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CANADA

Report of the
National Advisory Board
on Science and Technology

COMMITTEE ON ENERGY EFFICIENCY

Presented to the
Prime Minister of Canada

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COMPETITIVENESS THROUGH ENERGY

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National Advisory Board on Science and Technology

Conseil consultatif national des sciences et de la technologie

The Right Honourable Jean Chrétien, P.C., M.P.
Prime Minister of Canada
House of Commons, Room 309-S
Ottawa, Ontario
K1A 06A

Dear Prime Minister,


On behalf of the National Advisory Board on Science and Technology, I am pleased to present the Report of the Energy Efficiency Committee entitled "*Competitiveness Through Energy*". As your government has recognized in setting its agenda, one of the key challenges facing Canadian industries in an increasingly competitive global marketplace is to achieve integrated economic and environmental efficiencies.

In developing its report, the Committee consulted with energy producers and users who noted that many Canadian companies trail their world competitors in the application of existing, best-practice, energy efficient technologies to industrial processes and in the development of new energy efficient technologies. Our industries are losing their traditional competitive energy advantage in part due to rising electricity prices in many provinces, and they lag their competitors in the adoption of such creative solutions as independent power production, including co-generation.

The Committee recognizes that it is up to industry to take the lead in addressing these challenges, working in concert with the federal government, provinces, labour, utilities, universities and colleges. There is an important role for the federal government -- as a catalyst for action, in developing and disseminating knowledge and information on energy efficient technology, in setting an example of energy efficiency in its own operations and in managing a financial climate conducive to economic development.

Thank you for your support and encouragement of our work. Through renewed cooperation between the public and private sectors, we can more wisely manage our resources, improve our industrial energy efficiency, and contribute to the long-term competitiveness of Canada.

Yours sincerely,



Guy Dufresne

The views expressed in this paper are those of the authors and do not necessarily correspond to the views or policies of the Government of Canada.



NATIONAL ADVISORY BOARD ON SCIENCE AND TECHNOLOGY (NABST)

MANDATE

The Mandate of the National Advisory Board on Science and Technology (NABST) is to advise the Prime Minister on how science and technology can be more effectively utilized in Canada, and specifically to:

- Advise on the appropriate use of government instruments for encouraging the development of science and technology, including statutes, budget measures, and regulations;
- Propose means to sensitize people to the profound changes resulting from the technological revolution, and to help them make the necessary adjustments;
- Identify changes that may be required in the educational and training institutions;
- Develop methods by which government can assist industry in responding to the challenges of international competition;
- Advise on how best to coordinate the efforts of industry, labour, universities, and government in pursuing national goals;
- Recommend priorities for the support of scientific disciplines, strategic technologies, and national programs; and
- Respond to specific questions or tasks requested by the Prime Minister.

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EXECUTIVE SUMMARY

Objective

The Committee challenges Canadian industry to work in concert with the federal government, provinces, labour, utilities, universities and colleges to improve its international competitive position through greater energy efficiency. Energy efficiency, as it is interpreted by the Energy Efficiency Committee of NABST, must include both economic and environmental benefits. For purposes of this study, economic benefits are defined as cost savings to the producers and/or users of goods and services and may include quality improvements; environmental benefits are defined as the preservation and/or restoration of the natural environment in a manner that allows Canadian companies to compete effectively in world markets.

Approach

The Committee has chosen to approach its report chiefly from the perspective of the industrial user. Canadian industrial users have traditionally enjoyed natural competitive advantages in energy, and the Committee seeks measures whereby these natural advantages can be sustained despite rising energy costs. Given the fact that large corporations account for 91% of Canadian exports, and are dominated by energy intensive, natural resource-based industries (i.e. pulp and paper, and aluminum industries), the Committee has decided to focus its analysis on the larger, more energy intensive industries in Canada and to dedicate its recommendations on energy efficiency to improving the international competitiveness of those firms. By using existing energy efficient technologies and investing in the development and implementation of new energy efficient technologies, the Committee believes that industry can advance its competitive position and, at the same time, make a contribution to the environment.

Current Situation

The Committee analyzed six functional areas of energy efficiency: benchmarking, technology transfer, research and development, federal government example, the trend to deregulation, privatization and co-generation, and financial initiatives and awards. If Canadian industry were to address systematically each of these areas with assistance from governments and other stakeholders, industry could substantially improve its competitive position. Highlights of the Committee's findings are as follows:

Benchmarking

In the global marketplace, energy efficient technology is readily available to Canadian industry, as well as to its competitors. Yet both large and small Canadian firms are frequently unaware of, or not on par with, the best international practices of energy efficiency. The Energy Efficiency Committee sees a need for what may be termed "benchmarking", i.e. a need for Canadian industries to compare their levels of and initiatives for energy efficiency with the best of their international competition.

Technology Transfer

Due to the recent recession, some Canadian industries have been forced to downsize their operations and/or reduce expenditures on technology acquisitions. Experts consulted by the Committee indicated that Canadian industry is falling behind its international competition in the acquisition of energy efficient technology, in the transfer of energy efficient technology improvements from government and other laboratories to industry, and in the training for and practical application of energy efficient technology to industrial processes. The need for technology acquisition and transfer in energy efficiency applies to all producers and users, and training is an important element.

Research and Development

Many industry representatives expressed concern to the Committee that much government R & D in energy efficiency tends to be done without sufficient consultation with, and involvement of, industry. By the same token, government representatives contend that industry is not sufficiently involved in energy efficiency R & D. While there are some federal programs which have successfully developed linkages with industry, the Committee sees a general need for improved linkages between federal research centres and the industrial users who employ the results of energy efficiency research. All energy efficiency R & D projects within federal laboratories should serve the needs of identified and articulate clients, primarily within industry but also within government.

Federal Government Example

The federal government has developed several programs which enable it to set an example of energy efficiency. One illustration is the Federal Buildings Initiative (FBI) which provides federal departments with access to private sector capital through a financing mechanism whereby private lenders provide all up-front capital and are repaid from guaranteed energy savings. The program also facilitates access to private sector expertise in energy efficiency. Currently in its pilot phase, some 500 buildings -- or just 1% of federally owned buildings -- are involved. If it were fully and effectively implemented, the FBI would position the federal government as a leader in energy management and environmental protection in Canada.

Trend Toward Deregulation, Privatization and Co-generation

Industrial experts expressed intense concern to the Committee about Canadian industry losing its international competitive advantage, in part due to rising domestic energy prices, particularly for electricity. While the situation varies from province to province, executives point to the fact that the industrial price of Ontario Hydro electricity has more than doubled since 1982. Many electrical utilities are faced with high debt service costs and excess capacity brought on by over-building in the expectation of continued, higher demand.

Industrial experts who met with the Committee suggested that electricity production should be deregulated and privatized where feasible, with provincial utilities providing only transmission and distribution systems to all producers and consumers. They argued that natural market dynamics would lead to more efficient production and use of power. Industrial experts also recommended co-generation and other means of independent power production as ways to encourage higher energy efficiency in firms who would be better motivated to balance their energy loads and to find downstream uses for steam either within their own plants or in neighbouring facilities.

Financial Initiatives and Awards

The only fiscal incentive for the application of energy efficient technology is the Class 34 Accelerated Capital Cost Allowance (ACCA), revised and renamed Class 43 in the February 1994 federal budget. This ACCA applies to certain efficient or renewable energy equipment. Beyond this, past government policies have encouraged the extension of the life of older facilities. The consequence of this is that a great deal of capital is invested in less than best-practice equipment and processes. Measures to rebalance existing funding and support mechanisms would go far to enhance the competitive edge required by firms active in energy efficiency. To save costs, many utilities have dramatically cut their "Demand Side Management" programs, creating a further vacuum in energy efficiency incentive and award programs.

Recommendations

In making its recommendations, the Committee recognizes that responsibility for efficient use of energy lies mainly with the energy user. The key challenge for the energy user, in an increasingly competitive, global marketplace, is to minimize economic and environmental costs through improved overall energy efficiency. However, the competitive environment in Canada within which industry operates is also important. The Committee believes that the federal government can best encourage industry to use energy more efficiently by building on successful programs already established, and by developing and monitoring them according to specific industry priorities. While the focus of the recommendations is on science and technology, the Committee has chosen to address additional measures for meeting the energy efficiency challenge, such as pricing and training.

The Committee recommends that there be a new effort at cooperation among industry, the federal government, provinces, labour, utilities, universities and colleges to:

- ◆ benchmark or compare Canadian industry's energy efficiency to the best practices of industries in other countries and evaluate international best practices on a regular basis. The process of benchmarking is perhaps best done on an industry by industry basis and requires a continuous effort by firms to visit leading edge performers to learn the specifications and possible applications of a given technology;

- ◆ once our energy efficiency objectives are set, work to improve the awareness of, training for and practical application by Canadian industry of existing, best-practice energy efficient technologies. Technology acquisition from abroad in energy efficiency must be improved. Concurrently, technology transfer from federal government, private and university labs into the industrial workplace should be enhanced, especially through the formation of working relationships at the project identification stage. Canadian industry, in this case especially small- and medium-sized companies, requires effective information programs and international exchanges in new energy technology to help it compete internationally. In addition to initiating its own programs in this area, industry should make its specific interests known to the federal government, so that federal programs may be targeted more directly to industrial needs;
- ◆ strengthen energy efficiency R & D linkages between the federal government, universities, colleges, utility and provincial research centres and the industrial users of energy research and enhance R & D in energy efficiency and alternative energy sources. While the application of existing technologies is important for the short term, we should develop and deploy new energy efficient technologies to improve our competitiveness over the long term. It is an opportune time for industry and government to work more closely together as partners in R & D and to ensure that R & D meets Canadian industrial priorities;
- ◆ see that the federal government sets an example by ensuring increased energy efficiency in the majority of its own buildings when economically justifiable. By facilitating the adoption of economic, readily available energy efficiency techniques and practices, the Federal Building Initiative provides federal departments with an opportunity to reduce operating costs, stimulate the economy and protect the environment from harmful emissions associated with the generation and consumption of energy;
- ◆ promote serious examination of the benefits of deregulation and/or privatization of energy production, options for co-generation, improved connection of provincial electricity grids, and the reduction of provincial energy trade barriers. Given the international trends toward deregulation, privatization and independent power production, and the possibility of associated economic and environmental benefits, the Committee recommends that Canadian provinces who have not already done so seriously study their options for deregulation, partial or total privatization and independent power production, including co-generation, where economically viable. Since domestic utility regulation is essentially an area of provincial jurisdiction, the Committee believes that the federal government might best contribute to an efficient electricity supply system by reviewing its regulation of electricity exports and international power lines and by considering interprovincial transmission access issues where the provinces think such support would be helpful;

- ◆ use selective financial initiatives and award programs to promote greater energy efficiency in industry. For example, governments could work with the banks to explore ways to increase access to capital for industrial projects in energy efficiency. More subtle motivational techniques might also be employed. To complement the remaining incentives offered by the electrical utilities through their Demand Side Management programs, the federal government could create a national energy efficiency award program. Simply recognizing industrial accomplishments in energy efficiency through such a national award program could serve to foster a competitive spirit in energy efficiency among industrial users of energy.

I. INTRODUCTION

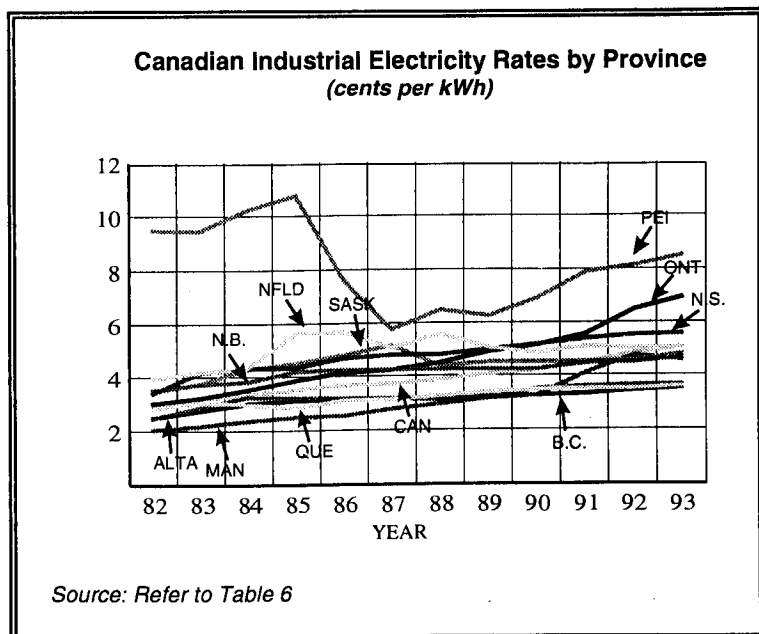
This report develops proposals on how the international competitive advantage of Canadian industry can be improved through greater energy efficiency.

MINIMIZE ECONOMIC AND ENVIRONMENTAL COST

One of the key challenges facing the Canadian industrial energy user, in an increasingly competitive global marketplace, is to minimize the economic and environmental cost of energy resources through improved energy efficiency. In its assessment of that challenge, the Committee on Energy Efficiency has surveyed the principal sources of energy for industrial use and reviewed the energy consumption practices of major industrial users.

FIRMS ARE STRAPPED FOR CAPITAL

Users as well as producers are beginning to understand that it is in their own best interests to improve their energy efficiency. When energy prices were lower, many firms didn't see the need to maximize their energy efficiency. In the meantime, prices have risen, particularly for electricity and to a greater degree in some provinces than in others (see Table 6 in Appendix E). Although firms better understand the long-term benefits of energy efficiency and conservation, they are now struggling for their short-term survival in an economic downturn. Many firms are strapped for the capital required to invest in energy efficiency technology.



***FOCUS ON
ENERGY
INTENSIVE
INDUSTRIES***

Given the fact that large corporations account for 91% of Canadian exports,^{1*} and are dominated by energy intensive, natural resource-based industries (i.e. pulp and paper, and aluminum industries), the Committee has chosen to focus its analysis on the larger, more energy intensive industries in Canada and to dedicate its recommendations on energy efficiency to improving the international competitiveness of those firms.

***INDUSTRY
SHOULD TAKE
THE LEAD/ WORK
CLOSELY WITH
STAKEHOLDERS***

It is the Committee's view that industry has the primary role in achieving greater energy efficiency, ideally working in concert with labour, universities, colleges, utilities and the provinces. In addition, there is a role for the federal government in developing and disseminating knowledge and information, in setting an example of energy efficiency in its own operations and in managing a financial climate conducive to economic development.

* See Appendix F for references

II. SCOPE

TECHNOLOGICAL INNOVATION IS THE CATALYST FOR ENERGY EFFICIENCY

In this report, and in practical terms for companies competing in the marketplace, energy efficiency is defined as the achievement of a desired output with the minimum use of energy. It includes economic as well as environmental benefits, and technological innovation is its catalyst.

“Energy efficiency is not simply "conservation", with its Spartan connotations of lowered thermostats and restricted driving.... Energy efficiency is about getting the same, or better, services from less energy by substituting ingenuity for brute force.”²

Energy efficiency is also gaining public and corporate attention because of environmental concerns. Worldwide energy use correlates with greenhouse gas emissions, and all countries are under increasing pressure to reduce these emissions. Canada's most pressing environmental problems have arisen from emissions related to the production and use of energy. Energy is reported to be responsible for 45% to 95%, depending upon the case, of acid rain, urban smog, and greenhouse gases. Most of these problems result from the burning of fossil fuels. Despite advances in hydroelectricity and nuclear power generation, 80% of Canadian energy use is based upon fossil fuels.³

BRUNDTLAND COMMISSION

The United Nations World Commission on Environment and Development, chaired by Prime Minister Gro Harlem Brundtland of Norway and best known as The Brundtland Commission, found that:

“Energy is not so much a single product as a mix of products and services, a mix upon which the welfare of individuals, the sustainable development of nations, and the life-supporting capabilities of the global ecosystem depend... A safe, environmentally sound, and economically viable future is clearly imperative. It is also possible. But it will require new dimensions of political will and institutional cooperation to achieve it.”⁴

INDUSTRIES SHOULD REDUCE ENERGY USE

Reductions in energy use by industries are necessary to preserve the environment, by reducing emissions such as CO₂, acid rain and ground level ozone. By instituting energy-saving measures such as the reuse of heated process water, heat recovery, energy efficient motors and adjustable speed drives, industries can save energy effectively and sustain the environment with existing commercial technologies. By investing in the development and implementation of new energy efficient technologies, industries can further

advance their competitive position and make a greater contribution to the maintenance of a healthy and productive environment.

The Committee recognizes that the nature of economic pressures for modernization and energy efficiency varies from country to country and may change in the future. Environmental realities, which are currently more favourable for Canada than for most of our competitors, will likely become part of the future economic pressures for modernization and energy efficiency. For example, it is the need to protect the environment (an economic necessity, not a public amenity pressure), along with higher basic energy costs, that has driven our European and Japanese competitors to invest in more energy efficient, modern plants. Similar environmentally driven, economic pressures can be expected in Canada during the lifetime of our present investments.⁵

While a balance needs to be achieved between short-term economic and long-term environmental objectives, there is clearly a need for more integrated resource planning. Electrical utilities have discovered that it can be more cost effective to convince customers to reduce consumption than to build new generating facilities.⁶ Depending on their available capacity, these utilities alternate between providing incentives to save energy and actively promoting the sale of electricity, on occasion encouraging both at the same time. In addition, they are reviewing many prospective co-generation projects with industrial producers of steam energy who, beyond producing their own energy needs, might be able to sell their excess energy to the utilities. But in times of excess capacity, interest in co-generation is minimal. The gas utilities are not as active as the electricity suppliers in promoting energy conservation, but their interest is increasing.

***WE SHOULD
BUILD ON
SUCCESSFUL
PROGRAMS***

While the onus is on industry to act, the federal government can encourage industry to increase its energy efficiency. The Committee commends Natural Resources Canada (NRCan) for the range of its initiatives in energy efficiency and for the depth of professional expertise in the department (see Appendix B). In making its recommendations, the Committee seeks to help industry improve its efficient use of energy by building on the successful programs of NRCan and other federal departments, wherever possible.

***PARLIAMENT HAS
RECOGNIZED
IMPORTANCE OF
SUSTAINABLE
ENERGY USE***

Parliament has recognized the importance of energy efficiency. The House of Commons Standing Committee on Energy, Mines and Resources published the results of a study on sustainable energy and mineral development in January 1993. It concluded that the energy efficiency challenge was one which could be addressed effectively only through complementary and coherent action on the part of governments and industry together.

"The Committee is convinced that for Canada to adequately achieve its environmental goals, a determined effort to improve the efficiency of energy use will need to be undertaken. At the same time, we must continue to make abundant and cheap energy our competitive strength. We should not load onto the energy and mineral industries punitive policy instruments which would put these natural advantages at risk. The Committee has therefore concluded that the federal government should undertake to devise innovative solutions to achieving energy efficiency gains, measures that would provide financial rewards to efficient energy users."⁷

***PRIVATE AND
PUBLIC SECTORS
MUST ACT
TOGETHER***

The Liberal dissenting opinion to the Standing Committee's report was even stronger. David Kilgour, MP, Edmonton Southeast, indicated that the Standing Committee's recommendation did not go far enough toward addressing the sustainability of Canada's energy program. He wrote:

"Income from an exhaustible resource [such as oil] is, by definition not sustainable forever... If rents are invested in assets - in increasing efficiency, improving net inputs, reducing wasteful outputs - then a limited form of energy sustainability can be achieved ... It is not more consultations that we need, it is a commitment by the public and private sectors to stop talking about environmental goals, and start acting."⁸

III. THE CANADIAN ENERGY PICTURE

Importance of the Energy Sector

ENERGY SECTOR IS VITAL TO THE CANADIAN ECONOMY

The energy sector is vitally important to Canada's economy in terms of employment, income generation and investment. This is underscored in numerous publications, including the "1992 National Energy Profile: Canada", by the Energy Council of Canada.

