Panel Session: Impacts of GHG Programs and Markets on the Power Industry

{Jim McConnach and Tom Hammons}

Sponsored by: International Practices for Energy Development and Power Generation[#]

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Topic: Integrating New Sources of Energy in Power Systems—Global Warming

INTRODUCTION

Global response to climate change is well established and growing daily due to international initiatives such as the Kyoto Accord and the recent Climate Pact which the USA and Australia have developed with a group of key Asian countries, notably China and India. There are also many programs and initiatives at national, state and regional levels to monitor, record and reduce Greenhouse Gas (GHG) emissions. An effective tool or mechanism to accelerate the achievement of cost effective GHG targets is the concept of emissions trading or transfers among participants. Essentially this involves treating GHG emission allowances and reduction/removal credit units like any other commodity in the marketplace. Arrangements are made for them to be traded on national and international exchanges. The marketplace sets the value of GHG emission credit units. These are bought and sold by countries and companies to facilitate meeting their GHG targets at lowest cost.

The main established markets for trading GHG credits and allowances are the European Emission Trading Scheme (ETS); the Chicago Exchange (CCX) and the International Emissions Trading (IET) scheme established as part of the flexibility mechanisms of the Kyoto Accord. There are many other markets and programs under development such as the Carbon Trust, Canada Offsets System; the Regional GHG Initiative (RGGI) in North-east USA; and the California Climate Action Register.

This panel session will provide an overview of the global responses to Climate Change and of the established and emerging GHG Markets and Programs arising from this. The impacts on the electrical power industry and how it is taking advantage of these programs and markets will then be discussed. This will include the impacts on policy, strategy and decision-making in major players such as governments, manufacturers, utilities, contractors and consultants and how they are leading by example within their own operations..

The Panelists and Titles of their Presentations are:

[#] Document prepared and edited by T J Hammons

1. Ahmed Faheem Zobaa, Cairo University, Giza, Egypt and James McConnach, Chair of IEEE-PES WG on Climate Change, Bracebridge, Ontario, Canada. *International Response to Climate Change: An Overview* (Paper 06GM0027).
2. Jean Luc Allard, VP, Environment, SNC Lavalin, Canada. *Impacts of Climate Change on Major Energy Projects* (Invited Discusser, Paper 06GM0918).
3. Romney Duffey, Principal Scientist, Atomic Energy of Canada Ltd. *The Value of Non-Carbon Power and Emissions Avoidance* (Paper 06GM0914).
4. Gilles Potvin, Senior Program Office, CDM & JI Office, Foreign Affairs Canada, Canada. *Canada's CDM and J I Office* (paper 04GM0660).
5. James E. Platts, ISO, New Zealand. *Impact of Regional Greenhouse Initiative and Renewable Portfolio Standards on Power System Planning in New Zealand* (paper 06GM0920).
6. Invited Discussers: Include:
   Speaker from World Bank
   Speaker from GE Canada
   Speaker from UN

Each Panelist will speak for approximately 25 minutes. Each presentation will be discussed immediately following the respective presentation. There will be a further opportunity for discussion of the presentations following the final presentation.

The Panel Session is organized by Jim McConnach (Castle Hill Engineering Services, Ontario, Canada) and Tom Hammons (Chair of International Practices for Energy Development and Power Generation, University of Glasgow, UK.

Jim McConnach and Tom Hammons will moderate the Panel Session.

PANEL SESSION PAPERS

1. International Response to Climate Change: An Overview

A. F. Zobaa, ***Senior Member, IEEE*****, J. S. McConnach,** ***Senior Member, IEEE***

Abstract**—** There is a scientific consensus that increasing concentrations of GHGs in the earth's atmosphere have begun to impact our climate and may be the dominant force driving recent warming trends. International efforts to reduce GHG emissions and stabilize atmospheric GHG concentrations have grown apace since the development in 1997 of the Kyoto Protocol under the UN Framework Convention on Climate Change. There is also considerable international effort aimed at adaptation to the climate change already occurring. This paper presents an overview of the international response for mitigation and adaptation to climate change.

Index Terms – Climate Change, GHG, Mitigation, Adaptation, International Practice

I. INTRODUCTION

Access to modern forms of energy is fundamental to development and the eradication of poverty in the developing world, but energy is also responsible for much of the Greenhouse Gas (GHG) emissions that threaten the stability of the climate system. Therefore the goal of GHG reduction efforts is not to deny people access to energy, but to reduce the carbon intensity of development - which means a less carbon-intensive energy supply, reduced energy demand and improved carbon sinks. As different approaches to achieve this goal are carefully evaluated and international negotiations continue, most countries have implemented programs that promote research, tracking and reporting on carbon emissions, voluntary mitigation and adaptation measures, energy efficiency and renewable energy technologies. However, with the exception of a handful of European countries that have implemented some form of carbon/energy tax, governments have not banned or placed restrictions on fossil fuels or CO_2 emissions.

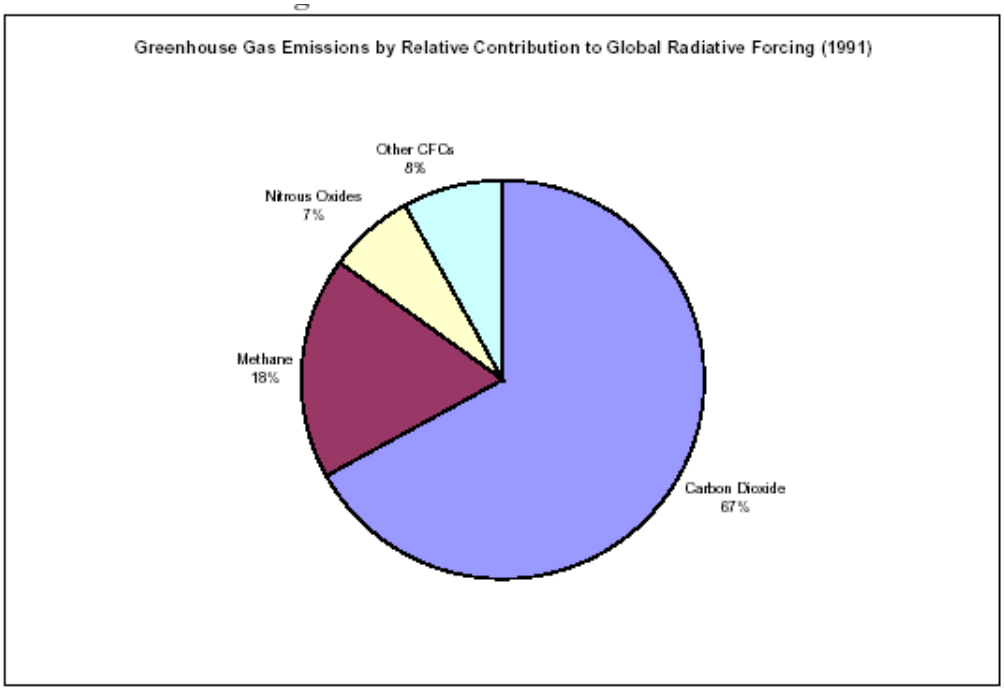
Efforts to reduce the carbon-intensity of the energy supply generally focus on increasing the efficiency of power plants and promoting low-carbon fuels and renewable energy (wind, solar, hydro, geothermal, etc.). Efforts to reduce energy demand typically promote energy efficiency and conservation in the industrial, commercial, transport and residential sectors. Efforts to encourage improved management of agricultural and forest lands and the protection of forests tend to enhance the Earth's natural capacity to assimilate carbon and mitigate the impact of CO2 emissions. This paper presents an overview of international efforts to reduce the impact of climate change and GHG emissions through mitigation and adaptation programs [1]-[12].

