

**The quest for a zero GHG emission province:
Can Manitoba offer Ontario energy lessons?**

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ABSTRACT

Canadian provinces have abundant energy resources, but historic energy development decisions have made Canada one of the highest per capita emitters of greenhouse gases in the world. New technologies and distributed network management have created opportunities for conservation and green energy supplies to reduce GHG emissions, but Canada's adoption rate lags behind several other countries. The promise of Ontario's new government to close its coal-fired power plants by 2007 and the aging of its nuclear power plants creates an immediate need for investments in approximately 20,000 MW of capacity over the next decade. Many advocates call for a shift from fossil and nuclear power to renewable energy. Ontario's neighbour, Manitoba, has embarked on a systematic energy plan to reduce fossil fuel use and increase renewables (including new energy efficiency standards, wind, hydro-electricity, biofuels, geothermal heat pumps and electricity exports) so that a net zero emission position can be reached. The paper reviews the green energy initiatives promoted in Manitoba and then considers these as options for Ontario. The conclusion is that Manitoba's plan of systematically linking its energy and economic development choices has created opportunities and lessons for other jurisdictions to also move toward a greener energy future.

INTRODUCTION

Canada has abundant energy resources, but a focus on fossil fuels has made it one of the largest per capita emitters of greenhouse gases (GHG) in the world. Canada also recognizes the consequences of its energy choices (IPCC, 2001) and ratified the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) in December 2002. The Kyoto Protocol came into effect on 16 February 2005 and green energy sources are expected to play a major role in achieving national targets¹. Despite numerous initiatives to reduce greenhouse gas emissions under the Climate Change Action Fund launched in 1998 and Action Plan 2000 on Climate Change, total Canadian emissions grew by 20% from 607 million tonnes of CO₂ equivalent (Mt CO_{2eq}) in 1990 to 730 Mt CO_{2eq} in 2000 (Canada, 2002; EC, 2005).

Most climate change discussions focus at the national or international level. The U.S. Energy Information Administration forecasts global CO₂ emissions to continue to grow at an annual rate of 1.9% (EIA, 2004). The annual growth rates are expected to be higher in Asian developing countries (2.9%) and North America (1.6%) in comparison to western Europe (0.6%) and Japan (0.7%). However, the continued pattern of growing emissions is counter to the objectives of the UNFCCC and the targets established in the Kyoto Protocol. The challenge is to reverse the direction and reduce emissions.

The reversal in emission trends may be best achieved at sub-national levels that can then serve as examples for other jurisdictions. In the United States, the national 2006 budget calls for significant cuts in renewable energy, energy efficiency, clean air, and climate change related-programs at the U.S. Department of Energy, U.S. Department of Agriculture, U.S. Department of Transportation, U.S. Environmental Protection Agency, and other agencies (Bossong, 2005). Among the renewables, only wind received a modest budget increase. In contrast, the \$US6 billion Climate Change Initiative included funds for "clean coal", advanced nuclear power generation, non-renewable hydrogen and carbon sequestration. Given this set of U.S. federal priorities, the leading programs for green energy are often found at the state level.

In Canada, the reliance of the federal government on many voluntary programs to reduce greenhouse gas emissions has not prevented an overall record of rapid emissions growth. However, the pattern is not uniform across the country. Provincial as well as federal policies are important influences on emissions. This paper examines the climate and energy policies developed and implemented in the province of Manitoba (Fig. 1). The comprehensive range of clean energy and related conservation initiatives is highlighted, then per capita emissions are reviewed and the policies considered for potential transfers to Ontario and other jurisdictions.

¹ The terms green energy and clean energy have often been defined in similar ways. Manitoba policy documents use the term clean energy so the terms are used interchangeably in this paper.

