Update

Developments in Transportation

Canada has a population of 27 million people who own and operate 11.9 million cars and four million trucks and buses. Oil provides 98% of the energy requirements for those vehicles. Even though between 1980 and 1990 the number of cars in Canada increased by 23% and the average distance driven increased by 11%, Canadians cut their gasoline consumption by 12%. This remarkable result was due to a significant increase in automobile efficiency. Some studies suggest that a further reduction of 30% could be achieved by 2000 without affecting the average size of a car.

In contrast, gasoline demand rose 10% in the US over the same decade. In 1990, Canadian drivers used about 200 litres less fuel than their American counterparts, despite the harsher climate in this country which tends to increase fuel consumption. The higher price of gasoline in Canada was no doubt the major cause for this discrepancy. The new US Administration has opted for a more broadly-based Energy Tax — the price of gasoline at the pump is expected to increase by only about 7.5 ¢/US gallon. The difference between Canadian and American gasoline taxation appears unusual when one considers that the US imports nearly half its oil requirements, while Canada is still a minor net exporter.

More rigorous environmental requirements are encouraging the use of alternative fuels in cars. Both methanol and ethanol are now added to gasoline to reduce emissions. Improvements seem likely in the processes that convert natural gas to methanol and other liquid fuels (see following section). In the case of ethanol, a major five-year, $12 million initiative to encourage the production and use of fuel alcohol was announced on November 23, 1992 as a component of the government's Green Plan. Currently, Canada's annual production of ethanol for fuel purposes is about 21 million litres, and most of this total is produced in two plants by Mohawk Oil in Minnedosa, Manitoba, and Pound-Maker Ethanol Ltd. in Lanigan, Saskatchewan. The latter facility is integrated with a cattle feedlot operation to optimize the use of by-products such as distiller's grain and thin silage, which are fed to animals in the adjacent feed lot. There is also a plant at Tiverton, Ontario, producing ethanol for fuel use in southwestern Ontario. In the future, ethanol produced from cellulosic materials from agriculture, forestry, or other urban organic wastes could also enter fuel markets at lower costs if R & D projects are successful. Progress in the field is rapid. A hybrid microbe was recently developed by genetic engineering techniques at the University of Florida that has the ability to produce ethanol from nearly any kind of plant material, corn stalks, old newspapers and even the sludge generated by paper mills.

Alcohol fuels derived from biomass sources could help deal with the global warming problem to the extent that their production can be made independent of the use of fossil fuels. Hybrid processes are also possible and the Hydrocarb Process developed at Brookhaven National Laboratory in the US permits the production of atmospherically-neutral methanol from natural gas and biomass by sequestering solid carbon.

Progress has also been rapid on other fronts. The Mazda Company of Japan recently demonstrated a car in Toronto which was equipped with a rotary engine that works well on hydrogen. Improved hydrogen storage methods are being investigated by this company and many others around the world. A concise survey of progress in this field appeared in *Technology Review*, Vol. 96, No. 2 (February/March) 1993, pp.15-16. Noteworthy is the proposal by H-Power, a small company in Belleville, New Jersey, to produce hydrogen on board vehicles by reacting sponge iron with steam. The oxidized iron could be reduced back to the reactive sponge metallic state in centralized facilities. According to the company's calculations, the iron system can store 25 times more electrical energy per unit of weight than the typical battery. The hydrogen released would be converted to electrical energy in a fuel cell.

Progress in the field of electric vehicles continues at a brisk pace. Canada will take part in a five-year agreement, under the auspices of the International Energy Agency, to cooperate in the development of electric vehicles. An American engineer, Joe LaStella, has claimed a world record of 724.5 kms travelled on one battery charge in an electric vehicle he is developing. He did not disclose the battery system employed.

Alupower Power Canada Ltd. is working on an aluminum-fuelled cell, and Ballard Systems Limited of North Vancouver, BC, is developing a system to convert methanol to hydrogen on board vehicles to provide electricity from fuel cells. Ballard will signal a major advance in this field with their announcement on June 8, 1993, of the success of the first electric bus employing this new system.

