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Update

First International Conference on Carbon Dioxide Removal

The First International Conference on Carbon Dioxide Removal was held in Amsterdam March 4-6, 1992. The major objective of this meeting was to explore the emerging option of capturing and sequestering this greenhouse gas in a carbon-constrained world. Events immediately before the Conference had heightened interest: the International Negotiating Committee (INC), in preparation for the United Nations Conference on Environment and Development (UNCED'92 to be held in Rio de Janeiro, June 1-12, 1992), had reached at least a tentative acceptable wording for a Framework Agreement on Global Climate Change; and the UK Minister of the Environment, the Rt. Hon. Michael Heseltine, had issued a statement just prior to the meeting strengthening the British position to bring it more into line with that of Germany, Holland, and the Scandinavian countries.

The Conference was attended by 265 delegates from 23 countries (including six from Canada). The large delegation from Japan (51) illustrates the increasing seriousness with which the problem of global warming is viewed in that country. About 75 papers were presented, of which four were from Canada: Wilson *et al*, *Recovery of Carbon Dioxide from Power Plant Flue Gases Using Amines*; Legg, *Overview of Carbon Dioxide Removal and Extraction and Disposal in Canada*; and two papers by Chakma *et al*, *Separation of Carbon Dioxide from Gas Mixtures with Liquid Membranes* and *Carbon Dioxide Separation and Recycling - a Route to Zero Net Production of Carbon Dioxide in the Alberta Energy Industry*.

Most papers presented at the conference focused on large point sources of CO_2, although two papers dealt with novel approaches for reducing emissions of carbon dioxide in the transportation sector. It was not surprising, therefore, that the major interest was in the field of electricity generation from fossil fuels, especially coal. Conventional separation methods were explored in detail, particularly the application of amine absorption techniques to the dilute low pressure gases characteristic of power stations, but emphasis was also placed on novel applications involving advanced power generation cycles, usually those employing gas turbines, and including the emerging membrane gas separation technology.

All avenues for the disposal of the captured carbon dioxide were explored, such as: storage in depleted natural gas fields; charging into aquifers; and discharge into the deep oceans. The utilization of captured CO_2 in enhanced oil recovery operations, the production of carbon-based chemicals, and the accelerated growing of biomass, both in the oceans and on land, were also considered. Not surprisingly, disposal in the oceans provoked the most controversy. Since carbon dioxide returns to the oceans in any case (though after a long time), sequestering this gas at depth is really, in a sense, only speeding up a natural process. Opinions are divided as to whether this approach will be either technically feasible or publicly acceptable.

Two new aspects of ocean disposal were discussed at the meeting. The first was the problem of sediment. Carbon dioxide will produce a stable hydrate (or clathrate) at certain pressures and temperatures analogous to the well-known methane hydrates. The density of the carbon dioxide hydrate is greater than seawater and so these clathrates will sink to the bottom. The environmental consequences of mounds of this material in the deep ocean are not known. The second new aspect came from Norway. It appears that the density of seawater to which carbon dioxide has been added is sufficiently greater than ambient seawater to cause the

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CO_2-laden volume to sink. This finding may be important to the Atlantic provinces. Up to now, most experts have assumed CO_2 would have to be released at over 3000 metres depth, where its density is greater than that of seawater. Now it appears that the gas could be introduced at much less depth, at a great saving in cost, provided the laden water was able to fall freely into the deep ocean.

No one can say for sure that a satisfactory new option for dealing with CO_2 containment yet exists, but there was enough encouragement from the information presented to suggest that a careful evaluation of the more promising avenues is justified. The extra cost of capturing and sequestering carbon dioxide is very substantial indeed and might raise the cost of generating electricity from the fossil fuels by 30 to 45%. Estimates of the cost of sequestering vary from US $15 to $70 per tonne of CO_2 — a wide range that is not surprising in view of the newness of the field. Considering that the world now relies on fossil fuels for about 88% of its primary energy, reducing CO_2 emissions is bound to be costly in one way or another. One Japanese author (Tazaki) even suggested the value of the sequestering industry could reach US$40 billion per year. The more promising, lower cost possibilities involve improving gas separation methods and perfecting the sequestering options.

