crown corporation whose principal purpose was the development of nuclear energy. In 1962 a 20 MW demonstration reactor achieved criticality, and for the first time nuclear-generated electricity was fed into a commercial grid.

AECL considered and pursued various designs including boiling-water reactor designs similar to those developed in the United States. In the end, the CANDU design was selected, a design that was unique.

The adoption of nuclear power in Ontario was justified on a number of grounds. Most of the hydraulic sites had already been exploited. (In contrast, Quebec had major potential for hydraulic development and its participation in the nuclear program was limited.) Nuclear energy was being touted as "too cheap to meter." Canada and Ontario had substantial supplies of uranium, thus there would be no concern about fuel availability. And the development of a nuclear industry could form part of an industrial strategy – one that offered escape from the traditional image of Canadians as "hewers of wood and drawers of water."

But eventually the selection of a unique technology as well as overwhelming dependence upon it at Ontario Hydro would leave a legacy that would benefit Ontario Hydro management and employees. Whatever the original reasons for the technological decisions made by Hydro, the choices that were made served to increase the asymmetry of information between Hydro and the various committees, commissions, and boards that would oversee Hydro. As a result, none of these bodies was in a position to fully and independently assess

Table 9-5. *World lifetime average capability factors by reactor type*

Reactor type	Average lifetime capability factor (%)
CANDU – Ontario Hydro	73.3
CANDU – all	74.2
Pressurized water reactors	65.5
Boiling-water reactors	61.9
Gas-cooled reactors	45.8

Source: Environmental Assessment Board Hearings into Ontario Hydro's Demand Supply Plan, Exhibit 519, Nuclear Panel Overheads, page 27.

the validity of Hydro cost estimates. That is not to say there were no benchmarks for comparison – after all, costs of Hydro nuclear generation compared favourably with those in the United States and France. Furthermore, capability factors at Hydro compared favourably with those elsewhere (see Table 9-5). There were a number of reasons for this, including multiple-unit stations, standardized design, and on-line refuelling. However, the uniqueness of the technology severely hampered any detailed comparisons between Ontario Hydro's nuclear program and those elsewhere.

The momentum behind nuclear generation continued into the 1980s, when new nuclear construction had all but halted in the United States. Despite the fact that there were major problems with pressure tubes involving significant capital costs, Ontario Hydro filed requests for approval before the Environmental Assessment Board in 1989 that included as many as 10 additional nuclear reactors (*Providing the Balance of Power,* 1989, pp. 15–28). These requests were subsequently dropped (January 1992) in the face of looming excess capacity.

Worker surplus

Wages and salaries: There is substantial evidence that Ontario Hydro employees succeeded in obtaining and sustaining a substantial surplus of workers. That surplus has been evident in at least three areas: compensation, overstaffing, and job security.

Nuclear technology confers bargaining leverage on Hydro employees. Management will not operate the nuclear reactors in the event of a strike, and given the very large share of nuclear power in Ontario's generating capacity, such a strike would paralyse the province. Furthermore, labour's willingness

to bring down reactors prior to a strike (as opposed to leaving them running) was not something that could be assumed but required agreement.[14]

Evidence presented at various rate hearings indicates that Hydro workers consistently receive wages and salaries that are about 10% higher than those in "reference communities." Furthermore, the attractiveness of jobs at Ontario Hydro is reinforced by the high application-to-hire ratio: over the period 1985 to 1990, there were typically 10 to 15 job applications for every person hired. Although Ontario Hydro management indicated its desire to narrow the wage differentials with comparable employee groups, there is no evidence that it succeeded in doing so during the course of the 1980s. Indeed, the approximate 10% premium paid by Hydro is consistent with broad findings of wage differentials in the public sector (see, for example, Freeman and Ichniowski, 1988, and Ehrenberg, 1979).

Staff levels: In the nuclear area, comparisons of Ontario Hydro staff levels to those at other utilities would suggest that Hydro is either much more efficient or grossly understaffed. Data from the Electric Utility Cost Group (EUCG), an international organization of major electric utilities, show that in 1986 Hydro employed one individual per 3 MW of nuclear capacity. The average for the EUCG was about 2.5 individuals per 3 MW of capacity.[15] Indeed, Hydro used such comparisons, combined with declining nuclear performance, to justify a massive nuclear hiring program during the late 1980s.

Since 1993, in response to internal cost pressures as well as a modest degree of external competitive pressure (Ontario Hydro remains a monopoly), management has been able to cut the regular staff complement by over 25%. In addition, nonregular and construction staff levels have been reduced by over 50%. Thus, although Ontario Hydro was able to sustain excess staff levels for an extended period – partly through the absence of regulation as well as the difficulty in assessing labour requirements of the nuclear technology – the realities of impending market pressures have had an impact. There is significant risk, however, to the continued viability of the nuclear technology given the much lower staff complements. Furthermore, safety issues could become more prominent in view of these changes as the nuclear units progress into the second half of their lifetimes.

