Energy Studies Review Vol. 12, No. 2, 2004 pp. 291-309

Canadian Energy Up-Date

John Walsh

Reports from The National Energy Board

Annual Report for 2003

The National Energy Board released its Annual Report for 2003 dated March 2004. In his letter of introduction, the Chairman, Kenneth W. Vollman, writes that `conventional crude oil production from the Western Canada Sedimentary Basin (WCSB) has been declining for some time, and natural gas production has been flattening out over the last two or three years.' The Board believes Canadians are facing increasingly complex and difficult energy choices, and that there has already been evidence of this at hearings held during the past year. The Report itself covers many of these matters in its 61 pages to which are appended eight supplements. Supplement VI in turn lists five appendices available separately at the Web Site or in printed form by calling 1-800-899-1265 (Fax: (403) 292-5503).

As usual the Report provides an overview of the main developments during the year. It notes that the energy industry accounted for about six percent of GDP and employed just under 300,000 people, representing 1.7 percent of the labour force. Energy export revenue accounted for an estimated 16 percent of all exports, up from 12 percent in 2002. This increase was due mainly to higher energy commodity prices. Canadian production of crude oil and equivalent reached a new record of 2.48 million barrels per day (395 000 cubic metres per day) up nearly seven percent over 2002. Declining WCSB reserves were nearly offset by reserve additions from the East Coast Offshore. The oil sands of Alberta accounted for some 34 percent of total Canadian crude oil and equivalent production.

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Production of natural gas decreased by about three percent despite record gas well drilling with the total production of marketable gas falling to 476 million cubic metres per day (6.13 TCF per year) as examined in more detail in the NEB report on the situation in the reports immediately following. Electrical generation fell slightly to 570.8 terawatt hours due in part to poor water supply conditions in some parts of the country and the major blackout to hit Ontario during the past year.

The British Columbia Natural Gas Market: An Overview and Assessment dated April 2004 is another in the series of *Energy Market Assessments* published regularly by the Board. The Province is the second producer of natural gas after Alberta with all its production coming at present from that portion of the Western Canada Sedimentary Basin located in its northeastern corner but there are opportunities for more gas discoveries in the offshore and some other locations. Marketable gas production has increased by 62% in the past ten years to 71 million cubic metres (2.5 billion cubic feet) per day in 2003. The price tripled at pipeline hubs between 1998 to 2003 reaching well over $C 6.00/GJ.

This report is timely in that the pattern of supply has now diversified with the additional links to the Alberta system and a second major pipeline system extending to Chicago to serve eastern North American markets. There is little storage for gas in the lower mainland major market and at times the pipelines are at capacity. This situation leads to a tendency to price spiking. There is evidence that the current high prices for gas are leading to a reduction in demand through the shut-down of some industrial facilities, the increased use of other fuels such as wood wastes of one kind or an other, and the switching to light fuel oil by some smaller users. Despite these difficulties, the Board concludes that natural gas prices in B.C. are now integrated with the North American gas market and that on balance the system is working well.

In April 2004, the National Energy Board published *Canada's Conventional Natural Gas Resources: A Status Report* a new assessment of this important fossil fuel as another of its continuing series of Energy Market Assessments (EMAs). 'The primary purpose of this report is to provide the current status of the Board's estimate of conventional natural gas resources in Canada. As well, this report will serve as a starting point for a series of assessments of the ultimate potential of conventional natural gas.' These new assessments will be carried out in conjunction with the provinces concerned. It is clear that this activity has been made necessary by the growing sense that Canadian gas production is reaching a plateau as indicated in its comprehensive study issued in 2003 titled *Canada's Energy Future: Scenarios for Supply and Demand to 2025* and also still available at the Board's Web Site.

This report provides a new estimate for the Alberta portion of the Western Canada Sedimentary Basin (WCSB) of 5 855 billion cubic metres (207 trillion cubic feet) which is slightly higher than the 2001 estimate of the Canadian Gas Potential Committee and the 1992 estimate of the Alberta Energy and Utilities Board with the values expressed in terms of marketable gas volumes. The Board notes that 'in spite of very high drilling activity and the exploration success over the 10-year period from 1990 to 2000, the total resource base did not increase substantially.' The Board also expects the majority of the undiscovered resources in Alberta will be found in the shallower Cretaceous zones and not in the deeper Devonian zones. Only four percent of the resources is off limits in restricted zones in cities, national parks and large lakes. There is a particular need for further assessment in northeastern British Columbia where there have been important discoveries and in the eastern off-shore where recent results have been disappointing. In total, some 8 148 billion cubic metres (286 trillion cubic feet) of marketable conventional gas is estimated as still undiscovered in the various regions of the country of which one-third is located in the WCSB.

