CANADA'S NUCLEAR INDUSTRY, GREENHOUSE GAS EMISSIONS, AND THE KYOTO PROTOCOL

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ABSTRACT

The Kyoto Protocol of the United Nations Framework Convention on Climate change, dated December 10, 1997 committed Canada to reduce greenhouse gases to 6% below 1990 levels by 2008-2012. Other nations also committed to varying degrees of reduction. The Protocol includes provisions for credit to the "developed" counties for initiatives which lead to greenhouse gas reduction in the "developing" countries and for the sharing of credit between "developed" countries for projects undertaken jointly. The rules and details for implementation of these guidelines remain to be negotiated.

We begin our study by establishing the magnitude of greenhouse gas emissions already avoided by the nuclear industry in Canada since the inception of commercial power plants in 1971. We then review projections of energy use in Canada and anticipated increase in electricity use up to the year 2020. These studies have anticipated no *(or have "not permitted")* further development of nuclear electricity production in spite of the clear benefit with respect to greenhouse gas emission. The studies also predict a relatively small growth of electricity use. In fact the projections indicate a reversal of a trend toward increased per capita electricity use which is contrary to observations of electricity usage in national economies as they develop. We then provide estimates of the magnitude of greenhouse gas reduction which would result from replacing the projected increase in fossil fuel electricity by nuclear generation through the building of more plants and/or making better use of existing installations. This is followed by an estimate of additional nuclear capacity needed to avoid CO_2 emissions while providing the electricity needed should per capita usage remain constant.

Canada's greenhouse gas reduction goal is a small fraction of international commitments. The Kyoto agreement's "flexibility mechanism" provisions provide some expectation that Canada could obtain some credit for greenhouse gas reductions established by deployment of Canadian CANDU technology in other countries. Such credits could ultimately result in economic benefits accruing to electricity generation which does not emit greenhouse gases. We explore the implications of the Kyoto Protocol to the Canadian nuclear industry and the Canadian economy. Establishing credit to

Canada for its contribution via nuclear technology poses many unanswered questions at this stage of development of the principles established by the Kyoto Protocol. Nevertheless, the potential contribution of nuclear energy to carbon dioxide emissions management is extremely large.

INTRODUCTION

The Kyoto Protocol of the United Nations Framework Convention on Climate change[1], commits Canada to reduce greenhouse gases to 6% below 1990 levels by 2008-2012. In practical terms this translates to a reducing Canada's greenhouse gas emissions by about 150 Mt annually[2] relative to current energy practice and expectations for population and economic growth. Many developed countries have made similar commitments. Developing countries, while not yet making numerical commitments, have indicated concern with the possibility of deleterious climate change and have undertaken to partake in an international effort to reduce emissions of greenhouse gas.

Several options and alternate means to reduce emissions from industry and the energy sector have been studied and proposed, including increased end use efficiency leading to reduced fossil fuel use, and an assumed increased renewable contribution (solar and wind power) . Canada already has a large CO_2 emissions free hydro and nuclear electricity generation base. Future increases in economic growth and hence energy use are projected by Natural Resources Canada[3] to be fueled largely by natural gas, coal and oil, the latter mostly in and for the transportation sector.

No nuclear electricity generation additions are projected or have been assumed for Canada in the studies to date. The business as usual projection[4] shows an increase in emissions from electricity generation and from total energy use. The element of competition, expected to be enhanced by deregulation[5] of the electricity industry, does not indicate an increase in nuclear electricity without special intervention to discourage the use of fossil fuel. No reductions in emissions occurs in any of the projections unless additional measures such as carbon taxes and emissions trading credits are assumed to be introduced[6]. There is concern that forced reductions or commitments to reduce emissions will have a large negative impact on economic and personal income growth, as well as on the energy intensive sectors of the economy, including the important Canadian oil and gas industry. Nuclear electricity has been proven to provide one of the few large scale means of providing copious quantities of energy with essentially no release of greenhouse gas. The fact that NO additional nuclear energy is factored into Canada's future energy plans and projections is surprising , and a notable omission in view of its track record as competitive[7], essentially zero greenhouse gas energy source. Significantly, this is also the case for the USA, whereas it is not so for the developing countries, particularly Asia, where nuclear generation could well exceed that in North America and Europe by 2020 or so.