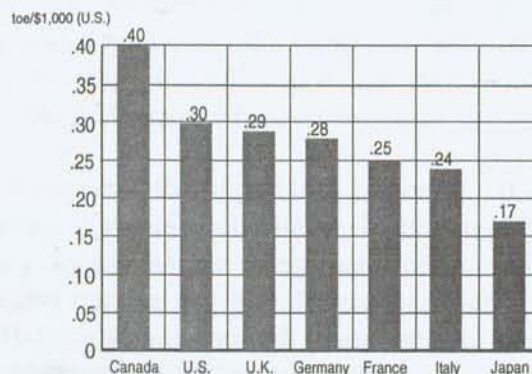
"[In 1990] the energy sector employs more than 300,000 Canadians, and accounts for 6.3% of GDP and 14.3% of total investment in Canada. However, there exist regional differences in the energy sector's contribution to the economy and in energy production and consumption. For example, about 80% of Canada's crude oil and 83% of its natural gas are produced in Alberta. In contrast, Quebec and Ontario together account for almost 60% of domestic petroleum consumption, and about half of Canadian natural gas requirements."⁹

Energy Intensity of Canadian Industry

WE ARE AN ENERGY INTENSIVE COUNTRY

Plentiful energy has been traditionally one of Canada's key assets and a source of comparative advantage in the international marketplace. Canada is also one of the most energy intensive countries in the world, whether measured by energy use per capita or per GDP (refer to Table 1 in Appendix E).

1991 Comparison of Energy Intensity in G-7 Countries*
(Total Final Consumption)

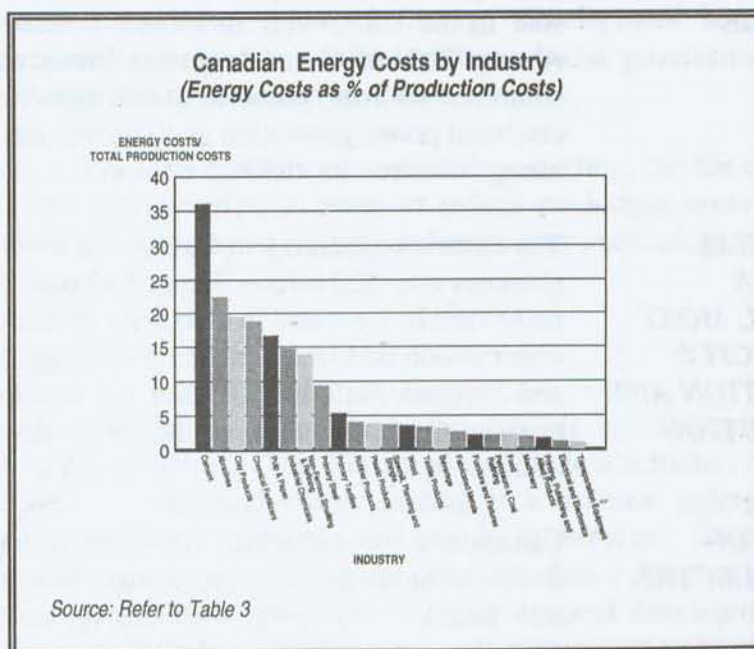


Source: Refer to Table 1

* Tons of oil equivalent per thousand of U.S. dollars (1985)

FOCUS ON PULP & PAPER AND ALUMINIUM SECTORS

If energy intensity is defined as the quantity of energy consumed (megajoules) per dollar of real domestic product, the pulp and paper, iron and steel, smelting and refining, chemicals, and cement industries can be identified as very energy intensive industries (refer to Table 2 in Appendix E). Energy costs represent approximately 9 to 36 % of total production costs for these major Canadian industries (refer to Table 3 in Appendix E). The Committee has chosen to focus on several of the most energy intensive industrial consumers, specifically the pulp and paper and aluminum sectors.



OUR ABUNDANT RESOURCES HAVE ATTRACTED ENERGY INTENSIVE INDUSTRIES

Canada's energy intensity is the result of many factors including an inheritance of abundant natural resources, a relatively cold climate, low population density (excluding large urban centres), and long transportation distances.¹⁰ Of these, perhaps the most important reason for the high energy usage rate in Canada is that we have inherited abundant and diverse natural resources (oil and gas, forests, minerals, etc.) which in turn have attracted our energy intensive industries. Until recently, these industries have flourished under the advantages of available, relatively inexpensive energy supplies.¹¹

Energy Sources

WIDE VARIETY OF ENERGY SOURCES

Canada has not only a generous supply of energy; it also has a wide variety of energy sources, not only abundant fossil-fuels but also a relatively large percentage of hydroelectric and nuclear power plants. We are a major exporter of natural gas and petroleum, coal, uranium and hydroelectricity.¹²

***SUBSTANTIAL OIL
RESERVES AND
LEADING-EDGE
TECHNOLOGY***

Canada produces almost 100 million cubic metres of crude oil per year, valued at more than \$11 billion in 1992. Canadian technology for the extraction of light and heavy oils and bitumen is leading-edge. Frontier reserves of oil are substantial but the cost of their recovery either from tar sands or from offshore deposits has to date been high in comparison to that for other sources.¹³

***NATURAL GAS AN
IMPORTANT
ENERGY
RESOURCE***

When potential reserves are included, Canadian natural gas reserves are estimated to be adequate for more than 120 years of our production needs, given present consumption and market trends. Half of current production is sold in the USA, with an estimated sales revenue of \$4.4 billion in 1992. Almost 30% of Canada's energy needs are supplied by natural gas. This, combined with the potential use of natural gas for transportation fuel and for electrical power generation in co-generation systems, makes it a very important energy resource for the future.¹⁴

***PROVINCIAL
UTILITIES
CONTROL MOST
ELECTRICITY
PRODUCTION AND
DISTRIBUTION***

The electricity industry in Canada contributes 3.3% of total GDP (1991) with revenues over \$22 billion. Exports amount to more than \$700 million. Canada ranks fifth in the world in electricity production and is a leader in long distance transmission and hydro power production. Coal, hydro, natural gas, uranium and biomass fuels are all used for electricity production. Most electricity production and distribution is under the control of provincially regulated utilities.¹⁵

***LEADER IN
HYDROELECTRI-
CITY***

Canada is a very successful developer of hydroelectricity, and leads the world in this form of electricity generation, followed by the USA, the former USSR and Brazil.¹⁶ In 1991, hydroelectricity represented 9-10% of the overall Canadian energy supply and 60% of electricity supply.¹⁷

***COAL MAINLY
FOR PRODUCTION
OF ELECTRICITY***

Canadian coal reserves are substantial, and half of the 60-70 million tonnes which are mined annually are exported to 23 countries. Most Canadian coal consumption is for the production of electricity. In 1992, coal represented 14% of total primary energy demand in Canada.¹⁸

***GOOD TRACK
RECORD IN
NUCLEAR
ENERGY BUT
LARGELY FOR
DOMESTIC USE***

Canada's record in nuclear energy production is recognized around the world. The 20 domestic CANDU reactors have the capacity to provide almost 20% of Canada's electricity needs. Although Canada ranks among the leading producers of nuclear electricity in the world, France (75%),¹⁹ Belgium (60%), Sweden (52%), Switzerland (42%), Germany (36%), Spain (35%),²⁰ and Japan (30%) have higher percentages of nuclear power production in their national energy grids. In Canada, most nuclear-generated electricity is used for dispersed domestic consumption rather than for energy-intensive industries such as pulp and paper and aluminum, which generally use hydroelectric sources or waste-biomass.²¹

***RENEWABLE
ENERGY SOURCES
ARE PROMISING***

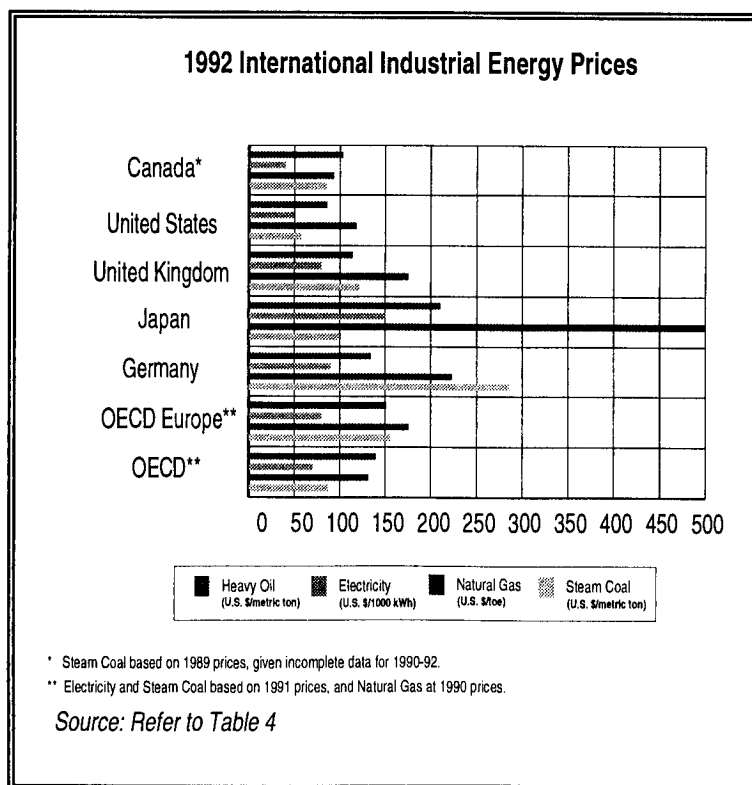
Renewable energy sources such as wind, solar, small hydroelectric projects, biomass and municipal solid waste currently represent approximately 6% of Canada's total primary energy demand.²² Bioenergy constitutes 4% of Canada's energy supplies. Most of this bioenergy is derived from the forest industry where wood-waste biomass is used for process heat and electricity, with about 25% used for residential/commercial heating.²³ Geothermal, wind and solar energy systems (totalling about 4 Gigawatt Hours (GWH)) and fuel grade ethanol from agricultural biomass round out Canada's energy suppliers, but none of these is a significant contributor at this time.²⁴ From an environmental perspective, renewable energy development is expected to receive increased priority from federal and provincial governments as they support the greening of Canadian industry.

Industry leaders now recognize waste reduction, recycling, and the efficient use of energy and raw materials as ways to reduce production costs and waste disposal costs, lower industrial liability and regulatory uncertainty, and improve overall efficiency.²⁵

Pricing Trends

***ENERGY PRICES
SUBJECT TO
FLUX***

Historical data are not a sound basis for drawing conclusions about the evolution of energy prices. This limitation applies to electricity, oil and gas. First, the data on industrial energy pricing is a national aggregate and is insensitive to various regional tax and supply differences. Second, energy pricing, more than for any other commodity, is often subject to supply and demand flux, geo-political instability and technological developments which alter energy needs and uses. Nonetheless, it is informative to have a sense of how energy prices have developed, so that we may understand how energy pricing has affected the competitiveness of Canadian industry (refer to Table 4 in Appendix E).



Fossil Fuels

PRICE TRENDS FOR OIL, GAS & COAL

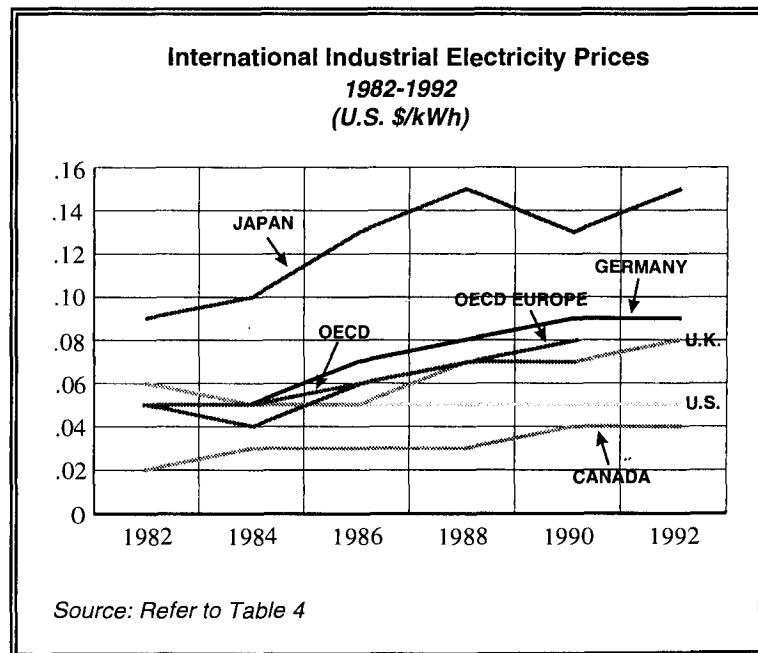
While the price of fossil fuels as a source of energy is subject to considerable short-term volatility, international industrial price levels for oil, gas and coal, in contrast to electricity, displayed a downward trend between 1982 and 1992. Recessionary conditions and oversupply have caused prices for heavy oil, which is used in intensive industrial processes, to decline more sharply than prices for natural gas and coal. Natural Resources Canada predicts that the price of heavy oil will remain relatively stable until approximately the year 2020.²⁶ For large industrial consumers, natural gas is the main alternative to heavy fuel oil. Natural gas prices have risen dramatically over the past twelve months and are projected by Natural Resources Canada to continue to rise until they become roughly comparable to international oil prices on an energy equivalent basis.²⁷

Finally, most Canadian-produced coal used domestically is consumed in thermal power plants to generate electricity. In the long term, the price of Canadian thermal coal is expected to grow at a rate less than that of inflation because most coal mines are owned by utilities.²⁸

Electricity

LOSING OUR COMPETITIVE ADVANTAGE IN ELECTRICITY PRICES

Due to an inheritance of abundant free water, rate regulation and government subsidization of public utilities, Canadian cities traditionally have enjoyed electricity prices which are among the lowest in the world (refer to Table 5 in Appendix E). Although our industrial electricity rates are dramatically lower than those of Japan, they have been steadily increasing since 1982, and we are losing our competitive advantage relative to the US (refer to Table 4 in Appendix E).



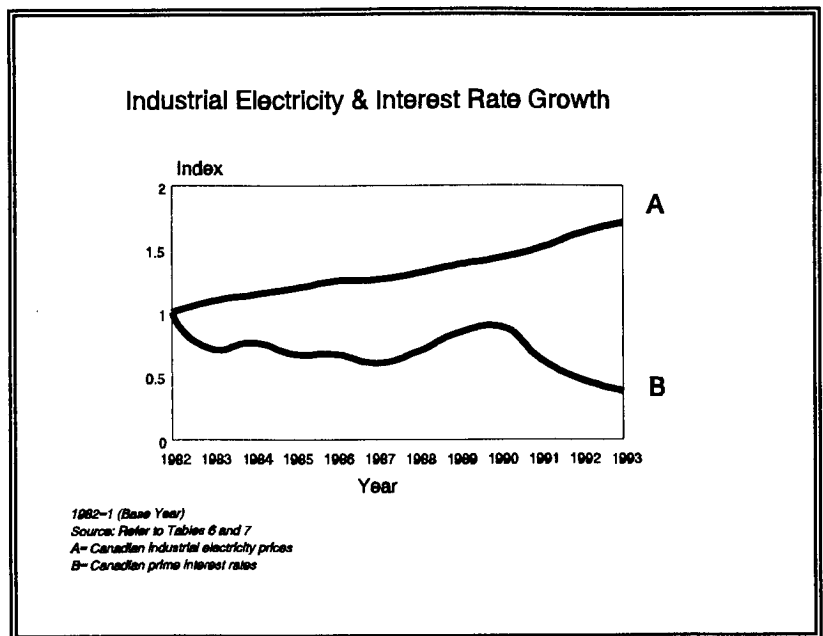
PROVINCIAL PRICES VARY

Industrial electricity prices levied by provincial utilities vary according to the volume of electricity consumed per industrial consumer, and larger industrial consumers usually are charged lower rates. The price of industrial electricity varies widely from province to province and has increased substantially. The largest electricity rate increases have been in Ontario. Since 1982, the electricity cost to Ontario industry has increased more than a full cent (1¢) per megajoule (cpm) of energy, from .83 cpm's in 1982 to 1.93 cpm's in 1993, i.e. a 131% increase. Over the past three years alone (1990-1993), industrial electricity rates in Ontario have gone up 35%.²⁹ As electricity rates have increased, some of Ontario's traditional energy advantage has been lost; many US cities and states now have cheaper energy.

UTILITIES ENCUMBERED BY DEBTS

Generally, the electric utilities have justified these price increases on the need to offset massive investment in generating and transmission equipment and the construction of new facilities. Provincial electric utilities are now heavily encumbered by debts and annual interest expenses. As of 1992, Ontario Hydro's debt load was \$35 billion, the annual interest on which represented 49% of operating costs. Similarly, Hydro-Québec carried a debt load of \$32.5 billion, which represented an interest service cost of 1.71 cents per kWh, or 40% of total operating costs.

Consumers of electricity have been led to believe that a major factor affecting energy pricing was interest expense and that, once interest rates dropped, the savings would be passed on to consumers. Yet, while interest expense represents a large percentage of the operational costs of Canadian electric utilities, electricity rates have not declined even as interest rates fell recently to a 27-year low.³⁰ Since 1982, Canadian industrial electricity rates have steadily risen, regardless of the fluctuations in interest rates (refer to Tables 6 and 7 in Appendix E).



Energy Efficiency

OBSTACLES TO COMPETITIVE PRICING AND ENERGY EFFICIENCY

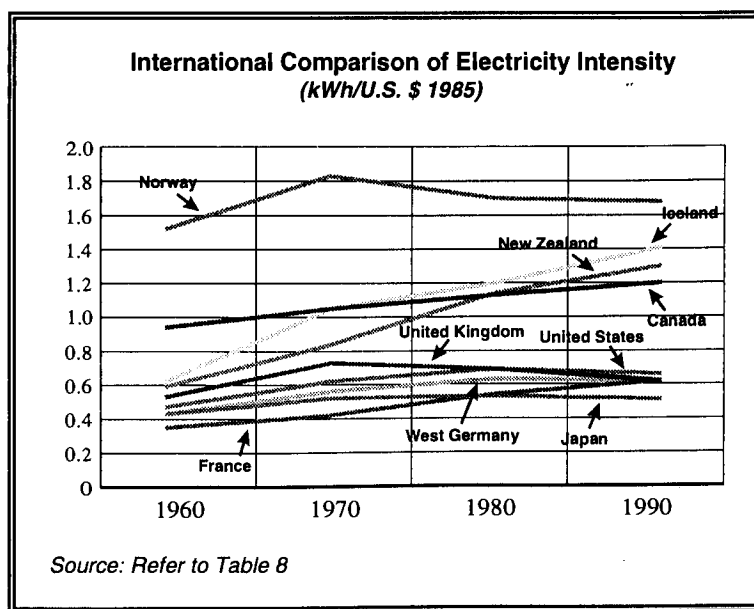
In theory, free market forces would lead to competitive pricing between the suppliers of energy and encourage the pursuit of energy efficiency by both suppliers and users of energy resources. In practice, this has not been the case for several reasons: short term economic decisions on the part of industry and government have over-ridden longer term efficiency considerations; governments have used energy pricing and energy taxation for public policy

purposes; energy pricing does not factor-in all costs (environmental damage and remediation, for example); and externalities create market failure (lack of complete information on alternatives, inadequacy of trained and knowledgeable personnel, inconsistency in energy and taxation policies, and unpredictable price trends).

The first oil shock (1973) drove other countries more than Canada to improve energy conservation and efficiency of use, though Canada did begin to introduce some energy efficiency measures in the 1970s. However, Canadians were cushioned by available low-cost supplies and low domestic pricing policies.

Canadians have significantly reduced overall energy intensity since the 1970s, from an energy intensity factor of .66 (Total Primary Energy Supply - TPES/GDP) in 1973 to a factor of .54 in 1992.³¹ This looks good until it is contrasted with the record of other nations. In Canada, we have tended to switch to other readily-available lower-cost energy supplies, rather than reducing use of energy overall.³² As we have done so, our electricity intensity has actually increased (see Table 8 in Appendix E).

**CANADIAN
ELECTRICITY
INTENSITY HAS
INCREASED**



Canada's record in energy efficiency through the latter half of the 1980s indicates a general backsliding of industrial and consumer effort to be more energy efficient, as energy prices (excluding electricity) stabilized and as the economy faltered. Industry experts consulted by the Committee noted that, in recessionary times, plants operate at lower capacity and firms tend not to invest

in new plants and technology. Therefore, their energy efficiency or at least the rate of improvement is reduced.