The Electrochemical Science and Technology Centre, established in 1987 as a self-financing, non-profit research institute at the University of Ottawa, continues an active program of research into batteries, fuel cells, and all aspects of electric vehicle technology. On May 11, 1993, the Centre announced that 20 electric vans would be put into service in the Ottawa area. These vans were manufactured in Canada by Conceptor Industries Inc., a firm affiliated with Magna International Inc., and were the first to be certified as roadworthy. Various organizations will operate the fleet, and the Centre will provide the necessary support infrastructure, including driver training and monitoring of vehicle performance.

An article by Dr. S.R. Ovshinsky and his colleagues in the April 21, 1993, issue of *Science* (Vol. 260, No. 5015, pp. 176-81) reports on details of important progress in the nickel-metal-hybrid battery system. The journal *Electric Propulsion* published by the Electric Vehicle Association of Canada (Suite 420, 301 Moodie Drive, Nepean, Ontario K2H 9C4) provides a useful source of information concerning developments in this field both here and abroad.

New Ways to React Methane

Two important new advances have been reported in papers printed back-to-back in the January 15, 1993 issue of *Science* (Vol. 259). In the first (pp. 340-43), Roy A. Periana and his associates of Catalytica, Inc., Mountain View, California, report a method of converting methane directly to methanol via a mercury chemical intermediate. (They had advice from Professor Henry Taube, a Canadian-born Nobel prize winner from the University of Saskatchewan who was thanked for his "guidance provided during all phases of our investigation of selective methane oxidation"). Methanol is currently produced in Canada and other countries by reforming methane with steam (a high temperature process) and then recombining the resulting hydrogen and carbon monoxide to form methanol by recirculating these gases over catalysts under pressure. Thermodynamically, it should be possible to react methane with oxygen directly to produce methanol, but, despite much effort (some of which was undertaken in Canada), this goal had become as elusive as the holy grail. In the new process, mercuric ions selectively catalyze the conversion of methane to methanol via a methyl bisulphate intermediate. The reaction occurs in a homogeneous system at 180°C, with yields of up to 43%.

Methanol, a liquid with about one-half the specific energy content of gasoline, is gaining importance as a transportation fuel, either on its own or in blends with gasoline. In some localities with severe air pollution problems, blends with methanol and other oxygenates are now mandated (usually in winter). In Canada and elsewhere, there are also promising programs by such organizations as Ballard Systems Limited of North Vancouver, BC, for the conversion of methanol to electricity in fuel cells to power vehicles.

In some regions of the Arctic, large quantities of natural gas may be available which will not be connected to the pipeline network for many years, if at all. The announced process thus offers new opportunities, especially as the production of natural gas has been steadily rising. The research was partly funded by Petro-Canada and an affiliate of Mitsubishi Oil Company Limited of Japan.

In the second paper, D.A. Hickman and L.D. Schmidt (*Science*, Vol. 259, pp. 343-46) reveal a new method of converting methane to hydrogen and carbon monoxide, based upon work conducted at the University of Minnesota. A mixture of methane and oxygen was largely converted to these gases, with greater than 90% selectivity for each, after they were passed over platinum and rhodium surfaces in metal-coated ceramic monoliths, with reaction times as short as 10^{-3} seconds. This development offers advantages over the conventional steam-reforming approach in terms of the size of equipment necessary and the specificity of gas composition, but a disadvantage in that not as much hydrogen is produced per unit of carbon in the methane.

There has also been steady progress in what might be termed the conventional approach to the production of transportation fuels from natural gas. In South Africa, the Mossgas Project for the conversion of natural gas, obtained from a reservoir located some 140 kilometres off-shore, to transportation fuels such as gasoline and diesel fuel began production in 1992. The gas is first reformed with steam, and the liquid fuels are then synthesized in a circulating fluid bed of the Synthol type. That process is also used by SASOL, the South African company that converts coal to about 100,000 barrels of oil equivalent per day of those fuels. SASOL itself has installed an improved fixed-bed fluidized reactor for the synthesis stage, which promises many economies.