The Board released another in its series of Energy Market Assessments entitled *Short-term Natural Gas Deliverability from the Western Canada Sedimentary Basin 2003-2005* on 8 December 2003. The Board 'projects that, with the expected high levels of drilling activity, deliverability from the WCSB will be maintained near its current levels at approximately 450 million cubic metres (16 billion cubic feet) per day over the next two years.' The Board also states that it 'estimates that new gas well connections in 2003 will total 14,400 and for 2004 and 2005, they are estimated to be 13,850 and 12,850, respectively.' At the end of 2003, deliverability from the WCSB will be 460 million cubic metres (16.2 billion cubic feet) per day at the end of 2003, 458 million cubic metres (16.2 billion cubic feet) per day at the end of 2004, and 448 million cubic metres (15.8 billion cubic feet) per day at the end of 2005. The report contains interesting figures illustrating the decline in production being experienced in connected wells over time. It also includes estimates for Coalbed Methane production. Approximately three hundred new CBM wells are expected to be connected in 2003 rising to 1200 new wells in 2005 which are expected to produce about 5.7 million cubic metres (200 million cubic feet) per day by year end 2005. (Web: www.neb-one.gc.ca)

Copies of these reports may be obtained from the National Energy Board, 444 Seventh Avenue SW, Calgary, Alberta, T2P 0X8 (Fax: (403) 292-5576). They may also be downloaded from the Web at www.neb-one.gc.ca. The extensive technical appendices of some reports can only be obtained in this way.

New Reports

Final Report on the August 14, 2003 Blackout in the United States and Canada: Causes and Recommendations

The *Final Report on the 14 August 2003 Blackout* that affected about 50 million people was released in both Canada and the U.S. on 5 April 2004. Addressed jointly to the Prime Minister and the President, it states 'the report makes clear that this blackout could have been prevented and that immediate actions must be taken in both the United States and Canada to ensure that our electric system is more reliable. First and foremost, compliance with reliability rules must be made mandatory with substantial penalties for non-compliance.' The economic loss quite apart for inconvenience was substantial in both countries. 'In Canada, gross domestic product was down 0.7 per cent in August, there was a net loss of 18.9 million work hours and manufacturing shipments in Ontario were down $2.3 billion.' Corresponding estimates of the cost of the blackout in the U.S. ranged from $US 4 to 10 billion.

A good part of the responsibility for the outage was placed on the inadequate practices of an Ohio utility. Nevertheless, a total of forty-six detailed recommendations were made to guard against a repetition of this serious incident. The report is also interesting in that it provides an insight into the complex considerations involved in the operation of a major electric grid system.

Copies of the report may be downloaded in .pdf form in full or segments at www.nrcan.gc.ca or www.energy.gov.

International Energy Outlook 2004 of the Energy Information Administration (U.S.)

The Energy Information Administration of the U.S. Department of Energy released its International Energy Outlook 2004 in April 2004. The EIA expects world marketed energy consumption to increase by 54 percent over the 24 years from 2001 to 2025 from 404 to 623 quadrillion BTUs. The IEO/2004 reference case outlook projects the strongest growth in energy consumption will be among the developing nations, especially developing Asia including China and India. World oil prices are expected to reach $US (2002) 27 per barrel or $51/barrel in nominal dollars in 2025. Consumption of all primary energy sources are expected to increase and non-fossil fuels are not expected to be economically competitive with fossil fuels over the forecast period.

Oil is expected to remain the dominant energy source worldwide through 2025. In the reference case, world oil demand increases by 1.9 percent per year over the period and so increases from the 77 million barrels per day in 2001 to 121 mbbl/day in 2025. This requires oil production to increase some 44 mbbl/day. It is this projection that is likely to be the most controversial in view of increasing concern that conventional oil production will peak before 2025. (The EIA does not expect this peak to be reached before 2038.) The fastest growing source of primary energy will be natural gas, increasing by 67 percent from the 2001 value to 151 trillion cubic feet in 2025 though this estimate is lower than in the previous year's outlook. Around the world, the consumption of natural gas is expected to equal that of coal on an energy basis by 2010 and exceed it by 12 percent in 2025. Coal consumption is expected to increase at an average of 1.5 percent through 2025 but its share in primary energy consumption will fall slightly from 24 percent to 23 percent by 2025. China and India are expected to account for 67 percent of the total increase in coal use worldwide.

World carbon dioxide emissions from the fossil fuels are projected to rise from 23.9 billion metric tonnes in 2001 to 37.1 billion tonnes in 2025. Copies of the *International Energy Outlook 2002* may be found on the Web at www.eia.die.gov/oiaf/.

New Book on Oil Depletion

Professor David Goodstein, a physicist and Vice-Provost of the California Institute of Technology, where he has been on the faculty for more than 35 years, has published *Out of Gas: The End of the Age of Oil.* This compact book of 140 pages (W.W. Norton Company, New York) gives a good introductory overview of the subject and gives reasons why this problem will be difficult to overcome. It is a good introduction for those not familiar with this subject, but the book does not deal in detail with the current controversies in this field. Professor Goodstein's Web Site may be reached at www.its.Caltech.edu/~dg/. Currently, an interesting history of the cold fusion field is mounted that raises more questions than it answers.

