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# Update

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## Seminar on Greenhouse Gases and Climate Change

The Framework Convention on Climate Change, negotiated at the Earth Summit in Rio de Janeiro by 155 countries in 1992, came into force in March 1994 following ratification by the 50th signatory. The ultimate objective of the Convention is "to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." The immediate aim is to return emissions to 1990 levels by the year 2000, but this is not a formal legal obligation. All parties are, however, examining strategies for reducing emissions and adapting to global climate change.

These obligations were considered in Canada at a federal-provincial meeting of Ministers of the Environment and Energy held last November 1993 in Saskatoon. The coordinating mechanism for these federal/provincial discussions is illustrated in the attached chart. Options for an Action Plan

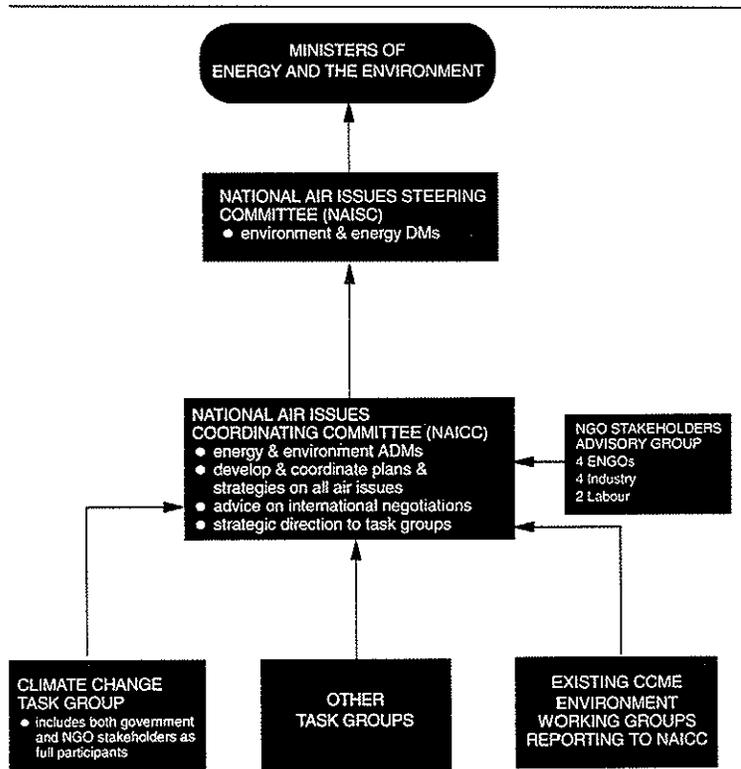
are to be considered at the next meeting of Ministers in November 1994. On August 23, a preparatory meeting was organized by Natural Resources Canada's Panel on Energy R&D (PERD) to review the status of the most recent scientific findings related to global climate change. In addition to government scientists and policy makers, representatives of the main Canadian energy and environmental groups concerned with this subject were invited to attend.

The special session, involving eight speakers, was introduced by M.D. Everall, Assistant Deputy Minister at NRCan and Chairman of PERD. He stressed the difficulties inherent in decisionmaking when there are many contradictions and uncertainties.

Dr. David Fisher of the Geological Survey led off with the most recent information available from the paleo record derived from ice cores, mainly in Antarctica and Greenland, although some have been drilled in the Canadian north. Because the maximum thickness of the ice is greater than 3 km in Greenland and greater than 4 km in Antarctica, it is possible to

determine the record over many years. This century has seen increases in Arctic summer and annual proxy temperatures derived from the cores that are unique over the last 1000 years, but not unique in the perspective of the last 11,000 years. The surprise has been the discovery of very rapid changes in temperatures during the ice age. These changes, now known as Dansgaard/Oeschger events, translate into sudden temperature changes of as high as 6°C. Rapid changes in the pattern of ocean currents may be the explanation.

Dr. Henry Hengeveld of the Canadian Climate Centre in Downsview, Ontario, presented information on the carbon cycle originating from Dr. Inez Fung of the University of Victoria, who was absent due to illness. The earth's carbon cycle was stable for the period 900-1800 AD, but the concentration of carbon dioxide in the atmosphere started to increase due to the rising consumption of fossil fuels and changes in patterns of land use. This has now been demonstrated by the depletion of carbon fourteen-isotope in the atmosphere below what would be



DM = Deputy Minister; NGO = Non-governmental organizations

**Figure 1:** Federal/Provincial Energy/Environment Coordinating Mechanism for Air Issues

expected since the fuels consumed now were fossilized long ago. The proportion of the CO<sub>2</sub> remaining in the atmosphere is between 0.4 and 0.6 of the fossil fuel emissions, but there have been recent variations in the change of atmospheric CO<sub>2</sub> content that are not yet adequately explained. In the overall balance, there is a missing sink of the order 1.7 ± 1.8 GT C/year, with changes in land use responsible for the greatest uncertainty.

