Update

Cold Fusion

A low-temperature process for production of energy based upon the electrolysis of deuterium oxide (heavy water) was announced by Professor Stanley Pons of the University of Utah and Professor Martin Fleischmann of the University of Southampton (England) at a press conference in Salt Lake City on 23 March 1989. Deuterium produced by the electrolysis reaction was discharged into an electrode of palladium in a relatively simple apparatus. The experimenters reported that the presence of tritium concurrent with the release of heat and neutrons could only be due to fusion of deuterium atoms present within the palladium. The announcement was greeted by much surprise, excitement and scepticism among the scientific community and, in the weeks that followed, other laboratories around the world reported similar results. (Such results were not, however, duplicated at the Chalk River Laboratories of Atomic Energy of Canada Limited.) The news was widely disseminated throughout the media and public interest was aroused, however briefly, in the hope of the discovery of a possible low-cost source of energy that would be, in effect, inexhaustible (when based upon the deuterium contained in the oceans) and virtually pollution-free.

It soon became known that another group, headed by Professor Steven Jones working at nearby Brigham Young University, had been obtaining similar, but less striking, results by diffusing deuterium into electrodes of various metals during electrolysis, with titanium electrodes giving the best indications. Their investigations had been undertaken partly in response to two suggestions made by Soviet scientists in 1978: that the earth contains an isotope of helium not easily accounted for other than by assuming that some fusion reaction is proceeding in its interior, and that the planet is not cooling as fast as it would in the absence of an internal source of heat.

The sudden announcement of the cold fusion results by way of a press conference, as opposed to the conventional route of publication in scientific journals, may have been the result of patent considerations involving the two research groups.

As the weeks passed, doubts grew. Experimenters who had previously confirmed the results withdrew their claims. But on 23 June 1989, Edmund Storms and Carol Talcott of the Los Alamos National Laboratory reported confirmation of the presence of tritium upon duplication of the original experiments conducted at the University of Utah. They concluded this could be accounted for only by a fusion reaction taking place at room temperature.

While it is possible that a discovery has been made, the cir-

cumstances surrounding the original announcement were bizarre and the implications for the energy field are far from clear.

Development of the Hibernia Oil Field

The recent oil and gas discoveries off the eastern coast of Canada have wonderful names — Hibernia, Terra Nova, Whiterose and Venture. A firm agreement to proceed with development of the Hibernia field was announced in July 1988 with final details to be negotiated by March 31, 1989 among the two governments (Canada and Newfoundland) and the oil industry partners led by Mobil. When that date was passed the official explanation for the delay was the size and complexity of the agreement, to which both governments reiterated their commitment because of the great importance of this project to the economic future of Newfoundland. Energy Minister Jake Epp now says construction of the $5.2 billion megaproject should start early in 1991.

The intention is to produce some 110,000 barrels per day from Hibernia, the first offshore field to be developed on a commercial scale in the eastern region of the country, which is now increasingly dependent upon imported oil. The main problem is uncertainty over the price of oil. At current prices the project may be just marginally feasible. The proposed design is being reevaluated to see whether savings are possible by reducing the number of modules to five or six 'super modules' that would sit on a concrete platform, rather than the previously planned 20 smaller modules and the main support frame. Consideration is also being given to the use of smaller and fewer tankers, with a view to landing the oil in Newfoundland, then exporting it by supertanker. This would involve a cheaper system for loading the oil from the platform. By the current schedule, construction of the huge concrete and steel drilling platform will be completed in 1996.

Government support for this and other recent megaprojects has been questioned, especially in last year's *Energy Options Report*. The government believes these projects are necessary for both regional development and security of supply. There is an implicit assumption that oil prices will increase to at least some degree in the next decade, thereby improving the rate of return on these rather large investments.

International Energy Agency (IEA) Meetings

The regular Ministerial Meeting of the Governing Board of the Agency took place in Paris on May 30, 1989. The Hon. Jake Epp, Minister of Energy, Mines and Resources, attended for Canada. Ministers focused particular attention on two aspects of the current energy situation, both of which they viewed with deep concern: (1) the growing worldwide consumption of oil, particularly for transportation purposes, with its eventual medium-term consequences of a tighter supply/demand balance and renewed vulnerability to supply disruptions; and (2) the environmental aspects of energy supply and consumption, including both the conventional well-known pollutants and the growing atmospheric concentration of CO_2 and other 'greenhouse' gases that have long-term consequences for global warming and climatic change.

