Ontario's Changing Electrical Sector: Implications for Air Quality & Human Health

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1.0 CHANGES IN ONTARIO'S ELECTRICAL SECTOR

At its meeting of September 15, 1998, the Toronto Board of Health requested that the Medical Officer of Health obtain data from Ontario Hydro on air emission from coal-fired stations, particularly from Lakeview and Nanticoke Generating Stations and report back with its findings. This request reflects concerns about how two major changes in Ontario's electrical sector may affect air quality. One change, the implementation of the Nuclear Asset Optimization Plan, is a time limited change that is currently affecting air quality in Toronto, and which will continue to affect air quality until at least 2000. The other change, the introduction of competition to Ontario's electrical market, is a long-term structural change that could have profound impacts on air quality in Toronto and the rest of Ontario for years to come.

1.1 Nuclear Asset Optimization Plan

In 1997, Ontario Hydro's Board of Directors developed the Nuclear Asset Optimization Plan (NAOP) to upgrade the performance and safety of nuclear facilities. The NAOP requires the closure of seven nuclear units while resources are directed at upgrading the efficiency and safety of the other 12 nuclear units. (Bruce A unit has been shut down since October 1995.) The NAOP, which came into effect late in 1997, has reduced power generation from the nuclear division by about 4000 megawatts (MW). It will continue to do so until at least 2001 (Select Committee, 1997).

Since late 1997, the electrical load from the nuclear division has been shifted to the fossil fuels division. In 1998, the five coal-fired plants and one oil/gas-fired plant in this division generated 34 million of the 145 million MW-hours of electricity produced in 1998. This represents an increase of 15 million MW-hours from 1996. The increased production from coal-fired plants has been accompanied by a significant increase in annual air emissions of sulphur dioxide and nitrogen oxides from all five coal-fired plants and from the two coal-fired plants that are upwind and in close proximity to Toronto, Nanticoke and Lakeview (see Table 1) (Ontario Hydro, Meeting, February 1999).

Table 1: Air Emissions from Ontario Hydro's Coal-Fired Generating Stations, 1996 & 1998

	Nitrogen Oxides * 1996	**Nitrogen Oxides 1998 ***	**Increase**	**Sulphur Dioxide 1996**	**Sulphur Dioxide 1998**	**Increase**
Five Coal Plants	35.4 kt	56 kt	58%	84.9 kt	143 kt	68%
Nanticoke	18.9 kt	27.5 kt	46%	46.2 kt	78.4 kt	70%
Lakeview	3.3 kt	7.8 kt	136%	9.6 kt	18.8 kt	96%

Ontario Hydro, Meeting, February 1999 * expressed as nitric oxide

Ontario Hydro expects to maximize energy production from its nuclear reactors when upgrades to those units are completed. The Pickering units are supposed to be phased into service between 2000 and 2002, while the Bruce units are supposed to be phased into service between 2003 and 2009. While electrical generation at the coal-fired stations could decrease once the nuclear units

are back on line, Ontario Hydro has indicated that the scenario may look different in a competitive market. The company will then be hoping to "maximize revenues by optimizing utilization of all of its generating stations within the environmental and market design restraints" (Ontario Hydro, Meeting, February 1999).

1.2 Introduction of Competition to Ontario's Electrical Market

In October 1998, the Government of Ontario proclaimed Bill 35, the *Energy Competition Act*, which introduces market competition to the production of electricity in the province of Ontario. Under Bill 35, new companies from Canada and the U.S. will have the opportunity to supply electricity to consumers in Ontario beginning in the year 2000. The intent of Bill 35 is to provide cost savings to consumers by providing a competitive market in electricity production. It is possible that Bill 35 may provide the market conditions necessary to promote alternative energy sources such as co-generation, and solar and wind-powered electricity. However, without the proper regulatory framework, Bill 35 could lead to further degradation of air quality in southern Ontario and eastern Canada.

Under Bill 35, electrical power companies from the U.S. may enter Ontario's electrical market. Many of these companies, particularly those from the Ohio Valley, are able to produce electricity at very low prices. Many of these facilities in the U.S. are coal-fired generating stations which produce greater quantities of air pollutants per unit of energy than similar plants in Ontario. Ontario's five coal-fired plants currently emit 37% less sulphur dioxide, 7% less nitrogen oxide, 20% less carbon dioxide, 31% less particulate matter, and 76% less mercury per unit of electricity than coal-fired generating stations in the U.S. Ohio Valley and Great Lake states (Institute for Environmental Studies, August 1998).

The introduction of competition to the electrical market in the United States in 1992 has increased the use of electricity produced in coal-fired plants that have the highest levels of emissions. A report prepared by the Northeast States for Coordinated Air Use Management demonstrates that several large electric power companies in the mid-western United States substantially increased their wholesale electricity sales between 1995 and 1996, with increases ranging from 23 to 84%. These increases were accompanied by substantial increases in power generation at the companies' highest polluting coal-fired power plants and resulted in substantial increases in emissions of nitrogen oxides and other air pollutants (Natural Resources Defense Council, 1998).