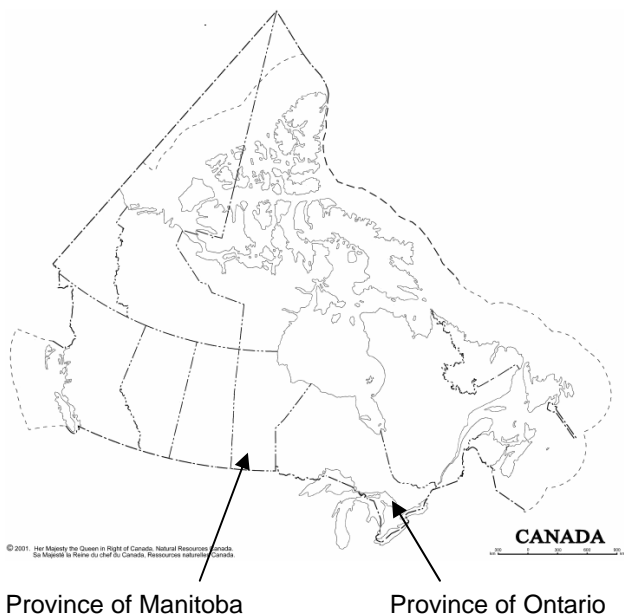


Fig. 1. Location study (NRCan, 2004)

DISTRIBUTION OF CANADIAN EMISSIONS

The provincial distribution of Canadian greenhouse gas emissions highlights the respective roles of provinces in the production and consumption of fossil fuels. Alberta and Ontario are the two largest sources of emissions with each province contributing over 200 Mt CO_{2eq} each year (Fig. 2) (EC 2005).

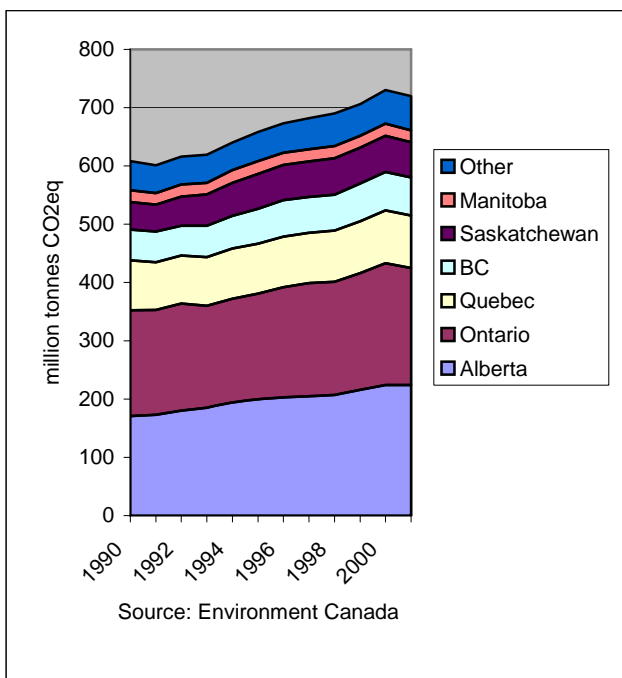


Figure 2. Canadian GHG emissions by province

Alberta surpassed Ontario as the largest provincial emitter in 1993 and has continued its pattern of rapid emission growth based largely on the prominence of fossil fuel production (oil, gas, coal and synthetic crude from tar sands) in the provincial economy. Stationary combustion accounted for 125 million tonnes CO_{2eq} in 2001 (electricity generation: 55 Mt, fossil fuel industry: 44 Mt CO_{2eq}) while transportation emissions totaled 33 Mt CO_{2eq}. In contrast, Ontario is Canada’s most populous province and the largest consumer. Transportation emissions (61 Mt CO_{2eq}) doubled those of Alberta while stationary sources were lower (100 Mt CO_{2eq}) and the distribution differed. Electricity generation (41 Mt CO_{2eq}) and fossil fuel industry (6.6 Mt CO_{2eq}) sources were lower than in Alberta while manufacturing (20 Mt CO_{2eq}) and residential were larger (18 Mt CO_{2eq}) (EC, 2005).