North American Natural Gas Situation

A useful paper *North American Natural Gas: Data Show Supply Problems* by Walter Youngquist and Richard C. Duncan has appeared in Natural Resources Research Vol. 12 No. 4 December 2003 (ISSN 1520-7439). This paper provides a timely review of the situation and includes an

assessment of such emerging options as Coalbed Methane (CBM), liquefied natural gas (LNG), and methane hydrates. The paper notes that gas production has passed its peak on a per capita basis in all three North American jurisdictions.
(Web: www. www.wkap.nl/journalhome.htm/1520-7439)

U.S. Department of Energy Hydrogen Posture Plan

On 10 March 2004, the U.S. Department of Energy released its *Hydrogen Posture Plan*, a document of 54 pages in total dated February 2004. The purpose of this document is to outline the activities, milestones and deliverables that the DOE plans to pursue to support a shift to a hydrogen-based transportation energy system. The budget request for the 2005 fiscal year includes $US 227 million to support this activity. This is additional to other current programs in the near-term energy efficiency and renewable energy sphere such as the FreedomCar activity which provides $US 90 annually for research into hybrid components and other advanced vehicle technology. The document quotes President Bush as saying `the first car driven by a child today could be powered by fuel cells.'

The key program milestones identified for achieving a hydrogen economy include the following:

- On-board hydrogen storage systems with a 9% capacity by weight to enable a 300 mile driving range;
- Hydrogen production from natural gas or liquid fuels at a price equivalent to $1.50 per gallon (U.S./U.S.) of gasoline at the pump, untaxed, no carbon sequestration, at 5,000 psi;
- Polymer electrolyte–membrane automotive fuel cells that cost $US 30-45 per kilowatt and deliver 5,000 hours of service, the anticipated effective life of the vehicle;
- Zero emission coal plants that produce hydrogen and power with carbon sequestration at $US 0.80 per U.S. gallon equivalent at the plant gate or $ 1.80/gallon (U.S./U.S.) delivered;
- Hydrogen production from wind-based electrolysis approaching $US 2.00 per U.S. gallon untaxed using wind electricity at $US 0.04 per kWH, delivered at 5,000 psi;
- Hydrogen fuel delivery technologies that cost $ 1.00 per gallon (U.S./U.S.) of gasoline equivalent.

There is an emphasis on hydrogen production from coal with co-generation of electricity and possibly other chemicals linked with carbon dioxide capture and sequestration.

This report may have been prepared in part to deal with criticisms of the hydrogen program and its coordination which was termed 'unrealistically aggressive' in *The Hydrogen Economy: Opportunities, Costs, Barriers and R and D Needs* (Web: www4.nationalacademies.org), an evaluation conducted by the Committee on Alternatives and Strategies for Future Hydrogen Production and Use established by the National Academy of Sciences and dated February 2004. (See below) Copies of the *Hydrogen Posture Plan* may be downloaded at www.eere.energy.gov/ hydrogenandfuelcells/pdfs/ hydrogen_posture_plan.pdf.

Report of the U.S. National Academy of Sciences on the Hydrogen Economy

A pre-publication version of a comprehensive report entitled *The Hydrogen Economy: Opportunities, Costs, Barriers and R and D Needs* prepared under the auspices of the U.S. National Academy of Sciences was mounted on the Web 5 February 2004, with the final version published in the Spring of 2004 by the National Academies Press ((ISBN 0-309-09163-2). The whole of the preliminary text may be read on-line but can only be printed page-by-page. This report of some 394 pages (including extensive appendices) was authored by a number of experts on the hydrogen economy drawn from both industry and academia of whom several were retired. The tone of the report is that there is much promise ultimately in the hydrogen economy but, in contrast to some recent official statements, it is not optimistic on the time it will take to make a significant contribution to the energy economy.

There is little that is new in this study but it is a useful review of the present situation in this field. Its recommendations are generally consistent with others if somewhat conservative. There are a number of R and D requirements identified including the need for the integration of these efforts with carbon capture and sequestration activities in the fossil fuel research area. Small-scale hydrogen production for local applications by either the reforming of natural gas or by electrolysis processes are stressed as the most likely approach to the introduction of the hydrogen economy. There is not much emphasis on activities outside the U.S. The report may be viewed on the Web at www4.nationalacademies.org/.