***ENERGY
EFFICIENCY
LEADS TO MORE
JOBS, ECONOMIC
GROWTH***

An American study of the indirect economic benefits of a high efficiency energy strategy examined the impact on employment and income resulting from reducing the cost of energy services. Based upon an input-output model, it deduced that the high efficiency scenario would lead to more jobs, higher personal incomes and a marginally higher GDP throughout a 20-year projected period. Positive employment and income results are due to the low labour intensity of the energy supply sector (coal, gas, oil, fuel refining and electric and gas utilities) compared to the high labour intensity of energy efficiency initiatives. Conserving energy reduces the energy bills of consumers and industries, thereby freeing up money for other purchases of goods and services.³³

Government Measures in Energy Efficiency and Conservation

***A STEP IN THE
RIGHT
DIRECTION***

In the 1980s, the Department of Energy, Mines and Resources (now Natural Resources Canada) was concerned primarily with reducing oil dependency through R & D and the development of alternative fuel sources and resources. As energy prices fell, energy programs were among the first victims of cost-cutting within the government (November 1984). Following the elimination of the National Energy Program (NEP), the department began to concentrate on reintroducing appropriate market signals to be more in step with world prices. The 1990s renewed concern about the environment and the rising importance of energy efficiency and reduction of greenhouse gas emissions. It became apparent that a key way to reduce emissions was to reduce the consumption of fossil fuels. With the introduction of the Green Plan, a commitment was made to stabilize CO₂ emissions at 1990 levels by the year 2000.³⁴ From an industrial perspective, the recent emphasis of the federal government has been on working with industry to provide information, support R & D, demonstrate new and existing technology and encourage technology transfer.

IV. THE COMPETITIVENESS OF CANADIAN INDUSTRY

Energy for Economic Development

EFFICIENT ENERGY USE IS KEY TO COMPETITIVE- NESS

The availability of energy and raw materials was the reason for the development of many energy intensive, resource-based industries in Canada. In turn, through exports such as pulp and paper and aluminum products, these industries have contributed to the economic development of Canada. The energy intensity of the pulp and paper and aluminum sectors underscores the importance of efficient energy use to Canada's long-term competitiveness.

Pulp and Paper Sector

PULP AND PAPER SECTOR, LONG A STRENGTH, NOW IN TROUBLE

Pulp and paper has been a traditional strength in the Canadian economy, although it is a very competitive marketplace today. Total revenues for the pulp and paper sector in Canada have declined annually since 1989, when they stood at \$19.8 billion.³⁵ As of 1991, the Canadian pulp and paper sector produced 24.5 million tonnes of pulp, paper and paperboard, which earned a sales value of \$15.7 billion. More significantly, the sector exported 20.5 million tonnes with a value of \$13.6 billion, and contributed a \$12.1 billion industry trade surplus to Canada's national trade balance.³⁶ The pulp and paper sector employs approximately 65,000 people.³⁷

ILLUSTRATES ERODING COMPETITIVE ADVANTAGE IN ENERGY

The pulp and paper industry's troubles illustrate Canada's eroding competitive advantage in energy. Just 10 years ago, relatively cheap energy helped our pulp producers override traditional Canadian disadvantages such as high wood costs, high transportation costs and high labour costs. Since the mid-1980s, for example, newsprint companies in Québec have seen their energy cost advantage of close to \$70 (Cdn.) per ton evaporate to \$3 or less compared to US producers. Or from a different angle -- between 1986 and 1990, US power costs per ton dropped 18% while Canadian costs per ton jumped nearly 20%.³⁸

The pulp and paper sector consumes about 30% of industrial energy, which accounts for 9% of total Canadian energy consumption (769.2 petajoules [PJ] or approximately 9 million tonnes of oil equivalent [MTOE]).³⁹

Energy consumption in the pulp and paper industry is driven by climate factors (heating of colder water), and can be reduced simultaneously with the reduction in the use of water for paper processing. This is attractive since less water means less effluent and hence fewer environmental problems.

**FIRMS THAT
HAVE
BENCHMARKED
AND
MODERNIZED
HAVE HIGH
ENERGY
EFFICIENCY
LEVELS**

Industry experts consulted by the Energy Efficiency Committee have indicated that in instances where Canadian firms are aware of their best competitors' benchmarks and have commissioned modern plants, their energy efficiency levels are on a par with the best in the world. For instance, Domtar Inc. completed a \$1.2 billion modernization of its Windsor, Quebec plant in 1989. The Windsor mill is now Domtar's largest and most strategic complex, producing approximately 500,000 short tons a year of fine paper (printing, photocopy, envelope, computer and business forms). The mill houses two state-of-the-art paper-making machines, and features the latest computerized technology which extends beyond the paper-making process to virtually every aspect of the operation, including energy efficiency.

Yet, due to industry over-capacity, depressed paper prices and increased electricity rates, the mill has struggled financially, incurring losses in 1990, 1991 and 1992, and finally producing a mild operating profit in 1993. In an effort to keep the mill's costs in line with key US rivals, Domtar is pursuing a \$200 million co-generation power plant with Hydro-Québec for the Windsor complex. The co-generation project is viewed as essential for the future development of the company's operations in Windsor, and is expected to cut the plant's annual energy bill by about 30% and help to increase productivity by providing a reliable power supply (eliminating costly power failures). If developed, the co-generation plant will position Domtar's Windsor mill on a more competitive basis with its strongest American rivals.

**MANY CANADIAN
PLANTS ARE
OLDER AND LESS
EFFICIENT**

In contrast, many Canadian plants are older and less energy efficient than Domtar's Windsor plant, leading to an energy efficiency performance that is poorer than the industrial world average. A 1991 study by Price Waterhouse confirmed that, in comparison to the southern and western US, Sweden and Finland, Canada's wood pulp and newsprint papers ranked last in total cost efficiency with respect to energy, labour and other manufacturing costs. In the wood pulp sub-sector, Finland maintained the lowest energy costs at \$9 Canadian per tonne compared to the Canadian industry average of \$43 per tonne. In the newsprint sub-sector, the southern US was the most energy cost efficient at \$85 per tonne, versus the Canadian average of \$95 per tonne. The fine papers sub-sector has also experienced severe price competition from large producers in the United States.⁴⁰

While industries are responsible for their own investment decisions with regard to energy efficiency programs, it is important to recognize that federal and provincial regional economic development programs of the 1970s and 1980s in part encouraged extending the life of older industrial plants and equipment rather than investing in new facilities as some of our firms and our international competition were doing. Mr. Peter Wrist, President of Paprican, commented to the Committee that "in hindsight it would have been better if the

public and private sector investments of this period had been directed at installing modern equipment rather than extending the life of older facilities. During this period, Canada kept some older plants and equipment operating while the competition was installing more new facilities. As a result, some of our facilities are now 70 or 80 years old.”

Since the energy crisis in the 1970s, there has been a continued increase in the use of sawmill waste (chips and sawdust) to make pulp and paper and of biomass (waste wood) combustion for process steam generation in the pulp and paper industry. This has lowered costs and increased the efficient use of biomass which otherwise creates disposal problems, but has not led to increased energy efficiency. The exception is where new biomass facilities have displaced older, less efficient steam generation facilities.

**MAJOR BENEFITS
ARE PROJECTED
FOR
DEREGULATION
AND CO-
GENERATION**

Total revenues for the pulp and paper industry in Canada for 1992 were \$14.9 billion. Industry Canada estimates that the deregulation of hydroelectric utilities and the consequential increase in co-generation would result in a total of \$12.3 billion of cumulative benefits (1992 dollars) accruing to the pulp and paper industry during the period 1995 to 2015. Given that approximately 150 pulp and paper mills are operating in Canada, this is the equivalent to an average of \$82 million in benefits per mill. These benefits would be achieved through production savings in electricity costs and by revenues derived from excess power sales and power repurchases (also known as crosshauling). Without crosshauling, the projected benefits derived by the pulp and paper industry are estimated to be \$8.6 billion.⁴¹

Industry experts told the Committee that the highest priorities of the pulp and paper industry relating to energy use are encouraging biomass (i.e. wood-waste-fired co-generation), continued global benchmarking (i.e. comparisons of energy efficiency to international best-practices) through cost-shared technology identification, demonstration and implementation programs, and rationalization of transportation costs.

Aluminum Sector

**ALUMINIUM
SECTOR DEPENDS
ON LOW-COST
HYDROELECTRIC
POWER**

Purification of aluminum is accomplished by a world-standard process (Hall-Heroult), requiring large amounts of electricity. Although Canada has no aluminum ore deposits of any real consequence, its abundant and historically inexpensive hydroelectricity has attracted and retained companies that refine the metal from alumina (partially refined ore).⁴² Assuming that our hydroelectric production infrastructure can continue to provide abundant power at a competitive cost, and given the proximity of Canadian aluminum producers to the US market and major shipping routes, our aluminum producers should be able to retain their competitive advantage for some time.

In the United States and Europe by contrast, smelters which depend on high-cost electricity based on fossil fuels or nuclear energy are becoming uncompetitive. Already, smelters in Japan, France, Germany, Italy and Spain have proven to be susceptible to closure due to a combination of energy costs and weakness in the price of primary aluminum.⁴³

The aluminum smelting sector in Canada is dominated by five strong corporate entities with 1993 production capacities as follows: Alcan, with 1,093,000 metric Tonnes of Primary Aluminum (TPA), is by far the largest producer. Other producers are Canadian Reynolds Metals at 400,000 TPA, Aluminerie de Bécancour (ABI) at 360,000 TPA, Aluminerie Luralco (Alumax) at 215,000 TPA, and Aluminerie Alouette at 215,000 TPA.⁴⁴

***TREND TOWARD
HIGHER VALUE-
ADDED
PRODUCTS***

In the 1950s, Alcan and other producers recognized the need to diversify into semi-fabricated products in order to develop new markets as well as to benefit from higher and more predictable profit margins than those available for primary aluminum. Over the years, there has been a gradual decrease in the volume of primary aluminum sold to other parties and a trend toward higher value-added products such as metal composites, semi-fabricated products, foil and finished products. Sales of primary aluminum now make up less than 30% of Alcan's total external sales.⁴⁵

***ALCAN
GENERATES ITS
OWN
ELECTRICITY***

In order to increase their control over traditionally low, but steadily rising electricity prices, several aluminum producers have entered into energy contracts with the utilities. Canadian Reynolds and ABI have long-term, risk-sharing energy contracts with Hydro-Québec. The Aluminerie Alouette and Aluminerie Luralco have recently entered into similar agreements with Hydro-Québec. Alcan, on the other hand, has traditionally relied on the generation of its own electricity. This policy has been highly successful in enhancing the ability of Alcan to control and predict its energy costs.⁴⁶

However, since aluminum is widely traded on world markets, shifts in international demand and supply can have a significant impact on market prices. Currently, North American aluminum companies are suffering from a surge of cheap imports from Russia, where large smelters in 1993 sent well over one and a half million metric tonnes of aluminum to the West. Prices fell to 49 cents (US) per pound, an all time low if inflation is factored in, and have recently recovered to levels around 60 cents (US) per pound.⁴⁷ The United States, Russia, Canada, the European Union, Norway and Australia have recently concluded discussions which may lead to voluntary production restraints on the part of aluminum producers in Russia and other members of the Commonwealth of Independent States.

**NORWEGIAN
ENVIRONMENTAL
CONTROLS ARE
CONDITION FOR
AID**

From an environmental perspective, Norway has taken the lead in international discussions by insisting on Norwegian-style environmental controls or standards in any Russian metallurgical plants that receive Norwegian financial aid.

In addition to shifts in international demand and supply, fluctuations in exchange rates can have a substantial influence on the profitability and competitiveness of the Canadian aluminum industry. Once a new balance has been achieved and metal prices stabilize following the integration of Eastern European and the former Soviet Union producers into the world market, the Canadian aluminum industry should occupy an enviable position in the international marketplace.⁴⁸

Other Energy Intensive Industries

While the Committee has focused on the pulp and paper and aluminum sectors, other energy intensive industries are worth noting. Mining, quarrying and smelting are major contributors to the Canadian economy (4.4% of GDP in 1991).⁴⁹ Excluding oil and gas, total exports and imports in 1992 of mineral commodities were \$24.9 billion and \$13.9 billion respectively.⁵⁰ The industry contributes over \$11 billion to Canada's trade balance and employs over 100 thousand people.⁵¹ Mining uses 13% of industrial energy, accounts for 3% of total energy use in Canada, and consumes 317.2 petajoules. Iron and steel consume 241.1 petajoules, and smelting and refining consume 190.5 petajoules.⁵²

The cement industry, while not involved in the export market to any substantial extent, is a major industrial sector in Canada. It employs 20 thousand Canadians⁵³ and consumes 51.6 petajoules of energy.⁵⁴

The chemical industry is another major energy consumer in Canada with annual exports of approximately \$4 billion and imports of an estimated \$5 billion. Employment in the chemical industry is more than 30 thousand,⁵⁵ and fuel and energy consumption is 237.5 petajoules.⁵⁶

Energy Efficiency of SMEs

**SMEs MUST ALSO
IMPROVE ENERGY
EFFICIENCY**

Although the Committee has chosen to focus its recommendations on large, energy intensive industries with the greatest potential for energy efficiency improvement, small- and medium-sized enterprises (SMEs) merit a brief overview since they must consider energy efficiency improvements in order to compete effectively in global markets.

To put SMEs in perspective, Industry Canada defines a small business as employing fewer than 50 people, a medium-sized business as employing 50 to 500 people, and a large corporation as employing in excess of 500 people.

More than 99% of all businesses in this country are small- or medium-sized businesses, which employ in excess of 6.5 million people representing more than half of all Canadian jobs, provide 38% of the Canadian gross domestic product (GDP), and export approximately \$12.3 billion in shipments annually (9% of national exports).⁵⁷

Our SMEs must strive continually to improve their competitiveness, one component of which is energy efficiency. The problems of increasing energy costs and environmental controls often hit SMEs harder than they do the larger industries. Although SMEs may lack the resources or incentives to adopt new technologies or management practices, their variety and size give them the flexibility to use ingenuity and locally-tailored changes to increase energy efficiency and environmental performance.⁵⁸ While SMEs account for only 9% of Canadian exports,⁵⁹ it is becoming increasingly evident that the country's future economic health depends on their ability to compete domestically and internationally with foreign corporations.

“Not all small businesses will export, nor will exporting be appropriate for many of them. But all small businesses will have to become internationally competitive, even if only to defend their domestic markets from international competitors. The globalization process is affecting all sectors and firms, even those, such as distribution industries, that have traditionally been insulated from the international economy. To continue to grow and create attractive jobs, Canada's small businesses will have to raise their productivity and secure competitive advantages. They will have to benchmark themselves against their international as well as their domestic competitors”.⁶⁰

***MANY CANADIAN
FIRMS LAG IN
ADOPTION OF
EXISTING, BEST-
PRACTICE
TECHNOLOGIES***

Like large corporations, SMEs can benefit by adopting energy efficient techniques. Yet, even when SMEs are aware of the need to benchmark themselves to the best of their international competition in energy efficiency, many firms lack the time and/or resources to familiarize themselves with technological change and the opportunities that it may present for their businesses. Studies conducted by the Economic Council of Canada (1987), the 1993 World Economic Forum and other sources suggest that Canadian businesses lag persistently in the adoption of existing, best-practice technologies and that “the diffusion of process technologies is too slow.”⁶¹

**SOME FIRMS
HAVE MET THE
CHALLENGE**

While many SMEs may lack the time and/or resources to pursue new energy efficient technologies, some firms have successfully met the challenge. Two good examples are MBB Mechanical Services Ltd. of Halifax, Nova Scotia and SED Systems Inc. of Saskatoon, Saskatchewan. Both firms are 1992 CEA annual industrial award winners for energy efficiency.

MBB Mechanical, a construction and maintenance company, manufactures pressure parts such as superheaters, economizers, headers and generating tubes. During peak periods, it employs 60 people. During a recent expansion of its Springhill plant, MBB greatly improved its energy efficiency and working conditions by converting from oil to geothermal heating. While MBB expanded the size of its facility from 651 m² to 1300 m², the conversion reduced the plant's purchased energy consumption by 46%.⁶²

MBB's environmentally friendly geothermal system is based on circulating naturally warm waters from wells in nearby coal mines into a system of 11 electric, ground-source heat pumps. Each heat pump is controlled by automatic changeover thermostats which provide 100% heating and cooling throughout the year. After the water has passed through the plants geothermal system, it is discharged back into the mine shaft for recycling.

Founded in 1965, SED Systems Inc. currently employs 275 people and is involved in four business sectors: space programs, satellite ground systems, defence and government systems, and custom manufacturing. Its operations are integrated under one roof in a modern 11,600 m² facility which was custom built in 1987. In 1992 SED Systems reduced annual energy consumption by more than 185,000 kWh (savings of approximately \$10,000 per year), by replacing 40-watt fluorescent tubes with high-efficiency 34 watt tubes, 150-watt incandescent bulbs with 13-watt compact fluorescent lights, and by installing timers on an internal fan system and exterior lighting. As a result, SED has reduced its electricity costs by 12.2%. The facility also employs a closed loop heating and cooling system, which can simultaneously heat and cool different areas of the plant.⁶³

While SMEs potentially can benefit tremendously from the adoption of energy efficient techniques, they are generally less capital and energy intensive than large corporations. Given the fact that large corporations account for 91% of Canadian exports and are dominated by energy intensive, natural resource-based industries (i.e. pulp and paper, and aluminum industries), the Committee has chosen to focus its analysis on the larger, more energy intensive industries in Canada and to dedicate its recommendations on energy efficiency to improving the international competitiveness of those firms.

V. ANALYSIS OF THE ISSUES, AND RECOMMENDATIONS

A. BENCHMARKING TO INTERNATIONAL BEST PRACTICES

Current Situation

CANADIAN FIRMS FREQUENTLY NOT ON PAR WITH BEST INTERNATIONAL PRACTICES

In the global marketplace, energy efficient technology is readily available to Canadian industry, as well as to its competitors. Yet both large and small Canadian firms are frequently unaware of, or not on par with, the highest international levels of energy efficiency.

The Committee sees a need for what may be termed "benchmarking", i.e. a need for Canadian industries to compare their levels of and initiatives for energy efficiency to the best of their international competition. Since different countries define and measure energy use up to different points in the production process, true international standards for energy efficiency do not exist, and thus benchmarking in its purest form is not yet feasible. However, "benchmarking" in the sense of comparing the energy efficiency levels and initiatives of Canadian firms to best-practices in energy efficiency worldwide, then working to improve industrial performance, is critical to the long-term competitiveness of Canada. Beyond benchmarking, improved awareness and training programs in energy efficiency technology are important to the competitiveness of our energy-based industries.

Large companies may be relatively aware of the best industrial benchmarks but, in many cases, Canadian industrial performance in energy efficiency is well below best practice. This may be due to the inability of some firms to judge benchmarks correctly for lack of adequate information or sufficient technical knowledge. Both large and small firms need to become aware of how important energy efficiency is to their future competitiveness, in view of expected rising energy and environmental costs, so that they can make use of international benchmarks in energy efficiency.

SMEs typically have more difficulty than large energy users in identifying and applying best practice technologies for energy efficiency. The NABST Report on Technology Acquisition and Diffusion reported in 1992 on the difficulties experienced by SMEs in keeping abreast of rapidly changing technologies.

While not the focus of this report, the Committee recognizes the importance of parallel programs in energy efficiency technology for commercial and residential users.

Opportunity

NEED TO "BENCHMARK"

As a first step toward ensuring the long-term competitiveness of Canadian industry, industrial energy users need to compare their levels of and initiatives for energy efficiency to the best of our international competition, then increase the knowledge of these levels and initiatives for energy efficiency among employees.

The opportunity is there to build on existing programs. At the federal level, the Canadian Industry Program for Energy Conservation (CIPEC) has worked for a number of years through industrial committees to establish sector targets for increased energy efficiency. This program is being re-invigorated to encourage information-sharing within industry sectors and to foster industrial improvements in energy efficiency and environmental controls including, as appropriate, the stabilization of greenhouse gas emissions, water use efficiency and water quality, and toxic waste management.⁶⁴

A CONTINUOUS EFFORT IS REQUIRED

Since the same technologies are available to firms worldwide and are refined on an on-going basis, substantial comparative advantage cannot be attained or sustained by Canadian firms through a one-time initiative. The process of benchmarking requires a continuous effort by firms to visit leading edge performers to learn the specifications and possible applications of a given technology.

The assessment of potential applications for technical improvements is perhaps best done on an industry by industry basis. For example, co-generation may be a viable, cost effective solution for some industries in certain locations, but may be unworkable for others.