Job security: There is also significant evidence that Hydro employees have benefited from considerable job security. During the period 1987 to 1991 involuntary job terminations averaged 42 per year. With staff levels averaging about 26,000 over this period, this would correspond to a termination rate of

[14] HR 19, transcript page 2562; Municipal Electric Association HR 19, Final Argument, page VI–11.
[15] Ontario Hydro Memorandum to the Board of Directors, May 16, 1988, p. 20.

less than 0.2% per year. Furthermore, Hydro has had a generous policy of continuity of employment that has included multiskilling to ensure employee flexibility, retraining, retirement incentives for those who choose to retire early, external placement, redeployment within the corporation, work sharing, educational leave, elaborate bumping provisions, wage maintenance provisions, moving expenses, limitations to turnover, limitations to the use of nonregular employees, mortgage assistance, and severance pay.[16] There is also evidence that the policy, at times, hindered Hydro from acquiring the most appropriate employees as its work programs change.[17]

In 1988 the Ontario Energy Board recommended reexamination of the continuity of employment policy and recommended that Hydro consider "dismissal of personnel who are found directly responsible for budgetary overruns without strong reasons or direct authorization from a superior."[18] Despite such utterances, little was done at Hydro until 1993 when quite suddenly Hydro found that it was overstaffed. The resulting terminations, however, should not be interpreted as evidence against the hypothesis of job security given the largely voluntary nature of the programs and the financial incentives to leave. (Incentive payments to employees under several major job termination programs averaged over $100,000 per person.)

Remuneration at the senior executive level: The one category of Ontario Hydro employees that is *not* overcompensated is at the most senior executive level. Although, overall, executive salary roll (ESR) staff receive remuneration above the reference community, the most senior executives are relatively underpaid. One recent study found that total compensation packages for this group were 35% below a comparison group consisting of comparable Canadian private sector employees. A second study, which did not adjust for the size of the corporations, found substantially smaller differentials.[19] Both studies concluded that an insufficient portion of the remuneration of senior executives was tied to performance.

From the point of view of the senior executives, it should be noted that because many of them have come through the ranks at Hydro, during which time their remuneration was significantly in excess of those at comparable institutions, the present value of their *lifetime* remuneration in all likelihood compares favourably with alternative career paths.

From the point of view of the corporation, the wisdom of such a policy is questionable. If one subscribes to the "specific human capital" model, where-

[16] HR 18, Ex. 6.4.12, 6.4.47, 6.1.13, p. 20, Municipal Electric Association (MEA) Final Argument, p. VI–22.
[17] HR 18, Ex 6.1.3, p. 13, Tr. p. 3075, MEA Final Argument, p. VI–24.
[18] OEB HR 17, Report of the Board, pp. 7/6, 7/10.
[19] HR 21, Ex 11.1.2, 11.2.1.

by employees at Hydro have limited mobility to jobs outside the corporation, then the current policy would not hinder the retention of the highest-quality employees at senior levels. On the other hand, if the human capital accumulated at Hydro has significant market value, then senior employees have considerable job mobility and there is significant risk that Hydro is not retaining senior staff best suited and qualified for making its most important decisions. In effect, there is a selection process through which the most gifted employees are also most likely to leave prior to reaching the most senior levels.

Benefits accruing to government through nontransparent transfers

As a quasi-governmental body subject to directives from the government, Hydro has engaged in a number of transfers and policies that it would otherwise not have engaged in as a private corporation.

Nuclear technology – construction and jobs: An argument can be made that the nuclear program was designed partly as an Ontario and partly as a Canadian industrial strategy. The fuel was indigenous to Ontario as well as other parts of Canada, and the technology was also indigenous to Canada. The CANDU heavy-water nuclear technology was Canadian, a product of Ontario R&D, employed many engineers and scientists, and was viewed as having exceptional export and spillover potential.

Table 9-6 provides data on Ontario Hydro's construction program as a percentage of total fixed investment in the province and as a percentage of government investment. In 1965 the construction program of Ontario Hydro (150 million 1965 dollars) was 17% of the government of Ontario's capital investment and 3.4% of all capital investment in Ontario. From 1975 to 1979, as the nuclear program was accelerating, Ontario Hydro's investment was 73% of the government's and 10% of all investment in the province. Ontario Hydro's capital program represented over 80% of all Ontario government investment between 1980 and 1984, and was still half in 1990.

During the early 1980s, declining growth in demand for electricity led an independent committee to conclude that continuation of construction of the Darlington Nuclear Generating Station was not desirable from a cost/benefit point of view. Nevertheless, the committee concluded that the government might decide to continue with the project because of the job implications.