When the trend over time is compared, Alberta’s emissions were 30% higher in 2000 than in 1990 while Ontario’s had risen by 15% (Fig. 3). It should be noted that this distribution of direct emissions would change if

the indirect emissions, for example the energy used to produce the oil and gas, were allocated to final consumers.

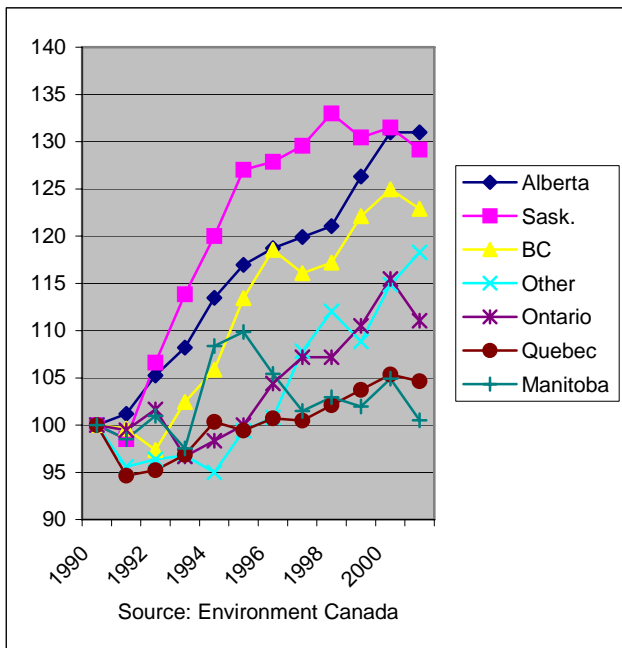


Figure 3: Provincial GHG emissions, 1990 = 100

In general, the western provinces of Saskatchewan and British Columbia also had high emission growth rates while Quebec with its focus on hydro-electricity remained lower along with Manitoba. The emission total for the Atlantic provinces and northern territories was about 60 MtCO_{2eq}, equivalent to the provincial total of Saskatchewan or British Columbia. The lower emission pattern of Manitoba is of particular interest if the country is to change from a path of emission growth to one of decline.

MANITOBA

“Manitoba is particularly sensitive and vulnerable to climate change because of the important role that renewable resources – like forests and agriculture – play in our economy. Manitoba is also home to vulnerable northern environments that are predicted to experience greater than average temperature changes.” (MCEC, IISD, 2001 p.9).

Manitoba is a prairie province with strong primary industries. Agriculture has been important since the province was settled and the capital Winnipeg grew as the gateway for settlers and goods coming into the region as well as the exit point for exports. Unlike Alberta and Saskatchewan, Manitoba does not have a large fossil fuel industry. It imports oil and natural gas (at an annual cost of \$C3 billion) to meet three-quarters of its energy needs. Hydro-electricity is the principal local source of energy and meets one-quarter of total energy demand. The provincial utility, Manitoba Hydro, has a dominant position in the industry with such facilities as the Limestone Generation Station on the Nelson River. Production exceeds provincial electricity demand and exports account for nearly half of the total generated (MCEC, IISD, 2001). However, drought and low rainfall conditions can reduce the energy available from this source as a direct sensitivity to climatic conditions is demonstrated.

The importance of climate change was recognized in Manitoba in the late 1990s. Studies by lead institutions such as the Manitoba Clean Environment Commission and International Institute for Sustainable Development highlighted the processes and expected impacts of climate change (MCEC, IISD, 2001). Recent experience with increased severity of flooding, fires and drought reinforced the message that climate change is underway.