Systems studies in the Netherlands (excluding a nuclear option) suggest that emissions could be reduced some 80% by the middle of the next century for a cost of about 1% of GDP. The same linear programming model was applied to the US (but including a nuclear option) and the model still called for the capture and sequestering of carbon dioxide. One interesting aspect of these systems studies is that the overall consumption of primary energy increases due to the losses inevitable in the capture and sequestering of carbon dioxide for the same delivered quantity of secondary energy.

All agree that the first priority for reducing carbon dioxide emissions is to increase the efficiency of the use of energy. The capture and sequestering of carbon dioxide from the fossil fuels may, however, prove to be an important addition to the next rank of choices. There may well be much progress in this field by the time of the Second International Conference on this subject now scheduled for the first half of 1994 in Kyoto, Japan. The proceedings of the First International Conference will be published in the journal *Energy Conservation and Management* in June 1992.

Energy Technology Options

A workshop/conference series directed to a large and difficult question is now underway at the McMaster Institute for Energy Studies. *Energy Technology Options for the Twenty-First Century: Environment, Economy and Society* is a dialogue among people who work on the development and implementation of energy technology and those involved in energy policy analysis and decision making. The first two workshops addressed supply options, the second two will focus on end use options. A wind-up conference on October 1-2 will draw together the threads of the workshop discussions and deal with questions that transcend their individual topics; for example, how global warming will influence energy technology choices, the contribution of energy demand management, and so on. The objective is to develop, by way of this series of dialogues, a realistic picture of the energy system that will take shape in the early years of the next century.

Workshop 1: *Centralized Energy Supply Alternatives*, held on January 23rd, featured three presentations on large scale electricity supply options and a fourth report on a series of smaller-scale options based on renewable energy sources. William Moore of the US Department of Energy described developments in coal-based generation involving advanced technologies to remove SO_2, NO_X and particulates. Systems based on coal gasification and gas turbines with an intermediate hot-gas cleanup stage are currently being developed in the US, Europe and Japan. With reductions in capital costs these alternatives will be competitive with conventional steam cycle technology.

Ralph Hart, of Atomic Energy Canada Ltd., speculated about a scenario in which, for environmental reasons, the bulk of world electricity growth in the next 40 years would come from nuclear energy. That would result in about 4000 new plants at a cost of $133 billion per year.

Work on developing nuclear fusion was described by Don Dautovich of the Canadian Fusion Fuels Technology Project. Current spending on fusion research is about $2 billion annually worldwide, with about $25 million of that in Canada. Fusion development depends on advances in materials science, robotics, superconductivity, gas and isotope processing, and other fields — no one country could hope to develop it on its own. Electricity from fusion is expected to cost about twice as much as that from advanced fission reactors in the

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next century, though there is much potential for spin-off benefits.

Frank Chu from Ontario Hydro's Research Division spoke on renewable energy power plants — electricity from hydro, photovoltaic, wind, and biomass energy. Biomass plants with 50 MW of capacity have been proven and 75 MW plants are possible, though with large land requirements (about 7000 hectares). There is now 2000 MW of installed wind generation capacity worldwide, including 1350 MW in southern California and 7.5 MW in Canada.

Afternoon sessions were devoted to a full discussion of centralized supply options in a broader context, led off by commentary from a panel of specialists on the environment and the economy: Stephen Blight of Environment Canada, economist and environmental consultant Terry Burrell, and Vaclav Smil of the University of Manitoba. From the lengthy discussion by all participants, one infers that making choices from among centralized supply options is a fearsome task. Though much was learned, changes of mind were not in evidence.

The dialogue was picked up again on March 5th with Workshop 2: *Decentralized Energy Supply Alternatives*. Jeff Passmore argued that a major decentralized energy system is available now, and set out his view of the barriers that currently constrain its growth. He cited California, where decentralized renewable sources already provide 18% of the electricity, as evidence of how easily these supply alternatives can be adopted if there is sufficient political will. Options such as wind, solar, small hydro, and biomass are more cost competitive with conventional centralized options when externality costs are accounted for. In his view, policies to promote a combination of technology-push and market-pull are needed to help these supply alternatives achieve their potential.