Carbon Dioxide Climate Report

The assessment of new research developments relevant to the science of climate change for the year 2002 has been published by Environment Canada. A total of 287 references are considered for that year under the

following headings: Introduction; Atmospheric Composition; Radiative Forcing; Models; Trends; Impacts; and Policy. Copies of the report may be obtained from the Science Assessment and Integration Branch, Meteorological Service of Canada, 4905 Dufferin Street, Downsview, Ontario, M3H 5T4 (Tel: (416) 739-4432; Web: www.ec.gc.ca)

Report on Energy Trends, Greenhouse Gas Emissions and Alternative Energy prepared by the ExxonMobil Company

A 22-paged Report on *Energy Trends, Greenhouse Gas Emissions and Alternative Energy* was published by the ExxonMobil Corporation dated February 2004. This report is valuable as it gives a good indication of the present views of a major oil company in an increasingly complex energy situation. It states `by 2020, we expect that the world will require about 40 percent more energy that today. By then the world's consumption is likely to approach 300 million barrels of oil-equivalent every single day. We expect that 60 percent of this 2020 demand will continue to come from oil and gas as these primary sources of energy are available in sufficient quantity to meet the world's growth and are, at the same time, the most economical.' The report acknowledges the importance of continued improvements in energy efficiency and the rapid growth in energy from wind and solar sources that are, however, expanding from a small base. `Because 80 percent of the world's growth demand in energy demand through 2020 will be in developing countries, 80% of the growth in carbon emissions will also be in the developing world. As a result, actions to reduce carbon emissions must include consideration of the world as a whole.' The report contains many excellent figures, especially one dealing with the large requirement for new oil and gas production to 2015, and places emphasis on the importance of technical progress. The company notes that it has divested in the coal extraction and nuclear and solar energy fields on the grounds on unsatisfactory returns. The company believes hybrid-energy technology will prove successful and criticizes the use of ethanol in gasoline. It believes fuel cell-equipped vehicles based upon hydrogen will achieve only from 11 to 35 percent less carbon dioxide emissions than gasoline-based hybrids. Good results are clearly expected from the cooperative (with General Electric, Toyoto and Schlumberger) Global Climate and Energy Project now underway at Stanford University. This report in may be downloaded at www.exxonmobil.com in .pdf format.

Paper by James E. Hansen in `Scientific American'

James E. Hansen of the Goddard Institute for Space Studies has written a personal view of the climate change situation in an article entitled *Can We Defuse the Global Warming Time Bomb?* which has appeared in the March 2004 issue of the Scientific American Vol. 290, No. 3, 68-77. An earlier extended version of this paper was presented to the Council on Environmental Quality on 12 June 2003 that may be found in .pdf format at pubs.giss.nasa.gov/docs/2003/2003_Hansen.pdf.
This paper stresses the importance of the climate forcing function of the greenhouse gases and the significant role of their non-carbon dioxide constituents. He notes that methane emissions appear to be reaching a plateau, which he attributes to corrective actions already taken.

Dr. Hansen's answer to the question he has posed is generally positive provided action is taken soon. It is noteworthy that he does not refer to the possible effect of climate change on ocean currents. He also states without further qualification that `International cooperation on coal use and sequestration is probably the most important action needed to stabilize atmospheric composition and climate.' He is generally critical of the scenarios employed by the Intergovernmental Panel on Climate Change (IPCC) which he regards as projecting too great a usage of the fossil fuels throughout this century.

Report of the Expert Panel on Science Issues Related to Oil and Gas Activities, Offshore British Columbia

The Report of the Expert Panel convened by the *Royal Society of Canada* at the request of Natural Resources Canada on the science issues related to potential oil and gas activities in the Queen Charlotte Basin along the northern section of the B.C. Coast was released on 17 February 2004. The Government of British Columbia had requested that the lifting of the present moratoria on off-shore exploration and development imposed by both levels of government in this region, in force for the last thirty years or so, be reviewed. About 100 million barrels of oil and 9.8 trillion cubic feet of gas are estimated to be producible in this basin. The Expert Panel concluded that provided an adequate regulatory regime is put in place, there are no science gaps that need to be filled before lifting the moratoria on oil and gas development. It also concluded that the present restriction on tanker traffic in transit along the West Coast of North America from entering the coastal zone should be maintained for the time being. Nevertheless, the Expert Panel identified many gaps in the scientific information needed. Its five recommendations include the establishment of

an advisory body; specifics of the needed baseline studies; related monitoring studies; closing of protected areas; and the identification of other specified exclusion zones. The Minister of Natural Resources stated that while the report is comprehensive, he must wait for two other related reports before making any decision on lifting the moratorium. (Web: www.rsc.ca/)

Newsletters of the International Association for Energy Economics

The *Newsletter* of the International Association for Energy Economics is now available on-line to members with links provided to the individual papers. Papers published in the issue for the Second Quarter of 2004 include a contribution from Erling Mork writing on 'Nord Pool: A Successful Power Market in Difficult Times'; from Tony Baldwin on 'Electricity Market: Price Volatility No Flaw'; from Paul Tempest on 'Qatar: A Strong New Bridge in Global Energy'; from Pierrre-Olivier Pineau 'The Treatment of Electricity in the Free Trade Area of the Americas'; Jon Ludwigson, Frank W. Rusco and W. David Walls on 'Buying an Option to Build: Regulatory Uncertainty and the Development of New Electric Generation'; and from Jyoti Prasad Palnuly and Norbert Wohlgemuth on 'Renewable Energy Financing: What Can We Learn from Experiences?'.