This paper begins by establishing the contribution nuclear energy has made to reduction of greenhouse gases in Canada since first commercial deployment in 1972 and makes projections with respect to helping Canada meet its commitment. It is important to note that nuclear electricity cannot meet all of the Kyoto commitment, since electricity is only one part (~30%) of the total energy picture . However, not only does it bring the target within striking distance, it can do so with minimal negative domestic economic impact. In fact, by increasing electrification measures, it can also assure that the historical trend of energy use in Canada is preserved without wrenching changes in Canada's competitive position and economic growth.

The implications of the Kyoto protocol in terms of the need to establish the detailed greenhouse gas accounting methodology required to establish and apportion credit for reductions in greenhouse gas emissions is then reviewed.

THE PAST AND POTENTIAL OF NUCLEAR ENERGY

The Nuclear Energy Track Record

Nuclear energy began to play a role in reducing greenhouse gas emissions in Canada in 1971. At that time the first commercial plants began operation at Pickering in Ontario. Environment Canada provides easily accessible historical data on carbon dioxide emissions[8] and nuclear electricity generation[9] which forms the basis to determine the contribution quantitatively. This is combined with information on carbon dioxide emissions[10] from the combustion of fossil fuels to establish the CO_2 emissions which have been avoided.

The only assumption needed in the methodology is what the replacement energy source would or might have been if nuclear was not available. This is not a difficult question , since the emissions from alternate generation sources have been given elsewhere. That raises the question of what was available back then, or would have been built. In fact, we find the largest sensitivity is to the choice of natural gas, which has about half the emissions of coal plants.

Figure 1 tracks the record of emissions avoided in Canada from 1971 to 1995 by Canada's nuclear plants.

Figure1 - The Significance of Nuclear Electricity to Canada's CO2 Emissions

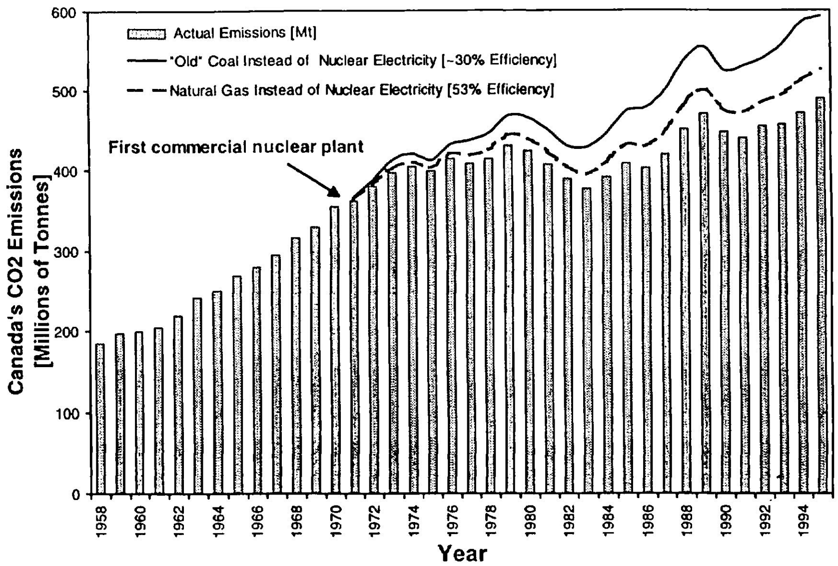


Figure 1 shows that continuing development of these nuclear stations in Canada has grown to the point they are avoiding the emission of approximately 100 Mt of CO_2 per annum in comparison with power plants using coal as a primary energy source . The emission avoided is estimated to be about 900 Mt of CO_2 in total as of 1995. This estimate is generally consistent with the 1,222 Mt of CO_2 avoided derived by independent NRCan[11] studies based on actual Canadian fuel use data to 1996. The annual reduction is about two thirds of the total amount needed to meet Canada's Kyoto commitment. Most of this avoidance occurred before 1990 and thus, somewhat perversely, can not be credited as helping to meet Canada's Kyoto commitment.