Prof. Nigel Roulet of McGill University dealt with the other greenhouse gases. Though less concentrated in the atmosphere, they tend to be increasing more rapidly than CO<sub>2</sub> (such as CH<sub>4</sub>, which has been increasing at 0.6%

per year) and be more active interceptors of radiation. Of special interest is the role of aerosols derived from sulphur, which is largely emitted in the non-ferrous metals industry and in combustion processes. Though shorter-lived in the atmosphere compared to CO<sub>2</sub>, the tiny dust-like particles which form inevitably from the oxides of sulphur mask the greenhouse effect. The most recent papers suggest that, while the global circulation models indicate that the present increase in CO<sub>2</sub> should have caused an increase in temperature of 2.1°C, the action of the aerosols may have screened 1.0°C of this heating effect, which would bring the prediction more closely in line with obser-

vations. Present efforts to reduce sulphur dioxide emissions to prevent damage from acid rain may therefore aggravate the warming tendency. Combustion processes are, however, a relatively minor source of nitrous oxide.

Dr. Lawrence A. Mysak of McGill University dealt with the oceans. For the following reason, they have become a very important topic in relation to climate change in recent years: oceans cover two-thirds of the earth and as much heat is stored in the top three metres of water as in the entire atmosphere. Carbon dioxide (but not other greenhouse gases) dissolves rather rapidly in the surface layer of the ocean and the large inertia of its thermal mass slows down climate changes.

The ocean currents account for about one-half the heat flow to the northern hemisphere, with the rest transported by circulation of the atmosphere. Recent studies have tended to concentrate on thermohaline circulation — the huge conveyor belt in the ocean that upwells in the Pacific and downwells in the north Atlantic. It is feared that this massive circulation, which brings much energy to the northern hemisphere, could be disturbed by climate change. Ironically, because of the bifurcation behaviour inherent in modern chaos theory, it is even possible that global warming could lead eventually to global cooling. The recent cooling of the water in the Labrador Current is believed to have adversely affected the eastern fishery, but it is too early to assign causal relationships to global climate change phenomena.

Prof. J.-P. Blanchet of the Université de Québec à Montréal reviewed the progress made in building climate system models, which fill the gap between theory and observation. There is now

increasing confidence that the climatic effects of volcanic eruptions and El Niño ocean surface currents can be predicted fairly well; recent events have proved a useful test of the validity of the models.

Prof. Daniel Harvey of the University of Toronto dealt with the question of climate change detection in terms of indicators, potential lags and short-term reversals, expected fingerprints, causal attribution, and diurnal patterns. He also believes there is evidence that aerosols originating from sulphur oxides are offsetting about one-half of the heating due to increases in the concentration of greenhouse gases. Furthermore, there are now indications that this effect underlies at least part of the diurnal heating pattern of greenhouse gases. It has been known for some time that heating occurs mainly at night and this effect, and the strong regional variations in global warming measurements also observed, can be explained to a considerable degree by the screening action of the sulphur aerosols with aerosols acting in conjunction with greenhouse gases. Overall, the warming observed to date is thus "consistent with the expectation of significant long-term warming (1.5°C-4.5°C for CO<sub>2</sub> doubling) in response to greenhouse gas increases."

Dr. Ian Burton of the Atmospheric Environment Service in Toronto discussed the vulnerability of ecosystems. He showed that it is the natural biological systems on land and in the seas that are the most at risk, since man and the biological systems he uses can adapt faster than nature left to itself without human intervention. The boreal forest that covers much of Canada was given as an example: in one scenario involving twice the

present CO<sub>2</sub> concentration in the atmosphere, this class of forest could decrease from 23% of the major world forest types to essentially disappear at 1%.

The last speaker, Dr. Erik Haites of the Toronto consulting firm Barakat and Chamberlin, serves on Working Group III of the International Program on Climate Change (IPCC). The present studies of this Group concern the formulation of six scenarios (not forecasts) for anthropogenic emissions of greenhouse gases without the intervention of policies to limit greenhouse gas emissions. These scenarios extend out to 2100 for a world divided into four regions and it not surprising that there are large differences in emissions among them. Carbon dioxide emissions range from 1.2 to 60.0 Pg C/year (1 Pg = 1GT = 1000 million tonnes) in the different scenarios, but the range of cumulative emissions over the period is smaller: from 494 to 3447 Pg C. This factor of about seven leads to atmospheric concentrations that differ by a factor of two. The reason for the differences among the scenarios arise from widely disparate views concerning population growth and economic activity throughout the next century. These scenarios will be used in other IPCC studies.