The need for increased international collaboration in dealing with environmental matters was acknowledged and it was agreed that the Agency will continue to cooperate with the OECD and will participate in the activities of the Intergovernmental Panel on Climate Change (IPCC), in effect recognizing the latter group as the focal point for these activities on the world scene. Ministers also noted with interest the special position of Sweden, which proposes to phase out the 12 nuclear reactors which now supply some 50% of its electricity; to control emissions of CO_2 from the consumption of fossil fuels; and, at the same time, to maintain economic growth. It is intended that these apparently contradictory objectives will be achieved mainly through combining conservation measures, such as increased use of combined heat and power stations, with greater reliance on (imported) natural gas and increased local use of biomass for energy. There are many similarities in the energy options open to Ontario and Sweden; developments there will no doubt be watched carefully here.

Prior to the Ministerial Meeting, on April 12-14, the Agency held an 'Expert Seminar' on 'Energy Technologies for Reducing Emissions of Greenhouse Gases.' Over 200 experts attended —

heads of research departments, government officials and scientists from 24 countries and international organizations. Seventy-two papers were presented, including one from Canada (by **Update's** Editor).

There were four specific objectives for the Seminar: (1) identification of energy technologies and systems to reduce emissions of greenhouse gases; (2) consideration of possible approaches to energy technology for the different energy use and conversion sectors, and adaptations of technologies to particular national or regional contexts, including the developing countries; (3) practical recommendations for R&D and demonstration initiatives in the main energy areas; and (4) development of suggestions for the coordination of energy technology programs and international collaboration. As this was the first major meeting to be held on this subject, it was difficult initially to focus discussion on the main objectives. However, as the meeting progressed, the main strands of agreement emerged. In this connection the following two points were emphasized.

(1) At present (and in the mid-term), technologies for improving energy efficiency seem to be the best option for reducing emissions of greenhouse gases, particularly carbon dioxide, the single biggest contributor. Development and diffusion of high-efficiency technologies in the transportation sector would offer the important additional advantage that they often increase productivity and economic growth. Furthermore, more efficient uses of energy reduce the waste heat generated directly and indirectly by all energy production and use processes, which may add to global warming.

(2) Other essential technologies are now available and have been demonstrated for reducing production of carbon dioxide. Experts repeatedly referred to technologies which set conditions for protecting forests and introducing reforestation schemes and to those which facilitate switching to less carbon-intensive fuels, such as natural gas, though the implications of the latter for the security of energy supply need appropriate analysis. (Canada and the USSR are among the few industrial countries that are also exporters of natural gas.) Additional key options would be those technologies which improve the characteristics of energy systems and fuel cycles in relation to greenhouse gas emissions; those which improve opportunities for increased use of carbon-free renewable sources, such as hydro, geothermal, solar and wind energy; and, where national and international conditions so allow and contemplate, those technologies which lead to continuing and expanding use of nuclear power.

Several noteworthy papers are briefly discussed here. G.J. MacDonald (Mitre Corporation, Mclean, VA) stressed the importance of natural gas in dealing with the global warming problem. He provided estimates of the resource base of natural gas, including an assessment of the extensive unconventional resources, such as the Arctic clathrates. He startled the meeting by reporting that there is now some evidence these clathrates are decomposing (perhaps a feedback link due to warming), thus releasing methane, a potent greenhouse gas, to the atmosphere.

Cesare Marchetti (International Institute of Applied Systems Analysis) extended his well-known logistic or 'market penetration' curves to the estimation of probable emissions of carbon in the next century. He believes that oil consumption will peak near the end of this century and natural gas consumption will increase rapidly in the early years of the next. He made the controversial prediction that one-half of the carbon emitted from the fossil fuels to the atmosphere will come from natural gas as early as 2010. The counter-intuitive conclusion from his studies: concentrate on controlling carbon emissions from natural gas, and link nuclear energy to the supply of natural gas via heat supplied from high-temperature gas-cooled reactors to provide the energy for reforming methane with steam.

M. Grubb (Royal Institute of International Affairs, London) made a careful and substantial contribution to the complex question of how to calculate carbon emissions from the three fossil fuels.