This U.S. experience is significant for Ontario residents both for what it demonstrates about a competitive electrical market, and for its direct implications for air quality in Ontario. Trans-boundary pollution from the mid-western U.S. contributes significantly to smog and acid rain in Ontario. Estimates indicate that 50% of the ozone that affects Ontario in the summer is generated as nitrogen oxides in the U.S. and that 90-95% of the sulphates that are deposited as acid rain in southwestern Ontario are generated as sulphur dioxide in the U.S. (Ontario Ministry of Environment and Energy, 1996; Acidifying Emissions Task Group, 1997). Given that air emissions have increased in mid-western U.S. as a result of competition in the U.S. electrical market, it can be assumed that air quality, the environment and human health in Ontario have been, and will continue to be, adversely affected. Furthermore, given that reliance on coal-fired

generating stations has increased since competition has been introduced to electrical generation in the U.S., the same can be expected to occur in Ontario unless regulatory action is taken to actively discourage it.

1.2.1 U.S. Experience: Renewable Energies and Energy Conservation

Before market competition was introduced in the U.S., electrical utilities in that country spent $6 to 7.5 billion in 1995 for "public-purpose programs" such as energy efficiency, renewable energy generation, and low-income assistance. Under the cost-cutting pressures created by competition, many companies have reduced their investments in these programs because of the belief that the programs place them at a disadvantage in a competitive environment (Institute for Environmental Studies, August 1998).

The U.S. federal government has responded to this trend by announcing a comprehensive electricity competition plan which proposes, among other things: 1) the establishment by the U.S. EPA of a nitrogen oxides emissions cap and trading system; 2) the preparation of a Ruling which requires the disclosure of information related to issues such as air emissions by suppliers of electricity; 3) the adoption of a federal Renewable Portfolio Standard be adopted which requires that electricity sellers ensure that a certain percentage of their electricity sales are generated with renewable energies such as wind, solar, biomass or geothermal technologies; and 4) the creation of a Public Benefit Fund of $3 billion per year to fund consumer education programs, energy efficiency programs, and the development of renewable energies (U.S. Department of Energy, March 1998).

1.2.2 Ontario: Stranded Debt and the Viability of Renewable Energies

Under the *Energy Competition Act* , Ontario Hydro will be divided into three companies. Two will be commercial enterprises: Ontario Power Generation (formerly identified as Genco) which will own and operate power generation facilities, and Ontario Hydro Services Company (formerly identified as Servco) which will own and operate the transmission and distribution systems. One will be a non-profit organization: the Independent Electricity Market Operator (IMO), which will dispatch power on the new electrical market in Ontario (Ontario Hydro, Meeting, February 1999).

The extent to which alternative energies such as wind, solar and co-generation, will be able to compete with Ontario Hydro's two successor companies will depend upon decisions made by the provincial government about the way to divide Ontario Hydro's accumulated debt of $39 billion. In order to keep Ontario Power Generation viable, it has been decided that some portion of Ontario Hydro's debt must be declared "stranded" and will be born equally by all consumers as a surcharge on all electricity that enters the electrical distribution system (Ontario Ministry of Finance, 1998).

Currently, estimates for the stranded debt range from $10 to $30 billion dollars depending on a number of factors, including the value given to the nuclear facilities. If the value of the stranded debt is set too low, Ontario Power Generation will not be viable. If the value of the stranded debt is set too high, Ontario Power Generation will be able to produce power at an artificially

low price and alternative energies will not be able to compete in the marketplace. When City Council considered the issue at its December 16, 1998 meeting, it recommended to the provincial government that a gradual approach be used when estimating the stranded debt for Ontario Hydro to ensure that competitors, including those offering renewable energy, are not placed at an unfair disadvantage (Toronto Works & Emergency Services**,** November 4, 1998**)**.

2.0 AIR QUALITY AND COAL-FIRED GENERATING STATIONS

When coal is burned to generate electricity, large quantities of sulphur dioxide, nitrogen oxides, carbon dioxide and persistent toxins are released into the atmosphere. In 1995, coal-fired generating stations in Ontario were responsible for 22% of the province's emissions of sulphur dioxide, 12% of the nitrogen oxides, 18% of the carbon dioxide, and 10% of the mercury. In the same year, coal-fired generating stations in the U.S. were responsible for 63% of that nation's sulphur dioxide, 26% of the nitrogen oxides, 31% of the carbon dioxide, and 21% of the mercury (see Table 2)(Institute for Environmental Studies, January 1998). Sulphur dioxide and nitrogen oxides are both precursors for acid rain and smog. Carbon dioxide is a greenhouse gas which contributes to global climate change. Persistent toxins are toxic substances such as mercury which can accumulate in the environment and in the food chain.

Table 2: Emissions Contributed by Coal-Fired Generating Stations in 1995

	Sulphur Dioxide	**Nitrogen Oxides**	**Mercury**	**Carbon Dioxide**
Ontario	22% (74 kt)	12% (43 kt) ***	10% (484 kg) **	18%* (15,387 kt)
United States	63%	26%	21%	31%

Institute for Environmental Studies, January 1998.

* in 1990 ****** kilograms (kg) ******* expressed as nitrogen dioxide[1]

2.1 Acid Rain: Sulphur Dioxide and Nitrogen Oxides

In the last two decades, great strides have been made in both Canada and the U.S. to reduce acid rain caused by emissions of sulphur dioxide. Between 1980 and 1996, the seven eastern provinces of Canada (including Ontario) reduced their sulphur dioxide emissions by 46% to 1,700 kt per year, while the U.S. reduced its sulphur dioxide emissions by about 30% to 16,500 kt per year in 1995 (Acidifying Emissions Task Group, 1997).

The Acidifying Emissions Task Group, established on behalf of the Environment and Energy Ministers of the federal, provincial and territorial governments in Canada, has determined that much more must be done about acid rain. In its 1997 report, "Towards a National Acid Rain

[1]Organizations can express nitrogen oxides as nitric oxide or nitrogen dioxide which can affect the figures provided as volumes. Nitrogen dioxide can be converted to nitric oxide by multiplying by 30/46.