The general discussion following the presentations was chaired by Dr. J.P. Bruce, Chairman of the Canadian Climate Program Board. It is clear that the science is difficult, the results complex, the uncertainties large, and the stakes enormous. The more we know, the more we don't know. There will be surprises yet, but the sooner action is taken the easier the problem will be to deal with. Although the science is on the right track in the main, no one should expect absolute answers in as soon as five years. The points raised by recent

sceptics (particularly after the very cold winter in eastern Canada in 1993/94) were on the whole addressed satisfactorily.

Recent papers on these topics are available directly from most of the speakers and a limited number of copies of a compilation of the overheads presented at the seminar can be obtained from the Office of Energy R&D, Natural Resources Canada, 580 Booth Street, Ottawa, Ontario, K1M 0E4 (Fax: (613) 995-6148).

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### World Energy Efficiency Association

The World Energy Efficiency Association (WEEA) was established as a private, non-profit organization in June 1993 in response to a study conducted by the Atlantic Council, entitled *Energy Technology Cooperation for Sustainable Development*. WEEA seeks to increase efficiency in global energy use by (1) serving as a clearing house for information on energy conservation programs, technologies, and measures; (2) disseminating this information worldwide; and (3) publicizing international cooperation efforts in energy conservation.

Under the chairmanship of W. Kenneth Davis, a former US Deputy Secretary of Energy, the new organization provides a center for information transfer to serve more than 100 energy efficiency/conservation organizations throughout developing countries, Eastern Europe, and the countries emerging from the former Soviet Union. Its members include private and governmental institutions with a significant interest in energy efficiency. About 50 such organizations were represented at the first annual meeting of WEEA held in Tunis in January 1994. The

Canadian Energy Research Institute in Calgary was among its founding members and is represented by its President, Dr. Gerry Angevine.

WEEA can be contacted at 1616 H Street, N.W., Washington D.C. 20006 (Fax:(202) 737-5163).

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## New Reports Available

### *NEB: Annual Report*

The Annual Report of the National Energy Board for 1993 was released at the end of March 1994. Canadian energy production increased strongly by 5.1% over 1992, though energy consumption rose at the more moderate pace of 2.9%, with the largest share of the latter increase coming from growth in natural gas demand. Total energy exports and imports are estimated to have risen by 9.0% and 5.8% respectively. The value of petroleum, natural gas and electricity exports is estimated to have increased from \$15.9 billion in 1992 to \$17.9 billion in 1993, leading to an increase of \$2.1 billion in the value of net energy exports for the year.

During 1993, activity levels in land drilling and the geophysical sector increased markedly from 1992 levels, reflecting growing optimism, particularly in the natural gas sector. The Board's estimate of remaining reserves of conventional crude oil is 680.1 million m<sup>3</sup> (4300 million barrels (MMbbl)) as of December 31, 1992. This is an increase of about one-half percent or 4.0 million m<sup>3</sup> (25 MMbbl) as compared to year-end 1991 and is equivalent to a replacement of 105% of conventional production during the year. A significant portion of these additions resulted from the application of horizontal drilling, as well as from an upward adjustment to reserves recognized

for the Hibernia field off Newfoundland. Total remaining established reserves of conventional oil and bitumen, as of December 31, 1992, were 1162.3 million m<sup>3</sup> (7300 MMbbl) compared with 1178.1 million m<sup>3</sup> (7400 MMbbl) at the end of the previous year.

Production of crude oil and equivalent in Canada averaged 289,300 m<sup>3</sup> (1.82 MMbbl) per day in 1993, an increase of 5.5% over the 1992 level. Production would have been higher had space been available on trunk pipelines. Supply from eastern Canada, though small, increased due to the start-up of production from the Cohasset offshore field and the introduction of year-round production from offshore Nova Scotia. Synthetic oil production from the oil sands mining-based plants in northeastern Alberta averaged 38,800 m<sup>3</sup> (243,900 bbl) per day in 1993, 4.2% higher than the previous year despite a number of operational problems that were experienced. Imports also increased by nearly 14%, but Canada remained a net oil exporter.

The Board's estimate of remaining established reserves of marketable natural gas is 1,911 billion m<sup>3</sup> (67.5 trillion ft<sup>3</sup>) a decrease of 369 billion m<sup>3</sup> (13.0 trillion ft<sup>3</sup>) from the previous year, but this was mainly due to a reclassification of reserves in the North. Nevertheless, production exceeded reserves additions in the Western Canada Sedimentary Basin in 1992. Natural gas production is estimated at 127.5 billion m<sup>3</sup> (4.5 trillion ft<sup>3</sup>) in 1993, an increase of 11% over 1992. Domestic demand increased by 5.8%, while exports to the US increased by about 8.6% to 63.0 billion m<sup>3</sup> (2.2 trillion ft<sup>3</sup>). All were new records.