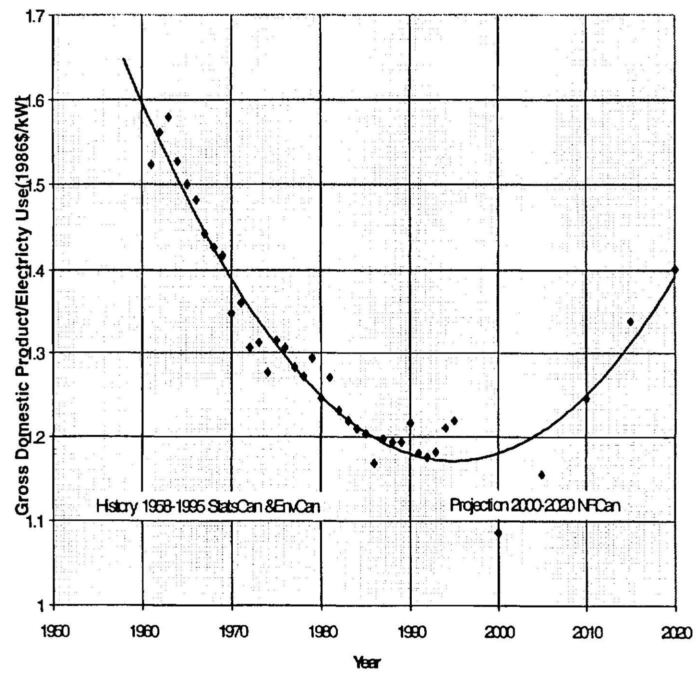
The Nuclear Electricity Potential

It is not possible to make projections without having some estimate of the economic, industrial and energy use in the future. These estimates should be firmly based on the historical development and trends, in order to minimize the effects of unrealistic assumptions or assumed trends.

The historical record of electricity and energy use in Canada is well documented by Statistics Canada. The data are available over the Internet. The records cover 1958 until 1995, and includes GDP in billions of 1986 dollars , electricity use in billions of kWh, and estimates of CO_2 emissions.. Projections of future energy demand and use are routinely published by Natural Resources Canada (NRCan) in their Energy Outlook[12] series. Another study commissioned, from the USA, by Canadian government departments provides alternative estimates of future energy in Canada[13]. In addition , the OECD[14] prepares data files on Canada and other countries. One of the key indicators is the ratio of the Gross Domestic Product (GDP)(in inflation adjusted $) to the total electrical generation (in BkWh). From all of these published sources we can track and make estimates of electrical generation needs based on historical trends.

We observe and utilize the following information and data extracted from the records. Historically, the growth in electricity usage in Canada has increased more than economic growth as indicated by the Gross Domestic Product(GDP). Since 1970 the ratio of the GDP to electricity usage(GDPER in 1986 dollars per kWh) has fallen steadily from 1.4 to 1.2 dollars per kWh leveling off over the last ten years as shown in Figure 2. NRCan projections of electricity usage versus GDP indicate an increase in the ratio from 1995 on to 2020. The average efficiency for electrical production from primary energy is ~50%, including hydropower[i], and the average emissions from electrical energy produced is about 65Mt CO_2/EJ or 235 kt CO_2/Twh[ii] averaged over the last 20 years.

Figure 2 - Canada's Gross Domestic Product and Electricity Usage 1958-2020



In predicting the future, there are many uncertainties. It is difficult to be precise, so certain assumptions are usually made about economic growth and future trends in supply and

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[i] This high efficiency is due to the large use of hydraulic energy to produce electricity in Canada. Energy accounting convention takes the primary hydraulic energy as equal to the electricity produced. Thermal electricity processes take into account the efficiency of conversion of primary energy to electricity. These efficiencies are on the order of 30% to 40%.

[ii] The amount of CO_2 per unit of electricity is extremely low since about 80% of Canada's electricity is from hydro and nuclear energy. Emissions from coal generated electricity typically exceed 1000 kt CO_2/Twh.

demand. The NRCan projections assume a moderate economic growth, and an increase in GDP, population ,energy use, electricity use and emissions. However, the increases also ***assume*** effectively no new nuclear capacity additions, a declining nuclear generation contribution, and increasing generation from alternate sources , including coal, oil, natural gas and wind and solar. No appreciable increase in residential energy use is forecast, based on increasing end use efficiency. The major increases in energy use are in transportation and industry. The DRI report[15] projects substantially larger use of electricity in the future than NRCan.