Uranium: During the late 1970s, Ontario Hydro negotiated major long-term uranium supply contracts with the Rio Algom and Denison Mines operating in Elliot Lake, Ontario. The contracts were on a cost-plus basis, and Hydro provided large capital advances for mine development that were to be recovered

Table 9-6. *Relative size of Ontario Hydro capital spending*

Capital expenditures in Ontario ($ million)	1965	1970	1975	1978	1981	1984	1987	1990
Total public and private	4,378.3	6,927.5	12,920.3	15,570	22,788	24,826	44,046	53,817
Utilities[a]	689.9	1,334.1	2,930.6	2,972	4,936	5,435	6,155	8,810
Government and institutions	884.2	1,299.7	2,003.4	2,904	2,573	3,548	4,497	6,758
Ontario Hydro	150.0	511.0	1,442.0	1,537	2,144	2,624	2,524	3,544
Percentage of total	3.4	7.4	11.2	9.9	9.4	10.6	5.7	6.6
Percentage of utilities	21.7	38.3	49.2	51.7	43.4	48.3	41.0	40.2
Percentage of govt. and institutions	17.0	39.3	72.0	73.4	83.3	80.0	56.1	52.4

[a]Including outlays on heavy-water plants ($250 million in 1975, $254 million in 1978).
Sources: Statistics Canada and Ontario Hydro.

from future purchases. The only significant risk borne by the producers was that uranium prices might rise even more than expected during the lifetime of the contracts. Two of the major reasons for procurement of provincially located supplies were security of supply and job creation. When the bottom dropped out of the uranium market during the 1980s, Hydro was left with contracts requiring it to pay prices that were several times market rates. When the opportunity to cancel the contracts arose in the early 1990s, Hydro was instructed, through a government directive, to continue the contracts until 1996 in order to preserve a modest number of moribund mining jobs. The costs to Hydro of delaying termination plus the additional contributions required by the government to the Northern Ontario Heritage Fund totalled about $250 million.[20]

Rural subsidies: The Power Corporations Act requires that rural electricity rates not exceed urban rates by more than 15%. This has led to substantial subsidies over the years. In 1992, rural rate assistance was approximately $115 million. The total costs for distribution to the rural sector were $371 million. Thus, nonrural customers bear a substantial portion of the incremental distribution costs imposed by the rural sector.[21]

Debt guarantee fee: Since the late 1980s Ontario Hydro has been paying a fee to the provincial government in the amount of 0.5% of Hydro debt. The ostensible rationale is that because Hydro debt is guaranteed by the province, Hydro customers benefit from lower borrowing rates than would be justified on the economics of the enterprise. In the case of an investor-owned utility, the shareholders bear part of the burden of adverse financial outcomes. In Hydro's case, unanticipated increases in costs are borne by the customers through future rate increases – indeed, the provincial government has never been called upon to provide funds of its own as a result of poor financial performance on the part of Hydro. Thus, the debt guarantee fee is more in the nature of a tax than a payment for service. (It should be noted that Hydro pays no corporate income tax.)

Comments on nontransparent transfers: The essential problem with nontransparent transfers is that the public has a very limited ability to assess the desirability of such transfers. Electricity consumers are generally unaware that the prices they pay have imbedded in them additional costs not directly related to the production and delivery of the product they are acquiring. Government intervention in the activities of Ontario Hydro for purposes of social engineering obfuscates the decisions that the electorate ought to be making on a rational and informed basis. Unfortunately, it is generally in the interest of an

[20] HR 20 MEA Final Argument, pp. XI–7.
[21] HR 20, Submission on 1992 Rates, pp. 65, 68.

incumbent political party to try to reap the political benefits of redistributive actions without paying the political costs of raising the required taxes in an obvious fashion. To illustrate the point, if the government had announced that it would raise taxes by $250 million in order to finance the subsidy Elliot Lake (see above), the public response would have been far stronger.

Ontario Hydro debt and financial policy

Ontario Hydro's debt is guaranteed by the Province of Ontario.[22] This arrangement permits Hydro to operate with a much higher proportion of debt in its capital structure than a private sector utility can. Indeed, since 1975, Ontario Hydro's debt ratio has remained above 80%. In 1994 it exceeded 90%. By comparison, investor-owned utilities in the United States have debt ratios in the range of 45 to 60%. Despite this very high debt ratio, Ontario Hydro has typically retained the highest credit ratings awarded by rating agencies such as Standard and Poor's and Moody's. The reason, of course, is the provincial guarantee of its debt.[23]

Over the past several decades there has been a secular deterioration in Hydro's financial performance indicators, most importantly its debt ratio and its interest coverage ratio. This has coincided with the advent of the nuclear program and a less conservative approach to financial policy.

If one examines real electricity prices over the past several decades, one finds that from 1965 to 1975, the real price remains fairly stable, just above 4 ¢/kWh (measured in purchasing power of the year 1991). In the mid-1970s, there is a real increase of about 30% followed by another period of stability. In the early 1990s there is another real increase in excess of 20%. Each of the two periods of rate shock was anticipated, yet little was done to smooth the effects over a longer period.