INDUSTRY SHOULD MAKE ITS INTERESTS BETTER KNOWN TO GOVERNMENT

While the primary obligation is for industry to act in this area, it should also make its interests in benchmarking for energy efficiency known to the federal government. In order to compete effectively internationally, industry also needs the involvement and full commitment of Canada's labour unions, and the support of Canadian universities and technical schools, in comparing and bringing our industrial processes up to the highest international levels of energy efficiency and conservation.

Recommendation 1:

Canada should benchmark its level of energy efficiency and environmental practice to industries in other countries.

A concerted effort should be made to compare Canada's level of energy efficiency to the best of our international competition, then work to develop a competitive international edge in energy efficiency. A consortium of private sector executives, with the support of Natural Resources Canada, Environment Canada, the Ministry of Foreign Affairs and International Trade, in tandem with labour representatives, energy specialists from utilities, universities, colleges and consulting engineers, should identify best practices in energy efficiency world-wide and work to build industrial awareness of these standards, on an industry-by-industry basis. While benchmarking is important to individual industries, it is equally important that such a consortium look at ways to improve the net overall efficiency of Canada's energy use. The International Committee on Science and Technology also recognizes the importance of benchmarking and further recommends that any government support for companies to benchmark themselves should be offered preferentially to business sectors with proven performance and strong market potential.

Recommendation 2:

Canadian government and industry should evaluate international energy efficiency trends and initiatives on a regular basis.

Once we have ranked ourselves against our best international competitors, the consortium described above should evaluate international trends and initiatives in energy efficiency every two or three years, on an industry-by-industry basis as well as a net overall basis. In order for international comparisons or benchmarking to be successful, a continuous effort will be required by this consortium to visit and consult with leading edge performers in energy efficiency.

Recommendation 3:

The Committee recommends further study of international best practices for energy efficiency in the transportation sector.

While the Committee has not focused on the transportation sector, a number of railway industry experts consulted by the Committee have noted the need for an effective system of measurement in energy efficiency. Because the international competitiveness of Canadian industry depends so heavily on transportation costs and efficiency, the Committee recommends that Transport Canada, with the support of the National Transportation Agency, Natural Resources Canada, Industry Canada, the National Research Council, and representatives from private industry and labour, establish a working group to study further international best practices and an effective system of measurement for energy efficiency not just in rail, but in land, air and sea transportation. Once a measurement system has been established, the Canadian transportation industry will be better positioned to monitor and improve energy efficiency on a competitive basis.

B. IMPROVEMENT OF TECHNOLOGY TRANSFER

Current Situation

WE ARE FALLING BEHIND

Due to the recent recession, Canadian industries have been forced to downsize their operations and/or reduce expenditures on technology acquisitions. As a result, experts consulted by the Committee indicated that Canadian industry is falling behind its international competition in the acquisition of energy efficient technology from abroad, in the transfer of energy efficient technology improvements from government laboratories to industry, and in the training and practical application of energy efficient technology to industrial processes.

CANMET ILLUSTRATES WHAT WE CAN DO

At the federal level of government, the Canadian Centre for Mineral and Energy Technology (CANMET) conducts a program of analysis of energy intensive industrial sectors, and works with industrial associations and individual firms to identify and develop those technologies with the greatest potential for environmental improvement and energy savings compatible with the profitable operation of firms.

Opportunity

TECHNOLOGY ACQUISITION AND TRANSFER FOR THE SHORT TERM/R & D FOR THE LONG TERM

In order to develop and maintain a competitive edge, Canadian industry must bring its practices in energy efficiency up to the highest international practices. Most industry in Canada would be energy-competitive were it simply to acquire known, best-practice technologies already being employed elsewhere. The need for technology acquisition and transfer in energy efficiency applies to all producers and users, and training is an important element. The Committee recognizes that technology acquisition and transfer are more effective in the short term than research and development in energy efficiency, although R & D is necessary for the long term viability of Canadian industry.

“Canada’s research, development and demonstration should be directed primarily to those market niches in which we have a comparative advantage and to Canadian opportunities and needs that may otherwise be neglected. As a smaller country, we cannot afford to cover all our research needs, and should acquire technology from other countries where possible. ... Many of Canada’s technology needs focus on unique resources, including oil sands, heavy oil and low sulphur coal in western Canada; off-shore oil and gas in ice-infested waters; hydroelectricity generation in Quebec, Manitoba, British Columbia and Newfoundland. Other needs relate to Canadian conditions such as climate (the R-2000 house), remote locations (renewable energy systems), and maritime needs (pollution controls for development).”⁶⁵

"Recent estimates by the International Energy Agency and Energy Mines and Resources Canada (now Natural Resources Canada) show that with appropriate investment and the adoption of available technology, current energy inputs in major energy-using sectors could profitably be lowered by 20 to 30% without reducing the output of products and services."⁶⁶

The need for greater industrial awareness and training in state-of-the-art energy efficiency technology is apparent. In addition to taking action on its own initiative, industry should make its specific interests known to the federal government, so that federal programs may be targeted more directly to industrial needs.

Metal 7 and Syncrude are two excellent examples of technological transfer from government sponsored research to Canadian industry.

Metal 7 is a Quebec-based firm which received collaboration from Natural Resources Canada, the National Research Council of Canada's Industrial Research Assistance Program (IRAP) and the former External Affairs Canada. Through this partnership they developed technology originating from a Technology Inflow Program (TIP) project in Scandinavia for an industrial fuel burner which handles oil and coal slurry more efficiently, and has increased productivity by approximately 10 to 20%.⁶⁷ This technology has resulted in significant savings for the iron ore industry, and has now been adapted to other basic industries such as pulp and paper.

Syncrude of Alberta, with the cooperation of Natural Resources Canada (CANMET), the University of Alberta and McGill University, developed improved analytical procedures which enable a faster turnaround on operational data. This system permits Syncrude to utilize more efficiently the recovery process of heavy oil and facilitates mining sections of the site for higher oil recovery.⁶⁸

Recommendation 4:

Following the identification of international best-practices in energy efficiency, industrial managers and workers should deepen their understanding of these best-practices in energy efficiency through information programs and international exchanges.

Canadian industry, especially small- and medium-sized businesses in this case, requires effective information programs and international exchanges in new energy efficient technology to help it compete internationally. Following the identification of international best-practices in energy efficiency, industrial managers and workers, with the support of Natural Resources Canada and Industry Canada, should develop and operate an effective information program and a series of international exchanges, the objective of which would be to deepen the industrial understanding of best-practice technologies in energy efficiency and conservation. The Committee understands that Natural Resources Canada has created a Minister's Advisory Council on Industrial Energy Efficiency to provide advice on industrial programs such as the Canadian Industry Program for Energy Conservation (CIPEC) and the Centre for the Analysis and Dissemination of Demonstrated Energy Technologies (CADDET). A priority of this council should be to ensure that more emphasis is placed on informing industry of current best-practices in energy efficiency, on requiring joint funding with industry, labour, and academic institutions, and on ensuring the involvement of all stakeholders in the delivery of energy efficiency initiatives.

Recommendation 5:

Technology acquisition and technology transfer in energy efficiency should be improved through industrial training and practical demonstration programs.

Technology acquisition from abroad in energy efficiency must be improved. Concurrently, technology transfer from federal government and university labs into the industrial workplace should be enhanced, especially through the formation of working relationships at the project identification stage. CANMET has developed effective systems for doing this. Natural Resources Canada should work with industry and the community colleges to continue to develop a series of industrial training and practical demonstration programs in energy efficiency. The Committee is aware of a series of industrial training initiatives such as the Canadian Energy Management and Environmental Training (CEMET) program which has an expanding curriculum to increase the skill base in energy efficiency and emerging energy technologies. In addition to the broad-based support of industrial consortia, the Committee envisages these initiatives as having the participation and support of labour, the utilities, provincial governments, universities and technical colleges at local levels.

C. RESEARCH AND DEVELOPMENT

Current Situation

WE NEED IMPROVED LINKAGES

Many industry representatives consulted for this report expressed concern that much government R & D in energy efficiency tends to be done without sufficient consultation with, and involvement of, industry. By the same token, government representatives expressed concern that industry is not sufficiently involved in energy efficiency R & D. While there are some federal programs which have successfully developed linkages with industry, the Committee sees a general need for improved linkages between federal research centres and the industrial users who employ the results of energy efficiency research.

Industry and government allocate funds to energy R & D very differently. Industry (including electric utilities) invests heavily in the development of fossil fuels, supporting technologies (including transportation of energy commodities, electricity transmission and distribution, and other), and energy conservation. In 1991, these categories represented 33%, 27% and 23% respectively of total industry energy R & D expenditures. In 1983, industry energy R & D in fossil fuels accounted for 53% of total industry energy R & D expenditures (refer to Table 9 in Appendix E). Since 1983, federal and provincial governments have primarily favoured nuclear energy and fossil fuel development. Nuclear energy and fossil fuel development represented 46% and 32% respectively of federal and provincial government expenditures on energy R & D in 1992 (refer to Table 10 in Appendix E). The government commitment to investment in nuclear energy R & D is largely in support of CANDU technology and enhancing its marketability and export potential.

R & D SHOULD BUILD ON NATURAL ADVANTAGES/ COMPENSATE FOR DISADVANTAGES

According to Mr. Horst Roth, Alcan Director of Energy Resources: "Canadian research should be done in those areas where we have a natural advantage that others do not have. We need good research to allow us to take good advantage of something no one else has. For example, we should do research into how to get oil from the tar sands as cheaply as it can be pumped from the ground." To improve our long-term competitiveness, we also need to apply R & D to those areas where Canada has a natural disadvantage, but cannot at present afford the development expense due to our climate, geography, etc. For example, R & D to enable industrial processes to use Canadian water supplies at a natural 5 degrees Centigrade instead of having to heat to 15 degrees Centigrade (which is a year-round, cost-free temperature in the US and Europe) could dramatically improve our competitiveness.⁶⁹

While Canadian firms need to produce innovative products and develop new processes for an increasingly dynamic international market, economic conditions have led to constraints on government R & D. The federal and

provincial governments have cut back significantly on energy R & D spending since 1984 (refer to Table 11 in Appendix E).

**LONG-TERM
PLANNING IS
ESSENTIAL**

Industrial energy users in Canada risk being placed at a strategic disadvantage over the long-term unless initiatives are taken now to identify and grow our future energy-based industries and to develop renewable energy sources.

**FOUR KEY
AGENTS IN
ENERGY R & D**

Energy R & D in Canada is carried out primarily by four key agents: industry, electric utilities, provincial governments and the federal government.

ENERGY R & D IN CANADA 1991⁷⁰

	\$ Millions	% of Total
Industrial Energy R & D	379.6	40
Electric Utility Energy R & D	228.5	24
Federal Energy R & D	291.0	31
Provincial Energy R & D	51.8	5

Total Canadian Energy R & D Expenditures in 1991: \$950.9 million

Private Sector and Electric Utility Energy R & D 1983-1991

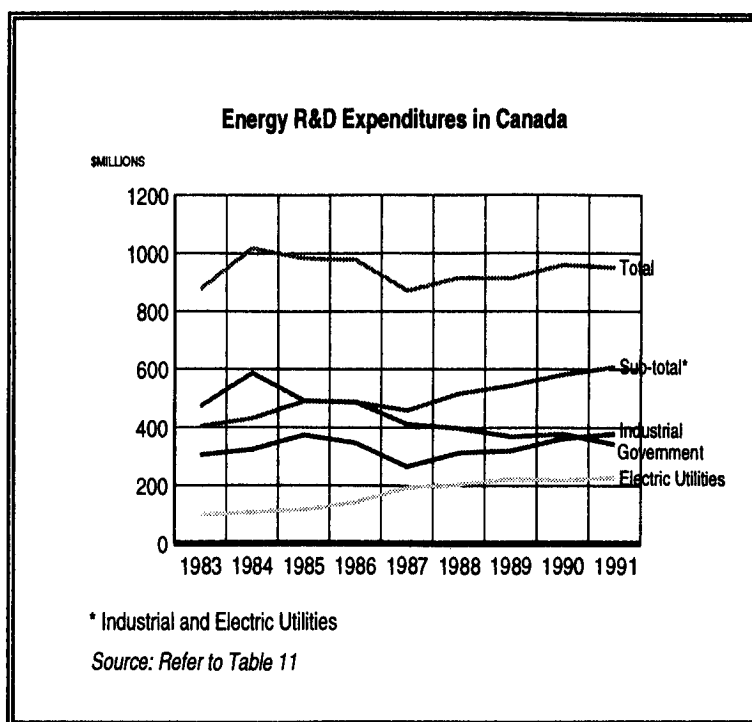
The total energy R & D investment in Canada by industry and electric utilities in 1991 was \$608.1 million, or 64% of total Canadian energy R & D expenditures. Between 1983 and 1991, annual energy R & D expenditures by the private sector and electric utilities have increased by 50%, from \$404.7 million to \$608.1 million (refer to Table 11 in Appendix E). Following the energy crisis of the 1970s, industry R & D expenditures were predominantly focused on fossil fuels (i.e. oil and gas) development. Between 1983 and 1985, industry energy R & D directed to fossil fuels represented approximately 50% of all annual industry energy R & D expenditures. By 1986, industry energy R & D expenditures began to shift to conservation and supporting technologies (e.g., transportation of energy commodities, electricity transmission and distribution, and other). In 1991, the major expenditure categories within industry energy R & D were: fossil fuels (33%), supporting technologies (27%), and conservation (23%) (refer to Table 9 in Appendix E).

A fundamental shift in the structure of private sector and electric utility energy R & D has recently taken place. Since 1983, aggregate energy R & D expenditures by electric utilities have more than doubled. In 1983, electric utilities accounted for only 24% of the combined total of private sector and utility energy R & D. Canadian industry, in turn, accounted for the other 76% of the R & D. By 1991, however, industry's share had dropped to 62% while that of electric utilities rose to 38%.⁷¹ Throughout the 1983-1990 period,

Canadian electric utilities became more active in improving energy efficiency for industrial processes. Most of this R & D activity was designed to maintain electricity's market share and focus on improved industrial processes.⁷²

Federal and Provincial Government Energy R & D Expenditure Trends:
1983-1991

Federal and provincial government energy R & D investment peaked in 1984 at approximately \$586.9 million (refer to Table 11 in Appendix E). Since then, government R & D has fallen to a 1991 level of roughly \$342.8 million. This 42% decline is due mainly to deficit reduction measures introduced by the federal government starting in 1984.



Since 1986, energy efficiency has received only a minority share of annual federal and provincial energy R & D expenditures (ranging from approximately 7 to 10%). Investment in renewable energy technologies has declined from \$61.7 million in 1984 (10.5% of total government expenditures) to approximately \$12.3 million in 1990 (3.4% of total government expenditures) (refer to Table 10 in Appendix E).

Opportunity

OPPORTUNITY TO REALIZE A VISION

The federal government which was elected to office in October 1993 has stated some very strong positions via the Red Book on sustainable development and energy efficiency, proposing to follow a vision which:

“incorporates the qualities of thrift, collaboration, and a special physical and spiritual tie to the land that are important to the Canadian identity. It is a vision of a society that protects the long-term health and diversity of all species on the planet, promotes energy efficiency and clean technologies as the basis of a competitive industry, and wisely manages and conserves its renewable resources...”

Tomorrow’s winning industries will be those that achieve these integrated economic and environmental efficiencies first...

Increased energy efficiency is widely recognized to have the largest potential for short-term contributions to sustainable development. As part of its sustainable energy strategy, [this] government will use the means at its disposal to support a shift towards energy efficiency as a first step, and a transition towards a more sustainable mix of energy sources in the longer term.” [emphasis added]⁷³

R & D SHOULD MEET CANADIAN INDUSTRIAL PRIORITIES

It is an opportune time for industry and government to work more closely together as partners in R & D and to ensure that R & D meets Canadian industrial priorities. Industry and government should seize this opportunity to increase further industrial involvement and financial participation in government R & D projects, to identify and grow Canada’s energy-based industries of the future and to decrease industrial reliance on non-renewable energy sources.

“Large expenditures for energy research and development, including efforts to increase efficiency and conservation in both supply and end-use, and prompt adjustments to price changes will have to be made to keep North America in pace with the rest of the world.”⁷⁴

BUILD ON EXISTING, SUCCESSFUL PROGRAMS

Wherever possible, we should build on existing, successful programs such as those of CANMET. CANMET is the main research and technology development arm of Natural Resources Canada. It serves the natural resource industries across Canada through its research facilities, expertise, funding programs and an extensive R & D network around the world.⁷⁵

With the help of CANMET, some Canadian firms have developed new industrial technologies and products which have positioned them competitively in the global marketplace. CANMET's partners such as Sunwell Engineering, Sceptre Resources, Ontario Hydro, Iron Ore Company of Canada, and Brunswick Mining and Smelting have developed products ranging from solarwalls to advanced cooling systems, gas furnace efficiency units, energy efficiency testing programs, water-based automotive paints which reduce air pollution and save energy, and horizontal well technology which substantially increases the amount of recoverable oil from reservoirs. Buyers for these products have included Ford Motors, General Motors, Takenaka Corp., and Diakin Industries.

Another particularly promising area, one where the government might inject considerable enthusiasm, is the recently formed Minister's Advisory Council On Industrial Energy Efficiency (MACIEE), a cooperative council designed to bring senior leaders of industry together with the Minister of Natural Resources Canada. This consultative process is designed to:

- facilitate the trading of ideas on the efficient use of energy;
- give industry an opportunity to tell the government what its needs are so that government can better orient its policies and activities to meet these needs;
- engage industry in the challenge of energy efficiency and greenhouse gas reduction;
- coordinate government/industry activity and arrange to cost share where appropriate.

Recommendation 6:

The R & D efforts of government in energy efficiency need to be better understood and linked.

Within the context of a horizontal review by the government of its S & T priorities, Natural Resources Canada, with the support of Statistics Canada, the National Research Council, Environment Canada and Industry Canada, should perform every two to three years an assessment of federal government R & D activities in energy efficiency, a subset of the \$6 billion spent annually by the federal government on Science and Technology* -- how much is applicable to energy efficiency, where the funds are located, who in industry is linked to these research efforts, and how S & T in energy efficiency is supporting a market-driven society. This assessment would build on the science and technology priorities analysis undertaken by NABST in its recent report "Spending Smarter".

* *Selected Science and Technology Statistics* (Ottawa: Industry, Science and Technology Canada, Science and Technology Sector, 1993).

Recommendation 7:

R & D in energy efficiency should be aligned with industrial needs, technological strategies should be developed jointly between the private and public sectors, and co-sponsorship of projects should be required.

The Committee recommends that Natural Resources Canada, working with the Minister's Advisory Council on Industrial Energy Efficiency (MACIEE) and with the support of the National Research Council, Human Resources Development, Industry Canada and senior representatives from private industry, create a task force to study methods for bringing the private sector and government together in energy efficiency R & D activities in this area. The mandate of this task force would be to ensure that government laboratory research in energy efficiency responds to the needs of identified and articulate clients, particularly those within industry. R & D projects should be strategically planned with industry on a sector by sector basis, have direct or in-kind industry financial support and be designed to enhance the transfer of technology. With the exception of R & D in support of the public good or specific government missions, government research projects which do not meet these requirements should be terminated. In addition, the work of the group should include: linking government research directly to the identification of international best practices in energy efficiency and environmental performance, exploring opportunities for joint government and private sector sponsorship, creating working industrial boards to guide government research in specific areas such as alternative fuels, and ensuring government research responsiveness to the guidance given. Increased emphasis should be placed on the joint private-public sector development of research programs which would involve government laboratories, industrial technology centres, universities and colleges in order to build the critical mass of energy efficiency research to make a significant difference to Canadian industry. CANMET's "Industry Targeted Program" is a good example of a federal program which endeavors to meet the needs of industry.

Recommendation 8:

Future industries based on non-renewable sources of energy and specific opportunities in renewable energy technologies should be identified.

A working group of senior representatives from the private sector, government and academe, with the support of Industry Canada, Natural Resources Canada and Environment Canada should attempt to identify industries of the future which can be based on Canada's non-renewable sources of energy. The objective of this group would be to identify specific industrial opportunities (e.g. for new industrial materials) which could capitalize on the availability of energy supplies in Canada. The working group would aim at finding new ways to take better advantage of our national energy assets -- not to replace, but rather to build on existing energy industries. In addition, this group might work with Natural Resources Canada to identify specific industrial opportunities in renewable energy technologies in order to ensure the long-term availability of energy to Canadian industry.