Strategy," the Task Group indicates that, with full implementation of the Canadian and U.S. programs for acid rain, 800,000 square kilometers of land and 95,000 lakes in southeastern Canada will receive harmful levels of acid rain in the year 2010. In order to protect eastern Canada from acid rain, the Task Group concluded that sulphur dioxide emissions in both Canada and the U.S. would have to be reduced by 75% from current emission caps.

The Task Group estimated that a 75% reduction in sulphur dioxide emissions in both Canada and the U.S. could prevent approximately 13,000 deaths and 5 million asthma symptoms days in Canada over a 15 year period. The Task Group estimated that the 75% reduction scenario could be worth $32 billion in health effects avoided in Canada over a 15 year period (Acidifying Emissions Task Group, 1997).

The Task Group has also reported that acid rain resulting from emissions of nitrogen oxides may be undermining the benefits from controlling sulphur dioxide emissions. While sulphur dioxide emissions have been reduced substantially in the past twenty years on both sides of the border, nitrogen oxide emissions have remained the same, at 2 million tonnes per year in Canada, and 20 million tonnes per year in the U.S. (Acidifying Emissions Task Group, 1997).

2.1.1 Action Identified for Sulphur Dioxide

The Acidifying Emissions Task Group has recommended that Canada and the U.S. should reduce sulphur dioxide emissions by 75% beyond their existing caps. For Ontario, the 75% reduction would result in an emission cap of 221 kt for sulphur dioxide from all sources. If the 75% reduction were applied to Ontario's electrical sector, the emission cap for sulphur dioxide would be reduced to 43.75 kt per year.

2.2 Smog: Sulphur Dioxide and Nitrogen Oxides

As major contributors of nitrogen oxides and sulphur dioxide, coal-fired plants contribute to smog in two significant ways. First of all, nitrogen oxides react with volatile organic compounds in the atmosphere to produce ground-level ozone, one of the two major components of smog. Secondly, both nitrogen oxides and sulphur oxide interact with other elements in the atmosphere to produce sulphates and nitrates, which contribute to the particulate portion of smog.

Particulates are solid and liquid particles that are small enough to be inhaled into the lungs. The particulate portion of smog can be composed of road dust, acid mists such as nitrates and sulphates, and metals such as mercury and lead. It has been estimated that about 25% of inhalable particulates (those smaller than 10 microns or PM_{10}) and 40% of respirable particulates (those smaller than 2.5 microns or $PM_{2.5}$) are sulphates that have been derived from sulphur dioxide (Ontario Ministry of Environment and Energy, 1996).

2.2.1 Ozone: Hospital Admissions

Smog is strongly influenced by weather. In the summer, when it is sunny, hot and dry, ozone levels are high and can trigger smog alerts. In the winter, particulates form the main component of smog. Both ground-level ozone and particulates have been associated with a broad range of

health effects. Several large scale studies have demonstrated a highly significant relationship between low readings of ground-level ozone and hospital admissions for asthma, chronic lung disease, and respiratory infections. In one study conducted in 16 cities across Canada, increased hospital admissions were documented with maximum ozone readings that averaged 31 parts per billion (ppb). These findings are significant for Toronto residents because ozone levels in Toronto frequently exceed the 1-hour air quality criterion of 80 ppb. For example, ozone levels in Toronto exceeded 80 ppb, 44 times in 1994 (Ontario Ministry of Environment and Energy, 1996; Ontario Ministry of Environment and Energy, 1995).

2.2.2 Particulates: Hospital Admissions and Mortality

A number of large scale studies have linked particulates (PM_{10}) with asthma, pneumonia, respiratory and cardiac disease, hospital admissions and premature mortality. When researchers summarized data from eight U.S. studies which examined the relationship between short-term increases in inhalable particulates and death rates, they found that for every 10 ug/m^3 increase in PM_{10}, there was a 1% increase in the overall death rate, a 1.4% increase in the cardiovascular death rate, and a 3.4% increase in the respiratory death rate. These increases were seen at PM_{10} concentrations just above 20 ug/m^3. In a Toronto study, hospital admissions for general respiratory conditions and asthma increased 3.4% and 2.1% respectively for each 10 ug/m^3 increase in inhalable particulates. As with mortality, increases in hospital admissions were observed at PM_{10} concentrations just above 20 ug/m^3. These findings are significant for Toronto because air levels of PM_{10} commonly exceed 20 ug/m^3 and can reach levels as high as 75 ug/m^3 (Ontario Ministry of Environment and Energy, 1996; Ontario Ministry of Environment and Energy, 1995).

2.2.3 Smog: Pyramid of Health Effects

While it has long been recognized that high levels of smog can aggravate a wide range of serious health problems including bronchitis, asthma and other respiratory diseases, there is a growing body of evidence which indicates that healthy people, particularly children, are affected by relatively low levels of ozone (Steib, 1995; Ontario Medical Association, 1998). It is generally accepted that air pollution produces a pyramid of health effects ranging from severe, uncommon events (ie. death) at the top of the pyramid to mild, common events (eye, nose and throat irritation) at the bottom of the pyramid. In between these two extremes are a range of health effects including hospitalizations for respiratory and cardiac distress, reduced lung function, and an increased rate of respiratory infections, with the less severe effects affecting larger numbers of people. The pyramid model helps to illustrate that the increased death rates and hospital admissions that are relatively easy to measure, represent a very small portion of the overall burden that poor air quality places on human health (Steib, 1995).