Two key factors appear to provide a plausible explanation for this failure to adopt a proactive policy on rates and a willingness to permit the financial picture to deteriorate. First, democratically elected governments find it in their interest to optimize with respect to short-term objectives, and they therefore explicitly or implicitly discourage rate increases until it is absolutely necessary to institute them.[24] Second, higher electricity prices have generally not been in the interest of Ontario Hydro because they would discourage demand and therefore reduce the requirements for future supply.[25]

[22] Hydro debt comprises about 40% of total provincial liabilities.

[23] HR 19-II, Report of the Board.

[24] Reference letters from the Minister to Ontario Hydro have typically asked Hydro to keep rates as low as possible while remaining consistent with financial soundness.

[25] During the 1980s, Hydro had a policy of "no real rate increases." This coincided with a period when Hydro was preparing major requests for approval for additional facilities.

The confluence of the interests of the government and Ontario Hydro undoubtedly contributed to the failure to increase rates on a graduated basis and to consistently delay the achievement of a sounder financial footing.[26] The key implication for the regulation of Ontario Hydro is that at least from the point of view of financial soundness and the smoothing of rate impacts it would be desirable if Hydro rates were regulated by a body that is independent from the government of the day. Perhaps the ineffectiveness of the current regulatory relationship is best illustrated by the fact that the OEB was unable to prevent or even smooth the rate shocks that occurred in the early 1990s.

Asymmetric information

A number of examples are consistent with or support the proposition that there is significant asymmetry of information between Ontario Hydro and its quasi-regulators. Four are presented here.

The first is operations, maintenance, and administration (OM&A) costs. These constitute the single largest controllable component of Ontario Hydro revenue requirement. During the decade of the 1980s, OM&A costs at Hydro grew substantially more rapidly than did electricity production. One of the reasons for this was the shift in generation mix toward nuclear, which is both capital- and OM&A-intensive, with relatively low fuelling costs. During the same period, Hydro systematically underestimated its OM&A costs.

For these reasons the OM&A budgets came under close scrutiny at the annual OEB rate hearings. Over the years, the Board has taken three approaches to OM&A costs. One approach involved presentation and analysis of budgets at very detailed levels and specific recommendations on where budgets should be reduced. A second approach involved review by external consultants.[27] A third approach consisted simply of across-the-board freezes or cuts in total OM&A costs. The very fact that the OEB resorted to the third alternative is consistent with asymmetry of information between the reviewer and the entity being reviewed. Indeed, Board reports are replete with references to the difficulties in assessing Hydro budgets.[28]

During the late 1980s, Hydro presented an urgent appeal for substantial increases in OM&A expenditures in the nuclear area. There is evidence that

[26] There is also evidence that Hydro delayed cost recovery through less than conservative accounting policy. For example, for years, it was Hydro's policy to depreciate the heavy water used in its nuclear program to the year 2040 (sic). Hydro's rationale was that the heavy water would be used in future CANDU reactors. The book value of heavy water far exceeded its market value.

[27] Elsewhere, we have indicated that following the most recent external review, (which found that Hydro was over-staffed by 10%), staff level increases *exceeded* those projected *prior* to the review.

[28] Ontario Energy Board, Report of the Board, HR 17, p. 7/4, HR 18, pp. 107, 108, 313.

Hydro had indeed anticipated the expenditures – various *leading* indicators or precursors to nuclear performance were cited in evidence, many of which had been declining for some time. Indeed, the Atomic Energy Control Board, a federal agency, was threatening not to renew certain operating licenses. On the other hand, the OEB apparently had not anticipated the need for additional funds to be allocated or reallocated to this area and was evidently previously unaware of the importance of the kinds of statistical data provided by Hydro. It even stated, "Reliability, it appeared, could be used to sanction any amount of expense," a statement it surely would not have made had it been in a position to *independently* assess costs, reliability, and safety.[29]

A second area where there is evidence consistent with asymmetry of information is labour. As we have indicated, Ontario Hydro pays substantially higher wages than those paid in various comparison groups. Hydro management and professional staff, consisting primarily of engineers, receive compensation that is 10% higher than that which is paid in an elite group of 15 comparison firms and institutions. Furthermore, Hydro unions have used their control of nuclear technology to advantage in bargaining disputes.

Third, there is the overoptimism in financial forecasting exhibited by Ontario Hydro during the 1980s. Again, this served the interests of the government by forestalling higher rate increases, and it served Hydro interests by not discouraging demand growth. Nevertheless, a number of down-side risks to the forecasts were known by Hydro in advance – and yet neither the OEB nor anyone else was successful in persuading Hydro to use more conservative assumptions in its financial forecasting. Indeed, the Board stated: "The experience has been that Hydro seldom, if ever, overestimates its eventual costs, especially of construction, but also of operations."[30]

Furthermore, there is evidence that Hydro has delayed costs. At HR 17, the OEB indicated that heavy water inventories (which were being depreciated to the year 2040!) and advances associated with uranium contracts were overvalued on the books.[31] Hydro did not recognize the problem until 1992.