D. FEDERAL GOVERNMENT EXAMPLE

Current Situation

PROGRAM FACILITATES ENERGY MANAGEMENT PROJECTS

The Federal Buildings Initiative (FBI) was developed by the Energy Sector of Natural Resources Canada in tandem with Treasury Board to assist federal departments in improving the energy efficiency of their buildings by providing products and services to help them undertake energy management projects. The initiative provides federal departments with access to private sector capital, through a financing mechanism whereby private lenders provide all up-front capital and are repaid from guaranteed energy savings. The program also facilitates access to private sector expertise in energy efficiency.

JUST 1% OF FEDERALLY - OWNED BUILDINGS ARE INVOLVED

The FBI started its pilot phase in FY 1993-1994. To date, all 14 custodial departments, defined as those departments that are responsible for their own buildings, have contracts for pilot projects in place or at the Request For Proposal stage. Some 500 buildings, or 1% of federally owned buildings, are currently involved.

Opportunity

OPPORTUNITY TO SET AN EXAMPLE

By facilitating the adoption of economic, readily available energy efficiency techniques and practices, the FBI provides federal departments with an opportunity to reduce operating costs, stimulate the economy and protect the environment from harmful emissions associated with the generation and consumption of energy. The FBI is one example of the type of energy efficiency program that the federal government could extend to its other energy-using activities such as its transportation fleet, office equipment purchases, etc. The Committee is aware of other similar initiatives such as the Federal Industrial Boiler Program. If the FBI were fully and effectively implemented, it would be an important step in positioning the federal government as a leader in energy management and environmental protection in Canada.

Recommendation 9:

The federal government should set an example by ensuring that it increases the energy efficiency of its own buildings.

The Prime Minister might consider requiring that all federal Ministers with custodial responsibilities develop plans and timetables to improve the energy efficiency of their facilities by the year 2000, and that they report annually to the Minister responsible for Natural Resources Canada so that she can include the FBI in her annual report to Parliament. Furthermore, the Prime Minister might consider requiring the Minister responsible for Natural Resources Canada to develop and implement a plan whereby the Government of Canada challenges all of the provinces, territories and municipalities to replicate the Federal Buildings Initiative and match the federal effort.

E. TREND TO DEREGULATION, PRIVATIZATION, AND CO-GENERATION

Current Situation

OUR ENERGY ADVANTAGE HAS ERODED

In Canada, the benefit of our abundant and relatively inexpensive energy supplies, particularly large scale hydroelectric and nuclear power, has eroded.

ELECTRIC UTILITIES OVERBUILT - NOW FACED WITH LARGE DEBTS

Ontario Hydro, as a regulated utility, is one case in point. The rise in electricity charges in Ontario is traceable to the high capital costs of large, central generating plants which were commissioned in the expectation of continued higher demands. Energy and environmental concerns, and the current recession have upset these projections.⁷⁶ For example, the utility is currently faced with excess-capacity, brought on by the overbuilding of its nuclear facilities, and must pay high service costs to cover the debts on these facilities. This partially explains the fact that the industrial price of Ontario Hydro electricity has more than doubled since 1982.

We need to restore our competitive advantage based on energy. Possible policies include deregulating and/or encouraging the partial or total privatization of Canada's hydroelectric and natural gas utilities, and promoting co-generation.

“Enhancing the effectiveness of markets and dismantling the barriers that artificially restrict choices will encourage Canadians to use energy more efficiently. Promoting economic energy efficiency should be an integral and continuing part of energy policy, because to do so will achieve the greatest benefit from Canada's energy opportunities.”⁷⁷

Definitions

Deregulation: is “relaxation or removal of regulatory constraints on firms or individuals. Deregulation has become increasingly equated with promoting competition and market approaches toward pricing, output, entry and other related economic decisions”.⁷⁸

Privatization: refers to “transfer of ownership and control of government or state assets, firms and operations to private investors”.⁷⁹

Independent Power Production: refers to electrical power production by companies other than utilities. Such power can be for a firm's own use or for sale to a utility.

Co-generation: is the simultaneous production of thermal and electrical power. It is, essentially, electricity generation via combustion of fossil fuels or biomass where the waste heat is used (often in an industrial process). Co-generation is one type of independent power production.

Interconnections

All of these terms, deregulation, privatization, independent power production and co-generation, are interconnected through their contributions, both indirectly and directly, to the power grid and to Canadian industrial competitiveness. Privatization and deregulation encourage open, more competitive markets and more accurate pricing of commodities and services. Independent power production, a spin-off of open markets, encourages competition in previously monopolistic utility industries. Co-generation is an efficient, and often cost-effective and environmentally-effective, technology for generating electricity by an independent power producer.

Despite the competitive advantages these initiatives offer, it should be noted that privatization must often be accompanied by regulations to ensure energy standards and continuity of service, to restrain monopolistic behaviour of newly privatized utilities, and to allow independent power producers to enter more easily and compete in the market.

Deregulation

Pros and Cons:

REGULATED UTILITIES ARE MORE RELIABLE THAN EFFICIENT

The purpose of utility regulation has been to control the prices and profits of privately owned utilities and the prices of crown-owned utilities that provide essential public service under conditions where only one supplier is present. The regulation of utilities, while successfully ensuring the availability of affordable, quality service, has been significantly less successful in promoting energy efficiency. Some critics point to the following inefficiencies of government utility regulation:⁸⁰

- 1) regulatory bodies have the potential of becoming the protectors of industry rather than its watchdog;
- 2) technological innovation is stifled because there is no incentive to innovate when revenues are assured;
- 3) consumers rarely get the correct price signal because the price is not set by the market. This increases the potential for inefficient allocation or use of power.

***MOST
INDUSTRIAL
EXPERTS CALLED
FOR
DEREGULATION***

Most industrial experts consulted by the Committee called for the deregulation of Canadian power companies and a move towards an open market for power generation, with perhaps a regulated power distribution network available to all suppliers and users. They argue that market dynamics would thereby lead to more efficient production and use of power.

The US Experience in Deregulation:

***THE US HAS
DEREGULATED
TO ENHANCE
COMPETITIVE-
NESS***

In the past several decades, American law makers have been extremely active in the deregulation of electrical utilities in an effort to enhance competitiveness and electrical generation capacity.

Deregulation of the electricity industry began in the late 1970s with the introduction of the Public Utility Regulatory Policy Act (PURPA).⁸¹ To encourage the development of independent sources of power, PURPA required utilities to buy excess power generated by the independent power producers and to provide them with back-up power at non-discriminatory rates. Today, the independent power industry accounts for about half of all new electrical capacity generation in the US each year.⁸²

The Canadian Experience in Deregulation:

***CANADA HAS
LIMITED
EXPERIENCE BUT
SOME INITIAL
SUCCESS***

Canada has limited experience with deregulation. However, the electrical power utilities in Alberta and British Columbia have had some initial success with partial-deregulation.

In December of last year, the Alberta electrical utility, TransAlta Resources Corp., was reorganized into two separate subsidiaries; TransAlta Utilities and TransAlta Energy Corp. TransAlta Utilities was mandated with supplying regulated electric energy to utility customers in Alberta, whereas TransAlta Energy Corp. was set up as a business designed to market co-generation outside of the province. TransAlta Energy Corp. sells excess energy to consumers outside of Alberta at unregulated prices, for profit.⁸³

British Columbia Hydro has also adopted a policy similar to that of Alberta with the partial-deregulation of its electricity market. Through the "Power Exchange Operation" ("Power Ex"), BC Hydro has set up a subsidiary corporation designed to sell excess power to consumers outside the province at a profit.⁸⁴ The CEO of BC Hydro suggests that the province's electrical utility is well on its way to becoming "an efficient market maker in a totally deregulated, open-access environment".⁸⁵

Partial or Total Privatization

PROVINCIAL BARRIERS SHOULD BE REMOVED

It has been suggested that a more market-oriented supply system is required in the Canadian electricity industry. At the very least, provincial barriers should be removed to allow cross-marketing and load-sharing on a competitive basis.⁸⁶

INDUSTRIAL EXPERTS SUGGESTED THAT ELECTRICITY PRODUCTION BE PRIVATIZED

Industrial experts have suggested to the Committee that electricity production should be privatized, with provincial utilities providing only transmission and distribution systems to all producers and consumers. Many other countries, including Great Britain, have privatized electrical utilities since 1970.⁸⁷

The British Experience in Privatization:

BRITAIN HAS POLICY OF PRIVATIZATION

Over the past 10 years, the British government has adhered to a policy of privatization. Since the early 1980s, all energy producing utilities (except nuclear facilities) have undergone privatization, in an effort to make them more cost efficient.⁸⁸ In 1986, British Gas was sold as a single corporation. This move transferred massive monopoly power to the private sector.⁸⁹ Then in 1990, the British government privatized the regional electricity distribution companies in England, Wales, Scotland and Ireland. The non-nuclear generating facilities in these regions were sold the following year. Extensive regulation has been used to ensure that consumers do not bear the burden of privatization through unreasonable rate increases.

The environmental, economic and industrial benefits have been significant. Polluting coal plants have been replaced with far cleaner, high efficiency gas technologies. The result of electrical utility privatization has been most often a lower cost and rate to power consumers. And according to the UK Energy Ministry, over 75% of industrial customers achieved savings of 10% or more in the first year of privatization, and nearly one-third saved 33% or more.⁹⁰

The Canadian Experience in Privatization:

SOME CANADIAN EXPERIENCE WITH PRIVATIZATION

To date, there has been limited Canadian experience with the privatization of provincial electric utilities. However, considerable public interest has developed from the privatization experience of Great Britain's utilities, as well as other foreign competitors.

Nova Scotia Power (NSP) was privatized in a public offering in August 1992. Prior to privatization, with a debt of \$2.4 billion, NSP's average power rate of 7.66 cents per kWh was the second highest among Canadian provinces.⁹¹

**ONE WAY TO
REDUCE DEBT
BURDENS**

Through the proceeds of a public share offering, NSP and the province of Nova Scotia netted in excess of \$850 million. NSP's \$650 million share was applied directly toward its \$2.4 billion debt. With interest expense prior to privatization running at approximately 2.19 cents per kWh, this major relief to the debt load has greatly reduced NSP's interest expense. (New additional debt incurred on construction of the Point Aconi power generating station has marginalized the debt and interest reduction.)⁹²

Now that NSP is privately owned, shareholders are expected to demand better accountability and price stability. NSP did not establish any power rate increases for 1994, and only a nominal average rate increase of 1.8% for 1993 (which included reduced industrial rates for small- and medium-sized businesses of 10% and 8% respectively).⁹³

Similarly, Ontario Hydro is attempting to deal with an enormous debt load (\$35 billion in 1992).⁹⁴ In response to its financial burdens and growing public pressure to privatize, Ontario Hydro embarked in 1993 on a major corporate reorganization. This restructuring was designed to move Ontario Hydro towards a business-oriented structure and system of accountability to ensure that it becomes more competitive and responsive to customers. The new structure recognizes three distinct but closely related functions: electrical generation and distribution; energy services, including energy management; and additional value-added activities, including international services and environmental technology.⁹⁵

At a June 1992 hearing of the Ontario Energy Board (OEB) for Ontario Hydro's rate increase application -- projected to exceed 33 % over two years -- Larry Ruff, partner of Putman Hayes & Bartlett Inc., commented that "Ontario Hydro appears to be dying financially and can only be cured by opening electric power generation to competition and exposing the power utility to market forces".⁹⁶

In September 1993, the brokerage firm of RBC Dominion Securities released a report which demonstrated the importance of Hydro-Québec as an asset to the Province of Québec, and more specifically as a significant factor in the overall credit quality of the province. The examination highlighted several interesting elements.

It is worth noting that as of 1992, Hydro-Québec was faced with a huge debt of \$32.5 billion. This represented approximately 30% of the provincial public debt. Hydro-Québec's interest expense (1.71 cents per kWh in 1992) represented its single largest cost component, totalling \$2.4 billion or 35.1% of total revenue.⁹⁷ RBC's report indicates that a public share offering of 35% of Hydro-Québec's ownership would generate \$6.6 billion in equity (at \$10 per

share). With these proceeds, HQ's long term debt could be reduced by 20.3%, or .35 cents per kWh.

Near the end of 1992, the government of Newfoundland released a strategic plan calling for the merger and privatization of its electrical generating and distribution Crown Corporations. Premier Clyde Wells reaffirmed his government's commitment to privatization of the province's power facilities in the Speech from the Throne, and there is at present a bill in the legislature that is under debate.

In the Yukon Territory, electricity is provided by the Yukon Electrical Company Ltd. (YECL) which has been privately held since its establishment in 1901, and by the Yukon Energy Corporation (YEC), a territorial Crown corporation. The bulk of the electricity is generated by YEC, with YECL responsible for its distribution. Electricity rates are set by the Yukon Utilities Board, a quasi-judicial regulatory agency. The government of Yukon is exploring privatization opportunities for YEC with Yukon First Nations on a preliminary basis.⁹⁸

And, in February 1994, Prince Edward Island (PEI) announced that it would attempt to purchase Maritime Electric Co. and sell it to New Brunswick Power in order to achieve parity with New Brunswick electrical rates. However, after discussions with Fortis Inc. and Maritime Electric Co., the government of PEI announced on March 17 that it was abandoning its approach in favour of a new arrangement whereby it would lower its rates for electrical power to within 10% of New Brunswick rates after 1997. On March 25, 1994, Fortis Inc. announced its intention to make a takeover offer to the other shareholders of Maritime Electric Co.⁹⁹

Independent Power Production and Co-generation

CO-GENERATION CAN IMPROVE ENERGY EFFICIENCY

The co-generation of electricity and heat can be an efficient, environmentally friendly means by which some manufacturing firms can enhance their competitiveness through independent power production. The principal environmental benefit of co-generation over conventional electricity generation is the efficiency of input energy use. In essence, co-generation conserves scarce energy resources by producing thermal and electric energy together, using less fossil fuel than conventional technologies.

"A conventional utility power generation technology converts some 35 percent of input energy to electric power. By utilizing both the thermal and electric energy in process, a co-generation facility can yield overall efficiency in the range of 80 to 85 percent of input energy."¹⁰⁰

Natural gas-fired co-generation systems, which represent the majority of existing and planned co-generation capacity in Canada and the US,¹⁰¹ are an attractive option from both an environmental and an energy efficiency standpoint.¹⁰²

“By all measures -- air emissions, solid wastes, water pollution, and water consumption -- natural gas is by far the most environmentally desirable fossil fuel. Compared to other energy alternatives, natural gas [co-generation] systems are also highly capital and resource efficient, requiring lower capital investment to produce, deliver and utilize a unit of energy.”¹⁰³

In addition to environmental benefits, co-generation provides potentially greater flexibility for utilities, diversified generation sources, and free-market competition in the supply of electricity. The possibility exists for very profitable additional revenues for industrial energy users who are able to produce and sell electricity (produced by the combustion of their waste products) to electric utilities at the power companies' avoided or incremental cost.¹⁰⁴

The US Experience in Co-generation:

**THE US HAS
ENCOURAGED CO-
GENERATION TO
INCREASE
ENERGY
EFFICIENCY**

Interest in co-generation in the US dates back to the 1978 enactment of the Public Utility Regulatory Policy Act (PURPA).¹⁰⁵ In an attempt to promote the more efficient use of energy in the US and to reduce dependence on imported oil, the act allowed for independent power producers to supply electric power to the local utility at the incremental cost which the utility would have incurred by obtaining the power from another source.¹⁰⁶ In a number of states, this has led to an over-supply situation. More recently, bidding processes have been allowed in which prices are determined through competitive bids rather than the utilities' incremental costs. Under PURPA, the Federal Energy Regulatory Commission was given a mandate to regulate various aspects of independent power production such as ownership, transaction rates and facility qualifications.¹⁰⁷

According to the Co-generation and Independent Power Coalition of America, there are “currently over 2,300 co-generation plants operating in various American jurisdictions.” By 1990, co-generation capacity in the US reached 30,500 MWatts, 4 % of the total installed US capacity.¹⁰⁸

The Canadian Experience in Co-generation:

CANADIAN INDUSTRY FAVOURS CO- GENERATION

Co-generation has been recommended by Canadian industry as a way to reduce energy costs through market pressure and to encourage higher energy efficiency in firms who would be motivated to balance their energy loads and to find downstream uses for the steam either within their own plants or in neighbouring facilities.¹⁰⁹

A recent study conducted by the Special Projects Branch of Industry Canada determined that the Canadian pulp and paper industry could substantially benefit from the adoption of American-style independent power production. American pulp and paper operations enjoy two advantages not generally available to their Canadian counterparts: the opportunity to produce and sell excess electricity to utilities, and extensive subsidies resulting from the repurchase of electricity at lower rates. There are no offsetting Canadian policies. The study found that 28 of the 29 pulp and paper mills examined would benefit from such an arrangement, and profits could range from \$14 to \$164 per ton of paper (or 1.3 to 28.6 % of sales). The investigation concluded that, until there is a significant change in the acceptance of non-utility generation in Canada, the Canadian pulp and paper industry will continue to be at a competitive disadvantage.¹¹⁰

When asked by the Energy Efficiency Committee what the federal government can do to boost Canadian industrial competitiveness, Mr. Bob Eamer, Domtar Vice-President of Research and Development, echoed the comments of many other executives when he said "What can governments do? They can provide a focus on energy efficiency. They can stop blocking co-generation. They can allow more burning of biomass for co-generation systems. Perhaps they can break up the power utilities' monopolies." While the Committee encourages the provinces and territories to study the benefits of co-generation, care must be taken to ensure that co-generation does not become a form of subsidy to industry.

Recommendation 10:

Industry and governments should undertake serious study of deregulation and partial or total privatization of our energy producers.

A number of experts consulted by the Committee expressed concern about Canadian industry losing its international competitive advantage due to rising domestic energy prices, particularly for electricity. While pricing was not the main focus of the Committee's terms of reference, the intense industry concern about the issue and the analysis undertaken elsewhere of deregulation, privatization, and co-generation suggest that these are important options which should be studied in more detail. The Committee has therefore addressed these issues in the context of its broader mandate. In order to compete internationally, our industrial users should be provided with a choice of energy sources which build on Canada's natural energy advantage while maximizing energy efficiency and conservation. Given the international trends toward deregulation, privatization and independent power production, and the possibility of associated economic and environmental benefits, the Energy Committee recommends that Canadian provinces who have not already done so seriously study their options for deregulation, partial or total privatization and independent power production where economically viable. Such studies should be broad-based, covering not only the economic aspects of deregulation, but also the environmental, source of supply, effect on industrial infrastructure, transportation and distribution infrastructure, and other aspects.

Promotion of Co-generation

Recommendation 11:

Co-generation by energy-intensive firms should be encouraged.

Provincial governments and provincial utilities should consider promoting co-generation projects where they have not already done so. Co-generation can enable industrial users to lower their energy costs by producing their own power, and then selling the excess power to a utility. It utilizes the energy in fuel more efficiently. In addition, co-generation may provide energy at a cost which can be lower than that of adding new centralized generating capacity, depending on the relative prices of fuels. Provinces might wish to place particular emphasis on the opportunities for co-generation in the pulp and paper industry.

Interprovincial Electricity Trade and Transmission Access

PROVINCIAL UTILITIES ARE HOLDING PRELIMINARY DISCUSSIONS

While all adjacent provincial utility grids are interconnected, some provinces might argue that they should be able to move power (on a commercial contract basis) through the transmission facilities of an intervening provincial utility to, or from, a third province. This arrangement would allow a utility to purchase or sell electricity from, or to, more than just the adjacent provincial utility. Provincial utilities in some regions of Canada are holding preliminary discussions in this area.

ACTIVITY AT THE FEDERAL LEVEL

At the federal level, the National Energy Board has submitted a report to the Minister of Natural Resources Canada on measures that the federal government could consider to encourage interprovincial electricity trade and access to transmission facilities on a commercial basis for the purpose of "wheeling" electrical energy. Following a presentation to the Minister, this report is expected to be released to interested parties for their review and comment. In addition, Industry Canada is working on an agreement with the provinces to reduce interprovincial barriers to energy trade. In this process, some consideration is being given to the interprovincial transmission of electricity.

Recommendation 12:

Provincial electricity grids should be better interconnected and provincial barriers to energy trade substantially reduced.