The Manitoba Climate Change Task Force was chaired by former Canadian Foreign Minister Lloyd Axworthy and consulted broadly with Manitobans. Given Manitoba’s strong interest in Canada’s clean energy future, the task force suggested that Manitoba take a leadership role in reformulating Canada’s climate change plans. Its report presented a series of recommendations to the government (MCCTF, 2001), including:

- crafting a provincial energy policy that demands the development of renewable and alternative energy options, maximizing the energy sector’s potential as an economic development tool
- reviewing the Manitoba Hydro Act
- introducing an expanded grants and interest rate program by Manitoba Hydro to encourage energy efficiency

- defining the climate change components that must be addressed as fundamental issues in the establishment of a continental energy policy with the United States and Mexico
- undertaking research and analysis in Manitoba with a focus on local and prairie regional effects of climate change
- establishing a northern strategic initiative that addresses climate change issues
- new measures that would provide incentives for alternative fuels and funding for transit
- initiating comprehensive education, outreach and training programs to raise the public's climate change awareness

Table 1: Manitoba GHG emissions by sector

	1990	1995	2000	1990	2000
	Mt CO _{2eq}			%	%
Energy	12.6	12.9	13.3	62	62
Stationary	4.9	4.2	5.4	24	25
electricity	0.6	0.2	1.0	3	5
fossil fuel	0.0	0.0	0.0	0	0
manufacturing	1.0	0.8	1.1	5	5
commercial	1.4	1.6	1.7	7	8
residential	1.6	1.5	1.4	8	7
other	0.3	0.1	0.2	1	1
Transportation	7.3	8.2	7.4	36	35
aviation	0.5	0.5	0.6	2	3
road	4.2	4.6	4.6	21	22
railway	0.6	0.6	0.3	3	1
other	2.0	2.5	1.9	10	9
Industrial	0.5	0.3	0.5	2	2
Agriculture	6.8	7.0	6.9	33	32
Waste	0.4	0.5	0.6	2	3
Other	0.0	1.6	0.0	0	0
Total	20.3	22.3	21.3	100	100

Source: Environment Canada, 2005

The sources of Manitoba's greenhouse gas emissions are well known with the transportation and agriculture sectors each accounting for nearly one-third and stationary sources accounting for one-quarter of all emissions (Table 1). The distribution and total amounts remained relatively stable during the 1990s, so a series of initiatives were brought forward to try to achieve the desired reductions by 2010.

Manitoba energy policy

"We are creating a prominent, new Department of Energy, Science and Technology to ensure we are making the most of our opportunities for economic growth, while also addressing serious challenges such as climate change." Premier Gary Doer (Manitoba, 2002 p.1)

As suggested, Manitoba developed new energy policies as the cornerstone of its climate change initiatives. Energy was given a higher departmental profile with an experienced minister, Tim Hale, and combined with Science and Technology to focus attention on new options. Studies were conducted to identify the best opportunities (Collins, 2004) and a comprehensive Energy Development Initiative was launched. The initiative included projects in agri-energy (bio-diesel and ethanol), geothermal, wind energy, new generation, hydrogen, clean power exports and efficiency (MEST, 2005).

The importance of the agriculture industry in the provincial economy leads to a desire for agri-energy to create new opportunities for the rural economy while also providing new sources of renewable energy (Manitoba, 2003a). The potential for bio-diesel is being explored while Manitoba has already positioned itself as the lowest cost producer of ethanol in North America (MEST, 2005). The ethanol plant owned by Husky Oil is being expanded with the assistance of federal funding (Manitoba, 2004a). The provincial government passed *The Biofuels Act* requiring ethanol to be blended in 85% of vehicle fuels by 2007. It also reduced taxes on ethanol at the pump and extended 10-year tax credits for the production and use of ethanol (Manitoba, 2005). These actions on both the supply and demand side of the industry stimulate the growth of the ethanol industry (Selinger, 2004) and result in a reduction in the carbon intensity of transportation.

The use of fossil fuels in the production of the feedstock for ethanol plants reduces the overall greenhouse gas savings; however, it is a start in switching transportation fuels from non-renewable to renewable sources. Manitoba's ethanol industry is reported to achieve the greatest greenhouse gas reductions (50%) among Canadian ethanol plants (Manitoba, 2004c). The use of lower-input winter wheat varieties as the feedstock for ethanol could reduce emissions further. The planned production of 130 million litres of ethanol annually (10% of the Manitoba gasoline market) would reduce CO₂ emissions by 135,000 tonnes.