II. GEENHOUSE GASES

The gases responsible for the strong atmospheric absorption of infrared radiation are called Greenhouse Gases (GHG). Water vapor and CO_2 are the most important GHGs and are responsible for the bulk of greenhouse warming. Both water vapor and CO_2 are naturally occurring as are other GHG including methane, nitrous oxide, and ozone. Human activities, however, add to the levels of most of these naturally occurring gases, and are the sole source of other powerful classes of GHG, including chlorofluorocarbons (CFCs), hydro fluorocarbons (HFCs) and per fluorocarbons (PFCs), among others.

GHGs generally persist for long periods in the atmosphere. While many conventional air pollutants may persist in the atmosphere for only a matter of hours or days, many important GHGs persist for decades or even hundreds of years. For example, CO2 has an estimated atmospheric persistence of 120 years and some CFCs may persist for as long as 400 years. As a result, these gases accumulate, become very well mixed in the atmosphere and have a global impact that is mostly independent of where they were emitted. GHG persistence has significant policy implications because the gases we emit today may impact the climate system for hundreds of years.

Greenhouse Gases differ in their ability to absorb infrared radiation. Among the most infrared radiation-absorbent are the CFCs, HFCs and PFCs. Other powerful GHGs include nitrous oxide and methane. For example, a molecule of CFC-12 is 15,800 times, CFC-11 is 12,400 times, nitrous oxide is 270 times and methane is 21 times as effective in absorbing infrared radiation as a molecule of CO_2. However, because atmospheric concentrations of these compounds are much less than concentrations of CO_2, they play a lesser role in greenhouse warming and climate change. Fig. 1depicts the relative contribution to greenhouse warming of various GHGs when both their radiation absorbing characteristics and their relative concentration are considered. As illustrated, CO_2 is the largest contributor to climate change, or radiative forcing, followed by methane and nitrous oxide, which together account for over 90% of total radiative forcing. Although water vapor plays a very important role it is not not included here because it is a feedback gas - meaning its concentration is mainly a function of other climate parameters, not emissions.



Source: Greenhouse Gas Assessment Handbook, World Bank 1998

Fig. 1. The contribution of selected Greenhouse Gases to Greenhouse Warming

III. CLIMATE CHANGE

Carbon dioxide and other atmospheric GHGs have long been known to absorb infrared radiation and create a natural greenhouse effect that warms the Earth. The natural greenhouse warming of the atmosphere keeps the Earth approximately 60°F warmer than it would be without an atmosphere. However, humans have been emitting increasing quantities of these GHGs since the advent of the fossil fuel-driven industrial age and now emit 25 billion tons of CO_2 annually. As a result, atmospheric CO_2 concentrations are now at their highest levels in more than 160,000 years and global mean temperature has increased approximately 1°F over the past century. There is a scientific consensus that these steady additions of GHGs have begun to impact our climate and may be the dominant force driving recent warming trends.

IV. KYOTO PROTOCOL

The Kyoto Protocol developed by the UN Framework Convention on Climate Change(UNFCCC) was signed in December 1997 after two years of debate and negotiation about the inadequacies of the UNFCCC and its voluntary mechanisms and the need for more meaningful requirements. Much of the impetus for the Protocol came from the Intergovernmental Panel on Climate Change's (IPCC) Second Assessment Report, which concluded that, "the balance of evidence suggests a discernible human influence on global climate change." The Kyoto Protocol commits developed countries which have signed the protocol to legally-binding emission reduction targets for six greenhouse gases – carbon dioxide, methane, nitrous oxide, hydro fluorocarbons, per fluorocarbons, and sulfur hexafluoride -- to be reached by the period 2008-2012. (CFCs are controlled under the Montreal Protocol.) These targets, which range by country from –8% to +10%, provide for a 5% emissions reduction from 1990 levels in aggregate.

With the ratification of the protocol by Russia in the fall of 2004, the required level of "55% of developed country emissions" was reached and the protocol officially came into force on February 16, 2005.

The Protocol is noted for its three flexible, innovative mechanisms – joint implementation (JI), emissions trading (ET), and the clean development mechanism (CDM). The primary goal of these mechanisms is to encourage the least costly emissions reduction to be made wherever they are possible. For example, the CDM is intended to promote "win-win" actions in developing countries - that is, actions that enhance development prospects while reducing growth in GHG emissions. The Clean Development Mechanism (CDM) allows industrialized countries to finance emissions reduction or avoidance projects in developing countries and credit some or all of the reductions achieved against their own emission limitation targets. CDM is a cost-effective way for industrialized Annex I countries to meet their Kyoto Protocol goals and at the same time aid development prospects of developing countries by stimulating technological "leapfrogging" and generating new investments.

V. RENEWABLE ENERGY

Renewable energy projects, particularly wind and solar, offer compelling environmental advantages when compared to conventional fossil fuel-based power generation, including little or no conventional pollutant and GHG emissions. However, renewable energy projects face serious challenges competing with conventional fossil fuel-fired power projects and have achieved only limited success in the marketplace.

In addition to high capital costs, one of the most significant challenges facing renewable energy projects is the subsidy given by many governments to conventional forms of energy. Another challenge facing renewable energy development is the remote, decentralized nature of many renewable energy projects. Very large conventional power projects, a gigawatt-sized fossil fuel-fired plant for example, can find investment capital at much lower interest rates and longer terms than can hundreds of thousands of micro-hydro projects or wind installations of a few kW each. Banks and financing agencies are generally ill equipped to manage myriad micro projects, so aggregation of demand is necessary if a "level playing field" is to be established in financing renewable energy projects. Such challenges led the U.S. Department of Energy (DOE) to conclude that over the next two decades it is unlikely that renewable energy can compete economically with conventional fossil fuel-based power generation. According to the U.S. DOE, "failing a strong world wide commitment to environmental considerations, such as the limitations and reductions of CO_2 emissions outlined in the Kyoto Climate Change Protocol, it is difficult to foresee significant widespread increases in renewable energy use" in the near to medium term.

However, there are indications that the market for renewables may be brighter than the above assessment would indicate. The wind industry, arguably one the biggest renewable energy success story, now has a global installed capacity of over 40,000 MW and is growing at 35 to 40% per year. Last year, for the first time, more new wind capacity was brought on line than nuclear power. And the solar photovoltaics industry, which is now a $1 billion industry, is growing at 30% per year. The potential of renewables has not escaped the big conventional energy companies, including BP Amoco, ABB, Enron and others, all of which have made considerable investments in the renewable sector. ABB, for example, has divested much of its conventional power portfolio and announced a new 'Alternative Energy Solutions' program, with a target of $1 billion turnover per year by 2005.

And many developing countries and emerging markets are beginning to make modest commitments to including renewable resources in their energy mix as well. India has a Ministry of Non-Conventional Energy Sources and has developed several policies to promote renewables, including tax incentives, automatic environmental clearances and soft loans for certain renewable energy projects. Brazil has committed to invest substantial sums to increase the number of its non-hydro renewable energy installations. Several African countries have implemented policies to promote renewable energy technologies. In addition, there are specialized, off-grid applications where renewables may be more competitive because the costs associated with transmissions lines and other requirements increase the cost of conventional fossil fuel-fired power projects. These types of policies and projects demonstrate the opportunity for national and international efforts that support investment in these countries that contributes to meeting the climate challenge ahead.