Progressing from the extensive work done to date, the federal and provincial governments should begin a more formal process of dialogue aimed at maintaining and possibly improving our international competitive advantage based on energy. In order to benefit fully from exports and lower energy costs, provinces should continue to improve their power-exchange programs and the interconnection of provincial electricity grids, with a view to substantially reducing all provincial barriers to energy trade. The federal government might best contribute to an efficient electricity supply system by reviewing its regulation of electricity exports and international power lines and by considering access issues where the provinces, even on a regional basis, think this would be helpful.

F. FINANCIAL INITIATIVES AND AWARDS

Current Situation

FINANCIAL BARRIERS TO ENERGY EFFICIENCY

Globally, technologies exist to improve energy efficiency in most industries. While there is the need to develop additional energy efficient technologies over the long-term through investment in R & D, the key to boosting Canadian industrial competitiveness in the near-term is the adaptation and application of existing technologies. Barriers to the adaptation and application of existing best-practice energy efficient technologies include a lack of awareness of the opportunities, insufficient access to capital, and unrealistic expectations of rates of return for energy efficiency projects. The only federal incentive for the application of energy efficient technology is the Class 34 Accelerated Capital Cost Allowance (ACCA), revised and renamed Class 43 in the February 1994 federal budget. This ACCA applies to certain efficient or renewable energy equipment.

In Canada, we have left it up to the electrical utilities to encourage energy efficiency and conservation. They are motivated to sell energy from existing capacity rather than undertake the expense of establishing higher production capabilities.¹¹¹

"Since the mid-1970s, many US providers of electricity or natural gas have realized that a saved watt (which we may call a "negawatt") is just like a generated watt, only cheaper, cleaner, safer, and faster to produce. Such utilities have therefore helped their customers to save electricity (or gas) through such specific programs as information, technical design support, concessionary loans, leases, gifts, and rebates for buying efficient equipment."¹¹²

CAPITAL INVESTED IN LESS THAN BEST- PRACTICE EQUIPMENT AND PROCESSES

Beyond this, past government policies have encouraged the extension of the life of older facilities. The consequence of this is that a great deal of capital is invested in less than best-practice equipment and processes. Although in principle "market driven", governments at federal and provincial levels have provided subsidies and tax concessions to proponents of mega-projects and to firms active in oil and gas development and nuclear operations. The federal government's spending for energy supply programs is calculated to have exceeded that devoted to energy efficiency and renewable resources of energy by a factor of 7.¹¹³ Measures to rebalance existing funding and support mechanisms would go far to enhance the competitive edge required by firms active in energy efficiency. However, this does not necessitate a radical change in the allotment of capital with respect to energy. The federal expenditures on 'supply programs' versus 'energy efficiency and renewables' tend to favour

supply programs because of large commitments to projects such as Hibernia, Candu, and the Tarsands. As a result, relatively marginal adjustments could be made to federal 'energy supply' programs with significant impact on efficiency and renewable energy programs. For instance, within the government energy R & D portfolio, a shift of 10% in funding from fossil fuels and nuclear R & D expenditures to supporting technologies (electricity and others), renewables or energy efficiency programs would increase their individual budgets by 84%, 91%, or 101% respectively (refer to 1992 figures in Table 10, in Appendix E).

***NEED TO
INTEGRATE
LONG-TERM
ECONOMIC AND
ENVIRONMENTAL
COSTS***

While much technology for improved energy efficiency exists, the capital outlay required to develop and implement such technology seldom provides a sufficiently rapid return on the investment. Industries such as steel and pulp and paper require massive infusions of capital to upgrade their technology to world class levels and enhance their ability to compete for world markets. To effectively compete in world markets, our industries must learn to integrate long-term economic costs with long-term environmental costs. Mr. Horst Roth, Alcan Director of Energy Resources maintains that "energy competitiveness will not come from more R & D only. What is required is capital replacement. Fiscal incentives are needed; for example, tax incentives for putting in co-generation facilities and for replacing old boilers. We need to find the lowest overall costs, not just the most energy efficient system".

Opportunity

***EXPLORE WAYS
TO INCREASE
ACCESS TO
CAPITAL***

Selective financial initiatives can be used by governments to encourage energy efficiency in Canada. For example, governments could work with the banks to explore ways to increase access to capital for industrial projects in energy efficiency.

***FOSTER
COMPETITIVE
SPIRIT IN
ENERGY
EFFICIENCY***

More subtle motivational techniques might also be employed. Simply recognizing industrial accomplishments in energy efficiency through a national award program could serve to foster a competitive spirit in energy efficiency among industrial users of energy.

The only national energy efficiency (EE) award program on record is the Canadian Electrical Association's EE Award which was presented to regional and national recipients annually for more than a decade through to 1992. The main objective of the program was to recognize the successful application of energy efficient practices and technologies in Canadian industry. The 1992 award winners were Brunswick Mining and Smelting Corporation, 3M Canada, SED Systems Inc., PPG Canada Inc., Albright & Wilson Americas, and MBB Mechanical Services Ltd.¹¹⁴

**OPPORTUNITY TO
CREATE A
NATIONAL
AWARD PROGRAM**

The Canadian Electrical Association (CEA) discontinued its award program in 1993 largely due to budgetary constraints and the fact that public utilities had begun to offer incentives of their own to industrial and residential customers as part of their "Demand Side Management" programs (DSM). These programs were designed by the utilities to maximize the use of their existing generating capacity and transmission facilities. Due in part to the recent downturn in the economy and in part to overbuilding, the electrical utilities are faced with excess capacity and major financial challenges. To save costs, many utilities have dramatically cut their DMS programs, creating a vacuum in energy efficiency award programs. To complement the remaining incentives offered by the electrical utilities, the federal government might create a national energy efficiency award program and broaden its scope to include all energy sources.

Recommendation 13:

Financial initiatives should be used to encourage energy efficiency.

The Department of Finance should undertake a study which would examine innovative ways to improve the access to capital for industry to develop energy efficient technologies. Using international best-practices of energy efficiency as a guide, the Department of Finance, with the input of Revenue Canada, Environment Canada, Natural Resources Canada and private industry, should identify a range of potential financial initiatives to encourage energy efficiency in Canada. This selection of possible initiatives could be discussed in detail with industry to determine what limited action (limited due to resource constraints) would be most effective in encouraging energy efficiency.

Recommendation 14:

A national award for energy efficiency should be established.

Industry Canada, with the support of Natural Resources Canada, should create a prestigious national award for energy efficiency in Canadian industry. The award, which could be developed under the umbrella of the Awards for Business Excellence, should be accompanied by a publication which highlights exemplary practices in Canada of energy efficiency, and provides a list of contact persons in industry.

VI. CONCLUSIONS

CHALLENGE TO INDUSTRY

The Committee challenges Canadian industry to use energy more efficiently and intelligently to improve its competitive advantage in the global marketplace. While the Committee's recommendations are applicable to all energy users and include the utilities, the focus of the recommendations is on large, energy intensive, industrial energy users such as the pulp and paper and aluminum industries. By using existing technologies and investing in the development and implementation of new energy efficient technologies, industry can advance its competitive position and, at the same time, make a contribution to the protection of the environment.

SET OUR ENERGY EFFICIENCY OBJECTIVES

As a first step, the Committee recommends that energy efficiency objectives be set according to the most innovative international approaches and best practices, on an industry by industry basis. It is up to private industry to take the lead in setting these objectives, working in concert with the federal government, provinces, labour, utilities, universities and colleges.

APPLY EXISTING, BEST-PRACTICE TECHNOLOGIES

Once these energy efficiency objectives are set, the same coalition should work to improve the awareness, training and practical application programs for existing, best-practice energy efficient technologies.

DEVELOP AND DEPLOY NEW TECHNOLOGIES

While the application of these existing technologies is important for the short term, we should develop and deploy new energy efficient technologies to improve our competitiveness over the long term. To this end, the Committee recommends a renewed effort to strengthen energy efficiency R & D linkages between the federal government, universities, colleges and utility research centres and the industrial users of energy research.

STUDY OUR OPTIONS

Industrial experts expressed intense concern to the Committee about Canadian industry losing its international competitive advantage in part due to rising domestic energy prices, particularly for electricity. Given the international trends toward deregulation, privatization and independent power production, and the possibility of associated economic and environmental benefits, the Committee recommends that Canadian provinces who have not already done so seriously study their options for deregulation, partial or total privatization and independent power production, including co-generation, where economically viable. Since domestic utility regulation is essentially an area of provincial jurisdiction, the Committee believes that the federal government might best contribute to an efficient electricity supply system by reviewing its regulation of electricity exports and international power lines and by considering interprovincial transmission access issues where the provinces think such support would be helpful.

***SET AN EXAMPLE
AND RECOGNIZE
ACCOMPLISH-
MENTS***

The federal government can further encourage energy efficiency by setting an example of energy efficiency in the majority of its own buildings and by using selective financial incentives and award programs to promote greater energy efficiency in industry.

By raising our sights to international best-practices in energy efficiency and working cooperatively between the private and public sectors, we can improve our industrial energy efficiency and contribute to the long-term competitiveness of Canada.

APPENDIX A: SUMMARY OF RECOMMENDATIONS

A. BENCHMARKING TO BEST PRACTICES

1. *Canada should benchmark its level of energy efficiency and environmental practice to industries in other countries.*

A concerted effort should be made to compare Canada's level of energy efficiency to the best of our international competition, then work to develop a competitive international edge in energy efficiency. A consortium of private sector executives, with the support of Natural Resources Canada, Environment Canada, the Ministry of Foreign Affairs and International Trade, in tandem with labour representatives, energy specialists from utilities, universities, colleges and consulting engineers, should identify best practices in energy efficiency world-wide and work to build industrial awareness of these standards, on an industry-by-industry basis. While benchmarking is important to individual industries, it is equally important that such a consortium look at ways to improve the net overall efficiency of Canada's energy use. The International Committee on Science and Technology also recognizes the importance of benchmarking and further recommends that any government support for companies to benchmark themselves should be offered preferentially to business sectors with proven performance and strong market potential.

2. *Canadian government and industry should evaluate international energy efficiency trends and initiatives on a regular basis.*

Once we have ranked ourselves against our best international competitors, the consortium described above should evaluate international trends and initiatives in energy efficiency every two or three years, on an industry-by-industry basis as well as a net overall basis. In order for international comparisons or benchmarking to be successful, a continuous effort will be required by this consortium to visit and consult with leading edge performers in energy efficiency.

3. *The Committee recommends further study of international best practices for energy efficiency in the transportation sector.*

While the Committee has not focused on the transportation sector, a number of railway industry experts consulted by the Committee have noted the need for an effective system of measurement in energy efficiency. Because the international competitiveness of Canadian industry depends so heavily on transportation costs and efficiency, the Committee recommends that Transport Canada, with the support of the National Transportation Agency, Natural Resources Canada, Industry Canada, the National Research Council, and representatives from private industry and labour, establish a working group to study further international best practices and an effective system of measurement for energy efficiency not just in rail, but in land, air and sea transportation. Once a measurement system has been established, the Canadian transportation industry will be better positioned to monitor and improve energy efficiency on a competitive basis.

B. IMPROVEMENT OF TECHNOLOGY TRANSFER

4. *Following the identification of international best-practices in energy efficiency, industrial managers and workers should deepen their understanding of these best-practices in energy efficiency through information programs and international exchanges.*

Canadian industry, especially small and medium-sized businesses in this case, requires effective information programs and international exchanges in new energy efficient technology to help it compete internationally. Following the identification of international best-practices in energy efficiency, industrial managers and workers, with the support of Natural Resources Canada and Industry Canada, should develop and operate an effective information program and a series of international exchanges, the objective of which would be to deepen the industrial understanding of best-practice technologies in energy efficiency and conservation. The Committee understands that Natural Resources Canada has created a Minister's Advisory Council on Industrial Energy Efficiency to provide advice on industrial programs such as the Canadian Industry Program for Energy Conservation (CIPEC) and the Centre for the Analysis and Dissemination of Demonstrated Energy Technologies (CADET). A priority of this council should be to ensure that more emphasis is placed on informing industry of current best-practices in energy efficiency, on requiring joint funding with industry, labour, and academic institutions, and on ensuring the involvement of all stakeholders in the delivery of energy efficiency initiatives.

5. *Technology acquisition and technology transfer in energy efficiency should be improved through industrial training and practical demonstration programs.*

Technology acquisition from abroad in energy efficiency must be improved. Concurrently, technology transfer from federal government and university labs into the industrial workplace should be enhanced, especially through the formation of working relationships at the project identification stage. CANMET has developed effective systems for doing this. Natural Resources Canada should work with industry and the community colleges to continue to develop a series of industrial training and practical demonstration programs in energy efficiency. The Committee is aware of a series of industrial training initiatives such as the Canadian Energy Management and Environmental Training (CEMET) program which has an expanding curriculum to increase the skill base in energy efficiency and emerging energy technologies. In addition to the broad-based support of industrial consortia, the Committee envisages these initiatives as having the participation and support of labour, the utilities, provincial governments, universities and technical colleges at local levels.

C. RESEARCH AND DEVELOPMENT

6. *The R & D efforts of government in energy efficiency need to be better understood and linked.*

Within the context of a horizontal review by the government of its S & T priorities, Natural Resources Canada, with the support of Statistics Canada, the National Research

Council, Environment Canada and Industry Canada, should perform every two to three years an assessment of federal government R & D activities in energy efficiency, a subset of the \$6 billion spent annually by the federal government on Science and Technology - how much is applicable to energy efficiency, where the funds are located, who in industry is linked to these research efforts, and how S & T in energy efficiency is supporting a market-driven society. This assessment would build on the science and technology priorities analysis undertaken by NABST in its recent report "Spending Smarter".

7. *R & D in energy efficiency should be aligned with industrial needs, technological strategies should be developed jointly between the private and public sectors, and co-sponsorship of projects should be required.*

The Committee recommends that Natural Resources Canada, working with the Minister's Advisory Council on Industrial Energy Efficiency (MACIEE) and with the support of the National Research Council, Human Resources Development, Industry Canada and senior representatives from private industry, create a task force to study methods for bringing the private sector and government together in energy efficiency R & D activities in this area. The mandate of this task force would be to ensure that government laboratory research in energy efficiency responds to the needs of identified and articulate clients, particularly those within industry. R & D projects should be strategically planned with industry on a sector by sector basis, have direct or in-kind industry financial support and be designed to enhance the transfer of technology. With the exception of R & D in support of the public good or specific government missions, government research projects which do not meet these requirements should be terminated. In addition, the work of the group should include: linking government research directly to the identification of international best practices in energy efficiency and environmental performance, exploring opportunities for joint government and private sector sponsorship, creating working industrial boards to guide government research in specific areas such as alternative fuels, and ensuring government research responsiveness to the guidance given. Increased emphasis should be placed on the joint private-public sector development of research programs which would involve government laboratories, industrial technology centres, universities and colleges in order to build the critical mass of energy efficiency research to make a significant difference to Canadian industry. CANMET's "Industry Targeted Program" is a good example of a federal program which endeavors to meet the needs of industry.

8. *Future industries based on non-renewable sources of energy and specific opportunities in renewable energy technologies should be identified.*

A working group of senior representatives from the private sector, government and academe, with the support of Industry Canada, Natural Resources Canada and Environment Canada should attempt to identify industries of the future which can be based on Canada's non-renewable sources of energy. The objective of this group would be to identify specific industrial opportunities (e.g. for new industrial materials) which could capitalize on the availability of energy supplies in Canada. The working group would aim at finding new ways to take better advantage of our national energy assets -- not to replace, but rather to build on existing energy industries. In addition, this group

might work with Natural Resources Canada to identify specific industrial opportunities in renewable energy technologies in order to ensure the long-term availability of energy to Canadian industry.

D. FEDERAL GOVERNMENT EXAMPLE

- 9. The federal government should set an example by ensuring that it increases the energy efficiency of its own buildings.*

The Prime Minister might consider requiring that all federal Ministers with custodial responsibilities develop plans and timetables to improve the energy efficiency of their facilities by the year 2000, and that they report annually to the Minister responsible for Natural Resources Canada so that she can include the FBI in her annual report to Parliament. Furthermore, the Prime Minister might consider requiring the Minister responsible for Natural Resources Canada to develop and implement a plan whereby the Government of Canada challenges all of the provinces, territories and municipalities to replicate the Federal Buildings Initiative and match the federal effort.

E. TREND TO DEREGULATION, AND PARTIAL OR TOTAL PRIVATIZATION

- 10. Industry and governments should undertake serious study of deregulation and partial or total privatization of its energy producers.*

A number of experts consulted by the Committee expressed concern about Canadian industry losing its international competitive advantage due to rising domestic energy prices, particularly for electricity. While pricing was not the main focus of the Committee's terms of reference, the intense industry concern about the issue and the analysis undertaken elsewhere of deregulation, privatization, and co-generation suggest that these are important options which should be studied in more detail. The Committee has therefore addressed these issues in the context of its broader mandate. In order to compete internationally, our industrial users should be provided with a choice of energy sources which build on Canada's natural energy advantage while maximizing energy efficiency and conservation. Given the international trends toward deregulation, privatization and independent power production, and the possibility of associated economic and environmental benefits, the Energy Committee recommends that Canadian provinces who have not already done so seriously study their options for deregulation, partial or total privatization and independent power production where economically viable. Such studies should be broad-based, covering not only the economic aspects of deregulation, but also the environmental, source of supply, effect on industrial infrastructure, transportation and distribution infrastructure, and other aspects.

Promotion of Co-generation

- 11. Co-generation by energy-intensive firms should be encouraged.*

Provincial governments and provincial utilities should consider promoting co-generation projects where they have not already done so. Co-generation can enable industrial users to lower their energy costs by producing their own power, and then selling the excess

power to a utility. It utilizes the energy in fuel more efficiently. In addition, co-generation may provide energy at a cost which can be lower than that of adding new centralized generating capacity, depending on the relative prices of fuels. Provinces might wish to place particular emphasis on the opportunities for co-generation in the pulp and paper industry.

Interprovincial Electricity Trade and Transmission Access

12. Provincial electricity grids should be better interconnected and provincial barriers to energy trade substantially reduced.

Progressing from the extensive work done to date, the federal and provincial governments should begin a more formal process of dialogue aimed at maintaining and possibly improving our international competitive advantage based on energy. In order to benefit fully from exports and lower energy costs, provinces should continue to improve their power-exchange programs and the interconnection of provincial electricity grids, with a view to substantially reducing all provincial barriers to energy trade. The federal government might best contribute to an efficient electricity supply system by reviewing its regulation of electricity exports and international power lines and by considering access issues where the provinces, even on a regional basis, think this would be helpful.

F. FINANCIAL INITIATIVES AND AWARD PROGRAMS

13. Financial initiatives should be used to encourage energy efficiency.

The Department of Finance should undertake a study which would examine innovative ways to improve the access to capital for industry to develop energy efficient technologies. Using international standards of energy efficiency, the Department of Finance, with the input of Revenue Canada, Environment Canada, Natural Resources Canada and private industry, should identify a range of potential financial initiatives to encourage energy efficiency in Canada. This selection of possible initiatives could be discussed in detail with industry to determine what limited action (limited due to resource constraints) would be most effective in encouraging energy efficiency.

14. A national award for energy efficiency should be established.

Industry Canada, with the support of Natural Resources Canada, should create a prestigious national award for energy efficiency in Canadian industry. The award, which could be developed under the umbrella of the Awards for Business Excellence, should be accompanied by a publication which highlights exemplary practices in Canada of energy efficiency, and provides a list of contact persons in industry.

APPENDIX B: FEDERAL GOVERNMENT INITIATIVES IN ENERGY EFFICIENCY

Natural Resources Canada (NRCan) has the federal lead in encouraging energy efficiency through its initiatives in the following areas: information programs, voluntary target setting, technology transfer, research and development, management of the government asset base, policies and advisory structures. The department is to be commended for its work to date in the area of energy efficiency. The Committee proposes additional measures which are desirable to maximize the energy efficiency of Canadian industry and would like to see its recommendations build on NRCan's existing programs, wherever possible.

NRCan is responsible for the Energy Efficiency Act which gives the department a leading role in energy efficiency in industry, consumer goods and manufacturing. The main focus has been in the area of consumer goods (household products). NRCan distributes information to encourage consumers to reduce energy consumption. NRCan also provides data and information to the operators of transportation fleets. The R-2000 program has promoted new energy standards for homes and NRCan is developing other opportunities for increasing energy efficiency in buildings.

The federal initiatives described below, while only a partial list, illustrate the range of government activity in energy efficiency in a number of departments.