The rise in emissions is inexorable, from about 450 Mt. of CO_2 per year in 1990 to over 600Mt per year in 2020. In view of substantial price increases projected for the consumption of fossil fuels[16] in the face of usage restrictions, it is surprising that market forces would not result in increasing nuclear energy deployment. A recent review indicates that the cost[17] of electricity generated from nuclear energy is comparable to other sources even in the absence of restrictions on fossil fuel use. Since the NRCan and DRI studies do not "permit"[18] new nuclear generation we have evaluated the potential for deployment of nuclear electricity generating plants to help Canada meet its Kyoto commitments.

To provide some needed insight , we analyze options for two alternate nuclear scenarios. We attempt to cover the extreme assumptions of policy and analysis beyond that of a declining nuclear contribution.

These options are :

1) The Environmentally Friendly Electricity Growth Option: all new and future Canadian power generation is assumed to be from effectively emissions-free generation sources (hydro and nuclear). This option avoids adding any new emissions from electricity generation using coal, oil or gas.

2) The Historically Economically Sustainable Option: where the Canadian Gross Domestic Product to Electricity Ratio (GDPER) is assumed preserved and to remain at its historical value of 1.2 $/kWh. This option does not require any assumptions or hypotheses about increases in energy efficiency, renewable penetration, taxation incentives or social changes in energy use patterns. It simply does not allow the ratio to increase - which is contrary to observed patterns of electricity consumption as economies develop. We note that this option is counter to the results of the studies by NRCan and DRI, which by their assumptions effectively result in the ratio rising to about 1.4$/kWh by 2020 as shown in Figure 2 above. This latter value implies that the economic models have been constrained to drive the economy to reduce the GDPER by 16% or so, counter to the historical trend and implying transformation of the pattern of electricity *use* in Canada.

In the first option we estimate some 15 CANDUs of 600MW(e) each, would provide all of the fossil fuel based electricity increase projected by NRCan studies. Two major greenhouse gas free electricity sources (hydro and nuclear) would thus meet all the

NRCan projected additional electricity need and could go about half way toward meeting Canada's commitment under the Kyoto Protocol. This additional capacity could be derived from some new plants combined with better utilization and life extension of existing nuclear plants. NRCan projects, based on business as usual expectations, that only about 10000 MW(e) of total nuclear generating capacity will be left in service by 2020. The scenario presented here assumes a deliberate effort to preserve and enhance the CO_2 free nuclear option by applying nuclear energy to generate projected increases in fossil fuelled electricity generation.

In the second option we take (GDPER) value as preserved or remaining at its historical value of ~1.2$/kWh. As noted above, NRCan projections, on the other hand, have this value rising to about 1.4 $/kWh by 2020 as a result of the combination of the assumed energy use and efficiency measures. This option requires an additional capacity of ~2000 MW(e) per year from 2005 to 2020. This option needs an additional CANDU build rate of about 3 plants per year from about the year 2003 to provide needed electricity while avoiding any additional CO_2 emissions, presuming that additional hydro power is not available.

The two options discussed are based strictly on the use of proven nuclear fission technology to generate electricity. The first option alone could provide Canada with a very substantial fraction (~50%) of the reductions committed by the Kyoto Protocol. The second option would allow for the electricity needed by the economic growth projections combined with a constant rather than increasing GDPER.

Additional penetration of nuclear electricity into Canada's energy needs is possible. A substantial component of fossil fuelled electricity remains in the above projections. The existing fossil plants could be phased out in favor of nuclear energy, preferably as the plants reach the end of their useful life. Canada makes considerable use of fossil fuel for heating buildings and for industrial processes. Some of these may be large enough in scale to warrant consideration of nuclear energy. Application of nuclear energy to transport, which is a major generator of carbon dioxide emissions, will require the deployment of alternative technology such as electrically powered transport or the development of hydrogen derived by electrolysis as a mobile fuel. We have not, nor have others, quantitatively evaluated the potential of nuclear energy as a means of reducing greenhouse gas emissions through use of these advanced systems. Such an analysis is clearly needed.