In New Zealand, a plant was built about a decade ago for the conversion of natural gas to transportation fuels. Methanol was produced first as an intermediate product, which was then converted to gasoline in the Mobil Process. Still another approach is being assessed in a facility being built in Sarawak, Malaysia, by the Shell Group of companies. The natural gas, after reforming, is synthesized selectively to waxy hydrocarbons of high molecular weight so as to minimize loss to unwanted gaseous compounds of lower molecular weight. The waxy compounds are then hydrocracked and hydroisomerized to middle distillates, such as kerosene and diesel fuels, again with minimum gas formation. Somewhat the same technique has been used at SASOL to convert waxes produced in the older Arge Process, which is also employed for synthesis at this facility, to diesel fuel of high quality.

The expanding Canadian natural gas option may well be reinforced by one or another of these promising new developments, which offer the prospect of the greater use of gas for transportation fuel as well as new ways of converting gas to more easily transportable liquids at remote or inconvenient locations.

Additional Support for Hibernia

On January 15, 1993, the new Minister of Energy, Mines and Resources, Bill McKnight, and Michael Wilson, the Minister of Industry, Science and Technology, announced that an agreement had been reached which will permit the Hibernia Oil Project off the coast of Newfoundland to proceed. New arrangements are necessary because of the withdrawal of a former partner, Gulf Canada Resources on February 4, 1992, due in part to the financial crisis that had affected its main shareholder, the real estate giant Olympia and York. A new member, Murphy Oil Corporation, confirmed its decision to join the project by acquiring a 6.5% share. The existing partners, Mobil Oil and Chevron, each agreed to increase their shares by 5%. Petro-Canada maintains a 25% share, but James M. Stanford, who succeeded W.H. Hopper as CEO in January 1993 (Mr. A.E. Barroll, a long-term member of the Board of Directors was appointed Chairman), has announced its intention of selling part of its holding. The privatization of the latter company has been delayed due to unfavourable market conditions. Faced with this situation, the Government of Canada acquired 8.5% of the project on its own account. Support for the project is also provided by a Primary Guarantee Facility (PGF) of $1.66 billion. Under the PGF, the government guarantees the repayment of funds borrowed by the companies for investment in the project. Principal and interest associated with the guaranteed loans are paid from each company's cash flow from the project. In view of the change in ownership, the government will transfer $141 million in PGF entitlements from the interest it is acquiring to Mobil, Chevron and Murphy in equal amounts of $47 million each. Special arrangements have also been necessary to insure the production platform.

The discovery well was spudded by Chevron Canada on May 27, 1979 and the discovery was officially confirmed on September 21, 1979. The field is located 315 km east-southeast of St. John's, Newfoundland, under an average water depth of approximately 80 meters. It is estimated to contain two billion barrels of oil, of which 615 million are expected to be recovered. The project life of the field, based upon an average daily production rate of 110,000 barrels per day, is 18 years. After a period of protracted negotiations it was announced on September 14, 1990, that the Hibernia consortium was to begin immediate construction and engineering work. A large concrete platform being built in Newfoundland will be towed to the production site to obtain maximum local benefits of the project. Production is now scheduled to begin in July 1997.

Hibernia has long attracted controversy and the new agreement has increased the debate. The government was much criticized for continuing with the project, but its supporters maintain it will be viable. The acute crisis affecting Newfoundland due to difficulties in the fishery and elsewhere may have been a contributing factor in the decision to keep the project going. Other factors include the general expectation of a gradual fall in the production of light oil in the Western Canadian Sedimentary Basin and the advantages of having an oil supply of high quality in the eastern region of the country. There are also other prospects for oil and gas production in the eastern off-shore fields, and success with Hibernia will no doubt lead to other developments, although possibly not on the same large scale.

Uncertain Nuclear Future for Ontario

On March 9, 1993, the new Chairman of Ontario Hydro, Mr. Maurice Strong, announced sweeping changes at Ontario Hydro. Electricity rates, which had risen rapidly over the past three years, were to be frozen for at least a year, and should thereafter increase no faster than the rate of inflation until 2000.

The Corporation's outstanding debt has reached $34 billion. To achieve the necessary savings, the budget has been cut substantially, and up to 5000 workers will be eliminated from the work-force of 28,000. The capital budget was cut as well, and much of the utility's 4000-member construction and engineering division will be disbanded. The planned re-tubing of the reactors at the Bruce Generating Station, which had been estimated to cost about $3 billion, has been cancelled. Apparently these reactors will be operated at reduced power for safety reasons as long as possible and then shut down.