Canada's net electrical generating capacity was estimated at 109.1 gigawatts, an increase of about 3% over 1992. Net generation is

estimated at 512,000 gigawatt-hours (Gwh), an increase of 2% over 1992, which was derived 62% from hydro, 22% from conventional thermal, and 16% from nuclear generation. Total Canadian consumption was estimated at 485,200 GWh, a 2% increase, and exports increased 12.2% due to favourable domestic hydraulic conditions and greater export demand. Total export sales were 29,364 GWh, with an associated revenue of \$858 million, a 23% increase with net exports at 26,673 GWh.

An extensive expansion of the trunk pipeline system of Canada is now underway. In 1993, the Board approved the construction of some 360 kilometres (220 miles) of line. In April 1994, the Board approved an expansion proposed by Trans Mountain Pipe Line Company Ltd that will permit the shipment of an additional 6,000 m<sup>3</sup> (38,000 bbl) of oil per day costing \$27.5 million.

In August, Foothill Pipe Lines (Alta) Ltd applied to construct and operate a pipeline consisting of approximately 215.5 km (134 miles) of 914 millimetre (36 inch) diameter pipeline, to be called the Wild Horse Pipeline, which would be capable of transporting 20.89 million m<sup>3</sup> (737.5 million ft<sup>3</sup>) of natural gas per day. The new line would link the facilities of NOVA Gas Transmission Ltd with the proposed Altamount Gas Transmission Company at the Alberta/Montana border.

The Annual Report as usual contains much valuable information concerning regulatory matters and a large number of useful tabular appendices.

*NEB: Canadian Energy Supply and Demand 1993-2010*

On July 28th, the NEB released its fifth report since 1981 in the series

*Canadian Energy Supply and Demand*, covering the years 1993-2010 (ISBN 0-662-22422-1). Since July 1987, when the Market-Based Procedure (MBP) for regulating natural gas exports was adopted by the Board, these reports have been published as one component of an ongoing monitoring process. The previous report was issued in the fall of 1991. The present report, subtitled *Trends and Issues*, is essentially a 61-page summary of studies conducted by the NEB; a supporting *Technical Report* is to be issued this fall.

NEB staff have continued to use the informal consultation process adopted earlier; it involves two rounds of discussions with interested parties concerning the identification of issues, the appropriate analytical approach and the report format. A brief report on the first stage of these consultations was released in July 1993. A second round of consultations, to discuss preliminary results, was held in December 1993 and important differences between the views of those consulted and the Board's analysis were noted and discussed in the report. The stated objectives are: (1) to provide a comprehensive 'all energy' market analysis and outlook to serve as a standard reference for all parties interested in Canadian energy issues; (2) to provide a framework for public discussion on emerging energy issues of national importance; and (3) to monitor the prospects for the supply, demand and price of natural gas in Canada pursuant to the MBP.

The report is in some important respects a natural gas-based view of the energy system and in this respect it is unusual. Also unusual for this type of study is the absence of international oil price projections, which are often used to derive various possible

outcomes. However, the report was prepared at a time of stable and indeed declining oil prices. An average economic growth rate in the OECD nations, including the US, at about 2.5% per year is expected, but with slower growth particularly in Europe and Japan. Higher growth rates are expected in the Far East and economic growth is expected to resume in Eastern Europe before the year 2000. The economic assumptions are thus quite conservative, perhaps reflecting the tenor of the time during which the report was prepared, when oil prices had fallen to the \$14-15 (US\$) range at their lowest.

Two main cases are postulated: in the first, termed Current Gas Supply Technology (denoted 'Current Tech'), supply costs increase as new reserves are found and developed; and in the second, termed High Gas Supply Technology ('High Tech'), supply cost increases are mitigated by technological improvements. Though derived for natural gas, these cases were applied comprehensively to all supply sectors and to the demand for energy. These cases were defined because of the rapid advances in exploration techniques (notably three-dimensional seismological analysis) and in production technology (especially horizontal drilling).

Large increases in production are considered possible for natural gas. The analysis suggests output could reach about seven exajoules per year (6.7 trillion ft<sup>3</sup>) towards the end of the study period, compared to 4.7 exajoules (4.5 trillion ft<sup>3</sup>) in 1993. Exports to the US are the most important influence. This production can be supported by the resource base without the need for supplies from the Arctic or from other non-conventional sources, such as methane

drainage from coal seams. Estimates of the resource potential are still increasing with time, though much more drilling will be needed to meet such a massive increase in production. By 2010, Alberta field-gate prices are projected to average about \$4.00 and \$2.25/GJ in real terms in the Current and High Tech cases respectively (an average annual increase of 6% and 2% respectively) as compared to the 1993 level of \$1.58.

In the case of oil, the outlook for production is thought to be very dependent upon price. Below \$US15 per barrel, only conventional oil from the Western Canadian Sedimentary Basin is viable and output will decline, although some low-cost exploration 'plays' remain. The advent of horizontal drilling is important in maintaining Canadian production. Within the \$US 15-26 range, the amount of production and the number of economically viable sources is sensitive to price changes. Prices above \$US26 are sufficient to justify the development of a number of additional Canadian sources, including the oil sands of Alberta and resources already known in the Beaufort Sea and off the East Coast. The study assumes a continued degree of cohesiveness among the OPEC producers, but notes that prospects for the development of non-OPEC oil around the world will prevent international prices from rising above about \$US25.