THE KYOTO PROTOCOL

The International Canadian Role

On a number of occasions, Prime Minister Chretien has made reference to the positive role which Canadian nuclear reactor exports play in addressing greenhouse gas emissions both on a domestic and on a global scale. For example, the two unit CANDU reactor project in China will result in approximately 9 Mt of carbon dioxide per year not being emitted from coal-fired electricity generation (this does not include the greenhouse gas emissions which are also avoided as a result of not mining, not processing, and not transporting coal). If this 9 Mt of avoided carbon dioxide emissions was to Canada's credit, then it would account for 6 per cent of Canada's reduction target for the year 2010 of about 150 Mt. This contribution could double or could even reach as high as 20 per cent if Canada were to supply two more CANDU units and if "life-cycle" emissions of alternatives were accounted for and included as part of the offset credit. The "Clean Development Mechanism" and "jointly implemented" projects provisions of the Kyoto Protocol set the stage for Canada to obtain some of the credit for CANDU export.

As shown by the indicators published and available from Environment Canada, emissions increase with increases in the Gross World Product, because of increases in global trade, economic and social growth, and the enhanced energy use and demand everywhere. The global nature of the greenhouse gas problem underscores the requirement to develop and implement international approaches in order to significantly address the challenge of achieving a sustainable reduction of greenhouse gas emissions. In fact the viability of the whole process may be determined by such mechanisms. Many countries are considering "carbon" or "emissions" taxes, and the DRI study[19] for Canada even went so far as to estimate the cost in economic terms of trading such globally valued emissions credits. The equivalent cost number so derived is country dependent, and for Canada is about $400/t, which for 600Mt emitted in 2020 values those total emissions at $240B/y, a truly staggering amount. Costs of this magnitude associated with the use of carbon dioxide emitting fuels will provide a major incentive to the development of emission free energy sources.

One of these approaches in the Protocol is the concept of "joint implementation" or "actions jointly implemented". In very basic terms, when implemented on a project basis, this concept involves one country (the "supplier" country) providing to a recipient country, a project (or projects) that would result in greenhouse gas emissions reductions with the agreement that the supplier country receives credits for some or all of these greenhouse gas emission reductions.
Although somewhat simplified, this calculation serves to demonstrate the potentially significant contribution which offset credits form CANDU reactor exports could make in the achievement of Canada's greenhouse gas reduction commitment, as part of a clean development mechanism project. However, the current situation is that the modalities and rules of procedure for implementation of the clean development mechanism are not yet established and agreed upon. As such, the opportunity exists to propose procedures within the clean development mechanism which would accommodate projects such as CANDU nuclear exports and thereby allow Canada to fully benefit from the opportunities so provided. In the absence of appropriate and accommodating "game rules", there is a risk that significant strategic opportunities may be lost.

It is within this context that this paper identifies fundamental issues which must be addressed in the development of rules of procedure for the clean development mechanism. These are the establishment of an agreed upon methodology (including implementation guidelines) for the quantification of greenhouse gas emissions avoided as a consequence of a clean development mechanism project (or projects); and, the role of the clean development mechanism "secretariat" to ensure that greenhouse gas emission reductions accruing from such projects are real and are systematically accounted for in a fully transparent, auditable, and internationally acceptable manner.

Clean Development Mechanism

Under Article 12 of the Kyoto Protocol to the United Nations Framework Convention on Climate Change, a "clean development mechanism" is defined in order to "assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objectives of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3". Parties not included in Annex I will benefit from "project activities resulting in certified emission reductions"[Article 12. 3. (a)]; and Parties included in Annex I "may use the certified emission reductions accruing from such project activities to contribute to compliance with part of their quantified emission limitation and reduction commitments under Article 3 ..."[Article 12. 3. (b)].

Emission reductions resulting from each project activity shall be "certified" by "operational entities to be designated by the Conference of the Parties" on the basis of:

(a) "Voluntary participation approved by each Party involved;

(b) "Real, measurable, and long-term benefits related to the mitigation of climate change; and,

(c) "Reductions in emissions that are additional to any that would occur in the absence of the certified project activity."[Article 12. 5.]

The modalities and procedures for the clean development mechanism shall be established by the Conference of the Parties with the objective of "ensuring transparency, efficiency and accountability through independent auditing and verification of project activities".[Article 12. 7.]

Participation under the clean development mechanism (including acquisition of certified emission reductions) may include private and/or public entities, and is "to be subject to whatever guidance may be provided by the executive board of the clean development mechanism".[Article 12. 9.]