Ontario Hydro is one of the largest corporations in Canada, and it is controlled, as we have pointed out, by a changing and ad hoc set of instruments. A single regulatory agency would be more able, and would have the incentive, to gather information and to regulate on a consistent basis. This, of course, would require either divorce from political uses of the firm or explicit recognition of political policies and their costs.

[29] OEB, HR 17, Report of the Board, p. 7/21.
[30] OEB, HR 18, Report of the Board, p. 313.
[31] OEB, HR 17, Report of the Board, pp. 8/14, 9/7.

Recent industry developments

Future requirements and Ontario Hydro's demand–supply plan: In 1989, after a number of years of plan development, Ontario Hydro submitted its 25-year demand–supply plan to the Environmental Assessment Board. Under the plan, Hydro was requesting approval for the construction of 8000 MW of nuclear facilities, 4300 MW of fossil generation, 2000 MW of hydraulic, as well as a 1000 MW transmission line from Manitoba. The plan also proposed to implement 5570 MW of demand management programs and incorporate 2120 MW of nonutility generation by 2014, the end of the 25-year period (Environmental Assessment Board, 1990–1993). Hydro's planning philosophy was predicated upon seeking to meet not median projections of load growth but "upper" projections. The purpose was to seek approvals so that in the event of upper load growth, Hydro would be in a position to respond more quickly with supply-side options.

In the year following the filing of these proposals, the New Democratic Party was elected to power for the first time in Ontario. Shortly after his inauguration, the Premier announced a moratorium on future nuclear developments, appointed a new CEO for Ontario Hydro, and announced that the government would be proposing changes to legislation affecting Hydro.[32] The legislation would provide for fuel substitution programs as well as more direct control of the government over Hydro policies and expenditures.

By the beginning of 1992, Hydro had decided to defer approval requests for *any* major nuclear or fossil stations. There were three major reasons for this change. First, demand management program targets were increased substantially on the expectation that government policy would mandate higher efficiency standards and would allow Hydro to offer incentives for fuel substitution. Second, nonutility generation was forecast to increase dramatically as a result of lower forecasts of natural gas prices. Third, Hydro had changed its planning philosophy. Rather than planning to meet upper load growth, Hydro would plan around the median. This change in planning philosophy was justified on the basis of increases in uncertainty regarding future demand.

By the end of 1992, as a result of stagnating load growth, it became clear that Ontario Hydro would have significant excess capacity until the turn of the century, and in January 1993 Ontario Hydro withdrew all requests for approvals before the Environmental Assessment Board.

Nonutility generation: As of 1989, a modest portion of electricity in Ontario was generated from sources other than Ontario Hydro. Installed nonutility generation (NUG) capacity in that year was 1288 MW, of which only 26 MW

[32] This left-of-center party had a long-standing policy of opposing nuclear power.

were classified as purchase generation. The remaining 1262 MW were load displacement NUG. These sources produced about 5 twh of electricity, or 4% of the total generation in Ontario.

In 1989 the government released a policy paper that underscored its desire to encourage NUG in the province. It indicated that Hydro should seek to achieve a target of 1000 MW of purchase NUG by the year 1995 and 2000 MW by the year 2000. In hindsight, these were woefully low estimates of the potential for NUG supply in Ontario.

A number of factors have contributed to substantial NUG potential in Ontario. First, there has been until recently the continental decline in the price of natural gas. Natural gas comes to Ontario principally from the western provinces, travelling several thousand miles through the TransCanada Pipeline System. Pipeline capacity is being expanded so that there is a significant supply of natural gas. Second, Hydro rates have risen by 30% in nominal terms in recent years, thus increasing the price differential with natural gas and increasing the incentive for load displacement nonutility generation. Third, nonutility generators benefit from an accelerated write-off of capital costs. Fourth, nonutility generators do not have to go through the kind of extensive environmental assessment required of Hydro projects. Fifth, nonutility generators do not have the "obligation to serve" required of Ontario Hydro. Sixth, for small projects (up to 5 MW), Hydro has offered purchase rates above avoided costs. The premium has been designed to encourage projects with greater thermal efficiencies or environmentally friendly characteristics.

However, there are a number of factors that NUGs claim give Hydro an unfair advantage. First, Hydro does not pay the usual corporate income taxes. Second, Hydro benefits from the provincial guarantee of its debt, thus lowering its borrowing costs. Third, nuclear generation in particular benefits from a federal statute that limits the liability of the generator. Finally, Hydro has benefited over the years from research sponsored by government (for example, in the nuclear area) as well as land grants.

Currently in Ontario there is no informed agency authorized to regulate and adjudicate disputes between Hydro and the NUG sector. An important role for the regulator would be to ensure that a level playing field exists so that neither Hydro nor private producers are accorded undue advantage.

In early 1993, Hydro announced that it was contemplating further limitations on NUG development in view of its own capacity surplus as well as internal financial pressures. Hydro has calculated that proceeding with currently planned NUG purchases would add as much as 3% to rates and as a result is reconsidering current contracts.