2.2.4 Action Identified for Nitrogen Oxides in Ontario

The Ontario Ministry of Environment has set an air quality target for Smog. By 2015, there is to be a 75% reduction in the number of times that the 80 ppm criterion for ozone is exceeded using 1990-1994 as the base years. In order to achieve the Air Quality Target, it has been estimated that nitrogen oxide and volatile organic compound emissions must be reduced by 45% of 1990

levels by the year 2015 (Ontario Ministry of Environment, 1998).

In 1991, Ontario Hydro made a voluntary commitment to reduce its nitrogen oxide emissions to 38 kt by the year 2000. In 1996, Ontario Hydro emitted 36 kt of nitrogen oxide emissions[2]. In 1998, nitrogen oxide emissions increased to 56 kt reflecting Ontario Hydro's increase reliance on coal-fired plants during those years. Ontario Hydro plans to achieve its nitrogen oxide target by 2000 by upgrading the low NOx burners at the Nanticoke plant. In 1998, the Nanticoke plant emitted 27 kt of nitrogen oxides. When the new low NOx burners are installed, Ontario Hydro expects that Nanticoke will emit 30% fewer nitrogen oxides per MW-hour of electricity produced. However, the emission reductions gained with the new low NOx burners will be off-set by increased utilization of the plant. Nanticoke is expected to produce about 20 million MW-hours of electricity in 2000 compared with 10.4 million MW-hours in 1996 (Ontario Hydro, Meeting). Hydro's ability to meet its nitrogen oxides target in 2000 will depend upon the success of its nuclear recovery plan.

2.2.5 Action Identified for Nitrogen Oxides in the U.S.

In the fall of 1998, the U.S. government passed a Rule entitled, "Final Rule Requiring Regional NOx Reductions in the Eastern U.S." This Rule aims to reduce ground-level ozone by reducing nitrogen oxide emissions in 22 U.S. states and the District of Columbia by the year 2007. Each of the affected jurisdictions must develop a State Implementation Plan by September 1999 which outlines the measures that will be taken to meet the assigned state budget for nitrogen oxides by 2003. When the Rule is fully implemented, it is expected to reduce nitrogen oxides from those

[2] These numbers are expressed as nitric oxide.

23 jurisdictions by about 28% in the ozone seasons (U.S. Environmental Protection Agency, 1998).

While each jurisdiction is free to determine the mix of control measures necessary to meet its nitrogen oxide budget, the EPA has suggested that significant reductions could be achieved in a cost effective manner if an emission rate of 0.15 pounds per million BTU (or 1.5 pounds per MW-hour) were applied to large electrical generating stations. The U.S. EPA has estimated that nitrogen oxide emissions from the electrical sector in the 23 jurisdictions could be reduced by 64% if the recommended emission rate is adopted by all 23 jurisdictions (U.S. Environmental Protection Agency, Personal Communication).

Thirty petitions have been filed against the Ruling including petitions from eight states covered under the Ruling and by a number of utilities. The Government of Ontario, as well as a number of states, have filed in support of EPA's action. Briefs for those supporting the EPA action must be submitted to the Court by June 1999. There is no injunction against the EPA and its Ruling at this time (Ministry of Environment, Personal Communication).

2.3 Global Climate Change: Carbon Dioxide

When fossil fuels such as coal, oil and gas are burned, carbon dioxide is released into the earth's atmosphere. Carbon dioxide is a greenhouse gas which contributes to global climate change. As the concentration of carbon dioxide in the atmosphere increases, the mean temperature on the planet is expected to increase. This increase in temperature is expected to have profound impacts on weather patterns, water levels, air quality and economies around the world. Consequently, global climate change is expected to have significant impacts, directly and indirectly, on human health.

The direct health effects of global climate change include those associated with increased air pollution, more frequent and more severe heat waves, and more frequent "extreme weather events" such as tornadoes and ice storms. For example, global climate change is expected to increase the rate of chronic illnesses such as heart and lung disease that are associated with declining air quality. The indirect health effects of global climate change are many and varied, and could include a significant increase in insect-borne diseases such as malaria, an increase in food-borne and water-borne diseases, and food shortages (Toronto Public Health, 1997).

2.3.1 Action Identified for Carbon Dioxide

The Intergovernmental Panel on Climate Change, a panel of experts established by the United Nations, has indicated that global carbon dioxide emissions will have to be reduced by more than 50% to stabilize the concentration of greenhouse gases in the atmosphere at their present levels (McMichael, 1996). At the international conference on global climate change convened in Kyoto, Japan, Canada committed to reduce greenhouse gas emissions by 6% of 1990 levels between 2008 and 2012. The City of Toronto has made a commitment to cut municipal carbon dioxide emissions by 20% of 1988 levels by the year 2005, and has made considerable progress towards that commitment (Toronto Public Health, 1997).

Ontario Hydro has developed a voluntary action plan which commits Ontario Hydro to stabilize its greenhouse gas emissions at 1990 levels by the year 2000 and to reduce emissions by a further 10% by the year 2005. Reporting trends show that Ontario Hydro's carbon dioxide emissions have increased since 1994 from 18,400 kt to 23,500 kt in 1997. This reflects the increased reliance on coal-fired plants in recent years due to the temporary closure of several of Ontario Hydro's nuclear units (Ontario Hydro, Towards Sustainable Development, 1997; Ontario Hydro, Meeting, February 1999).