Though 48% of the electricity generated in Ontario was produced by CANDU nuclear reactors in 1992 (down somewhat from 1991), this option is now in question for the future. The former Provincial Minister of Energy, the Hon. Brian Charlton, had already stated that no more reactors will be built and the existing ones will be phased out. Ontario Hydro has resigned from the Canadian Nuclear Association on the grounds it should not favour one form of energy over another. The costs of commissioning the latest nuclear station at Darlington have been very high, and substantial and expensive repairs have been needed at other reactors.

The lengthy recession coinciding with a period of severe industrial restructuring, aggravated by the effects of the Canada-US Free Trade Agreement, has led to markedly less demand for electricity in Ontario than expected. Savings in consumption arising from more aggressive conservation measures have also been important. On the supply side, the price of natural gas, though now rising, has remained low, which has encouraged the cogeneration option. At the same time, the cost of nuclear-derived electricity has increased due to commissioning and operational problems.

Despite all the problems confronting the nuclear industry, overall 1992 Canadian performance at 68.1% of capacity compared favourably with the average of US reactors at 68.9%. Seven reactors of CANDU design appear in the top 20 reactors worldwide on the basis of lifetime performance to the end of June 1992. CANDU units abroad have also performed well — the Wolsung-I unit operated by Korea Electric Power Company (KEPCO) operated at 86.8% in 1992.

Longer-term electrical options for Ontario are difficult to assess. There will surely be some degree of economic recovery. An increase in population is probably the most important single factor. Immigration to Canada remained at a high level all through the recession despite the high level of unemployment. With the continued growth in population, particularly in the third world, pressure to enter Canada is likely to increase.

The extent to which future pressures on the electrical network can be met by DSM techniques is uncertain. Paul L. Joskow and Donald B. Marron at MIT (*Energy Journal*, Vol.13, No. 4, pp. 41-74) have cast doubt on the costs of many DSM activities by US utilities. In a more general paper, Harry D. Saunders (*Energy Journal*, Vol.13, No.4, pp.131-48) argued that, according to the neo-classical economic synthesis, gains in energy efficiency can increase energy use directly by increasing the economic growth rate and decreasing the effective cost of energy. On the other side of the debate, Robert U. Ayres (*Journal of the World Energy Council*, July, 1992, pp.29-45) posits that the energy economy is profoundly out of internal equilibrium and that major savings are possible which may not be quantifiable by conventional economic methods. Furthermore, in the case of a long-lived technology such as CANDU, there is doubt as to the wisdom of applying discounting techniques over such a long time (See Jacoby and Laughton, *Energy Journal*, Vol.13, No. 2, pp.19-47). All that can be said is that the field is in a state of confusion at present.

The complexity of the conservation problem can be illustrated by the problem of heating houses and other small structures. Houses can now be built to such high standards that little energy is needed to heat them. The cost of this energy becomes less important than the capital cost of the heating system and the convenience of its control. Moreover, electrically-powered mechanical ventilation based on heat exchangers is almost always needed as well. Electrical methods are easy to use in such houses. The investment in the gas distribution network to serve new subdivisions may become doubtful in this case. Such conservation practices tend to lead to more electrical consumption, not less. The one thing that is certain is that it costs more not to have electricity than have it. The spectacle of the re-start of the reactors at Chernobyl in Ukraine is proof enough.

On the supply side, there are two other main options. In favourable cases, cogeneration has the advantage of using up to 80% of the energy of the fuel consumed in a useful way. But there are not many cases where large, efficient turbine installations may be coupled to steady thermal loads of one kind or another. Nevertheless, when proposals were sought for such activities, the response was greater than had been expected. Natural gas is generally the preferred fuel (though it is interesting that cogeneration involving nuclear power is carried out at the Bruce Generating Station). Although the price of natural gas is still low, it may not remain so, which makes it interesting that gas can also be consumed in combined-cycle generating facilities with efficiencies approaching 50%. This technique has the advantage that the units could be converted to coal at a later time by installing a gasification section at the front end of the plant should the price of gas reach unacceptable limits. Such a facility would meet environmental standards, except for greenhouse gas emissions.