It is in the interest of the U.S. to continue to encourage and assist developing countries in making these commitments to renewables. However, there is a need to understand more fully both the needs of renewable energy developers and how developing countries determine their energy requirements and establish bid specifications for power projects.

VI. EMERGING GHG MARKETS

Emissions Trading

An effective tool or mechanism to achieve cost effective GHG reduction targets is the concept of emissions trading or transfers among participants. Essentially this involves treating GHG emission allowances and reduction/removal credit units like any other commodity in the marketplace. Arrangements are made for them to be traded on national and international exchanges. The marketplace sets the value of GHG emission credit units. These are bought and sold by countries and companies to facilitate meeting their GHG targets at lowest cost. For this to work, just like any other commodity, there must be internationally accepted standards or a "common currency" for the measurement, monitoring, reporting, verification and certification of emission credit units.

Emerging GHG Markets

GHG markets can currently be split into two categories:

- The Kyoto compliant market;
- The non-Kyoto compliant market.

The bulk of the current global activity in GHG trading is centered on the Kyoto compliant market. Developed countries, which have ratified the Kyoto Protocol and accepted their GHG emission reduction target, termed Annex 1 countries, may meet their commitments through domestic climate change policy activity and the use of the Kyoto mechanisms. As already described, these "flexibility" mechanisms are Joint Implementation (JI); Clean Development Mechanism (CDM) and International Emissions Trading (IET).

Both JI and CDM are "project based mechanisms" and involve carrying out climate change mitigation projects for the reduction or removal of GHG emissions. JI projects allow Annex I Parties to implement projects that reduce GHG emissions by sources, or enhance removals by "sinks", in the territories of other Annex I Parties, and to credit the resulting "emission reduction units" (ERU) against their own emission targets. CDM projects allow Annex I Parties to implement projects that reduce or remove GHG emissions in developing countries. Annex I Parties may use "certified emission reductions" (CER) generated by CDM projects in developing countries to contribute to compliance with their GHG emission commitments. The rules governing the CDM are available at: http://cdm.unfccc.int/ and those for JI projects are expected to be similar. IET permits an Annex I Party to transfer (sell) part of its assigned GHG emission allowance (the amount of emissions the Party may emit during the commitment period) to another Annex I Party. It also permits trading of CERs and ERUs.

The main non-Kyoto compliant markets are the UK Emission Trading Scheme (UK-ETS); the European Union - Emission Trading Scheme (EU-ETS) the Chicago Climate Exchange and the recently announced Canada Climate Exchange.

The UK-ETS was launched in 2002 and was the world's first national economy wide GHG trading scheme. It is essentially a cap and trade scheme open to all entities in the UK, including 6,000

companies that already had Climate Change Agreements. Full details of the scheme and results to date can be found on the web-site of the UK Department of Environment, Food and Rural Affairs (DEFRA) at: **http://www.defra.gov.uk/**.

The EU-ETS was launched in January 2005 and trades in EU Allowances (EUA) are already taking place. In this scheme each regulated entity in the scheme is assigned an "allowance" or amount of GHG it is permitted to emit. Entities may buy surplus allowances from other entities to meet their CO_2 commitments. The EU scheme may also be linked with the Kyoto CDM and JI project mechanisms. Details of the EU-ETS may be found at:
http://europa.eu.int/scadplus/leg/en/lvb/l28012.htm

Although the current Presidential Administration in the U.S. did not seek ratification of the Kyoto Protocol, American companies are pursuing voluntary programs to reduce greenhouse gas emissions. Many are turning to emissions trading as a means of making reductions in their overall greenhouse gas emissions profile. Tradable units are Verified Emission Reductions (VERs) and have been trading since 1999.

Several states have instituted, or are considering instituting, greenhouse gas emissions reductions programs. (see Section VIII). Emissions trading is an integral part of several of these programs, as companies seeking to site new facilities purchase reduction credits to offset their greenhouse gas emissions.

Canada is developing a GHG Offsets system to give incentive for companies to achieve GHG reductions beyond their targets and to help Canada meet its Kyoto commitments. GHG reduction units may be sold to other entities or to the Government. The cap on price is Cdn$15 per tCO2e. The Canadian Climate Exchange for trading GHG credits was also recently announced.

Typical prices in voluntary GHG markets range from $1 to $10 per tCO2e and the EU market has ranged as high as $30 per tCO2e. Latest information on GHG market prices can be obtained by registering at the web-site of the Evolution Markets LLC: **http://www.evomarkets.com**

VII. ADAPTING TO CLIMATE CHANGE

While programs to reduce/remove GHGs will help mitigate the extent of change in global climate, there is still a need to adapt to the changes that have already occurred and may occur in the future. Thus adaptation programs are equally important to mitigation programs and there are many national and international initiatives for the assessment of climate change variability and impacts and associated adaptation measures. An internet search for the term "adapting to climate change" gives over 20,000 hits which is a measure of the global, extensive interest in this topic. Nearly every person and every sector of the global economy will be impacted by climate change and will need to adapt to some extent or other.

The Government of Canada Conference on Adapting to Climate Change held in Montreal in May 2005 covered the following key topics which is indicative of the global scope of climate change impacts:- Coastal Zones; Forestry and Forest Ecosystems; Infrastructure; Communities; Industry; Engineering; The Arctic; Health and Vulnerable Populations; Tourism; Regional Water Impacts: Physical and Social Health Impacts; Agriculture; Water Resources Management; Fish and Aquatic Resources. There were also general sessions on Risk Management; Hazards and Extremes; Research Programs and Tools; Adaptive Capacity; Economics; Education and Awareness; and Taking Action on Adaptation.

Here are a few noteworthy examples of adaptation programs:-

AIACC: Assessments of Impacts and Adaptations to Climate Change (AIACC) is a global initiative funded by the Global Environment Facility to advance scientific understanding of climate change vulnerabilities and adaptation options in developing countries. AIACC is implemented by the United Nations Environment Programme (UNEP). The information, knowledge, tools and skills that will be produced by AIACC research will enhance the ability of developing countries to assess their vulnerabilities and adaptation options.

Arctic Climate Impact Assessment: This is an international project of the Arctic Council and the International Arctic Science Committee (IASC), to evaluate and synthesize knowledge on climate variability, climate change, and increased ultraviolet radiation and their consequences. The results of the assessment were released at the ACIA International Scientific Symposium held in Reykjavik, Iceland in November 2004. The Arctic Council is a high-level intergovernmental forum. The members are Canada, Denmark, Finland, Iceland, Norway, the Russian Federation, Sweden, and the United States of America.

The U.S. Global Change Research Program: is a comprehensive and integrated research initiative to understand, assess, predict, and respond to human-induced and natural processes affecting the Earth's environment. In 1997 the program began a national assessment of the impacts of climate variability and change. The reports of the National Assessment were issued in 2000.

Canada Climate Change Impacts and Adaptation Program: The Government of Canada's Climate Change Impacts and Adaptation Program provides funding for research and activities to improve knowledge of Canada's vulnerability to climate change, to better assess the risks and benefits posed by climate change and to build the foundation upon which appropriate decisions on adaptation can be made. The Program also facilitates interaction between stakeholders and researchers through support of the Canadian Climate Impacts and Adaptation Research Network (C-CIARN).

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The financial and insurance industries are particularly interested in the risks and impacts associated with climate change. Reference 11 provides an overview of risks to the financial sector and stresses the need for international collaboration and research. Reference 12 provides the perspective of the insurance industry.