Hydro is very concerned that major industrial users and municipal utilities will build their own generating sources, which would increase the excess ca-

pacity on the Hydro system. Because the preponderant portion of Hydro costs is fixed, this would drive up rates for other users and thereby further attenuate demand. As a result, Hydro is implementing low incentive rates to certain industrial users in order to discourage them from building their own generation or otherwise curtailing purchases of electricity. However, such an approach could be in violation of the power-at-cost principle embodied in the Power Corporations Act.

Hydro's decision to severely limit the purchase of nonutility generation is being contested by the Independent Power Producer Society of Ontario, an organization that represents nonutility generators. The organization has taken the position that retubing of the Bruce A nuclear station, which is to take place during the 1990s, is not cost-effective and should not proceed. If the four units at Bruce A were mothballed, the 3000 MW surplus would disappear, and future needs could be met more cost effectively by private natural gas generation and cogeneration. (Most recently, Hydro has decided not to proceed with retubing of one of the Bruce nuclear units.)

One of the arguments that has been advanced in support of the competitive fringe is that it plays an important audit function because it is in the interests of private producers to discover and reveal Ontario Hydro costs. The current debate in Ontario about the cost-effectiveness of retubing nuclear reactors provides an example of this function.

Demand-side management: Ontario Hydro is implementing a range of demand-side management programs (DSM). Programs with the largest impact on demand are those that attempt to improve electrical efficiency in lighting, heating, and motors. In addition, Hydro has a load-shifting program and a fuel substitution program, as well as special rates for interruptible loads.

The residential sector accounts for about 29% of electricity consumption in Ontario of which more than half is for space and water heating. An additional 38% is for lighting and appliances and only 6% is for air cooling. However, the residential load is weather sensitive and generally contributes significantly to the winter and summer peaks. The commercial sector accounts for 34% of electricity consumption in Ontario, about 40% of which is used for lighting and another 40% for motors and equipment. The largest electricity consuming sector is industry, which accounts for about 37% of electricity consumed in Ontario, of which over 70% is used to drive motors and run equipment.

In evaluating potential DSM programs, Hydro uses the "total resource cost test," also known as the "total customer cost test." In calculating this test, Hydro incorporates the present value of the incremental cost of capital, changes in customer fuel and operating costs, program administration costs, and delivery costs. The test attempts to minimize the total societal costs of producing a given service.

The total customer cost test is premised on the idea that there exist market imperfections or distortions preventing the market from allocating resources efficiently. These include environmental externalities, pricing at average instead of marginal costs, imperfect information, differing social and private discount rates, and principal – agent problems. In a number of jurisdictions in the United States, there is movement toward monetization of environmental externalities in an integrated resource planning process that compares supply-side options to demand-side options. Recently, Hydro has been considering moving toward accounting methods that incorporate valuation of externalities.

In Ontario, electricity is priced at average historical cost. When marginal or avoided costs exceed average costs, there is potential for increasing economic efficiency by providing financial incentives that would reduce electricity consumption through conservation or fuel substitution. Economic efficiency would limit the incentive to the *difference* between avoided costs and average costs. Ontario Hydro, on the other hand, has considered paying incentives up to the level of avoided costs,[33] though the level of the incentive would be ultimately determined by program penetration rates as well as the overall impact on rates.[34] In 1989, avoided costs were estimated to be about 3.7 Canadian ¢/kWh.[35] Since then, as a result of excess capacity, avoided costs are expected to be below 2 ¢/kWh for most of this decade.

Hydro DSM programs are divided into the following categories: energy efficiency improvement, fuel substitution, load shifting, and interruptible power. Energy efficiency improvement programs encompass a broad range of initiatives in the residential, commercial, and industrial sectors. Included are programs to increase lighting efficiency (e.g., through the use of compact fluorescent light bulbs), to improve thermal envelopes, and to enhance motor efficiency and efficiency of industrial processes.

Load-shifting programs rely principally on time-of-use pricing. In 1989, Hydro initiated time-differentiated rates for all large industrial customers in Ontario.[36] Time-of-use rates are also available to municipal utilities on an optional basis.

Hydro's recent target of 2866 MW in demand management by the year 2000 is substantial – comprising in excess of 10% of the system peak. By the year 2015, Hydro plans to achieve close to 5000 MW of DSM savings, which would be about 15% of the system peak (see Table 9-7).

[33] *Providing the Balance of Power,* Ontario Hydro, Demand/Supply Report, page 7-6.

[34] The latter being the 'rate impact measure' or 'no losers test.'

[35] *Providing the Balance Power,* Ontario Hydro, Demand/Supply Report, page 7-14.

[36] Hydro is contemplating performing a real time pricing experiment with its large customers, (HR 21, Main Submission, p. 79).