The *Newsletter* for the First Quarter of 2004 also contains a number of papers and reports of interest. Joseph Cavicchi writes on 'Wholesale Electricity Procurement Strategies for Serving Retail Demand'; John R. Brodman on 'Energy (In)Security in the 21st Century'; Ferdinand E. Banks on 'Economic Theory and an Update on Electricity Deregulation Failure in Sweden'; Paul Tempest on 'Energy Security in an Insecure World'; and Douglas B. Reynolds on 'Government Ownership of Energy Infrastructure: The Case of Alaska.'

Copies or information concerning the *Newsletter* may be obtained from the IAEE at Suite 350, 28790 Chagrin Boulevard, Cleveland, Ohio, U.S.A 44122. (Web: www.IAEE.org; Fax: (216) 464-2737, E-Mail: IAEE@IAEE.org)

Short Notes

With the formation of the new government on 12 December 2003, the Hon. R. John Efford from Newfoundland was appointed Minister of Natural Resources. Prof. André Plourde, a former editor of the 'Energy Studies Review', has assumed a senior position in the energy policy field with the Department.

The International Energy Agency Greenhouse Gas R and D Programme now has 95 projects around the world in the field of carbon dioxide capture and sequestering registered on its *practical projects website* which may be found on the Web at www.co2sequestration.info. Two reports of interest to Canada have also been released this year: Report No. PH4/26 *Gas Hydrates for Deep Ocean Storage of Carbon Dioxide* (February 2004), and Report No. PH4/27 *Canadian Clean Power Coalition Studies on Carbon Dioxide Capture and Storage.* (March 2004). Contact IEA Greenhouse Gas R and D Programme, The Orchard Business Centre, Stoke Orchard, Cheltenham, Glos. United Kingdom, GL 52 7RZ; Fax: +44 (0) 1242 680758; E-Mail: andrea@ieagreen.demon.co.uk.

The General Electric Company has announced its intention of acquiring the Texaco entrained-flow coal gasification process from ChevronTexaco to link with its gas turbine-based combined cycle generating plants which are mainly fuelled by natural gas. The company now supplies about sixty per cent of such facilities for the generation of electricity around the world.

The January 2004 Newsletter #37 of the Association for the Study of Peak Oil and Gas (ASPO) contains a long section dealing with the oil sands of Alberta and the implications of counting oil derived from this source in the world's reserve base. (Web: www.peakoil.net)

A Calgary-based company, Sustainable Energy Technologies Limited has announced advances in the development of a pulse stepped inverter designed to convert the direct current electricity generated in many renewable energy sources to the alternating current required by most applications. (Web: www.sustainableenergy.com)

The *Institute for Fuel Cell Innovation* of the National Research Council will install a five KW Solid Oxide Fuel Cell to power a ground source heat pump to heat and cool their building in Vancouver. The SOFC provided by Fuel Cell Technologies Ltd. of Kingston, Ontario, will be operated first with natural gas and later with methanol.

A Japanese company – Sumitomo Electric Industries Limited – has announced it will begin volume production of superconductive wire based upon alloys of bismuth and copper.

The price is expected to be two to five times the cost of copper wire with the conductivity at less than 120 degrees C (within liquid nitrogen range) some 130 times as high.

A new family of thermoelectric materials has been discovered based upon a mix of silver, lead, antimony and telluride by researchers in Michigan and Greece. The work, reported in the 5 February 2004 issue of the U.S. Journal 'Science', suggests a coefficient of performance (ZT factor) as high as 2.2 at 527 degrees C and thus this material may be useful for the generation of electricity from heat. (Web: www.sciencemag.org).

Progress continues in the development of superconducting materials. Efforts now appear to be concentrated on the development of a yttrium-barium-copper oxide (YBCO) tape that uses nickel as its base and can be formed into wire.

On 1 March 2004, the Minister of Natural Resources, Hon. R. John Efford, announced a two-year initiative designed to encourage the capture and sequestering of carbon dioxide in the petroleum industry. As part of the *Action Plan 2000 on Climate Change*, $15 million will be available to projects in this field over two years. Eligible expenditures are defined as up to 50% of the cost of capital equipment and all other direct expenses required for capturing, compressing, transporting and injecting carbon dioxide into petroleum reservoirs: a single recipient can receive a maximum contribution of $5 million over the two-year program period. The purpose of the incentive is to demonstrate carbon dioxide-based enhanced oil/gas recovery in small-scale commercial projects that are near-economic to help overcome the higher costs of capture and storage of this greenhouse gas, and to facilitate the development of the capture and storage market. This program will be co-ordinated with similar activities supported by the Government of Alberta.