VIII. UNITED STATES CLIMATE ACTIONS

Climate change is a global environmental problem requiring an international response. USA leadership is pivotal to a successful outcome. Not only is the USA a major contributor to the problem, but it is also

the world's largest economy. As such it is well positioned to be a potential provider of technological solutions for both mitigation and adaptation. However, a clear policy signal is needed to drive business investment in climate solutions. This section provides a brief overview of GHG initiatives at the federal and state levels, as well as a description of several prominent voluntary programs targeted at business. While the US is not a signatory to the Kyoto Protocol there are growing indications that the federal government recognizes the need for action on climate change. Of particular note is the recent Climate Pact which the USA and Australia have developed with a group of key Asian countries, notably China and India.

The U.S. federal government does not currently regulate CO_2 domestically and the EPA has not promulgated emission limits for CO_2. However, in the absence of clear Federal policy limiting GHG emissions, many US states are moving ahead with their own legislation. For example, New Jersey has committed to reducing emissions to 3.5 percent below 1990 levels by 2005. Massachusetts has both imposed limits on CO_2 emissions from power plants and unveiled a plan in May 2004 to cut emissions by 10% by 2020. In June 2004, California proposed 30% cuts in car emissions by 2015. Many other states are weighing similar actions.

After completing an emissions inventory, many states choose to take the next step and develop a climate change action plan. a strategy to reduce greenhouse gas emissions through feasible and effective policies. Typically, the action plans are developed by state officials in consultation with stakeholders. Action plans are designed to minimize the impacts of climate change while ensuring that efforts to control emissions do not burden state constituents. Action plans are tailored to each state's specific circumstances and needs. An action plan typically includes a projection of the state's future greenhouse gas emissions and an emissions reduction goal. It identifies and recommends policy options based on criteria such as emissions reduction potential, cost-effectiveness, political feasibility, ancillary benefits, and public acceptance. Often the state will offer the plan for public comment. The impetus to develop an action plan or assess greenhouse gas emissions reduction options may come from the legislative branch, as in Wyoming and Oklahoma; a state agency; or, as in the case of Maryland, New York, and Texas, from the state administration.From FY 1992 through FY 2000, EPA's State and Local Climate Change Program provided technical assistance and approximately $2 million in grants and cooperative agreements to help 25 states and Puerto Rico prepare climate action plans. To date, 19 states and Puerto Rico have completed plans. Actions identified in several of the completed action plans could, if implemented, reduce green-house gas emissions in those states by a combined total of up to 70 MMTCE per year by 2010 and nearly 100 MMTCE by 2020. Actions already implemented by states avoid a total of more than 3 MMTCE annually.

New Jersey already has begun to implement a number of actions in its plan. For example, New Jersey's Clean Energy Program provides financial incentives for homeowners and small businesses that choose to install qualified clean energy systems where they live or work. The program supports technologies such as fuel cells, photovoltaics, small wind, and sustainable biomass equipment with incentives of $5/watt for small systems (less than 10 kilowatts), $4/watt for medium-sized systems (10-100 kilowatts), and $3/watt for systems larger than 100 kilowatts, up to a maximum of 60 percent of eligible system costs. The program is funded through an electricity surcharge approved by the New Jersey Board of Public Utilities. EPA provided technical and financial assistance toward the development of the action plan and toward several other activities related to climate change mitigation in New Jersey, such as the design of the trading program and outreach activities.

Highlights of Action Plans

In addition to New Jersey, seven states. Colorado, Delaware, Hawaii, Maine, North Carolina, Tennessee, and Utah, and the Commonwealth of Puerto Rico have completed state climate action plans since the State and Local Climate Change Program's previous progress report was published in 1998.

Colorado

The Colorado Department of Public Health and Environment released the report *Climate Change and Colorado: A Technical Assessment Examining Climate Change Science, Greenhouse Gas Production, Potential Impacts, and Mitigation* in December 1998. The plan provides an extensive menu of options describing national, state, and local programs and other potential strategies to reduce Colorado's greenhouse gas emissions. Actions implemented thus far have focused on pollution prevention at ski areas.

Delaware

The Center for Energy and Environmental Policy at the University of Delaware, in collaboration with the government agencies, businesses, and interest groups of the Delaware Climate Change Consortium, completed the *Delaware Climate Change Action Plan* in January 2000. The consortium adopted a target of reducing greenhouse gas emissions to 7 percent below 1990 emissions by the year 2010. To reach this target, the plan recommends cost-effective measures for each sector of the Delaware economy that, cumulatively, could reduce emissions by 15.25 percent during the next 12 years.

Hawaii

The Hawaii Department of Business, Economic Development, and Tourism and the Department of Health completed the *Hawaii Greenhouse Gas Reduction Strategy* in November 1998. The plan is primarily intended to encourage discussion, and it identifies options that could reduce the state's greenhouse gas emissions by nearly 1 MMTCE by 2010, restoring emissions to about 2 percent above 1990 levels by that year. The Hawaii Climate Change Action Team was formed in 1999 to catalyze actions such as reducing emissions through cost-effective and economically beneficial measures; exporting technologies, expertise, and services that reduce emissions; and developing a carbon offset forestry program.

Maine

The Maine State Planning Office, in collaboration with the Maine Climate Change Task Force, completed the *State of Maine Climate Change Action Plan* in 2000. The state agencies, public and private interest groups, business representatives, and state program administrators that participated in the task force evaluated each policy option in terms of expected emissions reductions, investment by the cost-bearing sector, and the net impact on Maine's economy. The plan sets a statewide goal to reduce carbon dioxide emissions by 0.12 MMTCE beginning in 2000. The plan calls to increase this reduction by 0.12 MMTCE each year over the course of the next 7 to 22 years until total annual emissions stabilize

at pre-1990 levels. In order to achieve this goal, the plan sets specific targets for the transportation, utility, industrial, commercial, and residential sectors.

North Carolina

The Department of Geography and Planning at Appalachian State University completed *North Carolina's Sensible Greenhouse Gas Reduction Strategies* in January 2000. North Carolina used the Greenhouse Gas Emissions Software developed for ICLEI to test pro-posed reduction measures. The state found that it could avoid 26 MMTCE, exceeding the strategy's target of reducing greenhouse gas emissions to 7 percent below 1990 emissions by the year 2010, and resulting in $6.7 billion in energy cost savings.

Puerto Rico

The Puerto Rico Department of Natural and Environmental Resources and Energy Affairs Administration, working with the Interagency Committee on Climate Change, completed the *Puerto Rico State Action Plan to Reduce Greenhouse Gas Emissions* in December 1999. The plan sets a goal to reduce annual emissions by 2.6 MMTCE.to 10 percent above 1990 levels by the year 2010. The report recommends 23 cost-effective measures or actions. The commonwealth concurrently conducted a public opinion poll to gauge knowledge and perceptions of climate change issues; the results prompted plans to develop an aggressive public education campaign.

Tennessee

The Center for Electric Power and the Tennessee Technological University completed *Tennessee Greenhouse Gas Emissions: Mitigation Strategies* in April 1999. The strategies identified in this report could reduce annual emissions by nearly 10 MMTCE, approximately 20 percent from the baseline level, by 2017. Based on economic models that simulated the impact on the state economy of changes in public and private spending, taxes, and prices, the state expects that policy measures aimed to reduce emissions also will result in a net economic gain.

Utah

The Utah Office of Energy and Resource Planning (OERP) and the Utah Division of Air Quality (DAQ) completed *Greenhouse Gas Reduction Strategies in Utah: An Economic and Policy Analysis* in March 2000. The analysis examined the economic impact of 13 fossil fuel-related strategies that Utah could implement, ranging from "feasible" to "potential" options. OERP and DAQ found that Utah could reduce annual greenhouse gas emissions by up to nearly 1 MMTCE, increase average annual earnings by up to about $24 million (mostly from energy efficiency retrofits), and increase average annual employment in the state by up to 1,600 jobs if all barriers to adoption were removed.