Table 9-7. *Ontario Hydro's demand-side management programs (MW)*

Year	Load shifting	Electrical efficiency improvements	Fuel substitution	Interruptible load	Total DSM	Total system peak
1991	150	293	8	652	1,103	22,625
1995	302	1,039	43	617	2,001	23,574
2000	600	1,389	237	640	2,866	25,562
2005	925	1,814	413	601	3,753	27,258
2010	1,125	2,134	566	640	4,465	29,350
2015	1,225	2,324	691	687	4,927	32,954

Source: Environmental Assessment Board Hearing into Ontario Hydro's Demand/Supply Plan, Exhibit 796, Attachment C, page 45; Attachment I, Table I-1-1.

The debate on industry restructuring: The flurry of privatization that has taken place around the globe has spawned a debate within Ontario as to the most desirable structure of the electricity industry. A number of alternatives have been aired, each with its advantages and disadvantages. The main impetus driving the debate has been declining performance of the utility, particularly with respect to nuclear generation, and a dramatically increasing debt load at a time of economic recession. A number of alternatives are available, including privatization; vertical unbundling and inducing competition among pieces of the still publicly owned firm; allowing increased NUGs and third-party access; and removing the constraints on wheeling. Regulatory reform is crucial in all these possibilities.

Figure 9-2 provides details on the present generating and distribution facilities in Ontario. The system consists of the East (the major portion) and West systems, interconnected by one 230 KV line. The major demand areas are around the southwestern tip of Lake Ontario. Note how major 500 KV transmission lines form a spine into the Toronto area. The system operates over long distances with few major demand nodes. There are 79 generating stations: 68 hydraulic, 5 nuclear, and 6 fossil-fuelled. The 68 hydraulic structures have a peak capacity of 6489 MW; three river sites account for 55% of this total (six on the Niagara River – 2005 MW; one on the St. Lawrence River – 740 MW; five on the Ottawa River – 846 MW). The five nuclear stations have a peak capacity of 14164 MW – 44% of system peak capacity (32.5 GW).

Schemes to privatize, unbundle, and increase intrafirm competition must begin with the reality of the facilities – generation, transmission, and distrib-

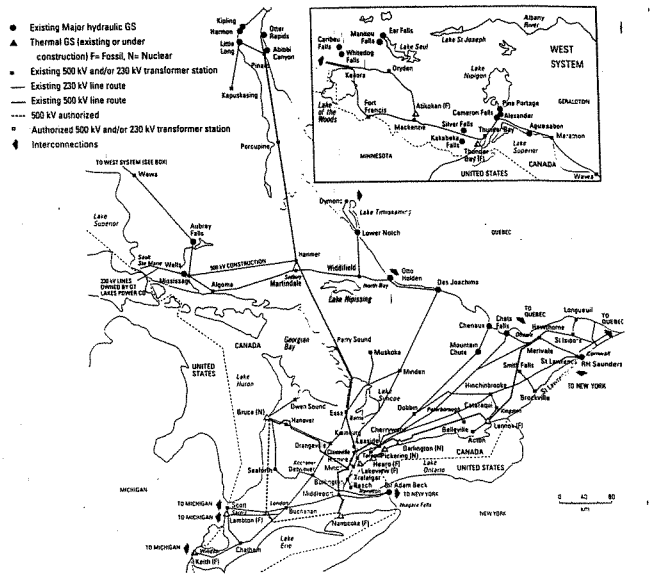

Figure 9-2. Map of Generation and Transmission Facilities in Ontario [Ontario Hydro Major Stations (greater than 100 MW capacity) and 500kV and 230kV Line Routes (mid 1989)].

ution. Complete privatization of Ontario Hydro generating facilities is unlikely. Over half of the energy generated by Hydro comes from nuclear sources. These systems account for 44% of system capacity, and such facilities are difficult to privatize, as recent experience in the United Kingdom underlines. (In the United Kingdom, nuclear power represents a much smaller share of capacity.)

Another 25% of current generation in Ontario is hydraulic, with major facilities at Niagara Falls and on two other river systems. Given the unique nature of this particular site and the history of Ontario Hydro, which began as the transmission utility connecting this site to municipal utilities, any attempt to privatize would be met with considerable public resistance. The water rentals now charged are low when compared to the opportunity cost of the water as determined by the price of alternative sources of electricity. Thus, the asset value of the hydro site is contingent on the water rentals charged. Privatizing hydro sites would be dependent on the stated intent of the owner of the water – the province – with respect to charges for water rentals. A continuation of low water rentals would mean high bids: the present value of the difference be-

tween the opportunity cost of water and the price. High water rental rates would result in low bids but higher annual yields in the future. Privatizing the Falls by transferring shares to the public at current water rental rates would produce the low cost firm by definition.

This leaves the fossil generation, much of which is aging or is being used in peaking mode. Furthermore, the use of fossil facilities is limited in Ontario by strict provincial caps on acid gas emissions. Because coal is the swing fuel in Ontario, output for this type of generation is the most volatile, leading to increased risk associated with the ownership of this asset.