The International Energy Agency and other such bodies have come to the conclusion that a nuclear option is needed somewhere. Had the 1.867×10^9 megawatt-hours of electricity derived from nuclear sources around the world in 1992 (not including nuclear generation in the CIS countries) been produced from oil, world oil consumption would have increased some eight million barrels per day to an insupportable level which would be reflected in a higher price. Were this electricity generated from coal instead, the environmental consequences would be severe.

None of this proves that Ontario needs a nuclear option. If it becomes necessary to reduce emissions of CO_2, the first options are likely to increase the efficiency with which energy is consumed and to improve the interconnection of Canadian utilities to make better use of the remaining hydroelectric potential. Nevertheless, the nuclear option is not far behind in second place. At the present time, improvements to nuclear technology appear to offer one of the few ways of pulling the energy system away from an undue reliance upon fossil fuels without greatly increased costs. This will be true particularly if the battery-based electric vehicle is improved sufficiently to be an attractive option.

The example of France will be interesting to watch. That nation now generates about 77% of its electricity from its nuclear facilities. There is sufficient nuclear capacity in France that reactors are actually used for load-following. Electricity has become a major item of exports to its partners in the European Community. The abundance of electricity is supporting the construction of high-speed electric trains and electricity-intensive industries such as aluminum. Japan is rapidly expanding its nuclear generation as well.

If a nuclear fission option is needed, what sort of option should it be? Improved nuclear technologies, developed in response to public concerns for safety, will have to be considered. As for CANDU in the shorter run, its problems are now generally understood. With successful re-tubing operations using an improved alloy, the reactors should last at least 25-30 years, and perhaps 40. The Koreans had full knowledge of CANDU's problems and they opted for additional capacity. Only time will tell. There is, however, an essential generic difference between the CANDU system and its competitors. CANDU reactors can be repaired so as to operate almost indefinitely into the future if it were economically attractive to do so. (It is not unusual to have very old generating facilities: there are hydraulic plants operating over 75 years old.) As one former AECL official was fond of saying: "My grandfather left me his axe. I have changed the handle three times and the head twice, but I still have his axe!" The question is how to value this capability properly.

Carbon Dioxide Disposal Symposium at Oxford

The Oxford Symposium, held at Christ Church College on March 29-31, 1993, was a component of the International Energy Agency's (IEA) Greenhouse Gas R & D Programme (see *ESR*, Vol. 4, No.1, pp. 81-82). The program started in November, 1991, when 13 countries (including Canada) signed an agreement to take part in research and development activities aimed at evaluating mitigation strategies as a response to the global warming problem. This cooperative effort brings together countries and industrial organizations that are interested in establishing techniques, costs and the environmental consequences of removing carbon dioxide from power station flue gases and storing or otherwise disposing of them. Task 1 under the agreement is a three-year study of the most likely options, which could culminate in proposals aimed at demonstration facilities should any of the technologies evaluated show sufficient promise. The program, directed by Mr. Ian Webster, well-known in the Alberta petroleum industry, is based at the Coal Research Establishment of British Coal at Stoke Orchard (near Cheltenham) in England, and is closely linked to the IEA Coal Research group which is located in London (see *ESR*, Vol. 3, No. 2, pp. 192-93).

The Oxford Symposium followed the First International Conference on Carbon Dioxide Removal (Amsterdam, March 4-6, 1992) which is generally considered to be the first major meeting to consider this new option (see *ESR* Vol. 4, No. 1, pp.77-78). At Oxford, there were 230 delegates from 28 countries who heard 62 papers (seven from Canada) from 13 different countries. Major continuing sessions were held on ocean, aquifer and biological disposal options, and on enhanced oil recovery. Plenary sessions were devoted to policy reviews and to sessions on economic aspects and international reviews. The dinner speaker was Elizabeth Dowdeswell, formerly of Environment Canada, who is now Executive Director of the United Nations Environmental Programme (UNEP), which is responsible for the follow-up to the decisions reached at the UNCED meeting held in Rio de Janeiro in June of 1992. Ms. Dowdeswell reviewed the history of the difficult negotiations prior to the signing of the Framework Convention on Climate Change, and gave a realistic but relatively optimistic outlook for the prospects for implementing this major agreement.