The outlook for renewable energy was presented by Verne Chant of Hickling Corporation. He focused on wind, small hydro, biomass and solar water heating. At current buy-back rates, small hydro can play a significant role in Ontario, while at somewhat higher rates there is a very large potential for biomass. The long term contribution of all these supply options is constrained by the fact that their production costs rise rapidly as the best available sites are used up. These supply alternatives could enable Ontario Hydro to reduce its CO_2, SO_2, and NO_X emissions by as much as 20% over the next 25 years.

Rob Brandon, general manager of PEI Energy Corporation, described a major district heating project which now provides 30% of Charlottetown's space heating needs. Based on European experience, he sees a great potential for this type of district heating scheme in Canada. It will require, however, the development of engineering expertise in district heating technologies and an increased participation by municipalities in the provision of energy services. The need to phase out CFC's may also point to an increased role for district cooling.

Brandon also sees considerable potential for wind energy in Canada, principally at sites on the east coast, in the north, and near Crow's Nest Pass in Alberta. Canadian promotion of this technology has been relatively modest compared with Europe and California, where high buy-back rates and tax credits have been used to help overcome the high initial costs.

Another decentralized supply technology that can play a major role in the next century is the fuel cell. According to Ontario Hydro's Craig Simpson, its advantages include reduced emissions, high efficiency, and fuel flexibility. Most importantly, because small fuel cells can operate efficiently, utilities can use them to add capacity incrementally in the face of uncertain demand and to reduce transmission costs through dispersed generation. Given uncertainty about the relative merits of competing technologies, and recent reductions in capacity expansion plans, it will be 10 to 20 years before fuel cells become a major source of supply for Ontario Hydro.

Industrial waste heat represents an enormous untapped source of energy. Nigel Fitzpatrick, Technical Director of Energy Products with Alcan Aluminum, gave an overview of the potential for industrial heat exchangers in decentralized electricity generation. Heat exchange technologies which have been tested in ocean thermal applications, can be used to cool water in nuclear plants and other industrial facilities. Alcan currently has a demonstration project in the UK and is planning another one (1 MW) at the Pickering nuclear plant. Tapping all sources of industrial waste heat at 10% efficiency could theoretically produce 1000 MW in Ontario, and 2000 MW in Canada overall. There is also an interesting economic potential for Canada in this technology as 22% of the world's supply of aluminum heat exchanger panels are produced in Ontario.

The afternoon session was led off by comments from Kevin Cliffe of Energy, Mines and Resources Canada, and Nilam Bedi

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of the Ontario Ministry of the Environment. One theme that emerged in the discussion that followed is that many decentralized options are based on already mature technologies which need only be adapted to the special needs of Canadian energy markets. The lack of an appropriate policy framework is the principal impediment to widespread adoption of these technologies. However, the creation of such a framework will be difficult given Canada's current constitutional and economic problems and conflicting regional interests. Furthermore, an appreciation of the role of decentralized options requires a systems-wide analytical approach which is not necessarily compatible with the institutional structure of the Canadian energy sector.

The series continues with Workshop 3: *End Use Options — Buildings, Processes and Appliances* on May 7; Workshop 4: *End Use Options — Transportation* on June 18; and the overview conference on October 1-2. More participants are invited. For information, contact MIES, McMaster University, Hamilton, Ontario L8S 4M4; telephone (416) 529 7070 ext 4527; FAX (416) 521 8232.

Electric Power in Canada

The annual publication *Electric Power in Canada*, issued each fall by the Electricity Branch of the Department of Energy, Mines and Resources, provides a convenient source of information on almost all aspects of the electrical power industry in Canada for the previous year. Subjects covered include the structure of the industry, federal and provincial regulations, statistics on electrical consumption, generation, capacity, trade, and reserves, and the future plans of the industry. It deals with such relevant matters as costing and pricing, demand-side management, non-utility generation, transmission investment, and financing, together with an outlook for the future.

First published in 1964 by the Water Resources Branch of the Department of Northern Affairs and Natural Resources, it was transferred to the Department of Energy, Mines and Resources when the latter was formed in 1967. The main utilities have been the principle source of information for such data as electrical supply and demand and the development and planning of new power generating facilities across the country. Data from Statistics Canada are relied upon in relation to the economy, demography, and historical electrical energy supply and demand. The National Energy Board supplies information on electrical trade statistics. About 6500 copies are distributed annually to readers in 75 countries.