IX. EUROPE CLIMATE ACTIONS

The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) is only a first step to address the serious global threat of climate change. Numerous reports, including the Intergovernmental Panel on Climate Change's Second and Third Assessment Reports, call for significant cuts in global emissions to well below 1990 levels, and to below the cuts that the Kyoto Protocol defines. Only significant cuts will allow atmospheric greenhouse gas concentrations to stabilise at a level that would "prevent dangerous anthropogenic interference with the climate system", as required by Article 2 of the UNFCCC.

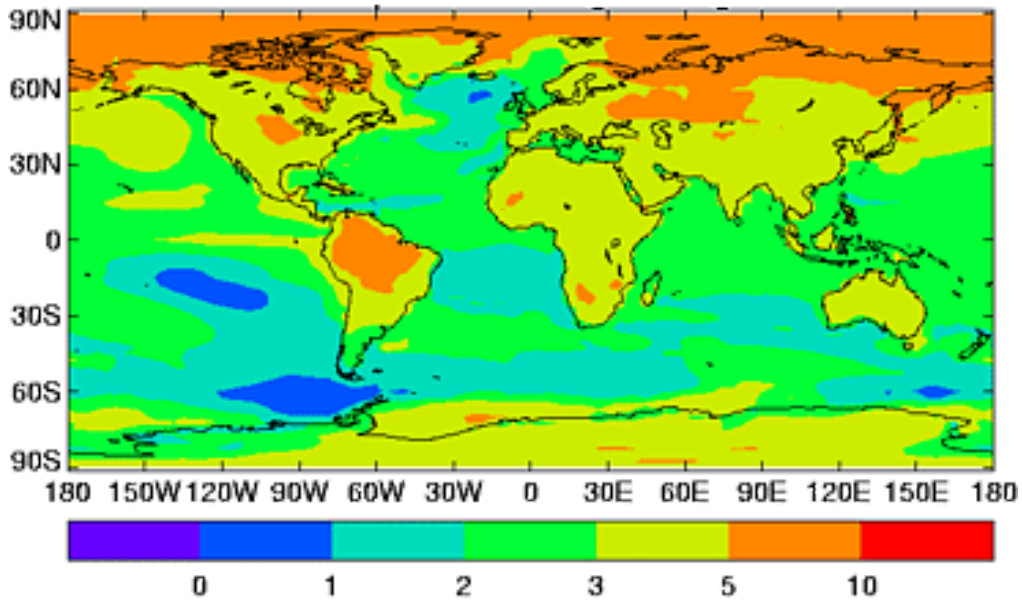

Fig. 2. Surface air temperature change in degrees Celsius

Fig. 2 illustrates the results of the coupled atmosphere-ocean general circulation model HadCM2, which assumes that CO2 concentrations will more than double over the course of the 21st century through mid-range economic growth, but no greenhouse gas mitigation measures.

The Kyoto Protocol requires the international community to initiate discussion on the global response to climate change after the end of the Protocol's 'first commitment period' (2008 to 2012) by the end of 2005.

- In anticipation of the international debate on the future of the global climate change regime, the European Council, at its meeting on 25 and 26 March 2004, announced that it will consider "medium and longer term emission reduction strategies, including targets" at its meeting in spring 2005.

The European Council's discussion comes in recognition of a growing awareness of the threat that climate change poses to our planet and the need to find responses that are environmentally effective while preserving and enhancing Europe's competitiveness.

- The European Council's discussion also seeks to create a stable and predictable policy environment concerning the EU's response to climate change, providing all sectors of the European economy with clear indications of how EU policy in this area is likely to evolve.

The conclusions resulting from the spring meeting will provide an important input into the international discussions on global climate change policy after the end of the Kyoto Protocol's first commitment period (2008-2012).

In preparation for its consideration of medium and longer term emission reduction strategies, including targets, the European Council requested that the Commission prepare an analysis of benefits and costs of action against climate change, which takes account both of environmental and competitiveness considerations. In response, the Commission on 9 February 2005 adopted the Communication on "Winning the Battle Against Climate Change" and a more detailed Staff Working Paper. The Communication outlines key elements for the EU's post-2012 strategy. It highlights the need for broader participation by countries and sectors not already subject to emissions reductions, the development of low-carbon technologies, the continued and expanded use of market mechanisms, and the need to adapt to the inevitable impacts of climate change.

X. ASIA CLIMATE ACTIONS

The early signs of climate change already observed in some parts of Asia and elsewhere may become more prominent over the period of 1 or 2 decades. If this time is not used appropriately, it may be too late to avoid upheavals and significant human impacts for some nations. Climate change could lead either to cooperation or to conflict over the world's major resources. Integrated planning may be the greatest global challenge, now motivated by the potential for environmental and social transformation caused by climate change.

In the 21st century, Asian countries will have to produce more food and other agricultural commodities under conditions of diminishing per capita arable land and irrigation water resources and expanding biotic as well as biotic stresses, including climatic constraints. The dual demands for food and ecological security would have to be based on appropriate use of biotechnology, information technology, and ecotechnology. Practical achievements in bringing about the desired paradigm shift in sustainable agriculture will depend on public policy support and political action. Critical areas for intervention would be:

- Improving the availability of seed/planting material of high-yielding varieties
- Developing and promoting the use of hybrids, especially for rainfed agro-ecosystems
- Expanding areas under different crops and commodities, through diversification of agriculture
- Improving the productivity of crops, existing plantations, and livestock
- Developing infrastructure for post-harvest management, marketing, and agribusiness
- Small farm mechanisms
- Transfer of technological inputs through assessments and refinements at regular time intervals in consonance with our understanding of climate variability and climate change.

Ensuring food security may remain an unaccomplished dream for many Asian countries unless appropriate strategies are put in place to ensure environmental and ecological protection and conservation of natural resources. The food security issue is highly dependent on equitable guaranteed access to foods. Equitable access is highly differentiated across populations in the agrarian nations of Asia. This situation is further aggravated by natural disasters such as floods and droughts, which are

known to have caused great famines in south Asian countries. Poverty in many south Asian countries seems to be the cause of not only hunger but even lack of shelter, access to clean drinking water, illiteracy, ill health, and other forms of human deprivation. Opportunities for assured and remunerative marketing at micro enterprise levels should promote equitable use of available food resources.

In view of present uncertainties over the pace and magnitude of climate change, the most promising policy options are those for which benefits accrue even if no climate change takes place. Such policy actions include the following:

- Breeding of new crop varieties and species (heat- and salt-tolerant crops, low-water-use crops)
- Maintenance of seed banks, liberalization of trade of agricultural commodities, flexibility of commodity support programs, agricultural drought management
- Promotion of efficiency of irrigation and water use and dissemination of conservation management practices
- Trans-national cooperation to promote sustainable water resources management and flood risk management
- Rehabilitation of degraded forests and watersheds (such strategies can enhance biodiversity conservation and provide source of livelihood for many poor forest and upland watershed dwellers)
- Strengthening of biophysical and socioeconomic resources and resource use-related databases for natural and social systems and focused research to further our understanding of the climate-ecosystem-social system interaction. Data and information generated through these activities will be useful not only for designing appropriate mitigation and adaptation measures but also for management planning and decision-making.