The possibility for disposal in the deep oceans continues to attract much attention, especially in Japan and Norway. Norwegian authors Austvik, *et al.*, now seem to believe that disposal in the form of clathrates (a solid hydrate of carbon dioxide and water which is stable at low temperatures and high pressures) is not feasible, an opinion obviously not shared by the Japanese. Another paper from Norway (Drange, *et al.*) exploited the higher density of sea water laden with carbon dioxide as a means of ensuring that this gas is carried to great depths under the action of gravity. A representative of the environmental organization Greenpeace cautioned that ocean disposal in general may never be acceptable to the public.

A special session of four papers dealt with an industry/government cooperative study begun in 1991. It was coordinated by the Alberta Oil Sands Technology and Research Authority (AOSTRA), whose object was to determine the technical and economic feasibility of capturing and disposing of CO_2 in reservoirs, where offsetting hydrocarbon recovery benefits could be obtained. Twenty-four participants provided a total of $600,000, as well as the technical direction of the study, which was conducted by specialist engineering contractors. The specific target was to capture 50,000 tonnes of carbon dioxide per day from seven specified sources in Alberta and Saskatchewan; this quantity is about 12% of the present total emissions of this gas from fossil fuel sources in the two provinces. Different capturing techniques were evaluated as appropriate to the respective sources, which ranged from coal-fired power plants to sour gas processing units. Six reservoirs were selected for evaluation, including light oil, heavy oil and natural gas cases. Oil production would be increased by about 20,000 cubic metres (125,800 bbls) per day with this quantity of gas. The delivered cost for carbon dioxide was found to be dominated by the cost of capture which was typically over $50/tonne. In the most favourable set of economic parameters, the revenue can just cover the costs, but in most cases there is still a substantial deficit. The net cost is, however, less than other carbon dioxide disposal options.

Dr. W.D. Gunter of the Alberta Research Council presented an interesting and optimistic paper dealing with CO_2 disposal in aquifers in the Western Canadian Sedimentary Basin where chemical reactions occur within the geological structure. A Japanese paper (Koide, *et al.*) studied disposal in aquifers containing some natural gas, which is already exploited on a small-scale in that country. The value of the natural gas recovered offsets the CO_2 disposal costs to some degree.

In the biological disposal field, several papers explored such measures as afforestration and the intensive growth of algae in large dedicated ponds.

Professor W. Seifritz of Stuttgart University made the most original (and controversial) proposal to the meeting for the storage of carbon dioxide. He proposed the large-scale storage of dry ice in spheres 400 metres in diameter insulated with two metres of glass wool. The spheres would be buried halfway into the ground with the site prepared and protected by low-cost methods. He calculates it would take about 800 years for half the dry ice to sublimate back to the atmosphere, which would be well after the crisis point had been passed. Every step of his proposal appears technically feasible, but many doubted his costs for producing dry ice. The aesthetics of a landscape dotted with hemispherical domes led to much discussion at mealtime at the typical Oxford long tables.

Much has happened since the Amsterdam meeting last year and progress in this field will be reviewed again in October 1994 when the Second International Conference on Carbon Dioxide Removal meets in Kyoto, Japan. No one can say yet whether a viable option for the capture and disposal or storage of carbon dioxide exists, but the issues involved have become much better defined in a remarkably short period of time. Major expenditures are being made by such nations as Japan, but Canadian efforts to date have been minimal. The Proceedings of the Oxford Symposium will be published in the British journal *Energy Conversion and Management* (Pergamon Press), and should appear about mid-summer 1993.

New Reports Available

A number of reports of interest have been released since our last *Update*. The joint Federal, Provincial and Territorial Advisory Committee on Climate Change has begun the publication of the *Global Warming Report*. The aim of this quarterly newsletter is to keep interested parties in government, industry, environmental and other groups informed of the activities of the Committee, and to be a vehicle for the exchange of information with non-government organizations active in this field. Copies may be obtained by writing to Editor, Global Warming Report, Climate Change Task Force, Department of Energy, Mines and Resources, 13th floor, 580 Booth Street, Ottawa, Ontario K1A 0E4.