Actions Required to Implement a Clean Development Mechanism Project

If a decision was taken to certify a CANDU reactor export project as a clean development mechanism project, then a necessary condition would be the development of a bilateral agreement with the recipient country which would serve to demonstrate the "voluntary participation approved by each party involved". (The recipient country would be a non-Annex I country.) Such a bilateral agreement would specify that the CANDU project is considered a clean development mechanism project. It is understood that the Kyoto Protocol does not preclude an existing project from being considered as a clean development mechanism certifiable project. The bilateral agreement would specify the amount of greenhouse gas emissions reduction credits which would be to Canada's account, as well as any side-payment terms and conditions (it may be that such side-payments consist of technology transfer, as an example). In order to reach such an agreement, it would be necessary to agree upon the methodology to be used to calculate and measure the greenhouse gas emissions that are avoided as a result of the CANDU project (or any other project, for that matter). As discussed below, this methodology would have to be certified by the clean development mechanism.

Issue 1: Calculation of "Certified Emission Reductions"

For a project to qualify as a clean development mechanism project, the project must provide "real, measurable and long-term benefits related to the mitigation of climate change".

Nuclear projects implemented within the framework of a well regulated nuclear safety and technologically-developed support and maintenance infrastructure can be shown to satisfy the "real" and "long-term" climate change mitigation benefits criteria. An inherent characteristic of nuclear generated electricity is that there are no greenhouse gas emissions at the electricity generating source. The very limited greenhouse gas emissions associated with nuclear generated electricity arise from the mining, processing, and transportation of nuclear fuel as well as from the manufacture and construction of the nuclear power plant. The quantity of emissions are highly dependent on the nuclear fuel cycle: a "once-through" (i.e., no reprocessing of spent fuel) light water reactor nuclear fuel cycle requires isotopic enrichment of the uranium fuel which is a very energy intensive process; on the other hand, a CANDU heavy water reactor once-through fuel cycle does not require fuel enrichment and is consequently less energy intensive. In both cases, the fuel cycles are technologically proven, and are not constrained by limits on uranium availability.

From a practical implementation perspective, one of the most important issues is the approach to measuring the amount of greenhouse gas emissions that are avoided by the project. This is an issue which is not unique to nuclear power plant projects, but rather will apply to all types of potential clean development mechanism projects that result in the avoidance of greenhouse gas emissions.

For a large project such as a nuclear power plant project, it is possible to identify what the alternate source of electricity generation would be. In most countries which have implemented a nuclear power program, the alternative to nuclear generated electricity is fossil-based generation, mainly coal-fired plant. This is primarily because of the following factors: coal-fired generating capacity is of comparable size to available nuclear power plants; both coal-fired plants and nuclear plants are used to provide base-load power (as opposed to peaking power) and capacity factors are comparable; the cost of electricity from a comparatively-sized coal-fired plant is comparable to that from a nuclear power plant.

Within the electricity sector, in order to quantify the greenhouse gas emissions avoided, the alternative electricity generation source needs to be identified and from this reference an analysis undertaken of greenhouse gas emissions on a life-cycle or full energy chain basis. Such an analysis takes into account all energy investments in the plant construction as well as in fuel production and transportation. When undertaken in a methodical and detailed manner that incorporates specific local conditions (e.g., heat and carbon content of fuel, fuel mining and processing technology, transportation distances and means, net power plant efficiency), this analysis will yield an value for full energy chain greenhouse gas emissions expressed in units of mass of equivalent greenhouse gas per kilowatt hour of net electricity generated (call this number Xa). The analysis process and methodology must be such that all aspects are verifiable and may be subject to audit. Means should also be included to quantify estimate uncertainty.

The difference between this number (Xa) and the comparably derived nuclear fuel-cycle full energy chain greenhouse gas emission (Xn) is the net amount of greenhouse gas emissions that are avoided on a per unit of net electricity production basis (Xa-Xn). It is essential that the basis for deriving Xn be the same as that for deriving Xa (i.e., if all nuclear fuel is to be imported and the complete nuclear facility is imported, then only greenhouse gas emissions resulting from local construction need be accounted for and proportioned over the lifetime design output). Based upon this project specific analysis approach, the amount of greenhouse gas emissions avoided per year because of the nuclear project is the product of two factors: the amount of avoided greenhouse gas emissions per unit of net electricity generation (Xa-Xn); and, the actual annual net generation of electricity from the nuclear project (measured in kilowatt hours).