Information Programs

The Energy Innovators Program offered by NRCan is an information program whose objective it is to persuade individual companies and/or local governments to identify and implement energy efficiency initiatives. The program is information- rather than technology-based.

Under the program, NRCan works with various partners to identify opportunities for energy efficiency and alternative energy by conducting analyses of specific end-use sectors and applications. Successful energy efficiency programs are publicized to increase awareness and to encourage others to seek similar energy efficiency gains.

Voluntary Target Setting

NRCan is supporting the Canadian Industry Program for Energy Conservation (CIPEC) which works through industrial committees to set voluntary standards for improving energy efficiency; report annually on sectoral progress in meeting these standards; increase the awareness of techniques within industry; encourage information exchange; and facilitate industry-government dialogue.¹¹⁵

Recently this program has been re-invigorated in an effort to encourage information-sharing within industry sectors and substantive change in industrial practices related to energy efficiency, global competitiveness and the stabilization of CO₂ emissions.¹¹⁶

While this initiative does not establish national or international benchmarks, it does set improvement targets.

Technology Transfer

CANMET has a number of programs related to energy efficiency and greenhouse gas reduction which have technology transfer components, for example its Industry Targeted Program which is described below.

In addition to CANMET, the Canadian Industry Program for Energy Conservation (CIPEC) acts as a conduit between energy efficiency technology specialists and industry.

The Centre for the Analysis and Dissemination of Demonstrated Energy Technologies (CADDET) collects and disseminates information on proven technologies from OECD countries.

In addition, the National Research Council and the Department of Foreign Affairs and International Trade jointly manage a Technology Inflow Program (TIP) for acquiring foreign technologies, but it is not specific to energy efficiency.

In sum, there are elements of technology transfer in many government programs. The real challenge for government, in support of industry, is to get the right information to the right industrial users. An information clearinghouse for the transfer and acquisition of energy efficiency technology might facilitate this process.

Research and Development

CANMET's Industry Energy Research and Development (IERD) program funds industry-led projects to develop and commercialize new products, processes and services that save energy. This program is funded by the interdepartmental Panel on Energy Research and Development (PERD). Other PERD programs address energy efficiency in specific industrial sectors.

CANMET's Industry Technology Program (ITP) seeks to develop and implement energy efficiency technology strategies for specific industrial sectors (e.g. pulp and paper, iron and steel), with the broad participation of industry and other stakeholders.

In addition, there are other federal government programs which do not target energy efficiency, but which will support energy efficiency projects (e.g. WED, ACOA and IRAP).

Management of the Government Asset Base

The government has initiated a Federal Buildings Initiative (FBI) for its own buildings. The FBI was developed by the Energy Sector of Natural Resources Canada in tandem with Treasury Board to assist federal departments in improving the energy efficiency of

their buildings by providing products and services to help them undertake energy management projects. The initiative provides federal departments with access to private sector capital, through a financing mechanism whereby private lenders provide all up-front capital and are repaid from guaranteed energy savings. The program also facilitates access to private sector expertise in energy efficiency.

The FBI started its pilot phase in FY 1993-1994. To date, all 14 custodial departments, defined as those departments that are responsible for their own buildings, have contracts for pilot projects in place or at the Request For Proposal stage. Some 500 buildings, or 1% of federally owned buildings, are currently involved.¹¹⁷

Under the Federal Industrial Boiler Program, CANMET provides technical services to other government departments to increase the efficiency and decrease the emissions from federally operated boilers (e.g. central heating plants).

Federal Policies

Although in principle "market driven", federal (and provincial) governments have provided subsidies and tax concessions to proponents of mega-projects and to firms active in oil and gas development and nuclear operations. These subsidies and concessions have often worked against energy efficiency and environmental conservation. In the Arctic, for example, the government imposed strict environmental standards, then gave cost-plus subsidies to enable firms to make money by meeting those standards.¹¹⁸ The federal government's spending for energy supply programs is calculated to have exceeded that devoted to energy conservation and renewable resources of energy by a factor of 7. Measures to rebalance existing funding and support mechanisms would go far to motivate industry to increase its energy efficiency.

Advisory Structures

The Minister's Advisory Council On Industrial Energy Efficiency (MACIEE) is a particularly well-designed cooperative council whose objective it is to bring leaders of industry together with the Minister of Natural Resources Canada. MACIEE's first meeting was held on February 7, 1994. The purposes of MACIEE's consultative process are:

- to facilitate the trading of ideas on the efficient use of energy;
- to give industry an opportunity to tell the government what its needs are so that government can better orient its policies and activities to meet these needs;
- to engage industry in the problem of energy efficiency and greenhouse gas reduction;
- to coordinate government/industry activity and arrange to cost share where appropriate.

The Minister's National Advisory Council to CANMET (MNACC) is an advisory council which assesses the relevance of CANMET's technology programs. One of MNACC's committees advises on CANMET's efficiency and alternative energy programs. The membership of MNACC is predominantly industry-based.

APPENDIX C: WORLD ENERGY CONSUMPTION

Historical Trends

“World energy consumption has grown three times since 1960. Since 1973 its rate of increase has slowed from 5% to 2% per annum, leading to a growth since that year of +40%. [Recent] growth has been much greater in developing countries than in industrial nations. In the former, total consumption has doubled since 1973 with per capita consumption increasing by +50%, while in the latter it has only increased marginally since 1973, mainly in the USSR and Eastern Europe.”¹¹⁹

International Outlook

In 1991, world total energy consumption was 351 quadrillion Btu.¹²⁰ Despite the rapid growth in energy consumption by developing countries, and the significant energy consumption by centrally planned economies, the OECD nations continue to be the largest energy consumers, with fossil fuel the predominant source of energy.

World Total Energy Consumption by Region 1991 (Quadrillion Btu)¹²¹

Market Economies

OECD

Canada	10.7
United States	84.8
Japan	18.8
Europe	63.3
United Kingdom	9.4
France	9.4
Germany	15.1
Italy	7.2
Netherlands	3.4
Other Europe	18.9
Other OECD	<u>4.9</u>
Total	182.5

OPEC	17.3
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Other Developing Countries	<u>47.1</u>
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Total Market Economies	246.8
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Centrally Planned Economies

China	29.2
Former Soviet Union	57.2
Other	<u>17.8</u>
Total	<u>104.1</u>

World Total 351.0

Energy Consumption in the OECD Countries

In the OECD countries, energy consumption is declining at the rate of 1.3% per year. The exception to this trend is Japan, where energy use is expanding at the rate of 1.7% per year.¹²² The recent decline in energy consumption by OECD countries is an aberration caused by the recession of the late 1980s. The long-term trend is still growth in energy usage, particularly in North America.¹²³

Conservation measures being carried out by most OECD countries and some developing countries, combined with a shift in consumption to relatively abundant natural gas, have contributed to a global decline in the use of oil as a primary energy source. Even with this decline, oil should remain the leading source of energy worldwide, at least for the next several decades. Natural gas is expected to continue to be one of the world's fastest growing sources of energy.¹²⁴

As identified above, OECD total energy consumption for 1991 was 182.5 quadrillion Btus. The breakdown of energy use on a percentage basis, by fuel source is as follows: oil 41.7%, gas 20.0%, nuclear 10.9%, solid fuels (coal and others) 24.6%, and hydroelectricity 2.8%.¹²⁵

Energy Consumption in the United States

The energy consumption trends of Canada's largest trading partner are similar to those in Canada. In the past several decades, the United States has shown significant improvement in energy efficiency.

Two long-term trends have slowed the rate of growth in American energy demand and consumption:

- (1) the increase in light manufacturing and service-based industries has replaced traditional growth in energy intensive heavy manufacturing;
- (2) population growth has slowed, thereby reducing growth of energy use in the residential and transportation sectors.¹²⁶

APPENDIX D: SUCCESSFUL ENERGY EFFICIENCY PROGRAMS

Among the larger Canadian companies, Albright and Wilson Americas and Brunswick Mining and Smelting Corporation Ltd. stand out for their contributions to energy efficiency.

Albright and Wilson Americas

Albright and Wilson Americas has been in business in Canada since 1896. It is a world leader in the manufacture of sodium chlorate. Demand for sodium chlorate is steadily increasing for use in the pulp and paper industry as an environmentally friendly alternative to chlorine as a bleaching agent. It is also used as a defoliant and herbicide in the agricultural industry.¹²⁷

Producing sodium chlorate involves an energy intensive electrolytic process, where electrical energy represents approximately 60% of the production costs. In 1992, Albright, intent on reducing energy consumption to maintain its competitive advantage, completed an "extensive expansion and modernization project at its North Vancouver plant, replacing graphite cell lines with state-of-the-art metal electrode technology. The conversion increased production capacity by 84% and reduced overall unit energy consumption by 28%."¹²⁸

The transition from graphite to metal cell technology also produced significant environmental benefits. The new process does not produce a waste by-product and has reduced the plant's solid waste by 97% since 1987. Furthermore, plant effluent has been reduced by 83%, air emissions by 86%, and the consumption of sodium hydroxide, acid and city water have decreased by 34%, 18% and 57% respectively.¹²⁹

Brunswick Mining and Smelting Corporation Ltd.

Brunswick Mining and Smelting Corporation Ltd. is a world leader in the production of zinc, copper and lead concentrates. With 84,000,000 tonnes of ore reserves and daily output of 10,000 metric tonnes, the company exports annually approximately 705,000 tonnes of concentrates to smelters in Quebec and Europe.¹³⁰

Brunswick Mining's "highly mechanized mining technique and ore processing technology are both energy intensive. As a result, energy use accounts for 13.5% of the company's total operating costs."¹³¹

The company's ongoing investment in energy efficiency, such as the replacement and maintenance of steam traps, and the use of low pressure flotation air has produced excellent results over the past decade. Brunswick Mining has also developed a semi-automated system to regulate the mine ventilation fans, allowing for deactivation during off-shift periods and reactivation for production shift start-ups. In 1992, this procedure reduced energy consumption by approximately 9,360,000 kWh per year or \$420,264.¹³²

During 1992, Brunswick Mining's energy management projects resulted in a 5.1% reduction in energy costs. With energy costs previously running at 13.5% of the company's total operating costs, Brunswick Mining will realize savings of approximately 1% of operating costs.

APPENDIX E: TABLES

Table 1
International Comparison of Energy Intensity*
(Total Final Consumption)

	1973	1979	1990	1991	1995	2000	2005
Luxembourg	1.43	1.18	0.78	0.81	0.73	0.56	0.53
Turkey	0.66	0.62	0.59	0.59	0.55	0.55	0.54
Portugal	0.39	0.43	0.49	0.49	0.50	0.50	n/a
New Zealand	0.35	0.35	0.45	0.46	0.45	0.44	0.42
Greece	0.38	0.38	0.42	0.41	0.42	0.42	0.42
Canada	0.55	0.52	0.40	0.40	0.39	0.39	0.37
Finland	0.50	0.44	0.36	0.38	0.37	0.35	0.32
Belgium	0.58	0.51	0.37	0.38	0.38	0.33	0.30
Netherlands	0.48	0.46	0.35	0.37	0.33	0.29	n/a
Ireland	0.45	0.43	0.33	0.33	0.30	0.27	0.25
Australia	0.35	0.35	0.32	0.32	0.31	0.29	0.26
United States	0.43	0.39	0.30	0.30	0.30	0.28	0.27
Sweden	0.44	0.41	0.29	0.30	0.29	0.28	n/a
Spain	0.31	0.34	0.29	0.30	0.31	0.29	n/a
United Kingdom	0.39	0.36	0.28	0.29	0.28	0.26	0.24
Norway	0.39	0.36	0.29	0.28	0.26	0.25	n/a
Germany	n/a	n/a	0.31	0.28	0.24	0.21	n/a
France	0.35	0.31	0.24	0.25	0.23	0.21	0.19
Italy	0.33	0.29	0.24	0.24	0.23	0.22	n/a
Switzerland	0.21	0.21	0.19	0.19	0.18	0.17	0.16
Japan	0.29	0.24	0.18	0.17	0.16	0.14	n/a

* Tons of oil equivalent per thousand of U.S. dollars (1985)

GDP figures do not include Eastern Germany prior to 1991

Source: International Energy Agency (IEA); Energy Policies of IEA Countries, 1992 Review.

Table 2
Canadian Energy Intensity By Industrial Sector
(Megajoules of secondary energy per dollar of real domestic product (1981\$))

	Pulp/ Paper	Iron/ Steel	Smelting/ Refining	Chemicals	Cement	Mining	Forestry	Constr.	Other Manu.
1978	97.65	93.29	70.91	47.50	31.95	9.92	11.45	2.81	12.99
1979	100.82	97.45	85.20	55.70	38.94	10.40	12.90	2.86	12.26
1980	106.77	111.30	101.51	60.50	39.04	11.50	12.19	2.33	12.65
1981	105.14	104.20	78.44	50.83	37.38	13.63	11.47	2.01	11.16
1982	119.11	129.16	80.98	56.11	38.90	12.84	11.47	1.69	11.91
1983	111.99	113.34	84.38	40.21	34.86	11.80	4.29	1.62	10.88
1984	109.34	102.46	66.49	45.54	34.91	11.76	4.52	1.69	9.68
1985	119.84	100.45	60.97	43.56	36.67	10.72	4.98	1.60	9.73
1986	118.74	101.13	63.22	47.42	35.43	11.18	5.48	1.42	9.87
1987	117.31	102.30	57.80	48.45	33.69	10.70	5.12	1.21	10.07
1988	114.75	98.97	55.60	45.08	33.53	11.63	5.55	1.25	10.41
1989	112.90	98.46	56.51	46.30	36.04	11.96	4.47	1.30	10.11
1990	112.34	86.49	56.09	43.13	35.60	11.47	5.87	1.45	10.64
1991	118.57	92.37	56.30	44.49	35.27	10.92	4.67	1.43	10.67
1992	115.50	88.00	58.00	39.30	35.10	10.60	4.10	1.50	9.80

Sources: Energy information: Statistics Canada, Quarterly Report on Energy Supply and Demand, Cat. No. 57-003. Real domestic product information: Informetrica Ltd.

Table 3
Canadian Energy Costs By Industry
(millions, current \$)

INDUSTRY	ENERGY	TOTAL	ENERGY
	COSTS	PRODUCTION COSTS	COSTS/ TOTAL PRODUCTION COSTS
	\$	\$	%
Cement	155.0	430.1	36.04
Abrasives	42.7	190.3	22.44
Clay Products	26.6	137.2	19.39
Chemical Fertilizers	8.4	44.7	18.79
Pulp & Paper	2040.8	12261.3	16.64
Industrial Chemicals	801.4	5442.4	14.73
Non-Ferrous Smelting & Refining	594.8	4317.3	13.78
Primary Steel	522.1	5593.9	9.33
Primary Textiles	96.3	1799.7	5.35
Rubber Products	68.5	1690.0	4.05
Plastic Products	149.6	3941.7	3.80
Sawmill, Planning and Shingle	246.1	6737.4	3.65
Wood	385.7	10806.8	3.57
Textile Products	73.5	2208.7	3.33
Beverage	86.9	2797.2	3.11
Fabricated Metals	307.1	11747.3	2.61
Furniture and Fixtures	62.4	2880.9	2.17
Food	598.7	28170.5	2.13
Petroleum & Coal Refining	351.1	16854.3	2.08
Machinery	123.2	6261.5	1.97
Printing, Publishing and Allied Products	124.4	7310.8	1.70
Electrical and Electronics	158.1	13656.6	1.16
Transportation Equipment	425.7	39673.6	1.07

Source: Catalogue 31-203 Annual, 1987, 1991, Manufacturing Industries of Canada: national and provincial areas.

Table 4
International Industrial Energy Price Levels

	1982	1984	1986	1988	1989	1990	1991	1992
Heavy Fuel Oil in US \$/metric ton								
Canada	141.22	166.15	100.84	92.32	99.32	110.03	104.00	102.94
United States	167.41	180.57	86.86	82.20	95.01	109.60	83.84	85.76
United Kingdom	205.15	204.92	119.40	116.42	114.65	135.28	123.19	114.36
Japan	253.12	234.36	200.53	192.96	178.04	187.78	240.45	210.32
Germany	189.39	191.69	108.55	104.21	122.61	143.14	137.61	133.83
OECD Europe	197.25	196.16	130.42	120.94	134.20	168.89	153.27	151.16
OECD	194.44	195.27	122.92	117.62	126.40	154.09	143.63	139.98
Electricity in US \$/kWh								
Canada	0.02	0.03	0.03	0.03	0.03	0.04	0.04	0.04
United States	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
United Kingdom	0.06	0.05	0.05	0.07	0.06	0.07	0.07	0.08
Japan	0.09	0.10	0.13	0.15	0.13	0.13	0.14	0.15
Germany	0.05	0.05	0.07	0.08	0.08	0.09	0.09	0.09
OECD Europe	0.05	0.04	0.06	0.07	0.06	0.08	0.08	n/a
OECD	0.05	0.05	0.06	0.07	0.07	0.07	0.07	n/a
Natural Gas in US \$/toe								
Canada	115.30	120.10	108.60	102.50	92.70	93.00	96.70	93.00
United States	165.70	180.70	138.30	126.70	125.00	123.80	112.30	118.20
United Kingdom	176.80	152.80	165.20	182.10	159.00	176.10	180.00	175.10
Japan	491.30	484.30	563.30	531.40	499.70	458.40	471.90	499.10
Germany	230.00	200.70	218.50	157.20	159.90	208.30	223.50	222.80
OECD Europe	211.70	189.50	178.70	151.20	150.70	181.30	169.61	175.41
OECD	179.30	181.50	154.70	139.10	136.80	145.10	128.41	131.66
Steam Coal in US \$/metric ton								
Canada	72.70	74.60	69.20	80.20	84.90	n/a	n/a	n/a
United States	71.80	68.70	62.70	58.50	57.80	58.80	58.60	57.40
United Kingdom	132.80	105.10	115.70	121.90	113.80	126.10	123.00	121.30
Japan	117.50	106.70	110.30	98.90	101.50	102.40	103.20	100.00
Germany	154.70	140.30	184.50	233.80	221.80	257.50	253.10	285.90
OECD Europe	127.50	103.20	124.70	141.00	132.90	159.60	155.40	n/a
OECD	92.30	81.30	83.90	87.30	87.30	87.30	87.30	n/a

Source: International Energy Agency, Energy Prices for OECD Countries, 1992.

Table 5
International Comparison of Electricity Prices
in the Industrial Sector, January 1993*

City	Country	Industrial Prices (U.S. cents/kWh)
Seattle	United States	3.29
Vancouver	Canada	3.68
Winnipeg	Canada	3.91
Portland	United States	3.95
Montreal	Canada	4.32
Calgary	Canada	4.38
Stockholm	Sweden	4.75
Minneapolis	United States	4.92
Ottawa	Canada	5.38
Sydney	Australia	5.89
Singapore	Singapore	5.93
Bangkok	Thailand	6.32
Houston	United States	6.51
Oslo	Norway	6.55
Sao Paulo	Brazil	6.73
Toronto	Canada	6.74
Paris	France	6.86
Taipei	Taiwan	7.04
Kuala Lumpur	Malaysia	7.31
Rotterdam	Holland	7.43
New Dehli	India	7.49
Detroit	United States	7.59
Chicago	United States	7.68
Los Angeles	United States	7.70
Boston	United States	7.95
Madrid	Spain	9.87
New York	United States	10.21
Geneva	Switzerland	10.27
Brussels	Belgium	11.03
Tokyo	Japan	12.34
London	United Kingdom	12.59

* Based on typical monthly billing demand of 1000kW and energy consumption of 400,000 kWh. Tokyo is based on a monthly billing of 980 kWh and energy consumption of 333,333 kWh.

Source: Electricity Branch, Natural Resources Canada.