Also from EMR a Discussion Paper was released in September of 1992 dealing with *The Regulation of Energy Efficiency and the Labelling of Equipment in Canada* pertaining to the Energy Efficiency Act, which received Royal Assent on June 23, 1992.

Ontario Hydro released the

proceedings of its Symposium on Demand Side Management entitled 'Sharing Experiences' which was held in Toronto on September 23rd, 1992. Statistics Canada published four reports on the environment which contain data of interest to the energy field: *Environmental Perspectives 1993: Studies and Statistics; Databases for Environmental Analysis: Government of Canada; Households and the Environment; and Human Activity and the Environment.*

Environment Canada released another report in the State of the Environment series entitled *The State of Canada's Climate: Temperature Changes in Canada 1895 -1991* (SOE Report No. 92-2). A report in the Environmental Protection Series No. EPS 5/AP/4 (December 1992) was entitled *Canada's Greenhouse Gas Emissions: Estimates for 1990.* The importance of this report is related to the choice of 1990 as the base year in the policy aiming at stabilizing Canada's greenhouse gas emissions by 2000.

A new book, *Buying Greenhouse Insurance: The Economic Costs of CO_2 Emission Limits* by Alan Manne and Richard Richels, has been published by MIT Press.

Short Notes

• The Atomic Energy Control Board (AECB) has reported on progress in the field of dry storage of irradiated fuel bundles at Canada's nuclear generating stations in its journal, *AECB Reporter*, Winter 1993 issue. These fuel bundles are retrieved from a CANDU reactor after about 12-18 months and immediately placed in a water-filled pool for cooling and storage. The pools are generally filled after about 10 years of reactor operation. The utilities have now opted for three different methods of on-site dry storage to follow this period. New Brunswick Power chose the concrete canister derived from the Atomic Energy of Canada (AECL) demonstration program in the mid-'70s. Ontario Hydro now proposes to use its own dry storage technology at the Pickering Nuclear Generating Station, while Hydro-Québec would prefer the new CANSTOR concept at its Gentilly 2 Plant. It is unusual to have three different methods selected to deal with this troublesome problem, but AECB reports that developments are still unfolding and that the International Atomic Energy Agency (IAEA) will not publish standards for another 18 months or so.

• Changes at the top. Following the retirement of the Hon. Jake Epp, the Hon. William McKnight became Minister of Energy, Mines and Resources on January 4, 1993. In February, Mr. Ronald L. Bilodeau became Deputy Minister replacing Mr. Bruce Howe, who became Deputy Minister of Western Diversification based in Edmonton. Dr. Terrance E. Rummery, formerly President of AECL Research, became acting President and Chief Executive Officer of Atomic Energy of Canada Limited replacing Mr. Howe. Mr. Roland Priddle was re-appointed for a further five years as Chairman of the National Energy Board in Calgary. Mr. Donald O. Downing has become President of The Coal Association of Canada, replacing Mr. Giacomo Capobianco, who has retired. In the US, following the inauguration of the Clinton Administration, Hazel O'Leary, a utility executive, became the new Secretary of Energy succeeding Admiral Watkins.

• There is still interest in the possibility of Cold Fusion. In the US, the Electric Power Research Institute (EPRI) will spend $12 million over the next three years in this area. EPRI claims to have a process that puts out four times as much energy as is consumed. Studies continue at the Stanford Research Institute and a number of other universities and private groups. The Japanese remain active — their scientists have filed about half of all the international patents granted in this elusive subject. According to the UK journal *New Scientist* (Vol. 136, No. 1850, p. 4, December 5, 1992), Advanced Film Technology, a research off-shoot of Nippon Telephone and Telegraph, is offering a cold fusion kit for sale for £350,000. The object is to encourage others to investigate this phenomenon. The original workers in the field, Drs. Stanley Pons and Martin Fleischmann, are now working in France supported in part with funds from Japan. While most physicists deride Cold Fusion, some electrochemists believe they have found an effect which at present defies explanation. In Canada, some work continues at the Whiteshell Laboratory of Atomic Energy Of Canada Ltd. At the Electrochemical Science and Technology Centre of the University of Ottawa, Mr. E.E. Criddle has continued to observe "excess heat" in his wet electrolytic apparatus. Mr. Criddle invites inquiries into his studies. This subject continues to be intriguing.