The electric power industry is very important to Canada, normally accounting for more than 50% of the total national investment in the energy sector and about 8% of the total overall investment in the economy. The industry employed 95,000 people in 1989, or about 0.9% of total Canadian employment. Total revenue that year was about $20.2 billion and the industry contributed 3.1% to the nation's GDP, a share that has been steadily rising since 1960. The contribution of electricity to total primary energy consumption has steadily increased from 14% in 1960 to 30% in 1990. Primary energy delivered in the form of electricity has grown on average at more than double the annual growth in non-electrical energy over these years, i.e., 5.7% vs. 2.5%.

There are 16 major utilities, together with about 60 industrial establishments generating electricity mostly for their own use, but sometimes for other local markets. Among the major electrical utilities, eight are provincially owned, four are investor owned, two are municipally owned, and two are territorial Crown Corporations. In the future, there is likely to be a marked expansion of cogeneration facilities, based mainly upon natural gas turbines, to meet local needs for heat and power once load growth resumes after the present severe recession.

As the main chronicle of record of the electrical generating industry, *Electric Power in Canada* is a useful document, especially for anyone who is interested in the great change currently underway in this industry. Of particular interest to those interested in energy policy is the graph plotted each year (reproduced here as Figure 1), which shows the still strong linkage between per capita electrical consumption and per capita Gross Domestic Product over more than 30 years. Many experts expect this close linkage will be broken in the coming years, just as the previous strong relationship between economic growth and total primary energy consumption was in the previous decade. Changes in structure, generation, and pricing are to be expected in the years to come, with environmental considerations a further complication. *Electric Power in Canada* will track these changes as they occur.

This publication, catalogued as ISBN 0-662-19038-6/ISSN 0070-962X, is available in either English or French at no charge by writing to the Distribution Section of the Communications Branch of EMR Canada, Ottawa, Ontario, K1A OE4. (Fax: 613-996-9094).

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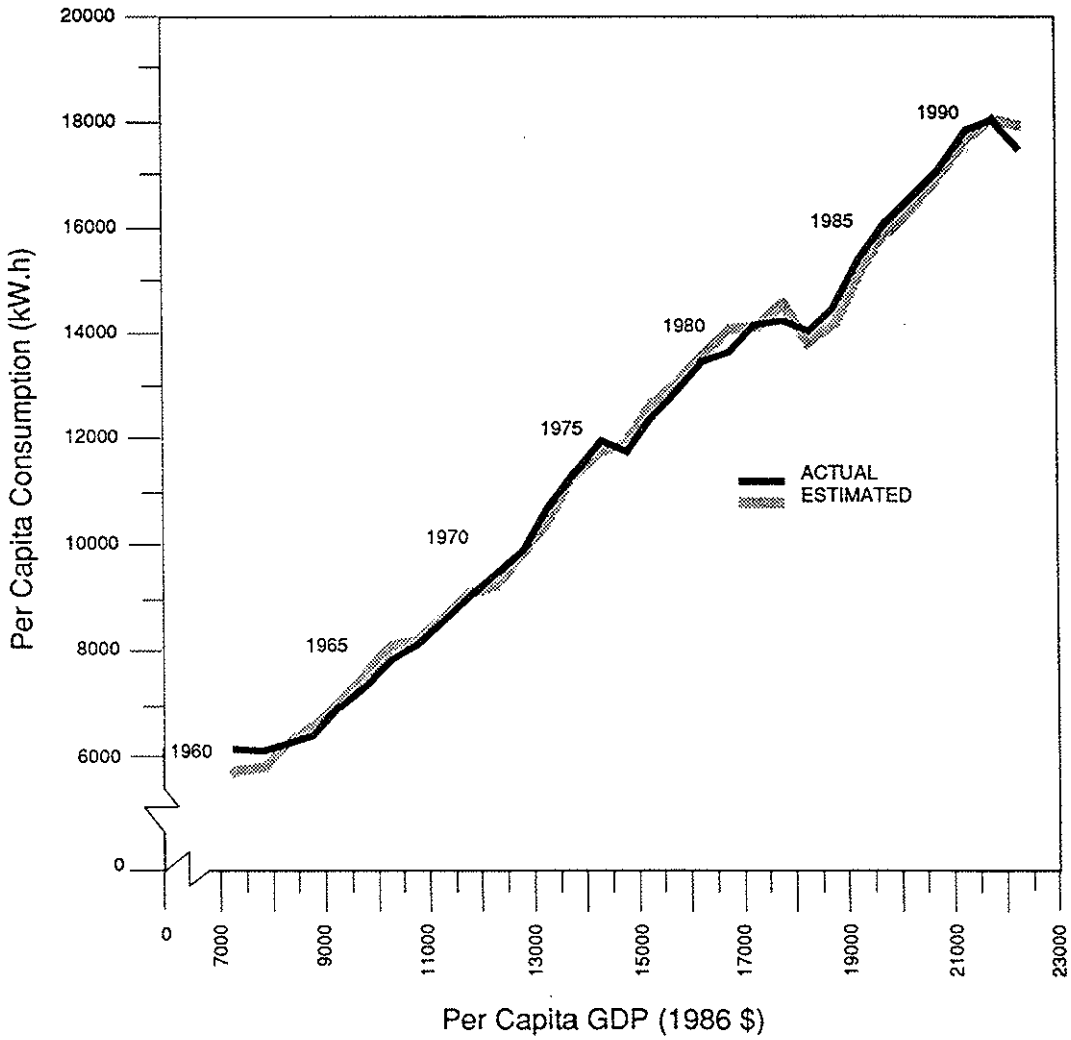