In the cases studied, Canadian electrical demand is projected to grow at just over 2% per year, from 477 to almost 700 terawatt-years from 1992 to 2010. It is assumed there will continue to be a surplus to support exports to the US. With greater inter-provincial cooperation, major hydroelectric projects in Manitoba and Labrador could make additional fossil fuel-generating capacity unnecessary in any

province "from Newfoundland to Saskatchewan" during this period.

Coal prices are expected to rise at an annual rate of 0.5% over the period, the lowest increases among the competing fuels. The authors believe inter-fuel competition and undesirable environmental properties, in combination with abundant supply, should act to maintain low coal prices.

The analysis in this report suggests that emissions of carbon dioxide and methane will continue to rise over the study period, assuming that specific greenhouse gas control measures are not implemented. Data used to prepare the graphs in this report will be provided on a computer disk on request.

*NEB: Licensing Oil Sands Production Exports*

At the request of a former Natural Resources Minister, the National Energy Board carried out an *Inquiry into the Licensing of Long-term Exports of Oil Sands Production*. This report (ISBN 0-662-21583-4, February 1994) on it was released by NRCan in May. The Board expressed the view that "it would be in the public interest to minimize any potential impediments to the attraction of the capital necessary for the development of this resource." Various regulatory options to reach this objective were then explored. A *Discussion Paper* appended to this report provides a succinct and valuable review of the present status of the very large resources available, the current development of the oil sands industry and the relevant regulatory framework.

These NEB reports may be obtained from the Board at 311 Sixth Avenue S.W., Calgary, Alberta, T2P 3H2 (Fax:(403) 292-5503).

*Energy Council of Canada: 1994 Assessment Report*

The second report in the Canadian Assessment Series, entitled *Energy for Tomorrow's World - A Canadian Perspective*, was released by the Energy Council of Canada in June. The 11-page report concludes that Canada has a secure energy future, but must continue to improve its energy efficiency and ensure that environmental regulations and economic competitiveness are appropriately balanced. The study also identified Canada's potential to help developing countries meet their increasing demand for energy in a sustainable way.

This document includes a review of a report from the World Energy Council on the same subject from an international perspective and concludes with an assessment of the current Canadian energy outlook.

Special attention is given to the problem of stabilizing greenhouse gas emissions, but the report concludes that the introduction of a national carbon tax would be an unnecessary and inappropriate action at this time. However, the Council does propose the early formation of a high-level, industry-driven task force that would examine such possibilities as: improving efficiency in energy supply and use by working with transitional countries on energy developments and nuclear plant safety; assessing hydroelectric and other renewable resource potential in specified developing countries; and further developing energy resources in specified developing countries in an environmentally sustainable manner. Extensive opportunities are foreseen for the Canadian energy industry in international ventures of one kind or another.

Copies of this new Assessment

Report may be obtained from the Energy Council of Canada, Suite 400, 30 Colonnade Road, Nepean, Ontario, K2E 7J6 (Fax:(613) 952-6470).

*US National Biofuels Roundtable: Biomass Energy Systems*

In May 1994, the Roundtable released a 26-page report entitled *Principles and Guidelines for the Development of Biomass Energy Systems*. The US National Biofuels Roundtable was established in 1992 by the Electric Power Research Institute and the National Audubon Society, with support from the US Department of Energy, for the purpose of reaching a consensus on the development of biomass energy in a sustainable manner. In 1990, the US obtained 3.7 EJ (3.5 quads) of energy from this source, of which 79% was derived from forest and mill residues. In 2030, the Roundtable expects biomass sources to provide 15.6 EJ (14.8 quads) — an increase by a factor of 4.2 — with 66% coming from dedicated energy crops.

The report proposes general principles for policymakers interested in promoting biomass energy development and guidelines for energy crop management. It also identifies the main barriers confronting commercialization of biomass energy and offers policy options to address these obstacles.

This study is of interest because Canada typically obtains about 3.5% of its primary energy from biomass. Many believe that Canada has the highest potential per capita biomass option in the world. Copies may be obtained by contacting the National Renewable Energy Laboratory, 1617 Cole Blvd., Golden, Colorado, USA 80401.

*Environment Canada: Modelling the Global Climate System*

This 20-page report was prepared in response to questions often posed by policy makers and others on how climate models work and what their roles are in improving our understanding of the global warming issue. It considers the climate system, the development of climate modelling, and the anatomy of a general circulation model, and deals with the question of what the models tell us, the question of confidence, and the steps needed for the reduction of uncertainties. The report concludes with a section on the status of international cooperation and the present and future of climate modelling.