• The Energy Council of Canada has published the *Canadian*

Energy Assessment for 1993 — the first in a series of annual reports on Canada's energy outlook. The aim is to provide a coherent, authoritative view of the energy scene in Canada, with emphasis on energy issues and priorities as perceived by the energy community. Mr. A.J. O'Connor, formerly with New Brunswick Power, coordinates this activity with the aid of an advisory committee. The *Assessment* identifies several of the priority issues for Canada, and concludes with a number of recommendations.

The new address of the Council is Suite 400, 30 Colonnade Road, Nepean (an Ottawa suburb), Ontario, K2E 7J6. The telephone number is (613) 952-6469 and the fax (613) 952-6470.

• The Coal Association of Canada has issued a useful report entitled *Canadian Coal 1993*. This report, which was first published in January 1993, will appear annually and will provide an overview of the industry and its role in the world energy economy. Copies may be obtained from the Association's offices in Calgary, Room 502, 205 - 9th Avenue SE., Calgary Alberta, T2G 0R3 (Fax: (403) 265-7604). Canadian coal production fell 9.3% in 1992 to 64.6 million metric tonnes with a value of $1.7 billion.

• The Bi-Provincial Upgrader was officially opened on November 20, 1992, at Lloydminster, Saskatchewan. This new facility converts the heavy oil of this region into 46,000 bbls/d of synthetic oil. This production will go a long way towards offsetting the steady decline in the production of light oil (useful for transportation purposes) expected from the Western Canadian Sedimentary Basin over the next decade.

• Canada remained the western world's leading uranium supplier in 1991. More than 8100 tonnes of uranium (tU) were produced that year, while total shipments under all active export and domestic contracts approached 8200 tU valued at a value of over $500 million. Although employment continued to decline in the industry, Canada's share of western world output was 31%, about the same level as in previous years. Uranium prices reached an all-time low in 1991, falling a little below US $7/lb. on the spot market. The price has recovered somewhat since.

• A Canadian company has announced that it has built the first successful commercial plant for the production of liquid fuels and valuable chemicals from renewable resources. Ensyn Technologies Inc. of Ottawa has developed a process, which is now in use at Red Arrow Products Ltd. of Manitowoc, Wisconsin, for converting 25 to 30 tonnes of sawdust daily into low-sulphur fuel oil. Red Arrow Products Ltd. extracts chemical products for its food flavouring operation from the bio-oil including hydroxyacetaldehyde (HA), a valuable substance with many possible industrial applications which is difficult to produce synthetically. In this 'fast pyrolysis' process, wood is heated very rapidly in the absence of oxygen and at atmospheric pressure. Rapid cooling ensures the preservation of the valuable liquid products. About three-quarters of the wood becomes a liquid bio-oil, while the remainder becomes charcoal and fuel gases. The latter are used to provide energy for the process. The bio-oil, with a heating value slightly more than half that of light oil, can be used to substitute for regular heating oil or heavy oil in driers, boilers and furnaces. Early tests in Finland indicate that diesels can be modified to accept this fuel directly, and additional tests in gas turbines are planned.

The European Community has announced its intention to fund a demonstration plant to be built in southern Europe with the expected participation of the Italian power utility ENEL. The process originated more than ten years ago at the University of Western Ontario and was developed with the aid of the CANMET arm of the Department of Energy, Mines and Resources and the Enersearch Program of the Ontario Ministry of Energy. Recently, Innovation Ontario Corporation has become an investor in the company. A minority position is held by RockCliffe Research and Technology Inc., a firm established by Dr. Stuart L. Smith, a former Chairman of the Science Council of Canada, who serves as Chairman of Ensyn's Board of Directors. Discussions are underway with a number of prospective Canadian users of the new process.

• China and Russia have separately each agreed to build two 300 MWe nuclear power stations in Iran. The three countries state that the new facilities are for peaceful purposes and that they will be subject to inspection by the International Atomic Energy Agency (IAEA).

Update *is written by John Walsh, Ottawa, Canada.*