The Federal Government announced in March the start of mandatory reporting of Greenhouse Gas Emissions by the operators of the major sources in Canada. In this first phase, only those who emit more than 100 kilotonnes of GHGs per year are required to report. The aim is to ensure that a workable system will be in place by the start of the first Kyoto Protocol period between 2008 and 2012.

The Government of Canada launched its One-Tonne Challenge on 26 March 2004 that calls upon individual Canadians to reduce their greenhouse gas emissions by one tonne or about 20%. The program is

supported by the *One-Tonne Challenge Web Site* at www.climatechange.gc.ca/onetonne/English/ and by a new publication *Your Guide to the One-Tonne Challenge.*

The content of carbon dioxide in the atmosphere as measured at the U.S. observation station high on the Mauna Loa volcano in Hawaii was about 379 parts per million (volume) on 19 March 2004 with an average of 376 ppmv for 2003. This is an increase of 3 ppmv over the value of 376 ppmv measured a year ago and an average increase of 2.5 ppmv in 2003 over 2002. The average increase in 2002 over 2001 was also 2.5 ppmv. Over the past decade, the average rate of increase has been substantially less at 1.8 ppmv ppmv. The rate of increase has been known to fluctuate in the past but this is the first time there have been increases of this magnitude in two successive years. The cause is not certain but may be related to more rapid growth in the consumption of the fossil fuels in China and India. There are indications, however, that the methane content of the atmosphere is stabilizing.

The total installed capacity to generate electricity from the wind around the world reached 39.294 GW in 2003, an increase of 8.133 GW or 26% over 2002, a record rate of expansion.

The report of a group appointed by the Ontario Government to examine the prospects for Ontario Power Generation foresees an electricity crisis in the Province within three years, particularly if coal-based generation is closed as was promised in the previous election. The Hon. John Manley, previously Deputy Prime Minister, Peter Godsoe, recently retired from Scotiabank, and the Hon. Jake Epp, a former Minister of Natural Resources, recommend a revival of the nuclear program including the immediate expenditure of $600 million to restore a unit of the Pickering Generating Station `A' to service as soon as possible. A 10-paged *Backgrounder on the Nuclear Recovery Program* dated 16 March 2004 which summarizes the history of the difficulties that have been experienced is available on the Web at www.opg.com.

Stuart Licht and colleagues at the University of Massachusetts at Boston have discovered a way of doubling the efficiency of solar-powered cells used to produce hydrogen. They make use of the energy in the infrared portion of the spectrum to provide heat for the cell to allow electrolysis at 600 degrees C.

Rusi P. Taleyarkhan (now at Purdue University) and colleagues at Oak Ridge National Laboratory in a paper published in the journal *Physical Review E* reported further experiments that lead credence to their earlier work which claimed that fusion was achieved in acetone bubbles using sound waves in a desk-top apparatus. In essence, these experimenters believe that ultrasonic vibrations squeezed tiny gas bubbles in the liquid so quickly and violently that temperatures reached million of degrees locally with the result that some of the hydrogen atoms in the solvent molecules fused with the release of neutrons.

Industry Canada will provide $30 million from its *Technology Partnerships Canada* program as part of a $122.5 project by Rolls-Royce Canada to develop a gas turbine in the 25-35 megawatt range which will claim the world's highest thermal efficiency. This project complements an earlier effort to develop larger industrial turbines derived from the Trent aeroengine with outputs up to 60 megawatts. A large market is anticipated for the smaller turbine in distributed generation and related applications in industry.

At the urging of a number of scientists, particularly Dr. Peter Hagelstein of M.I.T., the U.S. Department of Energy has agreed, without public announcement, to re-examine the cold fusion process. Advocates working in this field claim they can produce as much as two or three times more thermal energy than in the electricity supplied to the cell, that the results are now more reproducible, and that fusion by-products, particularly helium, have been generated in quantities proportional to the heat generated. An analysis by Michael McKubre of SRI International in California found that whenever the number of deuterium atoms loaded into the metal matched or exceeded the number of palladium atoms, excess heat was generated. Palladium loaded with slightly less deuterium produced inconsistent results, and if the deuterium level was reduced by a great amount, then no excess heat at all was produced.

The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) has approved the first U.S. nationally-recognized indoor air-quality standards developed solely for homes. This need arose from the problems caused by the tighter structures required for higher energy efficiency. *Standard 62.2, Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings* was approved in July 2003 after six years of deliberations on this difficult subject and has now been implemented. Web: www.ashrae.org). Canadian practice in this field usually follows ASHRAE Standards closely.