Figure 1: Historical relationship between electricity demand and GDP, 1960-1990

IEA Greenhouse Gas Program

On November 20, 1991, Canada was one of 10 nations to sign an Implementing Agreement for a program to evaluate technology options for the control of greenhouse gas emissions which result from the utilization of the fossil fuels. Those countries, together with British Coal which was also a signatory at the ceremony, have agreed to sponsor a three-year program of activities. In addition, Japan and the Commission of European Communities are expected to join in the near future as founder members. British Coal is the Operating Agent for the project which is based at its Coal Research Establishment in Stoke Orchard (near Cheltenham) in England (Postal Code GL52 4RZ; Fax 44 242 680758).

The overall aim of the program is to provide an evaluated range of technology options for the control of greenhouse gas emissions from fossil fuel utilization on a consistent basis. By pooling resources, the participants aim to avoid overlap between national programs and ensure dissemination of the most recent information. Internationally acceptable criteria for evaluation will ensure a non-partisan and objective comparison of proposed schemes. The

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new organization will also provide a forum through which further co-operative R & D activities can be initiated. As is usual in IEA Implementing Agreements, an Executive Committee, made up of a representative of each of the contributing parties, approves the annual program of work and the budget, with membership contributions based upon national levels of carbon dioxide emission.

In the preliminary evaluation phase now in progress, four studies of power generation processes have been deliberately selected to ensure a wide range of CO_2 concentrations in the exhaust gas: (1) a modern pulverized coal-fired station equipped with flue gas desulphurization; (2) a natural gas combined-cycle power plant; (3) an integrated-gasification combined-cycle power plant (IGCC) based upon coal; and (4) combustion of coal with oxygen in re-cycled stack gas. Other studies planned are $C0_2$ capture: (1) in gas/liquid scrubbing systems; (2) in gas/solid adsorption systems; (3) by using cryogenic techniques; and (4) by using membrane technologies. A preliminary review of CO_2 transport and disposal methods will also be undertaken.

Two publications are being produced as part of this program. The first, *Greenhouse Issues*, is available free of charge. The second, *Greenhouse Gases Bulletin* (ISSN 0964-9107) is available to those in member countries on payment of a subscription fee of £60 per year. Both publications first appeared in 1991. The *Bulletin* abstracts over 170 publications around the world which are divided at present into the following five chapters: (1) greenhouse gas emissions; (2) atmospheric chemistry and climatic change; (3) abatement; (4) control, removal, disposal, recycling and utilization; and (5) energy policy and economic models. The first issue, in November 1991, contained 200 abstracts; the March 1992 issue 400; and the following May issue is expected to list 500. Requests for subscriptions should be sent to IEA Coal Research, Gemini House, 10-18 Putney Hill, London SW15 6AA, England (fax: 44 81 780 1746).