The climate change issue has presented decision makers in Asian countries with a set of formidable complications: a considerable number of uncertainties (which are inherent in the complexity of the problem), the potential for irreversible damages to ecosystems, a very long planning horizon, long time lags between GHG emissions and effects, wide regional variation in causes and effects, the global scope of the problem, and the need to consider multiple GHG and aerosols. The value of better information about climate change processes and impacts and responses to arrest these risks is likely to be great. A prudent strategy to deal with climate change would be to collectively reduce emission levels of GHGs through a portfolio of actions aimed at mitigation and adaptation measures. The agriculture and forestry sectors in several countries of Asia have a large GHG mitigation potential that should make a significant contribution to this strategy.

The principle of sustainable development must guide all future development strategies in developing and developed countries of Asia. Serious efforts toward promoting innovative research on efficient technology options and creative environmental literacy are needed while Asian countries adapt to new environmental policies and programs. The challenge lies in identifying opportunities that would facilitate sustainable development by making use of existing technologies and developing policies that make climate-sensitive sectors resilient to climate variability. This strategy will require developing countries in Asia to have more access to appropriate technologies, information, and adequate financing. In addition, adaptation will require anticipation and planning; failure to prepare systems for projected change in climate means, variability, and extremes could lead to capital-intensive development of

infrastructures or technologies that are ill-suited to future conditions, as well as missed opportunities to lower the cost of adaptation.

XI. CONCLUSIONS

Business and governments can – and must – work together on climate change mitigation and adaptation. Working together, we can identify and implement policy measures that will create meaningful and effective solutions, while at the same time ensuring long-term value for shareholders.

With properly designed programs and incentives, we can unleash the power of the market to accelerate the deployment of low carbon technologies, engaging both producers and consumers alike. And with the right kind of focus on both the needs and aspirations of emerging markets, we can ensure that a truly global solution to the problem is achieved. The GHG reductions can be realized through use of the following four general measures: (i) market-based programmes in which customers or manufacturers are provided technical support and/or incentives; (ii) mandatory energy-efficiency standards, applied at the point of manufacture or at the time of construction; (iii) voluntary energy-efficiency standards; and (iv) increased emphasis of private or public RD&D programmes to develop more efficient products. Measures need to be carefully tailored to address market barriers. While all of the measures have some administrative and transaction costs, the overall impact on the economy will be favorable to the extent that the energy savings are cost-effective.

Adapting to climate changes will be equally important and will present challenges for all involved in infrastructure design and construction, health and medicine, water resources management, coastal zone management, agriculture, land use and forestry, and many other areas.

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XII. BIOGRAPHIES

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James S. McConnach graduated with a first class honours degree from St Andrews University, Scotland in 1964.

He spent his first years in manufacturing, involved with the development and application of special transmission equipment. During this time he gained a M.Sc. in HVDC Transmission from the University of Salford, England. In 1972 he joined a UK Consultancy, working on power system projects in many developing countries. He moved to Canada in 1977 to join Ontario Hydro where he had the opportunity to work on and manage a wide range of challenging projects in HVAC and HVDC transmission, hydro, fossil and nuclear generation, and energy efficiency.

He held managerial positions from 1982 until retirement in 2000. He is a registered Professional Engineer in Ontario, a Fellow of the IEE, UK, and a Senior Member of the IEEE, USA. He is vice-chair of the IEEE-PES Policy Development Coordinating Committee; Chair of the IEEE Working Group on Implementing Technology to Limit Climate Change and of the Task Force to develop a Standard (P1595) for the Quantification of CO2 Emission Credits.

2. Impacts of Climate Change on Major Energy Projects (Invited Discussion)

Jean Luc Allard, VP, Environment, SNC Lavalin, Canada. *Impacts of Climate Change on Major Energy Projects*

(SUMMARY PENDING)

3. The Value of Non-Carbon Power and Emissions Avoidance

Romney B. Duffey, Principal Scientist, Atomic Energy of Canada Limited, Canada

I. INTRODUCTION

We discuss the role and benefits of avoiding GHG emissions, and of deploying and promoting "emissions free" energy technologies, like nuclear, solar, wind, and carbon sequestered sources. We examine the projected needs, market penetrations and transition strategies for non-carbon sources to stabilize atmospheric concentrations of GHGs, including estimates of the benefits and impacts on future atmospheric concentrations, climate change and energy mix. Any actual reductions or changes in emissions that are achieved will be determined by fiscal, political, economic, business, legal, societal, technological, environmental and indeed moral values.

As a result of this approach, we are able to determine the value of avoiding or reducing GHGs. We may assign and define two values: a *monetary* value based on a market or trading of rights to emit GHGs and the associated emission avoidance costs; and a *social* value based on the estimates of the probabilities of mitigation, planetary, human lifestyle, migration and species change. The true "value" is therefore a composite estimate, including both the tangible and intangible costs and risks.

II. NUCLEAR ENERGY EXAMPLE

Using nuclear energy as an example, we illustrate the potential impacts of GHG reduction and avoidance, and the opportunities and benefits from fuel switching, which would be needed to stabilize the atmospheric GHGs to preserve economic growth and social progress.

We derive illustrative estimates of the "value" to be assigned to avoidance and reduction using nuclear energy, from the present zero values wrongly assigned to nuclear energy, to the actual economic and social values derived from emissions avoidance and enabling a sustainable energy future. These may be compared to values derived from carbon credit trading, energy portfolio standards, and carbon sequestration, including the direct and indirect costs, risks and uncertainties.

III. VALUING EMISSIONS REDUCTION

We can distinguish between the several different approaches to establishing a benchmark value for emissions avoidance:

a) The purely *economic value* of the emissions in producing financial wealth (such as the GDP) using carbon energy. This implies that the wealth of a nation or economy is directly linked to the energy use that drives the industrial, economic and product output and that changes in the resulting emissions from energy use directly are reflected in the economic output;

b) The *trading value* can be determined from a defined and hopefully market-driven "emissions trading" scheme, where the right to emit is established via some limit placed on the total allowed amount (a so-called cap and trade system). Within the pre-determined GHG emissions amount, which is distributed between emitters and energy market sectors, credits can be traded and exchanged for a price determined by credit supply and emissions demand.

c) The relative *socio-economic value* can be determined from the so-called external impacts. Here, the value is a composite based on relative health, emissions, land use, fuel supply, social and political aspects to arrive at relative rankings for differing energy sources in a portfolio of options.

d) The alternative *substitution value* is estimated, based on alternate energy technology options that reduce emissions but with added development, deployment and market costs that vary from technology to technology, and from sector to sector. Thus, in principle, it is possible to consider the value of emissions reduction versus emissions avoidance approaches (e.g., switching to hydrogen as an energy carrier).

e) The *conservation cost* obtained by adopting or encouraging restrictions in energy demand (so-called demand side management) and use, plus the impact of efficiency and conservation measures versus adding energy sources.

IV. RESULTS

Using existing data, we can evaluate and provide estimates for the value to be ascribed to the use of nuclear energy in these typical schemes, including the impact of conservation and efficiency measure. The results show a definite trend that confirms the considerable advantage of adding new nuclear energy, as potentially the lowest cost emissions reduction option with the highest value.

BIOGRAPHY

Romney B. Duffey: is the Principal Scientist with AECL (Canada). He is a leading expert in commercial nuclear reactor studies, is active in global environmental and energy studies and in advanced system design, and is currently leading work on advanced energy concepts. He has an extensive technology background, including energy, environment waste, safety, risk, simulation, physical modeling and uncertainty analysis. Romney is the author of the original text about errors in technology ("Know the Risk", Butterworth-Heinemann, 2002), and of more than 150 published technical papers and reports. He is the past Chair of the American Society of Mechanical Engineers' Nuclear Engineering Division, an active Member of the American and Canadian Nuclear Societies, and a past Chair of the American Nuclear Society's Thermal Hydraulics Division. Recently elected a Fellow of ASME for his exceptional engineering achievements and contributions to the engineering profession.