The report is a brief but comprehensive guide for the non-expert observer of this field. It was prepared as a Special Edition in the Climate Change Digest Series (designated CCD 94-01) and is available from the Climate and Atmospheric Research Directorate of Environment Canada at 4905 Dufferin Street, Downsview, Ontario, M3H 5T4 (Fax: (416) 739-4882).

*Environment Canada: State of the Environment Indicator Bulletins*

State of the Environment Indicator Bulletin 94-3, titled *Energy Consumption* and dated March 1994, gives a brief (four-page) but concise picture of the consumption of energy in Canada from 1958-1992 in the form of graphs and charts. The *Technical Supplement* (available separately) provides these data in detailed tabular form with references to sources and the methodology used. The Bulletin notes that "on a per-person basis Canada consumes more energy than any other country in the world except Luxembourg" and provides the

following reasons: "vast distances that encourage car use, a cold climate, an energy intensive-industrial base, and relatively low energy prices." The report further notes that "the extent and nature of [energy use] are major influencing factors affecting both environment and the economy" since, in 1992, 6.9% of Canada's gross domestic product, 16.0% of gross investment, 11.2% of gross export income, and 1.8% of employment were represented by the production of energy.

State of the Environment Indicator Bulletin 94-4, titled *Climate Change* and dated May 1994, is a four-page synopsis of greenhouse gas emissions in Canada that includes easily read graphs with the following titles: Canadian Carbon Dioxide Emissions (1958-1992), Global Atmospheric Concentration of Carbon Dioxide (1958-1992), Global and Canadian Average Temperatures (1895-1992), and Concentrations of Other Greenhouse Gases. There is also a pie-chart of CO<sub>2</sub> emission sources by sector. General industry is the largest single source, accounting for 27% of emissions in 1992, followed by power plants at 22% and gasoline vehicles at 16%. An extensive *Technical Supplement*, which provides much background data in tabular form, is available separately.

The Bulletin notes that Canadian emissions of CO<sub>2</sub> from the use of fossil fuels were more than twice as high in 1992 as in 1958.

These Bulletins are to be updated annually. Copies may be obtained from Environment Canada, Ottawa, Ontario, K1A 0H3 (Fax: (819) 953-2225).

*IEA: Greenhouse Gas R&D Programme*

A 28-page summary report, entitled

*Carbon Dioxide Capture from Power Stations* has been published by the International Energy Agency's Greenhouse Gas R&D Programme. It is priced at £13. A number of case studies of fossil fuel-based power plants were conducted, coupled with carbon dioxide removal technologies at the common scale of 500 MWe. The removal technologies assessed were absorption, adsorption, membranes and cryogenic processes.

These studies have been undertaken for several reasons: because there is a large existing investment in fossil fuel consumption; the technology is available and implementation is possible within 10 years; the cost is in the range of other major control options; and because this option is likely to result in less structural change in society than most others directed to the same end. The incremental cost of electrical energy with the addition of capture and disposal means for CO<sub>2</sub> using the best available technology was optimized at 1.5-2.0 ¢/kWh using natural gas as the fuel, and 2-3 ¢/kWh for coal.

It has been agreed that the work of the Programme will continue until November 1997. Canada will remain a member, along with Australia, Denmark, Finland, Italy, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, the UK, the US and the European Union. The Electric Power Research Institute in the US will also become a sponsor, joining some German organizations that are already private participants. British Coal is the Operating Agent and a contributing member. The Project Director is Mr. I.C. Webster, a Canadian well known in Alberta oil industry circles.

The publication of the news circular *Greenhouse Issues*, available without charge, will continue.

These and other publications may be obtained by writing to the IEA Greenhouse Gas R&D Programme at the Coal Research Establishment, Stoke Orchard, Cheltenham, Gloucestershire GL52 4RZ, United Kingdom (Fax:+44 242 680758).

## Short Notes

### *Government Policy*

- In August, the federal government and the Province of Alberta announced they will relinquish their interest in the Bi-Provincial Upgrader at Lloydminster, Saskatchewan, to the operator, Husky Oil Company, and the Province of Saskatchewan, who will share ownership equally. This installation, designed to convert heavy oil to synthetic crude at a capacity of about 7,313 m<sup>3</sup> (46,000 bbl) per day, has been losing money steadily. The agreement ends the federal government's involvement in the project for a payment of about \$42 million for its 31.67% share. Alberta will receive about \$32 million for its 24.17% share. The investment in this undertaking cost the two governments \$558 million and \$424 million respectively. The agreement provides for some recovery of the funds invested if the spread between heavy oil prices and the synthetic crude produced widens sufficiently to allow a profit to be made. Some 400 jobs will be preserved.

- According to a 37-page strategic plan, entitled *Fueling a Competitive Economy*, the US Department of Energy is re-examining its mission. Less emphasis is to be placed on coal and oil and more on renewable and alternative energy sources. DOE will concentrate on five areas in the future: national security, industrial competitiveness,

energy resource conservation, new uses for science and technology, and environmental protection. The future of the national laboratories is still unresolved and a commission has been appointed to review how best they may be employed in the post-Cold War era.