(Some quantitative life cycle carbon dioxide emission analyses of power systems have been undertaken. A wide range of assumptions have been made with respect to the degree of fossil fuel use during the lifecycle phases of construction, operation, and decommissioning. A summary review of some of these is presented by another paper[20] at this conference. The CANDU nuclear fuel cycle is evaluated in this context. The review provides more information on the nature of issues which will require the development of a formal protocol to ensure lifecycle studies for specific projects are conducted on a fair and equitable basis.)

Implementation of this project-specific approach for measuring and certifying the quantity of avoided greenhouse gas emissions requires that the following conditions be met:

- all parties agree on the alternative electricity supply source and the specific characteristics of such alternative supply source including agreement on relevant energy and fuel chain characteristics;

- agreement on the approach and the specific methodology to be used for the analysis of greenhouse gas emissions (e.g., analysis to be done on a life-cycle, full energy chain basis taking into account site-specific, project-specific, and local characteristics).

Issue 2: Role of Clean Development Mechanism Secretariat/Organization

In order to effectively and efficiently implement those aspects of the clean development mechanism which relate to certification of emission reductions, it will be necessary to reach agreement on the role of the organization which will need to be established under the executive board of the clean development mechanism. For the purpose of this paper this organization is called the Clean Development Mechanism Secretariat (the "Secretariat"). The following role is proposed for the Secretariat:

- to provide a standard methodology for the calculation and analysis of greenhouse gas emissions on a full energy chain basis;

- to provide guidance in the implementation of this methodology;

- to facilitate the provision of expert services as may be required to undertake greenhouse gas emission analysis on a full energy chain basis and to assist in the provision of input data and technical specifications and information required for the analysis;

- to facilitate and/or undertake whatever reviews and assessments may be required of full energy chain analysis in order to provide assurance and confidence to the international community that the climate change mitigation benefits of the projects are real and are being adequately measured and accounted for; and,

- to maintain a register of clean development mechanism projects which would include a project description, technical specifications, analysis of avoided greenhouse gas emissions; certified emission reductions tally.

Canada should continue to develop its position on the approach to be proposed for determining the quantity of avoided greenhouse gas emissions and to propose a methodology for calculating and measuring avoided greenhouse gas emissions accruing from a project which on this basis may be certified under the clean development mechanism.

CONCLUSIONS AND RECOMENDATIONS

The emphasis on emissions reduction leads to a new set of considerations for nuclear energy in Canada. The historical use of hydropower and nuclear in Canada has saved significant emissions to this point. Projections based on adding no nuclear capacity lead inexorably to increased emissions, and probably not meeting the Kyoto targets for reductions.

The projections also lead to increased demand for and reliance on fossil fuels (coal, oil and gas)..Voluntary or market forces to reduce emissions are not successful without some controls and/or incentives - it is always cheaper to burn what is available today. The historical pattern of electricity use in Canada show a distinct link to economic growth, which is altered by the current projections.

Future scenarios for Canada have NOT included additional nuclear capacity or increased electrification : as a result s emissions rise and demand for oil and gas increase. We presented some alternate scenarios that show nuclear can make a significant impact on reducing total emissions in Canada, both by helping to meet agreed targets, and also through increased electrification and electrical generation . Nuclear and hydropower generation may well be essential to future sustained economic growth in an emissions constrained environment, despite our efforts to improve efficiency and réduce end use..

Emissions are an international issue. In order to be in a position to make and to discuss proposals for the rules of procedure for the clean development mechanism, Canada should develop a position on the basis for determining the quantity of greenhouse gas emissions that are avoided as a consequence of a clean development mechanism project. The development of such a position should include, among other things, a Canadian proposal to include in the rules of procedure of the clean development mechanism a methodology for the determination of greenhouse gas emissions that are avoided as a consequence of a clean development mechanism project. For electricity sector projects, this methodology should be based upon a life-cycle full energy chain analysis which fully takes into account local factors and local conditions thereby ensuring a full and representative accounting of all greenhouse gas emissions avoided.

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