4 . Canada's CDM and JI Office

Gilles Potvin, Senior Program Officer, CDM & JI Office, Foreign Affairs Canada

I. INTRODUCTION

In December 1997, 160 countries negotiated the Kyoto Protocol, a landmark agreement to address the challenge of climate change. Under this agreement, industrialized countries agreed to greenhouse gas (GHG) emissions reduction targets that would result in an overall reduction of 5% from 1990 level by 2008-2012. These reductions can be achieved through both domestic and international actions. The global benefit of reducing GHG emissions is the same no matter where in the world the reduction is made, but emission reduction costs vary by location. The Kyoto Protocol became effective on February 16, 2005.

Canada's Clean Development Mechanism and Joint Implementation (CDM & JI) Office was established within the Climate Change and Energy Division of the Department of Foreign Affairs and International Trade (DFAIT)) in 1998. The Office is the federal government's focal point for CDM and JI activities. It was created to enhance Canada's capacity to take advantage of the opportunities offered by the
CDM and JI.

II. ROLE OF CANADA'S CDM AND JI OFFICE

Under the Kyoto Protocol, three mechanisms were established to help developed countries meet their targets. These include International Emissions Trading, the Clean Development Mechanism (CDM), and Joint Implementation (JI). The CDM and JI help industrialized countries, including Canada, to achieve their Kyoto targets in a cost-effective manner. In addition, these mechanisms provide opportunities for Canadian organizations and enterprises to participate in international projects to obtain emission reduction credits. Clean Development Mechanism projects can be undertaken in developing countries. In addition to reducing GHG emissions, they must also contribute to the sustainable development of the host country. Joint Implementation projects can be undertaken in industrialized countries with GHG emission reduction targets.

Under Action Plan 2000, the CDM & JI Office received funds for the period 2001-2005 to pursue the following three objectives:-

1. To strengthen Canada's capacity to take maximum advantage of the Kyoto Mechanisms. These include the Clean Development Mechanism, Joint Implementation, and emission trades backed up by emission reduction projects.

2. To encourage and facilitate Canadian participation in the Kyoto Mechanisms by building awareness, promoting cost-effective opportunities and lowering transactions costs, while also engaging developing countries and countries-in-transition in such activities.

3. To assist Canadian entities in obtaining emissions reductions credits from CDM- and JI-type projects according to international rules and guidelines which can assist Canada in meeting its Kyoto target.

With the elaboration of international rules and guidelines at Marrakech in November 2001, the Office is primarily focused on project facilitation including:-

- guiding companies on the technical requirements for CDM and JI activities and issues related to ownership of emission reduction credits;
- providing financial support for market identification studies, feasibility assessments, baselines and monitoring plans, risk assessments and environmental impact studies;
- preparing Memoranda of Understandings and project-specific agreements with host country governments; and,
- matching project developers with project investors and credit buyers.

These services are aimed at reducing transaction costs for Canadian companies that will be critical to entities undertaking CDM and JI activities, given the elaborate steps and procedures for these mechanisms.

The Office also actively conducts outreach activities within Canada and internationally through meetings, workshops and conferences; develops and disseminates information on the Kyoto Mechanisms; trains officers at Canadian embassies abroad; and assists developing countries with the technical aspects of CDM or JI offices or focal points start-up. Canada's CDM & JI Office is guided by an Interdepartmental Steering Committee comprised of representatives from Industry Canada, Natural Resources Canada, Environment Canada, the Canadian International Development Agency, and International Trade Canada.

III. CLEAN DEVELOPMENT MECHANISM

The Clean Development Mechanism (CDM), as outlined in Article 12 of the Kyoto Protocol and elaborated in the Marrakech Accords, is a project-based mechanism that allows public or private entities to invest in greenhouse gas (GHG) mitigating activities in developing countries and earn abatement credits, which can then be applied against their own GHG emissions or sold on the open market. In addition to reducing emissions, CDM projects have the dual objective of contributing to the sustainable development of the host country.

The simplified modalities and procedures for small-scale CDM projects were agreed to at the Eight Conference of the Parties (CoP8). Further technical details related to baseline and monitoring methodologies are being elaborated by the Clean Development Mechanism’s Executive Board.

IV. JOINT IMPLEMENTATION (JI)

Joint Implementation (JI) is a mechanism that assists Annex I countries in meeting their Kyoto targets by participating in projects with other Annex I countries. Entities may participate in JI projects to generate emissions credits, known as Emission Reduction Units (ERU), in order to use them for compliance with

their targets or to sell on the international emissions trading market. JI projects may begin as of the year 2000 but can only generate ERUs beginning in 2008.

What are the benefits of participating in the CDM and JI?

Canada's target under the Kyoto Protocol is to reduce greenhouse gas (GHG) emissions to 6% below the 1990 level by 2008-2012. Recognizing that emission reduction costs are often lower in developing countries and countries with economies in transition (such as Eastern Europe), the CDM and JI allow Canadian entities the flexibility to reduce GHG emissions in more cost-effective ways than may be open to them in Canada.

The CDM and JI provide opportunities for Canadian entities to pursue international projects that reduce GHG emissions, while contributing to international efforts to address climate change. In addition, the two mechanisms provide several benefits for the host countries.

Opportunities for Canadian industry can include: (1) Generation of emission reduction credits; (2) Access to new markets and investment opportunities; (3) An opportunity to demonstrate the viability of a voluntary approach; (4) A showcase for environmental leadership.

V. BIOGRAPHY

Gilles Potvin is a Senior Program Officer in the CDM & JI Office of Foreign Affairs Canada since July 2004. Prior to this assignment he has occupied various positions at Foreign Affairs and International Trade Canada since 1989 including two postings in the Canadian Embassies in China and Romania.

5. Impact of Regional Greenhouse Gas Initiative and Renewable Portfolio Standards on Power System Planning

James E. Platts, *Member IEEE*[1]

Abstract–Two developments are having an impact on power system planning in the Northeastern U.S.: a seven-state regional CO_2 emissions cap and the growth of renewables from Renewable Portfolio Standards (RPS). The CO2 cap will increase energy costs of fossil units and could affect reliability. RPS provides targets for renewable energy supply by the load serving entities and are resulting in mostly remote installations of small wind and biomass plants. The paper discusses the implications of these two developments.

Index terms – Greenhouse Gas, CO_2 Emissions Cap, Renewable Portfolio Standards, REC

I. INTRODUCTION

Two developments in the Northeastern United States are having an impact on power system planning in that region. One is a cap on CO2 emissions recently adopted by seven states. This is the result of a voluntary Regional Greenhouse Gas Initiative (RGGI) developed by nine states over the last two years. The second development is Renewable Portfolio Standards (RPS) that have been implemented in most states in the Northeastern U.S.

II. RGGI

RGGI is an agreement (www.rggi.org/agreement.htm) by seven states (Maine, New Hampshire, Vermont, Connecticut, New York, New Jersey and Delaware) that have signed a Memorandum of Understanding (MOU) to implement a cap and trading program for CO_2 emissions from power plants greater than 25 MW in those states. While the participation in RGGI was voluntary, the MOU makes the cap mandatory.