J.M. Ogden and R.H. Williams (Princeton University) presented an interesting and optimistic view of the possibilities for production of hydrogen in sunny regions in thin film solar cells.

K. Blok, C. Hendriks and W.C. Turkenburg (University of Utrecht) presented one of three papers at the Seminar which dealt with the costs of removing carbon dioxide from the exhaust gases of thermal power plants. Though the cost of electricity is thereby approximately doubled for a conventional power plant, the incremental cost of removing carbon dioxide in the emerging integrated-gasification combined-

Table 1: Importance of Energy Activities in the Generation of Major Pollutants

Pollutant	Man-made as % of total	Energy activities as % of man-made	Source of energy-related releases
SO_2	45% [3]	90% [3]	Coal combustion: 80% [1] / Oil combustion: 20% [1]
NO_x	75% [3]	85%	Transport: 51% [1] / Stationary sources: 49% [1]
CO	50% [3]	30-50% [3]	Transport: 75% [1] / Stationary sources: 25% [1]
Lead	100% [3]	90% [1]	Transport: 80% [2] / Combustion in stationary sources (including incineration): 20% [2]
Particulate matter	11.4% [3]	40% [1]	Transport: 17% [1] / Electric utilities: 5% [1] Wood combustion: 12% [1]
Volatile organic compounds	5% [1]	55% [1]	Oil industry: 15% [1] / Gas industry: 10% [1] Mobile sources: 75% [1]
Radionuclides	10% [3]	25% [3]	Uranium mining & milling: 25% [2] Nuclear power stations & coal combustion: 75% [2]
CO_2	4% [3]	55-100% [3]	Natural gas: 19% [2] / Oil: 47% [2] / Coal: 34% [2]
N_2O	25-45% [3]	75-95% [3]	Fossil fuel combustion: 85% [3] Biomass burning: 15% [3]
CH_4	60% [3]	15-40% [3]	Natural gas losses: 20-40% [3] Biomass burning: 30-50% [3]
CFC_3	100% [3]	10-30% [3]	Refrigeration, air conditioning: 40% [3] Insulation foam: 60% [3]
Hazardous wastes (excluding nuclear)	100% [3]	12% [3]	Main sources: combustion of coal & petroleum products, oil refinery, oil drilling & coal mining [4]

Notes:
1/ Estimates for OECD countries.
2/ Estimates for US.
3/ Global estimates.
4/ Hazardous wastes do not form a homogeneous category of pollutants. A percentage breakdown of the contribution of various sources is difficult.

Sources:
US. Dept of Energy (1986) *Environmental Trends Associated with the 5th National Energy Plan,* Argonne National Laboratory.
Wuebbles, O.J. and J. Edmonds (1988) *A Primer on Greenhouse Gases* [for the US Dept of Energy].
OECD (1985) *The State of the Environment 1985.*
Commission of the European Communities (1988) *The Greenhouse Issue,* (Environmental Resources Ltd).

cycle (IGCC) technology (including the costs of an additional 'shifting' stage) was shown to be possibly manageable. Disposal of the carbon dioxide into depleted natural gas reservoirs (as are becoming available in The Netherlands) was recommended. This technology may be of interest for application in western Canada.

The Proceedings of this Seminar have since been published by the OECD (ISBN 92-64-13267-8).

In August, Canada's energy ministers decided against adopting a target for reducing CO_2 emissions. In a communiqué issued after their meeting, the ministers "encouraged everyone to work toward a reduction of 20%" of 1988 levels, but set no target or timetable for reducing emissions.

The above table dealing with the importance of energy activities in the generation of major pollutants has been prepared by the IEA and the OECD.

Progress in the Field of Photovoltaics

Efforts continue worldwide to improve the technical performance of photovoltaic cells. Most industry observers believe the turning point for the success or failure of large-scale commercial photovoltaic activities is near. Small solar cells are already common in calculators and wristwatches, but large arrays of cells have only just begun to penetrate a large market. These involve such applications as highway and billboard lighting, navigation buoys, remote communications equipment and off-grid residential power. There are about a dozen experimental photovoltaic power plants in operation in the US, with peak outputs ranging from 4 kilowatts to about 6 megawatts. Large-scale electric utility applications, the ultimate goal of much of the current research, awaits greater manufacturing efficiencies and further technical progress.