- In June, the Minister of Natural Resources Canada, the Hon. Arne McLellan, announced an extension of the Market Development Incentive Payments programs (MDIP) to establish new markets for natural gas and methanol as alternative transportation fuels. The MDIP extension will continue initiatives launched by the Federal and Alberta governments in 1989. During the next three-year period, NRCAN will administer the balance of the MDIP funds, totalling approximately \$15 million on programs in support of the two fuels. Typically, the program provides funds in the range of \$500 to \$1000 for either new or after-market conversions of vehicles to one or other of the two fuels. Funds are also available for underwriting of up to 25% of the capital cost (to a maximum of \$50,000) for fueling facilities.

### *Oil and Gas*

- Production has begun at the Shell Oil Company's Auger Platform in the Gulf of Mexico, erected in the deepest water yet at 872 metres (2,860 feet). Built at a cost of \$US1.2 billion, production from the 14 wells on the platform is expected to reach 7313 m<sup>3</sup> (46,000 bbl) of oil and 3.54 million m<sup>3</sup> (125 million ft<sup>3</sup>) of natural gas per day by the end of this year. The oil is piped to another rig nearer the shore for final shipment. The company is planning to begin production in 1996 from still deeper water at 894 metres (2,933 feet) at the Mars platform, some 323 km

northeast of the Auger platform. (This successful development is relevant to the problem of the disposal of captured carbon dioxide in the deep ocean, for which it may be necessary to lay pipelines at even greater depths.) In contrast, the Hibernia platform will stand in about 80 metres of water off Newfoundland and produce 17,488 m<sup>3</sup> (110,000 bbl) per day. The Hibernia platform must contend with the more difficult conditions in the North Atlantic and the occasional iceberg, while the Auger facility must deal with the odd hurricane.

- Quebec's natural gas distribution system will be extended with the aid of the federal government's infrastructure program. The federal and Quebec governments will contribute \$34 million of a \$125 million project to lengthen Gaz Metropolitan's pipeline system to more than 500 kilometres. Natural gas service will be extended to the Laurentian area north of Montreal, to the Beauce region south of Quebec City, and to Val-d'Or in the northwest part of the province. The Trans Quebec and Maritimes Pipeline Inc. has applied to the National Energy Board to construct a pipeline that will cross the St. Lawrence River at Quebec City to serve new markets and to allow the development and operation of a new underground natural gas storage facility near the town of St. Flavien.

- A two-million dollar test of the cosmologist Thomas Gold's theory of the non-biological origin of oil is under way in western Canada. A well will be drilled 2,100 metres through the oil sands of Alberta into the Precambrian rock below. The Calgary geologist Warren Hunt believes, following Gold, that the oil sands were formed when oil originating in the granite seeped into the sands above. A deep well

drilled to test the theory in Sweden some years ago was disappointing, but some anomalous results were found.

#### *Nuclear Notes*

- Nuclear generation in the US fell 1.4% in 1993, suggesting that the long period of increases in that country are at an end as the industry reaches maturity. No new reactors have been ordered for a long time.
- Surplus weapons-grade plutonium from Russia and the US may be disposed of in operating CANDU reactors. AECL and Ontario Hydro are investigating this possibility in conjunction with American agencies. Existing American light water reactors are not suitable for this practice.
- An interesting article by Alexander V. Kalinin on the nuclear weapons and power industry of the old Soviet Union has appeared in *IEEE Spectrum* (May 1994, pp. 32-38). By the late 1980s, this industry had produced and maintained a stockpile of 45,000 nuclear warheads and was operating 40 power reactors in the Soviet Union. The nuclear-industrial complex was also responsible for propulsion reactors for submarines and ice-breaking vessels, facilities for mining and enriching uranium, and fabricating and reprocessing fuels, as well as conducting research and the other needs of self-sustaining nuclear establishment. Its total staff numbered at least one-half million. By the end of the 1980s, the natural uranium being used for the Soviet Union's military needs had reached about half the consumption of natural uranium for power production in the entire world. The total Soviet plutonium heritage might be about 300 tonnes.

In light of the break-up of the

USSR, most of the sensitive operations have now been relocated into Russia itself. Supplies and services are now being offered on world markets, sometimes publicly and sometimes not. At the end of 1992, the total installed nuclear capacity of the former Soviet Union was 39 GW, about 12% of total electrical capacity. The article deals extensively with the deficiencies of the different power reactor types that were placed in service.