The MOU establishes a CO_2 cap of 126.1 million tons for these seven states that would be implemented starting in 2009 and remaining at this level until 2014. In 2015, a gradual reduction in the cap would start and reach a 10% lower level by 2019. The cap would be implemented with a Model Rule as a framework for states to implement state regulations governing the details of the state cap and trading rules, compliance etc. The overall program would be administered through a Regional Organization, but which would not have regulatory authority.

The CO_2 cap would be apportioned among the seven states and the states would apportion their caps to the individual generators in their state granting one CO_2 allowance for each ton of emissions. The trading of CO_2 allowances would be allowed across the seven states. To provide consumer benefits from

[1] Mr. Platts is employed by ISO New England in Holyoke, MA

this program the states would withhold 25% of the allowances from the generators. These could be sold and the funds used to support energy efficiency, renewable resources, carbon capture, or customer rebates.

A compliance flexibility feature of the RGGI program will be the ability of an affected generator to use offsets for up to 3.3% of its compliance obligation. Offsets are reductions in CO_2 or other greenhouse gases made outside of the electric sector that have been approved and certified by a regulatory process as to their legitimacy. These offsets can be created from a number of possible designated greenhouse gas reductions in the RGGI states on a one for one basis, or created in the U.S. outside of RGGI on a two for one basis. An additional flexibility aspect of the RGGI program is that it has two price triggers when CO_2 allowances reach price thresholds of $7/ton and $10/ton. With allowances at these price levels, more compliance flexibility is allowed in the use of offsets with an increase in the percentage use for compliance and a broader geographical area from which the offsets can be created and bought.

Massachusetts (MA) and Rhode Island (RI) also participated in the development of the RGGI program but did not sign the final MOU. MA implemented its own CO_2 cap this year affecting six fossil generating plants in that state. The MA cap is based on historical emissions (tons), and on a maximum emissions rate of 1800lb/MWH. It also established price caps so it has similarities to the RGGI program. MA and RI can still join the RGGI cap, as can other states.

III. RPS

RPS have been implemented by state legislation and regulation to encourage the development of renewable resources. The RPS are percentage targets of the energy supplied that the load serving companies are required to meet on an annual basis. The percentage target generally increases each year and can be met with a range of renewable technologies. These typically include solar photovoltaic, wind, biomass, energy from wastes, and in some states fuel cells. The Northeast states with RPS include Maine, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania and Maryland.

Compliance by the load serving entities generally is made from the energy from renewable projects across the region and is accomplished with the purchase of Renewable Energy Certificates (RECs[2]) associated with these projects. The value of a REC adds to the worth of the energy from a project, and provides greater incentives for investing in the development of renewable resources. Projects generally have to be qualified by the state regulatory agencies as meeting certain specifications and vintage of a particular renewable technology before recognizing their RECs. ISO New England and PJM have implemented systems to track and manage RECs based on the energy produced from the renewable projects in their respective regions.

IV. IMPACTS ON POWER SYSTEM PLANNING

Both RGGI and RPS have impacts on electric system planning in the region. The RGGI program would function similar to the SO_2 and NO_x cap and trade systems that have been functioning in the US and Canada. These systems provide regulatory certainty as to the emission requirements for the generating plants affected, and RGGI would be adding a third mandatory emissions cap for power plants in the seven participating states.

[2] A REC equals one MWH of renewable energy.

Generating plants have few options to reduce CO_2 emissions since there are no cost effective CO_2 control options. Hence, buying allowances or offsets would appear to be their most feasible compliance path. The effect of the RGGI program would be to create an energy cost adder for the fossil generating plants that reflects the value of the allowances that they would consume.

The RGGI Cap would function in the same manner like the SO_2 and NO_x caps, and cause dispatch or bidding adders that would increase the operating cost of fossil plants, especially coal and oil since these fuels have the highest CO_2 emission rates. These costs could change the relative dispatch of the units and hence the system transmission flows. Ultimately, this could impact electric system reliability. Unlike the SO_2 and NO_x market that have a fixed number of allowances, the RGGI cap has a safety valve of offsets with the potential geographical inventory for offsets increasing at the price triggers. The use of these offsets may appear to represent an increase in CO_2 emissions, but it would reflect additional reductions in CO_2 or other greenhouse gas emissions from elsewhere in the U.S. and the world.

In the modeling conducted during the development of the RGGI program, a wide range of natural gas price assumptions was examined for the electric system expansion to show the feasibility of the cap. The results showed a very diverse set of generation additions to serve the energy and peak load growth out through 2024. For assumptions of more historical levels of natural gas prices the additions included a large amount of natural gas fueled combined cycle (NGCC) and onshore wind generation. For assumptions of higher natural gas prices, such as were experienced in 2005, clean coal plants were the major capacity addition with a lesser amount of NGCC and a similar amount of wind was selected in the model (to meet RPS) as with lower natural gas prices. The large amount of wind may not be feasible if the siting difficulties of current wind projects continue. These RGGI scenarios also assumed that the natural gas infrastructure would be expanded as needed. In the ISO/RTOs' regional planning processes, generation expansion scenarios will need to be examined with more detailed modeling to confirm that system reliability can be maintained and to determine the magnitude of the market costs of implementing the RGGI CO_2 cap.

RPS is providing some incentives for new renewable projects, especially wind and biomass. Based on the ISO/RTO system interconnection queues, wind and biomass appear to be the more attractive renewable projects being built. These renewable projects have to be sited where the energy source is located, which is usually not close to a major load centers, i.e. on remote ridgelines for onshore wind or where there are forested areas to provide wood harvesting with minimum transportation costs. Because the renewable projects are generally small in size, usually tens of MW, they can be integrated into the system at lower voltage transmission or distribution levels. As the number of these projects increase, they can have an impact on the electric operation of the system. For instance, given the variability of wind, this could require greater operating reserves to cover this variability. Larger projects, such as the proposed Cape Wind project (420 MW) in Nantucket Sound off Cape Cod, will impact the operation and dispatch of the regional grid more significantly. The collective impacts of these projects will need to be examined as the renewable resources grow in the system.

V. CONCLUSIONS

The RGGI CO_2 cap and the RPS requirements are adding new impacts and considerations for power system planning in the Northeast region. RGGI will most likely increase energy costs from fossil generators in the states where it will apply and possibly affect reliability. RPS will encourage smaller renewable resource projects mostly onshore wind and biomass fuels that will interconnect at lower

transmission or distribution voltage levels and will not likely help serve large load centers. As larger amounts of wind projects are added, they could affect the need for increased operating reserve.

BIOGRAPHY

James (Jim) E. Platts: has worked at ISO New England since 2001 providing environment and renewable resource planning expertise in the development of the ISO's regional electric system plan. He has prepared study reports on the reliability need for generating units and administered an RFP for 80 MW of emergency resources. He has been the ISO's principal representative to a stakeholders group during the development of the Regional Greenhouse Gas Initiative, a regional CO2 cap and trade program

His prior experience includes 30 years at Northeast Utilities (CT) in generation and transmission planning, environmental issues, research and distributed and renewable generation. He served as project leader/coordinator for the company's environmental reporting, and administered the buying and selling of air emissions credits for both NU's power plants and customers. He developed strategies for the use of surplus credits and the company's response to climate change.

He was a transmission planner with the Houston Lighting and Power Co. for two and a half years and he served three years in the Peace Corps in São Paulo, Brazil working in rural electrification.

Mr. Platts received his MSEE from Texas A&M University, a BEE from Rensselaer Polytechnic Institute, and a BS from Trinity College (Hartford, CT) and is a Member of the IEEE.

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