Canadian Research into Global Warming

On January 28, 1992, the Federal Minister of the Environment, the Hon. Jean Charest, announced the expenditure of $85 million over the next six years into research on global warming and its probable consequences. Earlier, the Minister had announced the allocation of $30 million dollars to strengthen Canada's acid rain control program. About 70% of the money for global warming will go to universities and private research activities to gather data and further develop computer modelling techniques. The assessment of the potential effects of global warming will also be intensified.

In the meantime, the Department of the Environment has released a publication entitled *A State of the Environment Report* (SOE 91-2), available from Environment Canada, Ottawa, K1A 0H3. (ISBN 0-662-18687-7/ISSN 0843-6193). Like many other countries, Canada has implemented a State of the Environment (SOE) Reporting program which takes the form of fact sheets, special reports, newsletters, environmental indicators, a database, and five-year national reports. This report series, prepared in partnership with various levels of government, academia, industry, non-governmental organizations, and interested individual citizens, is designed to provide Canadians with careful, objective analysis and interpretation of data which will identify significant conditions and trends in the environment. This report has short but useful chapters on such subjects as enhancing the greenhouse effect, predicting climate change, and the implications of a warmer world. The text is well illustrated.

Also available from Environment Canada is a report prepared by the Canadian Climate Program Board entitled *Climate Change and Canadian Impacts: The Scientific Perspective* (CCD 91-01/ISBN 0-662-58041-9/ISSN 0835-3980). The members of this Board are drawn from a wide variety of institutions across the country to make independent assessments of the situation. Among its conclusions are: "there is a strong consensus in the scientific community, both in Canada and globally, that the observed and continuing increases in greenhouse gas concentrations due to human activities will result in an unprecedented global warming and sea-level rise unless emissions are substantially reduced;" and that "the energy sector merits particular attention in developing strategies to limit greenhouse gases."

The International Energy Agency in a Changed World

The International Energy Agency (IEA) was formed during the oil crisis of the early 1970s to provide an institutional framework for

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dealing with the challenge of OPEC and similar organizations. It came into being as the collective response of the major industrialized nations to the export embargo that had been imposed on Holland and the similar threats to other nations. The IEA was to coordinate emergency measures (some of which are still in effect and were revisited during the time of the Gulf War) and encourage long-term cooperation on energy matters generally. It now plays a role in coordinating the research and development effort of the main western nations (see 'R & D Programs of the IEA' by P.J. Dyne, ESR 1:1) and it increasingly acts as a clearing house for energy technology, with more attention now being placed on the needs of the developing world.

The IEA operates as an autonomous organization within the framework of the OECD (itself a response to the economic situation in Europe after World War II). The Agency was created as a separate entity in part because of France's refusal to take part in a collective OECD response (on the grounds that the proposed activities would be excessively confrontational with the Arab world) and partly because of the precedent of the specialist Nuclear Energy Agency (NEA), which had also been established within the framework of the OECD to deal with the emerging nuclear industry. The IEA presently has 23 members (including Canada), with France having finally indicated it would join in late 1991.

In the Agency's early years, when both energy prices and industrial profits were high, security of supply was perceived as the primary issue. Many options seemed to be available and the main question was how to bring the potential new supplies into production. Now the energy situation is very different. The east-west political landscape has changed, both energy prices and industrial profits are low, and there are few choices. With all the problems facing the fossil fuels, particularly coal and oil, the growing public opposition to nuclear power together with its disappointingly high costs, and the rising objections to even hydroelectric development, there seem to be only two main options for the future: increasing the efficiency with which energy is consumed and the more extensive use of natural gas.

An important question now arising is how effective market-based policies will be in encouraging increased efficiency in the energy economy. If the results are unsatisfactory, there may have to be a return to a regulatory approach, particularly in the transportation sector. There are also doubts concerning the extent to which a major natural gas option can be brought into play in many countries. In this more complex situation, the IEA believes its role will be primarily as a facilitator helping nations develop stable and predictable policies to encourage long-term investment.