Source: IEEE Spectrum

Suspected Health Effects of Low-level Electrical and Magnetic Fields

The publication of a sequence of three extensive articles in *The New Yorker* magazine by Paul Brodeur (June 12, 19 and 26, 1989) has again called public attention to this question. Despite the low intensity, some epidemiological studies suggest there is a risk, mainly to pregnant women, from magnetic fields arising from local 60 hertz power distribution networks in certain circumstances and from working long hours at the video display terminals now ubiquitous in the workplace. There have also been studies (some conducted in Canada) which found measurable effects on laboratory animals at these low ranges. In the past, it was generally believed that the dosage levels were too low to give rise to any significant health effects. As more is learned about long-term exposure to weak electromagnetic fields, it may prove that this earlier assessment of the situation was overly optimistic. This is another problem which must be added to the list of uncertainties facing the energy system and it would seem wise for those most at risk to take a few sensible precautions now.

World Energy Congress

The 14th World Energy Congress was held in Montreal September 17-22, 1989, the first time in Canada in the 65-year history of this international institution. In his closing remarks the Hon. Jake Epp, Canada's Minister of Energy, Mines and Resources, stated: "During the week, Montreal has been the centre of the world of energy — the point where an incredible number of interlocking networks have converged." The World Energy Congress, soon to be renamed the World Energy Council, is a major international non-governmental organization dealing with the full range of energy matters, with active membership from over 85 countries. A total of 5195 delegates from 91 countries participated in the Conference and some 900 people took advantage of the extensive tours of energy facilities in many parts of the country after the meeting. Over 175 papers were presented in the formal sessions of the Congress — these were published and distributed in advance. (They are now available for $100 from the CANWEC Office at Suite 305, 130 Albert Street, Ottawa, Ontario, K1P 5G4.) The Digest of the Congress, to be published shortly, will contain the Congress Conclusions and summaries of the addresses given in the Opening and Closing ceremonies, the Keynote Addresses and the papers and discussions in sessions on Strategic Energy Issues, Round Tables and Working Groups.

The well-attended Round Table sessions were of particular interest, dealing with: Energy and Industrial Evolution, Energy Planning or Drifting to Disaster?, Financing of Energy Programs — Private or Public?, Energy Policies and the Public, What Shall We Do Now About the 'Greenhouse' Effect?, and Energy for Tomorrow in the Developing World. The Session on the greenhouse effect was noteworthy for the worldwide attention now paid to this emerging major environmental concern. Television-quality video tapes of most sessions, useful for education purposes, will be available in early 1990.

Following the Congress, the Secretary-General of the World Energy Conference, Ian D. Lindsay, announced that a major new

global energy commission will be launched, which incorporates in its title the theme of the 14th WEC Congress. This Commission, entitled "Energy For Tomorrow's World — The Realities, the Real Options, and the Agenda for Their Achievement", will be set up immediately. It will take up the challenge of the United Nations Commission Report, *Our Common Future*. It will be subscribed to by not only the WEC membership, but also invited universities, foundations and other energy institutions with which the WEC has particularly close working relations.

The next Canadian National Energy Forum, organized by CANWEC, is planned for Toronto, November 4-6, 1990. The World Energy Congress meets again in another three years in Madrid, September 20-25, 1992.

Seventh Canadian Bioenergy R&D Seminar

Bioenergy consumption in Canada has more than doubled over the past ten years, from 3 to 7% of Canada's primary energy use. There was, therefore, much interest in the Seventh Canadian Bioenergy R&D Seminar held in Ottawa April 24-26, 1989. Over 250 delegates from the emerging industry, the technical community and government attended to hear plenary topics addressing environmental and policy issues, including the role of bioenergy in the reduction of carbon dioxide emissions, international collaboration on R&D, case studies of commercialization, and a special panel debate on the role of bioenergy in Canada's energy scenario for the year 2010.

Individual papers highlighted some recent Canadian successes, including the Chapleau, Ontario, wood-fired cogeneration project; the work at Laval University to recover oil from waste tires; a new hog fuel moisture detection device developed by Forintek; and the continuing efforts of companies like Iogen to perfect an economical means of producing ethanol from cellulose. There has also been progress in the multiproduct approach to the thermal conversion of cellulose, which can produce transportation fuels and higher-valued chemical by-products concurrently.