A variety of alternatives exist for partial transfer of ownership, including public sale of shares in Ontario Hydro from which the proceeds would be used to reduce Hydro's $36 billion debt. Another option would be to transfer partial ownership of the generating utility to the municipal distributing utilities, which in any event have never relinquished their historic claims to ownership of Hydro. The municipal utilities have very little debt and would be in a position to shoulder a significant portion of the debt. The *quid pro quo* would likely be increased representation of Ontario Hydro's Board of Directors, and thus greater influence on the decisions taken by Hydro. However, it should be noted that any attempts to introduce private ownership should occur *after* the transmission grid and distribution facilities owned by Ontario Hydro are separated from generation. Otherwise, the creation of private property rights would severely hamper any future possibilities for vertical unbundling of the natural monopoly segments of the industry (transmission and distribution) from those that can benefit from competition (i.e., generation).

There are a number of scenarios that would contemplate a larger role for private generation and a competitive element in the electricity industry of Ontario. One would involve competition at the wholesale level. The transmission company would be separated from generation and would be responsible for purchasing power from any willing suppliers at the lowest possible cost. It would then sell it to distributors. A second scenario would involve permitting third party access (TPA) to the grid. Municipal utilities and large users could purchase their power as they pleased. Current market conditions – in particular, high costs at Hydro combined with low natural gas prices – would yield a strong response to either wholesale or retail competition. However, moving to wholesale rather than retail competition has a major advantage in that the latter is essentially irreversible. Again, private property rights (e.g., contractual agreements amongst private purchasers and sellers) would be difficult to reverse if a decision were made at some point in the future to move to wholesale competition.

In any event, a central problem that would need to be resolved would be the "stranded assets" that could be created as customers purchased from genera-

tors other than Hydro. A critical role for the regulator would be to determine appropriate transmission charges, which could include levies for assets that a former customer could be deemed to have stranded. The regulator would also resolve transmission disputes as well as conduct rate and capital expenditure reviews of Hydro. In the short run, competitors would serve a useful auditing function in reviewing Hydro costs. In the long run, there is potential for downward pressure on prices through competition and innovation. A second central issue deals with the obligation to serve (or to ensure that adequate supplies of power are available). In any system, there would be strong political pressure to ensure that this responsibility resides with *some* entity.

Recently, discussion has begun in the province on how intrafirm competition might be introduced. In its restructuring, Hydro has been divided administratively into transmission, fossil, hydraulic, nuclear, energy services, and international enterprise units. Could the generating facilities at Hydro be induced to compete against one another? The economics literature is not supportive of this idea because managers would have to be induced to take risks and thus would have to earn rewards or be punished. Unless new compensation schemes were introduced, providing unit managers with contingent claims, competition between units would not be real.

Summary

Public ownership and the form of regulation in Ontario have not avoided the problems that have plagued private electric utilities in the United States. Indeed, a cursory examination of rate changes between Ontario Hydro and average U.S. rates shows similar increases in the mid-1970s but for totally different reasons. United States utilities were to a substantial degree oil-based, and the rate jumps in the United States in the mid-1970s were due to exogenous increases in fuel price. In Ontario, the rate increase in the mid-1970s was endogenous – the result of bringing nuclear onstream. Similarly, U.S. utilities and Ontario Hydro faced the high interest rates of the 1980s. Again, rate increases were common to all. Ontario Hydro, however, saw substantial (30%) rate increases in the early 1990s, rate increases largely absent in the United States. The long lead times, large capital requirements, huge construction overruns of the nuclear program in Ontario, and lower-than-expected load growth created upward pressure on rates.

In earlier sections we described how Ontario Hydro developed as an integrated publicly owned monopoly from its inception as a transmission utility. The firm was able to avoid direct regulation and supervision by intense political lobbying. As the complexity of the electricity system grew, so did the

cision-making process and the need for greater accountability. Among its many recommendations were the following:

> The Ontario Energy Board should be empowered to hold bi-annual public review of Ontario Hydro's Resource Development Plan, and publish a public report with recommendations to Cabinet. (p. 65)
>
> The Ontario Energy Board Act should be amended to give the Board the powers to regulate electricity rates. (p. 75)[37]

The recently aborted review of Ontario Hydro's 25-year plan before the Environmental Assessment Board proved fruitless principally as a result of the difficulties in forecasting over such an extended period such variables as load growth, fuel prices, economic activity, natural conservation, private generation, and technological change. An incremental approach, with regular capital program reviews, as recommended by the Select Committee, is far preferable. Furthermore, such reviews should be conducted by the same agency so that the regulator can benefit from the accumulation of information and thereby mitigate, to some modest degree, the informational asymmetries. Whether the appropriate forum is the Environmental Assessment Board, the Ontario Energy Board, or a forum that includes representatives from both of these is yet to be determined. However this is resolved, the authority to regulate, not just to recommend, should be granted.

Third, the informational asymmetries between Hydro and the regulator will persist because of the nuclear technology. However, an increase in performance-based pay and an increased role for competitive forces would substantially offset this disadvantage.

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[37] See also OEB, Report of the Board, HR 17, page 3/12.

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