Since the former Soviet Union was the world's largest producer of oil and natural gas, there is considerable worry about the future of the former Eastern Bloc and its effect on the west. Disruptions in supply would affect western Europe adversely as well as impinge upon Russia's (and some other republics') main source of foreign exchange. Production in 1992 may well fall to about 9.2 million b/d as compared to over 12 million b/d as recently as 1989. The safety of the nuclear facilities still operating in the east is also a matter of grave concern, with another accident reported in March of 1992, though one that was soon down-rated to the Class II level. All agree that, as a matter of urgency, steps should be taken to increase the efficiency with which energy is used in these countries. Here too, the IEA has taken the role of a specialist agency providing energy expertise. It has conducted country reviews of Poland, Hungary, and Czechoslovakia. As part of the Partners in Transitions activity, the IEA prepared the chapter in the World Bank/IMF study dealing with energy in the CIS.

IEA activities are also broadening in other areas. It played an active part in drafting the European Energy Charter (which Canada signed on March 18, 1991) and is developing relationships among the emerging nations of the Pacific Rim where energy consumption is still rising rapidly. A review of South Korea was recently conducted. Relations with the oil producing nations are also changing. Discussions now centre on facilitating trade and investment, not prices and volumes, which were a divisive topic in the past. This change has come about with the return of western investment in some oil producing nations and the investment of some oil producers in down-stream facilities in consuming nations. Also, international trade in oil is denominated in US dollars, and there is an increasing prospect of financial surpluses accumulating in at least some of the oil-producing nations as the world becomes more dependent upon supply sources in the Middle East later in this decade. Producing nations thus have a greater stake in the financial health of the industrialized nations where they make most of their investments. Independent oil exporters like Mexico have also signalled their intention to follow IEA activities more closely, as has Brazil.

The IEA is also concerned with

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the potential for global climate change. In keeping with its generally market-oriented approach, it has been examining the possible role for carbon taxes as a means of reducing carbon dioxide emissions to the atmosphere. In its studies, it has identified four climate change policy cases: (1) a tax of $US 130/tonne of carbon applied only in the OECD nations; (2) forcing the proportion of electricity generated from non-carbon dioxide generating sources to increase by one means or another to a 65% share; (3) deliberately tripling the use of natural gas in the generation of electricity; and (4) a combined case where a carbon tax would be imposed at the same time non-fossil generation of electricity would be forced to increase.

The Agency has also reviewed the announced policies of the OECD nations with respect to carbon dioxide emissions. If all these policies were implemented to their fullest extent, emissions would fall by some 314 million tonnes of carbon by 2005. Though this is a large quantity that could only be achieved with considerable cost and effort, the fall in relation to the world total is only a small fraction of the overall emissions total. So far, policies are inadequate to deal with the problem of global warming if, in fact, vigorous steps have to be taken.

Recent reports of the IEA of interest to Canada include: *Energy Policies of IEA Countries 1990 Review; Energy Efficiency and the Environment;* and *Natural Gas Prospects and Policies* (all published in 1991 by the OECD).

The Need for More Efficient Energy Use in Eastern Europe

The newly reforming nations of eastern Europe have experienced extensive environmental degradation in recent decades. One major reason has been the widespread reliance on the generation of electricity from abundant, relatively cheap, surface-minable resources of brown coals in several of these nations. Particulate collection in the electrostatic precipitators of fossil-fuelled power stations was usually the only control technology employed. The high sulphur content of some of these coals has led to extensive damage.

Several East European countries also have nuclear generating facilities. There is considerable concern about the inherent safety of these installations. The Russian-designed reactors in the former German Democratic Republic have been shut down because they are not compatible with German safety standards. In the other countries, most of this class of reactors must be kept running to supply urgent electrical needs. Opinions on the safety of these nuclear installations vary. Lord Marshall, a well-known British nuclear expert, expressed the view at a recent British conference that several are operated in a reasonably safe manner. On the other hand, there has been a recent nuclear incident in Russia and there are particular concerns about the large nuclear station in Bulgaria, which supplies nearly 50% of that nation's electricity. Canada has recently entered into an agreement with Romania to complete the CANDU reactors started there under the previous regime.

Many energy observers feel that the most important step required is to increase the efficiency with which energy is used in that region. Studies along these lines have been conducted by the International Institute for Applied Systems Analysis (IIASA) in Austria and by the International Energy Agency, among others.