A note of warning was sounded by Dr. Les Reed of the Forestry Department at the University of British Columbia, who stated that bioenergy producers may have to reduce their estimates of forest waste and other wood products available for energy applications. A study in 1982 estimated that about 113.5 million oven-dried tonnes of forest biomass would be available each year for conversion into energy. For a number of reasons, including the fact that present harvesting practices exceed forest replanting and natural regeneration, Dr. Reed believes this estimate should be reduced to about 50 million tonnes. Nevertheless, this author believes the bioenergy option would quickly become more important should oil prices rise.

Joint Meeting of the Canadian Nuclear Association and Canadian Nuclear Society, Ottawa, June 5-7, 1989

This meeting was held at a time when the future of nuclear energy is being reexamined in Canada. In his address to the meeting, the federal Minister, Hon. Jake Epp stated that he had begun a new assessment of nuclear energy. He referred to the many achievements of the industry since AECL was established in 1952, saying, "I wonder who would have believed back then that, in three decades or so, nuclear energy would produce as much electricity as Canada was then producing from all sources." Despite these encouraging words and praise for the new CANDU 3 design, it is clear that a major restructuring of the industry is being contemplated.

Dr. Alvin M. Weinberg, one of the founders of the American nuclear program, presented an interesting review of the history of the industry as part of a look forward towards the next 50 years. He spoke of the need for an inherently safe reactor — one which "a sceptical elite, as well as an informed public" would accept. The objective is passive safety. He was optimistic that such a design is possible.

It was perhaps symptomatic of the problems facing the industry that an article appeared in the July 1989 issue of the prestigious US magazine *Technology Review* ('Canada's Post-Chernobyl Challenge,' p.50) in which the passive

safety features of the CANDU design were questioned. Canadian nuclear experts were quick to correct the impression left by this article that there might be a safety problem in the CANDU reactor system, but the article did not help the nuclear cause.

Annual Report of the National Energy Board

The 1988 report of the National Energy Board, available to the public, was released April 24, 1989. It summarizes the functions and responsibilities of the Board and reviews its regulatory and advisory activities during the year. The report outlines recent changes in legislation and regulations that affect the Board and some important developments on the Canadian and international energy scene. Canadian exports of petroleum and natural gas increased over 20% in 1988 and, as a result, many pipelines operated at or close to capacity. Electricity exports fell 34% to the lowest levels since 1980, due mainly to the drought.

Call for Papers: INFOR

A special issue of INFOR (Information Systems and Operational Research) on the modelling of energy and environment systems will be published next year under the direction of Guest Editor Richard Loulou of McGill University and GERAD *(Groupe d'études et de recherche en analyse des décisions)*. Possible topics include:

- Integrated models of energy systems, either descriptive or normative
- Modelling environmental emissions by energy systems
- Multi-regional energy trading (electricity, gas, oil, etc.)
- Energy/Environment/Economy equilibrium modelling
- Analysis of special issues: greenhouse gas emissions, emissions of acid-producing gases and abatement, etc.
- Integration of emission, transportation and deposition models into a global framework
- Models as decision aids in policy formulation.

Authors with submissions should send 5 copies, by May 31, 1990, to Professor Richard Loulou, GERAD - HEC, 5255, Decelles Avenue, Montréal, Canada H3T 1V6.

Call for Papers: North American Meeting of the IAEE

The next North American meeting of the International Association for Energy Economics will be held in Ottawa on October 1-3, 1990. The theme of the conference is *Energy Supply/Demand Balances: Options and Costs.*

Interested persons are invited to submit abstracts of papers for presentation at the meetings. Topics for consideration include:

- Oil Markets
- Natural Gas Markets
- Electricity Markets
- Energy & the Environment
- Energy & Transportation
- North American Energy Trade
- Energy Investment Issues
- Energy Modelling & Forecasting
- Role of the Government in the Energy Marketplace

Send abstracts of about 250 words (to arrive by March 31, 1990) to:
André Plourde, Program Chairman, Department of Economics, University of Ottawa, 550 Cumberland Street, Ottawa, Ontario, Canada K1N 6N5.

Update *is prepared by*
John Walsh, Ottawa, Canada