Table 6
Canadian Domestic Industrial Electricity Rates
(cents per kWh)

PERIOD	NFLD	PEI	N.S.	N.B.	QUE.	ONT.	MAN	SASK	ALTA	B.C.	CAN.
1982	3.94	9.47	3.36	3.50	2.83	3.00	2.04	3.45	2.46	2.47	2.93
1983	4.17	9.43	4.16	3.72	3.04	3.21	2.18	3.74	2.85	2.74	3.18
1984	4.34	10.22	4.33	3.81	2.97	3.52	2.36	4.29	3.24	2.99	3.35
1985	5.61	10.76	4.33	4.19	2.84	3.85	2.49	4.51	3.20	3.10	3.49
1986	5.66	7.58	4.68	4.24	3.08	4.13	2.52	4.80	3.17	3.15	3.66
1987	5.06	5.72	4.79	4.24	3.12	4.23	2.77	5.16	3.17	3.15	3.70
1988	5.58	6.45	4.79	4.24	3.25	4.49	2.94	4.36	3.10	3.15	3.84
1989	5.06	6.22	4.98	4.24	3.38	4.89	3.14	4.51	3.24	3.16	4.04
1990	4.85	6.90	5.18	4.24	3.47	5.15	3.50	4.51	3.24	3.25	4.19
1991	5.09	7.88	5.38	4.45	3.50	5.56	3.57	4.51	4.09	3.30	4.42
1992	5.00	8.11	5.52	4.49	3.48	6.48	3.62	4.56	4.74	3.43	4.79
1993	5.06	8.49	5.56	4.65	3.58	6.94	3.64	4.80	4.56	3.52	5.01

* Based on average monthly consumption of 3,100,000 kWh

Includes PST AND GST

Source: Energy Statistics Handbook
Statistics Canada - Cat. No. 57-601
Energy, Mines and Resources Canada
August 1993

Table 7
Canadian Prime Rates
1982 - 1993

YEAR	PRIME RATES
1982	15.81
1983	11.17
1984	12.06
1985	10.58
1986	10.52
1987	9.52
1988	10.83
1989	13.33
1990	14.06
1991	9.94
1992	7.48
1993	5.94

Source: Bank of Canada

Table 8
International Comparison of Electricity Intensity*
(kWh/U.S. \$1985)

Country	1960	1970	1980	1988	1989	1990
Norway	1.52	1.83	1.70	1.68	1.68	1.68
Iceland	0.62	1.05	1.20	1.25	1.38	1.41
Luxembourg	0.93	1.56	1.30	1.30	1.24	1.31
New Zealand	0.59	0.84	1.14	1.33	1.24	1.30
Sweden	0.71	0.86	1.06	1.33	1.30	1.23
Canada	0.94	1.05	1.13	1.22	1.22	1.20
Portugal	0.49	0.60	0.86	1.05	1.08	1.10
Finland	0.44	0.66	0.85	1.02	0.98	1.02
Greece	0.24	0.50	0.74	0.95	0.96	0.98
Turkey	0.19	0.34	0.59	0.76	0.81	0.82
Australia	0.39	0.55	0.70	0.79	0.80	0.81
Spain	0.34	0.50	0.71	0.72	0.73	0.73
Belgium	0.44	0.55	0.66	0.72	0.71	0.71
United States	0.47	0.62	0.69	0.65	0.66	0.66
Austria	0.52	0.58	0.62	0.65	0.66	0.66
Ireland	0.33	0.58	0.66	0.65	0.64	0.63
West Germany	0.43	0.56	0.63	0.64	0.63	0.62
France	0.35	0.42	0.54	0.63	0.62	0.62
United Kingdom	0.53	0.73	0.69	0.62	0.61	0.62
Netherlands	0.30	0.45	0.54	0.57	0.56	0.56
Denmark	0.20	0.39	0.51	0.53	0.53	0.52
Italy	0.36	0.45	0.48	0.50	0.50	0.51
Japan	0.43	0.52	0.53	0.50	0.50	0.51
Switzerland	0.37	0.37	0.44	0.48	0.49	0.51

* Electricity intensity is defined as total electricity consumption per dollar of gross domestic product.

Source: Natural Resources Canada, "Electric Power in Canada 1992".

Table 9
Industry Energy R&D Expenditures by Technology Area
1983-1991
(millions, current \$)

Year	Renewable Resources	Transportation and Electricity Transmission	Conservation	Fossil Fuels	Nuclear	Other	Total
1983	17.7	41.1	69.4	212.5	44.4	19.6	404.7
1984	20.8	58.1	66.3	212.0	53.8	20.4	431.5
1985	26.2	61.9	76.4	259.4	47.7	19.3	490.9
1986	60.9	67.9	87.7	185.1	63.9	23.8	489.3
1987	24.2	106.0	68.0	158.5	52.2	51.0	459.8
1988	21.7	133.8	82.9	173.9	44.9	60.3	517.5
1989	18.7	138.3	108.4	185.1	46.8	47.3	544.7
1990	23.6	124.4	120.0	213.2	60.8	39.8	581.7
1991	27.0	122.3	138.9	201.5	78.6	39.8	608.1

Source: Natural Resources Canada, Office of Energy Research and Development, Ottawa.

Table 10
Federal and Provincial Government Energy
R&D Expenditures by Technology Area
1983-1992
(millions, current \$)

Year	Renewable	Electricity	Efficiency	Fossil Fuel	Nuclear	Others	Total
1983	61.0	8.5	70.2	131.7	182.8	19.5	473.6
1984	61.7	10.0	82.2	216.2	198.3	18.5	586.9
1985	33.2	9.3	78.4	165.6	197.3	8.9	492.7
1986	19.8	7.7	32.6	227.1	192.6	8.3	488.1
1987	17.7	5.4	34.5	170.9	176.8	7.4	412.7
1988	16.8	5.4	38.0	171.7	159.9	6.1	397.9
1989	14.6	5.2	38.4	136.6	156.1	18.6	369.4
1990	12.5	4.6	39.4	147.4	162.0	12.6	378.5
1991	13.6	6.0	36.1	100.4	166.9	19.7	342.8
1992	14.3	11.2	31.5	116.8	170.9	22.9	367.6

Note - 1992 represents estimated expenditures.

Source: Natural Resources Canada, Office of Energy Research and Development, Ottawa.

Table 11
Energy R & D Expenditures in Canada
1983-1991
(millions, current \$)

Year	Industrial	Electric Utilities	Sub-Total	Government	Total
1983	305.5	99.1	404.7	473.6	878.3
1984	324.3	107.2	431.5	586.9	1,018.4
1985	374.3	116.6	490.8	492.7	983.5
1986	347.6	141.7	489.3	488.1	977.4
1987	265.8	194.1	459.8	412.7	872.5
1988	313.8	203.8	517.6	397.9	915.5
1989	320.7	224.1	544.7	369.4	914.1
1990	362.8	218.9	581.7	378.5	960.2
1991	379.6	228.5	608.1	342.8	950.9

Source: Natural Resources Canada, Office of Energy Research and Development, Ottawa.

APPENDIX F: REFERENCES

1. *Growing Small Businesses* (Ottawa: Industry Canada, Entrepreneurship and Small Business Office, March 1994), pp. 3-39.
2. *Energy and Canadians: Into the 21st Century. A report on the Energy Options Process* (Ottawa: Energy, Mines and Resources, August, 1988), p. 96.
3. *The Energy Emissions Crisis: A Viable Alternative* (Ottawa: Report of the Standing Senate Committee on Energy, the Environment and Natural Resources, January 1993), p. iii.
4. *World Commission on Environment and Development, Our Common Future* (London: Oxford University Press, 1987), p. 8.
5. Based on information provided by E.F. Roots, Science Advisor Emeritus, Environment Canada, on April 21, 1994.
6. *Demand Side Management in Canada - 1992* (Montreal: Canadian Electrical Association, 1992), p. 2.
7. *Sustainable Energy and Mineral Development: A Realistic Response to the Environmental Challenges* (Ottawa: House of Commons Standing Committee, January 1993), pp. xv-xvi.
8. *Ibid.*, pp. 187-189.
9. *National Energy Data Profile* (Ottawa: Energy Council of Canada, 1992), p. 2.
10. J.A. Coombs, *Energy Intensity in Canada Compared to Other IEA Countries* (Ottawa: Energy, Mines and Resources, January 1990), pp. 1-8.
11. *Energy and Canadians: Into the 21st Century, A Report on the Energy Options Process* (Ottawa: Energy, Mines and Resources, August 1988), p. 3.
12. *Canadian Energy Assessment 1993* (Ottawa: Energy Council of Canada, 1993), p. 3.
13. *Ibid.*, pp. 3 and 4.
14. *Ibid.*, p. 5.
15. *Ibid.*, p. 6.
16. *Electric Power in Canada 1992* (Ottawa: Energy, Mines and Resources, Electricity Branch, Energy Sector), p. 18.
17. *Canadian Energy Assessment 1993* (Ottawa: Energy Council of Canada, 1993), p. 5.
18. *Ibid.*, p. 4.

19. *Ibid.*
20. *Nuclear Energy Data 1993* (Paris: Nuclear Energy Agency, Organization for Economic Co-operation and Development, 1993), p. 10.
21. Based on information provided by E.F. Roots, Science Advisor Emeritus, Environment Canada, on April 21, 1994.
22. *Canadian Energy Outlook 1992-2020* (Ottawa: Energy, Mines and Resources, Energy Sector, September 1993), p. 29.
23. *Canadian Energy Assessment 1993* (Ottawa: Energy Council of Canada, 1993), p. 5.
24. *Ibid.*
25. *Creating Opportunity, The Liberal Plan For Canada* (Ottawa: The Liberal Party of Canada, 1993), p. 66.
26. *2020 Vision: Canada's Long Term Energy Outlook Working Paper 1988-2020* (Ottawa: Energy, Mines and Resources, Energy and Fiscal Analysis Division, 1989), pp. 5-10.
27. *Ibid.*, pp. 12-14.
28. *Ibid.*, pp. 16-17.
29. *Energy Statistics Handbook* (Ottawa: Energy, Mines and Resources, August 1993), Table 10.37.
30. Bank of Canada.
31. *Energy Policies of IEA Countries, 1992 Review* (Paris: Organization for Economic Cooperation and Development, 1993), p. 489.
32. *Canada and Ontario's International Standing in Energy and Electricity Efficiency, and the Relationship Between Low Electricity Prices and Generation of Wealth* (Toronto: Energy Probe, July 1989).
33. *Energy Efficiency and Job Creation* (Washington, D.C.: American Council for an Energy-Efficient Economy, Economic Research Associates, October, 1992), p. III.
34. *Canada's Green Plan* (Ottawa: Government of Canada, 1990), p. 13.
35. *Reference Tables 1992* (Montreal: Canadian Pulp and Paper Association, October 1993), Table A-6, p. 4.
36. *Reference Tables, 1992* (Montreal: Canadian Pulp and Paper Association, October 1993), Table A-16, p. 6.

37. *Employment, Earnings and Hours* (Ottawa: Statistics Canada, 1993), Catalog 72-002.
38. R. Guertin, *Spotlight on Energy Costs* (Montreal: Report to the Energy Cost Competitiveness Committee of the Canadian Pulp and Paper Industry, May 1992), p. 15.
39. *Energy Demand by Fuel* (Ottawa: Energy, Mines and Resources, 1992).
40. *The Forest Industry in Canada 1991* (Vancouver: Price Waterhouse, June 1992), pp. 6 and 8.
41. *Competitiveness of the Canadian Pulp and Paper Industry: Co-generation Analysis*, (Ottawa: Industry, Science and Technology Canada, January 1993), p. 54.
42. *Aluminum Smelting Industry Profile* (Ottawa: Industry, Science and Technology Canada, 1993), p. 4.
43. *Ibid.*, pp. 4 and 5.
44. *Ibid.*, pp. 2 and 3.
45. *Ibid.*, p. 4.
46. *Ibid.*, p. 5.
47. *Business Week*, Issue No. 3342 (New York: October 21, 1993), p. 46.
48. *Aluminum Smelting Industry Profile* (Ottawa: Industry, Science and Technology Canada, 1993), p. 8.
49. *Mining in Canada, Facts and Figures* (Ottawa: The Mining Association of Canada, 1992), pp. 2-4.
50. Statistics as provided (Ottawa: Natural Resources Canada, Mining Sector, April 1994).
51. *Mining and Metallurgy Sector* (Ottawa: CANMET, 1993), p. 1.
52. *Industrial Sector Energy Demand by Industry and Fuel* (Ottawa: Natural Resources Canada, Energy Sector, Efficiency and Alternative Energy Branch, 1993).
53. *Present and Future Use of Energy in the Cement and Concrete Industries in Canada*, (Ottawa: Natural Resources Canada, Energy and Alternative Energy Technology Branch, 1993), p. 15.
54. *Cement Energy Demand By Fuel* (Ottawa: Natural Resources Canada, Energy Sector, Efficiency and Alternative Energy Branch, 1993).
55. *Sector Update* (Ottawa: The Canadian Chemical Producer's Association, 1991), Section "A" Totals.

56. *Chemical Energy Demand by Fuel* (Ottawa: Natural Resources Canada, Energy Sector, Efficiency and Alternative Energy Branch, 1993).
57. *Growing Small Businesses* (Ottawa: Industry Canada, Entrepreneurship and Small Business Office, March 1994), pp. 3-39.
58. Based on information provided by E.F. Roots, Science Advisor Emeritus, Environment Canada, on April 21, 1994.
59. Sector information provided by Industry Canada, Entrepreneurship and Small Business Office, March 1994.
60. *Growing Small Businesses* (Ottawa: Industry Canada, Entrepreneurship and Small Business Office, March 1994), p. 39.
61. *Ibid.*, p. 36.
62. *Annual Industrial Award* (Montreal: Canadian Electrical Association, June 1992), Case Study No. 41.
63. *Annual Industrial Award* (Montreal: Canadian Electrical Association, June 1992), Case Study No. 42.
64. *Efficiency, Trade and the Environment* (Victoria: 14th Canadian National Energy Forum, May 1992), pp. 13-32.
65. *Energy and Canadians: Into the 21st Century, A report on the Energy Options Process* (Ottawa: Energy, Mines and Resources, August 1988), p. 107.
66. *Ibid.*, p. 97.
67. *Industrial Research Assistance Program (IRAP) Case Studies* (Ottawa: National Research Council of Canada, Corporate Services, 1993).
68. *Ibid.*
69. Based on information provided by E.F. Roots, Science Advisor Emeritus, Environment Canada, on April 21, 1994.
70. *A Review of Canadian Energy Research and Development Expenditures 1983-1991* (Ottawa: Natural Resources Canada, Office of Energy Research and Development, April 1994), p. 2.
71. *Ibid.*, p. 3.
72. *Science and Technology in Canada, Energy R & D Policy in Canada* (Ottawa: Industry, Science and Technology Canada, 1993), Chapter 8.

73. *Creating Opportunity, The Liberal Plan For Canada* (Ottawa: The Liberal Party of Canada, 1993), pp. 63, 66 and 67.
74. *Energy for Tomorrow's World* (Report of the North American Region to the World Energy Council, 1990), p. 29.
75. *CANMET... Technologies for Prosperity* (Ottawa: Natural Resources Canada, Cat. No.: M39-55/92-E, 1992), p. 1.
76. M. Strong, Chairman, *Chairman's Speech to 1994 Municipal Electric Association Conference* (Toronto: Ontario Hydro, February 28, 1994).
77. *Energy and Canadians: Into the 21st Century, A Report on the Energy Options Process* (Ottawa: Energy, Mines and Resources, August, 1988), p. 102.
78. *Glossary of Industrial Organization Economics and Competition Law* (Paris: Organization for Economic Cooperation and Economic Development, 1993), p. 73.
79. *Ibid.*, p. 69.
80. The Honourable Richard D. Cudahy, *The Wearing Away of Regulation: What Remains* (Arlington, Va.: Public Utilities Fortnightly, October 1989), p. 10.
81. L. Greenberger, *The Birth of Independent Power* (Arlington, Va.: Public Utilities Fortnightly, March 1992), p. 17.
82. *Ibid.*
83. *Compact Disclosure Canada* (Toronto: Micromedia Ltd., April 1994).
84. *Power Ex* (Vancouver: British Columbia Hydro, 1993), profile.
85. L. Solomon, *The International Trend Toward Electricity Privatization* (Toronto: Energy Probe, 1992), p. 38.
86. J.T. Bernard, *Hydroelectricity, Royalties and Industrial Competitiveness* (Kingston: Queen's University, School of Public Studies, Discussion Paper No. 93-04, 1993), pp. 1-20.
87. L. Solomon, *The International Trend Toward Electricity Privatization* (Toronto: Energy Probe, 1992), pp. 1-5.
88. *Ibid.*, p. 9.
89. *Ibid.*, p. 16.
90. *Ibid.*, p. 21.

91. *Hydro-Québec: A Powerful Asset For Quebec* (Montreal: RBC Dominion Securities, September 14, 1993), p. 22.
92. P. Flemming, Interview on March 14, 1994 (Halifax: Nova Scotia Power Corporation, Rates and Regulation Department, March 1994).
93. *Ibid.*
94. *Hydro-Québec: A Powerful Asset For Quebec* (Montreal: RBC Dominion Securities, September 14, 1993), p. 5.
95. D. Curley (Toronto: Ontario Hydro, Public Affairs-Communications Office, March 1994).
96. L.E. Ruff, PhD., from testimony presented to the Ontario Energy Board (Toronto: Putnam, Hayes and Bartlett, Inc., June 1992).
97. *Hydro-Québec: A Powerful Asset For Quebec* (Montreal: RBC Dominion Securities, September 14, 1993), p. 9.
98. *Demand Side Management in Canada - 1992* (Montreal: Canadian Electrical Association, 1992), pp. 135-141.
99. Based on comments made by Mr. Stanley Marshall, Vice-President of Fortis Inc. and Acting President of Maritime Electric Co., on March 28, 1994.
100. A.E. Reinsch and E.F. Battle, *Industrial Co-generation in Canada: Prospects and Perspectives* (Calgary: Canadian Energy Research Institute, March 1987), p. xv.
101. From information provided by Natural Resources Canada, Domestic Natural Gas Division, March 1994.
102. N.E. Hay, P.L. Wilkinson and W.M. James, *Global Climate Change and Emerging Energy Technologies For Electrical Utilities: The Role Of Natural Gas* (Arlington, Va.: American Gas Association, 1988), Abstract.
103. *Ibid.*
104. *Ibid.*, p. 4.
105. L. Greenberger, *The Birth of Independent Power* (Arlington, Va.: Public Utilities Fortnightly, March 1992), p. 19.
106. *Ibid.*, p. 19.
107. *Competitiveness of the Canadian Pulp and Paper Industry, Co-generation Analysis* (Ottawa: Industry, Science and Technology Canada, January 1993), p.10.
108. *Ibid.*, p. 30.

109. *Ibid.*, pp. 1-3.
110. *Ibid.*, p. 49.
111. T. Adams, *Seven Problems with Subsidised, Utility Driven Conservation Programs* (Toronto: Energy Probe, July 1989), pp. 1-3.
112. A. Lovins, *Making Markets in Resource Efficiency* (Snowmass, Colorado: Rocky Mountain Institute, June 1989), p. 3.
113. *1992/93 Government R & D Expenditures* (Ottawa: Natural Resources Canada, Office of Energy Research and Development, 1994).
114. *Promotional Kit* (Montreal: Canadian Electrical Association, Energy Efficiency Program, 1993), p. 1.
115. *Efficiency and Alternative Energy Programs, Background* (Ottawa: Energy, Mines and Resources, Efficiency and Alternative Energy Branch, September 20, 1993).
116. *Energy Forum 92* (Victoria: British Columbia Hydro, the Energy Council of Canada, and the British Columbia Provincial Ministries of Energy, Mines and Petroleum Resources and Environment, Lands and Parks, May 1992).
117. *Federal Buildings Initiative* (Ottawa: Energy, Mines and Resources, 1993), program description pamphlet and comments of R. McKenzie, Director, Energy Ventures Division, Natural Resources Canada.
118. Based on information provided by E.F. Roots, Science Advisor Emeritus, Environment Canada, on April 21, 1994.
119. *Energy: Society's Expectations - Are They Compatible?* (Halifax: Energy Council of Canada and World Energy Council, Canadian National Energy Forum, October, 1991), p. 12.
120. *International Energy Outlook 1993* (Washington, D.C.: US Department of Energy, Energy Information Administration, April 1993), p. 21.
121. *Ibid.*
122. *Ibid.*, p. vii.
123. *Ibid.*
124. *Ibid.*, p. 23.
125. *Quarterly Oil Statistics and Energy Balances* (Paris: International Energy Agency, First Quarter 1992), p. 9.

126. *National Energy Data Profile* (Ottawa: Energy Council of Canada, January 1989), Section 46, p. 2.
127. Annual Industrial Award, (Montreal: Canadian Electrical Association, June 1992), Case Study No. 45.
128. *Ibid.*
129. *Ibid.*
130. Annual Industrial Award (Montreal: Canadian Electrical Association, June 1992), Case Study No. 39.
131. *Ibid.*
132. *Ibid.*