Recently, a report entitled *Energy Efficiency, Developing Nations, and Eastern Europe* was prepared for the US Working Group on Global Energy Efficiency. Membership in this Working Group is drawn from a large number of governmental agencies, non-governmental organizations, research laboratories, and universities in the US, with the object of providing broad-based advice on this issue of steadily growing importance. The report, whose principal author was Mark D. Levine of the Energy Analysis Program at the Lawrence Berkeley Laboratory, Berkeley, California, provides a valuable overview of the status of energy efficiency in eastern Europe and the developing countries. The report concludes: "The US and other industrialized countries can play a major role in helping to spur energy efficiency in developing countries and Eastern Europe. Four activities will be most valuable: (1) setting up training and information programs; (2) making access to capital for energy efficiency investments much easier to obtain; (3) initiating major programs in energy efficiency and other activities to increase awareness of the role of efficiency; and (4) increasing access of developing countries to improved energy technologies. A much larger effort than that now underway is essential if significant strides to increase energy efficiency are to be made in developing countries and Eastern Europe."

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The Oxford Institute for Energy Studies

The Oxford Institute for Energy Studies (OIES) was founded in December 1982 as a centre for advanced research into the social science aspects of the energy problem. With an annual budget of about CDN$1 million and a total staff normally in the 18-22 range, including those on secondment or participating part-time, it is the largest organization in this field (with the possible exception of some in Japan).

OIES is committed to the idea of scholars representing different sides of the international energy debate; members of the Institute represent both the oil-producing and the oil-consuming nations. This international character is also reflected in the composition of the research team with such cooperation intended to lead to more informed assumptions in the research concerning the behaviour, motivations and objectives of the various players operating on the international energy scene. The Institute is also committed to achieving high academic standards. Oxford University and three of its colleges (St. Antony's, St. Catherine's, and Nuffield) are members of the Institute and occupy six seats on the Board of Governors.

As a general policy the Institute concentrates mainly on topics which have an international character and which have significant implications for the interface of producers and consumers. The research carried out encompasses the following disciplines: (1) the economics of petroleum, gas, coal, nuclear energy, solar and other forms of renewable energy; (2) the politics and sociology of energy; (3) international relations between oil-producing and oil-consuming nations; (4) the economic development of oil-producing and non-oil producing nations of the developing world; and (5) the economics and politics of the environment in its interface with energy. In this latter field of growing importance, the Institute has contributed new theoretical work, studies of technological aspects of the energy/environmental interface particularly in the field of transport, and the analysis of policy issues.

The Institute regularly publishes the results of its research. Generally, 7-10 reports are released each year, but in 1991 the output was 17, while in 1990, an unusual year, 21 were issued. Individual papers are sold for £20 each though it is possible to subscribe for the entire report series. At present there are 13,000 names on the mailing list. Those wishing to be notified of these studies or to receive the quarterly *Oxford Energy Forum* should write OIES, 57 Woodstock Road, Oxford, OX2 6FA, England (Fax: (0865) 310527).

Short Notes

- There are now concerns in the aluminum industry related to the emissions of the carbon fluorides CF_4 and C_2F_6 in the smelting process. These inert gases are released in only small quantities and, since they exhibit no known toxic properties, were of little interest in the past. However, it now appears that they may be strong greenhouse gases. If the aluminum were to be produced from electricity generated exclusively from coal, (not the case in Canada where hydraulic resources are used), one calculation suggests that the warming potential from these possibly potent compounds would amount to 45% of the total effect resulting from the production of this metal, despite the very large quantity of CO_2 also produced in the electrical generation stage.
- On December 18, 1991, Canada signed the European Energy Charter in The Hague. This charter promotes broad energy cooperation in the development of the global energy economy. Based upon principles of non-discrimination and market-oriented reform, it includes objectives for the development of trade and investment in energy; provides for cooperation in the energy field; and promotes energy efficiency and environmental protection.
- Le Group de recherche en économie de l'énergie (GREEN) at Laval University, in co-operation with the Department of Energy, Mines and Resources, has announced the following scholarships for the year 1992-93: five valued at $12,000 each at the masters' level and two valued at $20,000 each at the doctoral level. These scholarships are offered to those who wish to specialize in the study of economics related to the energy sector. Applications should be made to the Director of 'GREEN' at Laval University in Québec City G1K 7P4.

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

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