- Atomic Energy of Canada (AECL) announced it is negotiating the sale of as many as seven nuclear reactors to China. The reactors would be of the CANDU 6 class — the same type as those recently sold to Korea. AECL hopes to complete the first sale within two years. China continues to grow rapidly and faces severe shortages of electricity. As the world's largest producer and consumer of coal, the Chinese energy economy is heavily dependent upon this fuel; this has resulted in severely adverse environmental conditions in some regions. Financing would be required from the Canadian Export Development Corporation and private banks, and it may be necessary to resolve issues involving safeguards. Competition is expected from suppliers in the US, France and the UK. Good performance of CANDU reactors in Korea may be a factor in influencing the Chinese decision.

- On the occasion of the visit in June 1994 of the Argentine President, Carlos Saul Menem, Canada and Argentina signed a treaty on international nuclear cooperation. The signing was made possible by the acceptance by Argentina of international conventions governing the peaceful use of nuclear power. The agreement will enable Canadian companies to pursue opportunities in Argentina arising from the privatization plans of the

Menem government. These facilities include a 650 MW(e) CANDU reactor that went into service in 1983 and operated at 99.8% of capacity in March. Nuclear energy supplied 15.7% of the country's electricity in the first quarter of 1994. A second reactor of 350 MW(e) capacity is in operation, also based upon heavy water and natural uranium, and a third is under construction but both the latter are of German design. The new agreement would allow Canada to sell new reactors and to supply parts and fuel for the reactors of German origin.

- The Clinton Administration has approved \$317 million in loan guarantees through the Export-Import Bank to finance a project by the Westinghouse Electric Corporation in which it will use its own technology to complete two Soviet-designed nuclear reactors in the Czech Republic. The reactors at Temelin are of the VVER-1000 type, the most advanced reactors of Soviet design. The Czechs would like to diversify their sources of energy and reduce their dependence on the consumption of high-sulphur coal. The project is aimed at increasing the safety of this plant and as a step towards the conversion of 16 uncompleted reactors in Eastern Europe, as well as the more than 50 units either operating or under construction in Russia, Ukraine, and Bulgaria. Objections to this proposal have been made by near-by Austria and there have been concerns raised in the US as to the possibility that one of its agencies might become liable for damages in the event of an accident.

#### *Technology News*

- United Solar Systems Corp. of Newport News, Virginia has announced a \$30 million facility for

the manufacture of photovoltaic panels that will begin production in 1995. A new process is employed based upon amorphous silicon technology developed with the support of the US Department of Energy. It is expected to reduce the cost of generating electricity to about 12 ¢/kWh. US utilities charged residences an average of about 8.2 ¢/kWh in 1992. (Source: IEEE Institute)

- In May, Prof. Martin Green, Head of the Centre for Photovoltaic Devices and Systems at the University of New South Wales in Australia, announced important progress in the field of solar generated electricity. He stated: "Now we know how to do it" and projected an investment cost of less than \$1/watt, a level competitive with other generation techniques. No technical details were disclosed.

- At the American Tour de Sol, a race for electric and solar-powered cars held in May of 1994, a General Motors Geo Metro car converted for battery operation by the Solectria company cruised a record 345.5 km (214.2 miles) without stopping.

At the same race, a 25-passenger electric zero-emission transit bus based upon hydrogen fuel cells was demonstrated by its prime contractor, the H-Power Corpora-

tion. The hydrogen was produced on board this bus by the reforming of methanol. While the fuel cells employed were of the phosphoric acid type of Japanese origin, this company is also interested in cells based upon the more promising proton exchange membrane (PEM) system, which is used in another bus demonstration project mounted by Ballard Power Systems of North Vancouver, B.C.

- The three major auto manufacturers in the US have announced a collaborative effort to develop natural gas-fuelled vehicles. The main objective of the new program will be to reduce the cost of on-board natural gas storage by such techniques as winding strengthening wire cages around the pressurized tanks, the high cost of which has been an important obstacle to the widespread adoption of this technology.

#### *Environmental Issues*

- In May it was disclosed that Ontario Hydro was considering using the rainforests of Costa Rica as a sink for carbon from CO<sub>2</sub> emissions from fossil fuels. The utility was examining the possibility of acquiring some 12,200 hectares (about 30,000 acres) for this purpose. From time to time other

generators of electricity — utilities and non-utilities alike — have made similar proposals for what are now termed 'joint implementation' (JI) activities. JI activities are defined as actions taken to reduce greenhouse gas emission undertaken by one party or country in cooperation with and located within another party's or country's boundaries. This particular option, though reasonably cost-effective in comparison with other CO<sub>2</sub> control measures, evoked considerable political controversy. The main objection seems to be spending money outside the country for this purpose. Though vigorously defended at first by the Chairman of the utility, Maurice Strong, the proposal is likely to be dropped.

- Studies conducted in Finland and the US suggest an association exists between electromagnetic fields and Alzheimer's disease. People with a high occupational exposure to EMF fields were found to be at least three times as likely to develop this disease as those without significant exposure. The degree of association was higher than that previously reported by some investigators with leukaemia.

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