2.4 Air Toxins: Mercury and Others

Coal-fired generating stations emit a number of toxic pollutants that are persistent in the environment, including lead, cadmium, chromium, arsenic, nickel, beryllium and mercury. Lead is a neurotoxin that can affect the mental development of children at extremely low levels of exposure. Cadmium is toxic to the kidneys, the lungs and the bones, and is present in the environment in quantities that are considered hazardous to human health. Both lead and cadmium are suspected carcinogens while chromium, arsenic, nickel and beryllium are well recognized as human carcinogens (Health Canada, 1997; Government of Canada, 1994; NIOSH, 1990).

As an environmental toxin, mercury is particularly worrisome because of its mobility in the environment. In both its metallic and inorganic forms, mercury combines readily with organic materials to become organic mercury which can accumulate in the food chain. Mercury is toxic to birds, mammals and humans upon ingestion. Prenatal life (the embryo and fetus) is particularly sensitive to the toxic effects of mercury. Organic mercury crosses the placenta and can affect the development of the brain and nervous system of the fetus. Behavioural changes, reduced intellectual abilities and reduced motor skills have been observed in children exposed while in utero (Health Canada, 1997). Mercury is responsible for 22% of the fish consumption restrictions placed on fish in Lake Ontario and for 99% of the restrictions placed on fish from inland locations in Ontario (Ontario Ministry of Natural Resources, 1997-98).

2.4.1 Action Identified for Mercury

Mercury is one of four substances identified under the North American Free Trade Agreement to be banned or phased out by the governments of Canada, the U.S. and Mexico. Canada, Ontario and the U.S. have made a commitment under the Canada-Ontario Agreement and under the Binational Toxics Strategy to reduce mercury emissions to the Great Lakes by 90% by the year 2000. The International Joint Commission (IJC) has called for the virtual elimination of mercury from the Great Lakes Basin.

3.0 EMISSIONS REDUCTIONS SCENARIOS

Air emissions from coal-fired generating stations are related to a number of factors: the age of the facility, the quality of the emission control technology, and the sulphur content of the coal burned. Older plants that have not been upgraded with newer emission control technologies tend to have higher emission rates for sulphur dioxide, nitrogen oxides and air toxins. When high

sulphur coal is burned, between 5 and 50 pounds of sulphur dioxide can be emitted for every MW-hour of electricity generated, depending upon the emission control technologies employed. When low sulphur coal is burned, sulphur dioxide emissions can be reduced below 10 pounds per MW-hour (Institute for Environmental Studies, January 1998).

Emissions of toxic metals such as mercury, chromium, cadmium and arsenic are directly related to the existence of these metals in the coal. The emissions of these toxins are not reduced by the use of low sulphur coal. Nor are they greatly affected by emission control technologies directed at sulphur dioxide or nitrogen oxides. As a rule, carbon dioxide emissions increase when best available control technologies are employed on coal-fired plants because more coal has to be burned to produce the same amount of electricity. In those situations where the utilization of the plant increases after the investment is made to upgrade emissions control technologies, carbon dioxide emissions can increase very substantially (Personal Communication, Environment Canada).

When electricity is generated with natural gas, sulphur dioxide and the persistent toxins are eliminated entirely while carbon dioxide and nitrogen oxide are reduced substantially. When electricity is generated with renewable energies, air emissions are eliminated entirely.

3.1 Feasibility Study: North America

In a study commissioned jointly by the Institute for Environmental Studies (IES) at the University of Toronto and Pollution Probe, it was determined that sulphur dioxide and nitrogen oxide emissions from coal-fired generating stations in eastern Canada, Ontario, the northeastern U.S., the Ohio Valley and surrounding states, could be reduced by 80%, particulate emissions by 50% and mercury emissions by 50 to 90% by 2010, if all of the coal-fired stations were retrofitted with best available control technologies. Under this scenario, carbon dioxide emissions would only be reduced by 16% because even the “cleanest” coal-fired plant produces large quantities of carbon dioxide (see Table 3)(Institute for Environmental Studies, January 1998).

Table 3: Eastern Canada, Ontario, Northeastern U.S., Ohio Valley & Surrounding States, Emissions Reductions from Coal-Fired Plants, 2010

	Sulphur Dioxide	Nitrogen Oxides	Particulates	Carbon Dioxide	Mercury	Other Toxins
Best Available Control Technologies (BACT)	80%	80 %	50%	16%	50-90%	May increase
BACT & shift older plants off coal	90%	90%	76%	61%	95%	Will decrease

Institute for Environmental Studies, January 1998

If however, all of the coal-fired generating stations built before 1970 were replaced with non-coal-fired stations, and all other coal-fired stations were retrofitted with the best available control technology, it was determined that carbon dioxide emissions could be reduced by 61% because natural gas produces much less carbon dioxide than coal. Under this scenario, reductions in sulphur dioxide, nitrogen oxides, particulates and mercury would be much greater as well because natural gas releases no sulphur dioxide, much less particulate matter, and none of the persistent toxins (see Table 3) (Institute for Environmental Studies, January 1998).