In the Speech from the Throne on 2 February 2004, the new government made clear its support for the Kyoto Protocol. An `equitable' national plan is promised which will close the expected gap of 60 million tonnes in excess equivalent carbon dioxide emissions per year not as yet dealt with to meet this commitment. The new measures will rely upon the introduction of `innovative environmental technologies', `energy-efficient transportation' and `non-polluting industrial processes.'

A new study conducted under the auspices of the International Geosphere-Biosphere Programme, (based in Sweden) launched by Nobel Prize-winner Professor Paul Crutzen and in which Canadian scientists from the Bedford Institute in Nova Scotia have participated, suggests that the `fingerprint of global warming' has been found in the oceans. The ocean has become saltier in the tropics and sub-tropics and fresher towards the Poles over the past 50 years. This change in salinity may reduce the drive behind such ocean flows as the Gulf Stream and therefore result in major cooling in Europe. (Web: www.igbp.kva.se)

On 13 February 2004, The Ministers of Natural Resources (Hon. John Efford) and Agriculture and Agri-Food (Hon. Bob Speller) announced that seven companies would receive $78 million to build conventional facilities to produce ethanol from corn and other grains across the country under the Ethanol Expansion Program. As a result, Canadian production of this fuel alcohol is expected to increase four times to just less than one billion litres per year. The largest of these facilities will be built by Suncor Energy Products Inc. where $22 million will be contributed from this Program to help fund a $120 million plant to be built near Sarnia which will produce 208 million litres per year. The objective is for 35% of the gasoline sold in Canada to contain at least 10 % ethanol by 2010 to help meet greenhouse gas emission standards. This goal will require a production of 1.4 billion litres of fuel ethanol per year. In Round Two of this program, non-conventional enzymatic facilities that convert straw, corn stalks and similar waste cellulosic materials to ethanol of the type being developed by Iogen Corporation in Ottawa are expected to qualify.

The Iogen Corporation has reached an agreement with Petro-Canada to market ethanol produced by the enzymatic treatment of cellulose normally derived from corn husks and stalks in ten percent blends with gasoline. The ethanol is produced in the one million litre per year demonstration plant in Ottawa. The first full-scale facility (200 million litres per year) is now being planned but the company requires a loan guarantee of about $ 100 million to proceed.

In the U.S. journal 'Science' (Vol. 303 No. 5660), researchers at the University of Minnesota announced they have built a device capable of extracting hydrogen from ethanol by partial oxidation small enough to be mounted on vehicles to power the fuel cells that consume this gas. (Web: www.sciencemag.org)

Chris D. Thomas from the University of Leeds writing with a number of investigators from several other institutions in the journal 'Nature' on 8 January 2004 (Vol. 427 No. 69) have estimated that climate changes expected by 2050 will likely kill off about one quarter of the world's land animals and plants. Their meta analysis examined 1,103 species in decline which caused these authors to believe that the changed climate will kill between 15 and 37% of land species for a mid-range projection of climate change. (Web: www.nature.com)

The Carbon Dioxide Information Analysis Center (CDIAC) at the Oak Ridge National Laboratory in the U.S. has extended its data collection and interpretation activities to the sequestration of carbon. Initially the efforts of this group will be devoted to sequestration in terrestrial ecosystems involving such aspects as grassland, afforestration, tillage and crop rotation, but this work will be extended to emissions from the fossil fuels. (Web: cdiac.ornl.gov)

Based upon preliminary data, the year 2003 was the third warmest on record. It was also the 27th consecutive year that average temperatures have exceeded historical averages.

As part of its objective to provide 10% of total British energy from renewable sources by 2010 (20% by 2020), the U.K. government announced additional support for generation from the wind in December of 2003. The aim is to install seven GW of wind generation capacity that will supply seven per cent of Britain's total energy needs by the end of this decade. Energy companies plan to place more than 1,000 turbines off England's coastline in the $US 12.4 billion project that will create the world's largest source of wind energy. Fifteen sites have been designated in three off-shore regions – the Thames Estuary, the Greater Wash, and the Northwest. The Energy Bill now being considered by Parliament will enable developers to build wind farms more than 12 nautical miles out to sea beyond territorial waters.

Extensive resources of solid methane hydrates exist in Canada and around the world in the form of clathrates – methane molecules boxed in

by frozen water molecules. In total, more energy is thought to exist in this form than in all the other fossil fuels put together including peat. Progress on the Mallik 2002 Gas Hydrate Production Research Well Program, led by Natural Resources Canada with participation from India, Germany, Japan, and the U.S. (including some petroleum companies), was reported at a conference held in Japan in December. Some $ 25 million is budgeted for this activity at the Mallik deposit that was discovered in the Mackenzie River delta in 1971. For the first time, it has been demonstrated that gas production from this class of resource is technically feasible. An uninterrupted flow of a maximum of 1,500 cubic metres a day over five days was achieved by a combination of warm water treatment and mechanical stimulation. Methane is an aggressive greenhouse gas and because these hydrates are only stable over a limited range of pressure and temperature, there has always been concern they would decompose in a positive feedback mode thus accelerating climate change. For this reason as well as their potential as a source of energy, there is a strong incentive to study this resource.