3.2 Feasibility Study: Ontario

The IES study demonstrated that nitrogen oxide emissions from Ontario Hydro's coal-fired generating stations could be reduced from 48 kt to less than 6 kt[3] per year by 2010 if the two plants built before 1969 were closed (ie. Thunder Bay and Lakeview) and if the three plants built after 1969 (ie. Nanticoke, Lambton and Atikokan) were retrofitted with best available control technologies. In this study, it was assumed that the three remaining plants would produce 14.4 million MW-hour of electricity and that the best control technologies would result in a nitrogen oxides emission rate of 0.9 pounds per MW-hour of electricity generated. In 1995, emission rates from Ontario Hydro's five coal-fired generating stations ranged from 3 to 5 pounds per MW-hour for nitrogen oxides (Institute for Environmental Studies, January 1998).

The Ontario Clean Air Alliance (OCAA), a coalition of 54 organizations including the Canadian Institute of Environmental Law & Policy, Toronto Hydro, the Ontario College of Family Physicians, and the City of Toronto, commissioned a feasibility study using data provided by Ontario Hydro, Environment Canada and Natural Resources Canada. This study demonstrated that in 2014, sulphur dioxide emissions from Ontario Hydro's coal-fired generating stations could be reduced by 90% by shifting 90% of coal-generated electricity projected for that date to natural gas (38.6 of 42.5 million MW-hour). This scenario would reduce emissions of nitrogen oxides by 84%, carbon dioxide by about 57%, mercury emissions by 90%, and arsenic, beryllium, cadmium, chromium, lead and nickel by 90% (see Table 4). The cost for these reductions was estimated at $1,819 million or $1.86 per month for the average residential customer. Under this scenario, approximately 3.9 million MW-hours of electricity would still be provided by coal-fired generators (Ontario Clean Air Alliance, November 1998; Ontario Clean Air Alliance, Letter, February 23, 1999).

[3] Expressed as nitrogen dioxide

Table 4: Ontario, Emission Reductions from Ontario Coal-fired Plants, 2014

Scenario	Sulphur Dioxide	Nitrogen Oxides	Carbon Dioxide	Mercury	Other Toxins
Shifting 90% from coal to natural gas	90%	84%	57%	90%	90%

Ontario Clean Air Alliance, Spreadsheet, November 1998

When the OCAA added the air emissions from all other sources of electricity in the province, including those from non-utility generators, it concluded that air emissions from the entire electrical sector could be capped at the levels identified in Table 5 by 2002 by shifting 78% of projected coal-generated electricity to natural gas (14.3 of 18.3 million MW-hour). This would require building an additional 2,595 MW of gas-fired capacity by 2002. Under this scenario, approximately 4 million MW-hours of electricity would still be produced by coal (Ontario Clean Air Alliance, Letter, February 24, 1999):

Table 5: Annual Air Emission Caps for Ontario's Entire Electrical Sector, 2002

Pollutant	Caps	Pollutant	Caps	Pollutant	Caps
Sulphur dioxide	17.5 kt	**Arsenic**	19 kg	**Chromium**	180 kg
Nitrogen oxides	25 kt	**Beryllium**	9 kg	**Lead**	24 kg
Carbon dioxide	15,000 kt	**Cadmium**	7 kg	**Nickel**	228 kg
Mercury	45 kg				

Ontario Clean Air Alliance, November 1998 * expressed as nitric oxide

3.3 Feasibility Study: Lakeview

In the fall of 1998, Ontario Hydro announced a proposal to produce 550 MW of gas-fired electrical generating capacity at the Lakeview plant. Ontario Hydro has indicated that this is a proposal and that no commitment has been made to this project yet. A feasibility study is being conducted to determine if it is financially feasible. Ontario Hydro has indicated that the gas-fired generating capacity could be added to the coal-fired capacity of the plant or used to displace some of the coal-fired capacity. If the gas-fired generator is used to displace coal-fired capacity, the proposal could result in reduced emissions of nitrogen oxide emissions because combined-cycle gas turbines produce 80% less nitrogen oxide emissions than coal-fired generators. If however, the gas-fired generator is added to the coal-fired capacity of the station, the proposal could increase emissions because the emissions from the gas-fired generator would be added to

those from the coal-fired generator. Ontario Hydro indicated that, in a competitive environment, utilization of this plant could increase in the future (Ontario Hydro, Meeting, February 1999).

4.0 ONTARIO: REGULATORY AND POLICY ACTIONS

The Market Design Committee was the group established in January 1998 to provide advice to the Minister of Energy, Science and Technology on the market rules, powers and responsibilities that any regulatory agency would need to ensure support for a competitive electrical market. On environmental matters, the Market Design Committee indicated the need: 1) to establish an air emission cap and trading system; 2) for increased Ministry support to promote consumer energy conservation programs; 3) to develop a mechanism to verify company claims of "green" power; and 4) for public disclosure by electrical suppliers on sources of electricity and pollution emissions. In its Final Report, the Market Design Committee recommended that an environmental panel be established by the Ontario Ministry of Energy, Science and Technology to implement the above recommendations (Market Design Committee, February 1999).

4.1 Air Emission Caps

Bill 35 makes only one reference to the Market Design Committee's recommendation respecting air emission caps and emissions trading. It indicates that the *Environmental Protection Act* will be amended to allow the development of regulations that will essentially establish "an emission trading system for environmental and cost benefits". Currently, in Ontario, there is one regulation which applies air emission caps to the generation of electricity. Regulation 355, established under the *Environmental Protection Act* requires that Ontario Hydro limit its release of sulphur dioxide to 175 kt per year, and its total emissions of sulphur dioxide and nitrogen oxides to 215 kt per year, after 1993. Regulation 355 does not apply to any other air pollutants emitted by Ontario Hydro. Nor does it apply to any other generator of electricity in or out of the province. Consequently, unless Regulation 355 is revised, air emissions related to the production of electricity for Ontario consumers could actually increase in the future under a competitive electricity market (Select Committee, December 1997).

The Ministry of Environment is currently reviewing Regulation 355 to determine how best to proceed on this issue. This review presents the provincial government with the opportunity to improve air quality in Ontario by setting air emissions caps for sulphur dioxide and nitrogen oxides that are more protective than those which currently exist. By extending air emissions cap to carbon dioxide and seven persistent toxins including mercury, the provincial government could make considerable progress towards its smog target for nitrogen oxides and towards its commitment on global climate change. It would also be encouraging a shift away from coal generated electricity towards natural gas, solar and wind generated electricity.

4.1.1 Sulphur Dioxide Cap

The Acidifying Emissions Task Group recommended that Canada and the U.S. should reduce sulphur dioxide emissions by 75% beyond existing caps. This recommendation has been adopted by the Toronto Environmental Alliance (TEA), the Sierra Club, and the David Suzuki Foundation, which have founded a coalition called the OntAIRio Campaign, and the Ontario Medical Association. The study commissioned by the OCAA has demonstrated that it is financially feasible to reduce the sulphur dioxide emissions cap for all companies providing electricity in Ontario by 90% to 17.5 kt by the year 2002. This would be achieved by shifting 78% of coal-fired electricity projected for that date to natural gas.

4.1.2 Nitrogen Oxides Cap

The Ontario government has determined that nitrogen oxide levels in Ontario must be reduced by 45% of 1990 levels by the year 2015 in order to reduce the number of times that the health based criterion for ground level ozone is exceeded. Given that Ontario's coal-fired generating stations were responsible for 12% of Ontario's nitrogen oxide emissions in 1995, and that its share of those emissions has increased in the past two years due to an increased reliance on coal-fired plants, it is fair to seek greater reductions in this sector.

In a 1998 position paper on air quality, the OMA recommended that Ontario Hydro's voluntary commitment to nitrogen oxide reductions should be replaced with a regulation which would limit emissions from Ontario Hydro and imported electricity to no more than 6 kt annually. The OntAIRio Campaign has recommended that nitrogen oxide emissions from all companies providing electricity to Ontario consumers (excluding non-utility generators) should be capped at 6 kt by 2005. The 6 kt[4] recommendation is based upon the feasibility study conducted by IES. The OntAIRio Campaign is promoting the idea that the 6 kt cap can be achieved with a mix of policy initiatives including an aggressive energy conservation program to reduce the demand for electricity, the promotion of renewable technologies, fuel conversion, and the application of best available control technology (Toronto Environmental Alliance, Personal Communication).

The OCAA maintains that nitrogen oxide emissions from all companies producing electricity in Ontario (including non-utility generators) could be reduced to 25 kt[5] by the year 2002 by shifting 78% of coal-fired electricity to natural gas. It assumes that 12 kt of nitrogen oxide emissions would be produced by what are currently considered non-utility generators, that 3 kt would be emitted from the new gas-fired generators, and that another 10 kt would be produced by the remaining coal-fired generators. When the 12 kt estimate for non-utility generators is added to the 6 kt recommendation (which is 3.9 kt when converted to nitric oxide) the difference between

[4] Expressed as nitrogen dioxide

[5] Expressed as nitric oxide

the OCAA cap and the OMA cap is only 9.1 kt of nitrogen oxides (when expressed as nitric oxide).

4.1.3 Carbon Dioxide Cap

The Intergovernmental Panel on Climate Change, established internationally, has indicated that global carbon dioxide emissions would have to be reduced by more than 50% to stabilize the concentration of greenhouse gases in the atmosphere at their present levels. Toronto has committed to reduce greenhouse gas emissions by 20% of 1988 levels by 2005, and has made considerable progress towards that goal. In 1990, coal-fired plants in Ontario were responsible for 18% of the carbon dioxide emissions in Ontario at 15,387 kt. By 1997, carbon dioxide emissions increased by about 50% to 23,50 kt due to increased reliance on coal-fired plants. The OCAA study demonstrated that, by shifting 78% of coal-fired electricity to natural gas, carbon dioxide emissions could be reduced by 48% to 9,200 kt by 2002. When emissions from existing non-utility generators are added to these emissions, the total carbon dioxide emissions in 2002 would be 15,000 kt.

4.1.4 Mercury, Persistent Toxins Caps

Ontario, Canada and the U.S. have made a commitment under the Canada-Ontario Agreement and under the Binational Toxics Strategy to reduce mercury emissions to the Great Lakes by 90% by the year 2000. The IJC has called for the virtual elimination of mercury from the Great Lakes Basin. The OntAIRio Campaign has asked the provincial government to commit to the virtual elimination of mercury emissions by 2005. The OCAA study has demonstrated that air emissions of mercury and six other persistent toxins from Ontario's electrical sector could be reduced by 78% by 2002 by shifting 78% of coal-fired generation to natural gas.

4.1.5 Recommendations

Given that it appears technically and financially feasible to reduce emissions of sulphur dioxide, nitrogen oxides, carbon dioxide, mercury, arsenic, beryllium, cadmium, chromium, lead and nickel from the entire electrical sector to 17.5 kt, 25 kt, 15,000 kt, 45 kg, 19 kg, 9 kg, 7 kg, 180 kg, 24 kg and 228 kg respectively, and the compelling human health and environmental arguments in favour of doing so, it is strongly recommended that the provincial government move to adopt these levels recommended by the OCAA as air emission caps for Ontario's electrical sector for the year 2002.