Electric Vehicles and Hydrogen

On 27 April 2004, the Secretary of the U.S. Department of Energy, Spencer Abraham, announced the details of the allocation of $US 350 million of the $US 1.2 billion previously provided to develop the hydrogen economy. Three centers of excellence have been chosen to coordinate the projects which involve 30 lead organizations and over 100 partners from industry, academia and other laboratories: Los Alamos National Laboratory (Chemical Hydrogen Center), Sandia National Laboratory (Metal Hydride Center), and the National Renewable Energy Laboratory (Carbon Center). The research areas include: hydrogen storage where the objective is to enable a driving range of 300 miles without loss of cargo or passenger space; vehicle and infrastructure learning demonstrations; fuel cell research, and hydrogen education. Only one Canadian company – Ballard Power Systems in Burnaby, B.C. – is mentioned in the long lost of participants. (Web: www.energy .gov)

During a visit to B.C. on 1 April 2004, Prime Minister Martin announced funding for the Hydrogen Highway to be ready between Vancouver and the Whistler site for the Olympic Winter Games to be held in 2010. It will be possible to travel to the site of the games from the city in a fuel cell-equipped vehicle. Among the projects to be funded include fuelling stations, production of hydrogen by electrolysis, and the development of an improved hydrogen dispenser.

The Saskatchewan Research Council, working with Ecce Energy Corporation of that Province, has modified a 6.6-litre turbocharged diesel-powered pick-up truck to operate on a combination of hydrogen and diesel fuel without loss of performance. A second prototype will operate with a mixture of hydrogen and gasoline. (Web: www.src.sk.ca)

The Samsung Company of Korea has joined other major electronic companies, such as Fujitsu, Hitachi and Toshiba, in the development of direct methanol fuel cells (DMFCs) to extend the service time for powering computers and similar small-scale portable devices. The company claims a new membrane that halts 90% of the methanol crossover frequently encountered in this type of cell and the use of mesoporous carbon as a catalyst. Such developments are expected to be ultimately useful in vehicles.

Ebara Ballard, the Japanese affiliate of Ballard Power Systems of Burnaby, B.C., together with Nippon Oil have announced the development of a one kilowatt combined power and heat fuel cell system based upon hydrogen obtained by the reforming of kerosene. Some 26% of the residential energy requirements are met with kerosene fuel in that country. A market launch is expected in 2006 given a successful trial period.

Stuart Energy Systems Corporation of Toronto has received $1.4 million in support from Technology Partnerships of Industry Canada to adapt their technology for the electrolysis of water for use in hydrogen backup power generators and hydrogen-based storage systems for renewable energy sources such as wind and solar power.

Hydro-Québec, through its subsidiaries *TM4* and *AVESTOR*, has entered into an agreement with two French companies – Groupe Industriel Marc Dassault and Groupe Henri Heuliez who together control *Société de Vehicles Electriques* (SVA) - to produce some 10,000 four-seater cars to cost about $24,000 and have a range of 150 km at 120 km/h. Re-charging time is stated as between six and eight hours. TM4 has developed a power system that uses a brushless inverter rotor configuration that can be embedded inside a wheel of regular size thus obviating the need for a central drive motor, transmission, differential, universal joints and the drive shaft. The battery developed by AVESTOR is of the lithium-metal-polymer (LMP) type which promises superior performance to those used in electric vehicles to date. The French companies will complete the prototype in 2004 and it is planned to market the cars by 2006. The batteries will be built in Boucherville south of Montreal. A manufacturer has yet to be chosen to assemble the vehicles.

Suk Won Cha and Fritz Prinz of Stanford University have found they can significantly improve the output of hydrogen-based fuel cells by etching microchannels to conduct the gaseous fuel to the interior of the

cell. Though this work is presently directed to increasing the performance of small fuel cells designed to power computers and the like, there is no reason in principle this advance should not be applicable to larger cells designed for vehicles.

A trial of battery buses is scheduled for the tourist city of Hangzhou in China. The maximum speed will be 85 km/hr with 280 to 380 km between electrical recharges of four to six hours duration.

Energy Conversion Devices, a U.S. firm, has devised a hydrogen storage system for vehicles that permits the holding tank to be operated as low as 200 to 300 psig by placing novel hydride–forming constituents into the tank.

Peter Fairley of Victoria, B.C., writing in the April 2004 issue of *Technology Review* (Vol. 107 No. 3, Web: www.technologyreview.com) reviews the prospects for hybrid vehicles with emphasis on the activities of the Toyoto Company in an article entitled *Hybrid's Rising Sun.*