Furthermore, it is recommended that a reduced annual air emission cap for nitrogen oxides be established for the year 2010, which reflects the cap recommended by the OMA for coal generated electricity.

4.2 Promote Energy Conservation and Renewables

Bill 35 captures the Market Design Committee's recommendation respecting energy conservation and renewables with rather vague language. It indicates that it will be the Ontario Energy Board's (OEB) responsibility "to facilitate energy efficiency and the use of cleaner, more environmentally benign energy sources in a manner consistent with the policies of the Government of Ontario." The OEB should examine the Renewable Portfolio Standard and the Public Benefit Fund proposed by the U.S. Administration when developing a strategy to ensure that energy conservation and renewable energies are promoted in the new competitive market place.

4.3 Disclosure of Information

Several sections of Bill 35 have captured the Market Design Committee's recommendations respecting disclosure of information. The Ministry of Environment is considering developing regulations that require energy producers to report on 28 air pollutants. At this time, the Ministry does not know whether it would have the legal authority to apply these regulations to electricity producers in the U.S.. It is seeking a legal opinion on that issue. The Ministry may initiate a consultation process to discuss the nature of the information to be disclosed and the process by which disclosure occurs (Ministry of Environment, Personal Communication).

The Ministry of Energy, Science and Technology under the *Ontario Energy Board Act* is developing regulations for energy labeling. It is the Ministry's intent to ensure that information on environmental emissions is provided to allow consumers to make environmentally informed choices (Ontario Ministry of Energy, Science and Technology, Personal Communication). The effectiveness of these regulations will depend however upon details that have not yet been developed.

5.0 UNITED STATES: REGULATORY ACTION

In 1998, the OMA recommended that electrical generators in the U.S. should not be allowed to release more than 0.15 pounds of nitrogen oxides per million BTU of electrical power generated, and that no exemptions should be allowed for older plants. The emission rate recommended by OMA is the same rate recommended for coal-fired plants by the U.S. EPA in its proposed Rule for nitrogen oxides. The U.S. EPA considers this rate to be cost-effective for large electric generators while providing improvements in air quality during ozone seasons (Ontario Medical Association, 1998; U.S. Environmental Protection Agency, Personal Communication).

The 0.15 pound per million BTU emission rate is the equivalent of 1.5 pounds per MW-hour which is more than 50% greater than the 0.9 pounds per MW-hour emission rate applied in the feasibility study conducted by IES. The U.S. EPA emission rate does, however, represent a substantial reduction in the emission rates of companies currently operating in the U.S.. According to the National Resources Defense Council, the 10 top producing electrical companies in the U.S. are currently performing at emissions rates ranging from 5.5 to 10 pounds per MW-hour (National Resources Defense Council, 1998). The U.S. EPA recommended emission rate is

also much lower than the current emission rates for Ontario's five coal-fired plants of 3 to 5 pounds per MW-hour. If the U.S. EPA successfully defends its proposed Rule for nitrogen oxides, it could substantially improve air quality with respect to ground level ozone. However, a great deal depends upon how the 23 affected jurisdictions implement the federal Rule.

Before the U.S. EPA announced its Rule for nitrogen oxides, the OMA recommended that the Canadian government, the Ontario government or an appropriate municipal government should petition the U.S. EPA Administrator to use Section 115 of the *U.S. Clean Air Act* to require the sulphur dioxide and nitrogen oxides reductions necessary in the U.S.. If the U.S. EPA successfully defends its proposed Ruling for nitrogen oxides and its 1.5 pounds per MW-hour emission rate is adopted by a number of the 23 jurisdictions, the U.S. will be moving ahead of Ontario on air quality related to its electrical sector. For this reason, it is recommended that all levels of government monitor the progress of the U.S. EPA Rule to determine what actions, if any, should be taken in the future to encourage action on air emissions in the U.S..

6.0 SUMMARY OF RECOMMENDATIONS

It is recommended that the Ontario Minister of Environment and the Ontario Minister of Energy, Science and Technology:

1. establish the regulatory framework necessary to ensure that competition in Ontario's electrical sector does not lead to greater reliance on coal-fired generating stations and further degradation of air quality, human health and the environment in Toronto and the rest of southern Ontario;

2. establish annual air emission caps for the entire electrical sector to limit the volume of air pollutants released each year, ensuring that caps:

    a) apply to companies supplying electricity to Ontario as well as those generating electricity in Ontario;
    b) encompass carbon dioxide and persistent toxins as well as sulphur dioxide and nitrogen oxides to encourage a shift towards natural gas and renewable energies for the production of electricity;
    c) for the year 2002 be set as follows: 17.5 kilotonnes (kt) for sulphur dioxide, 25 kt for nitrogen oxides, 15,000 kt for carbon dioxide, 19 kilograms (kg) for arsenic, 9 kg for beryllium, 7 kg for cadmium, 180 kg for chromium, 24 kg for lead, 45 kg for mercury, and 228 kg for nickel, as recommended by the Ontario Clean Air Alliance;

d) for 2010 reduce the annual air emissions cap for nitrogen oxides to reflect the cap recommended by the Ontario Medical Association for coal generated electricity;

3. establish a renewable energy standard which defines the percentage of electricity that must be generated with renewable energies by electrical suppliers serving Ontario consumers; and

4. establish a public benefit fund to support the promotion of energy conservation and the development of renewable energies with a surcharge on the transmission of electricity.

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