A bi-product of ethanol production is Distillers Dried Grains which is a protein rich material that can replace imported animal feed (Manitoba 2004c). This would reduce the long distance transport of feeds and stimulate local rural industries.

Manure is another major source of greenhouse gases in the agricultural sector and a large scale anaerobic digester was constructed for a 6,000-head hog feeder farm to demonstrate the viability of the Canadian design "Bio-Terre". The methane is produced, captured and then used to heat farm buildings (Manitoba, 2004c).

Manitobans lead Canada in the per capita installation of geothermal or ground source heat pumps. This technology has been identified by the European Electric industry as the leading technology to reduce greenhouse gas emissions through improved energy efficiency (EURELECTRIC, 2004) and by the U.S. Environmental Protection Agency as the most energy efficient, environmentally friendly and cost-effective heating and cooling technology available. To achieve its global potential reduction of 1.4 billion tonnes of CO₂, the technology needs to be promoted. Heat pumps are proposed as a principal means to reduce residential emissions in the UK and 95% of new homes built in Sweden have these systems (Manitoba, 2004c). In Manitoba, the provincial government plans to double the number of heat pump installations over the next two years and currently trains over 50% of all Canadian installers to ensure that it has the capacity to expand the industry's market share (Manitoba, 2005). More systematically, the new Waverly West urban development is to use heat pumps instead of natural gas furnaces for residential and commercial heating. The CO₂ savings are estimated at 10 tonnes per house and 50 tonnes per commercial unit (Manitoba, 2004c). Manitoba Hydro offers incentives and utility financing to encourage heat pump installations. Whether there is an elimination of fossil fuels from this traditional heating market requires one to look at the proposed sources of electricity to run the heat pumps.

New sources of electricity are considered, but hydro-electricity remains the dominant current source (95%) and the leading source proposed for future increases. The proposed 200 MW Wuskwatin hydro project is expected to require \$C900 million in investment and was being reviewed by the Clean Environment Commission in 2004 (Manitoba, 2004b). The project has been revised as a run-of-river hydro project with lower output, but much lower flooding impacts than a previous 350 MW proposal for the site. Flooding impacts have been reduced from 140 km² to less than 0.5 km² (Manitoba 2004c).

Sites have been identified for several potential hydro-electric developments and negotiations are underway with First Nations communities in northern Manitoba to gain support for development. In addition to a direct share in revenues from an equity partnership in Wuskwatin, employment opportunities will be created during construction and operation. Manitoba Hydro is already Canada's largest industrial employer of Aboriginal people, with over 500 on staff, and additional opportunities are expected (Manitoba 2004c).

Wind energy has been identified in many jurisdictions as a viable renewable energy source. Manitoba's wind resource has also been assessed as strong – an extension of North Dakota's wind resource that has earned the state a reputation as "the Saudi Arabia of wind". The flat southern prairies offer great wind potential as well as good access to the existing grid. The decision to create Canada's largest wind farm, 99 MW, at St. Leon was promoted in the 2004 budget at an estimated cost of \$C190 million (Manitoba, 2004c; Manitoba, 2005). The intermittent nature of wind energy is argued to be complementary to the hydro-electricity capacity of the province. In addition, the stronger average winds in winter match the peak energy consumption season.

The availability of clean, low carbon electricity is also the basis of a hydrogen future where hydrogen is used as the fuel for transportation. Manitoba Hydro has installed a commercial electrolysis unit that is already cost-effective. In addition, the province has partnered in a project to develop and demonstrate the world's most efficient fuel-cell bus that combines New Flyer's advanced chassis and a combination of fuel-cell engine and hybrid electric motor (Manitoba 2004c). In this way, Manitoba's existing bus manufacturing industry can move toward fuel and technology systems of tomorrow. Buses are expected to be an early adoption niche for hydrogen fueled vehicles with 10% of the North American transit bus market identified as a potential market over the next decade.

Winnipeg has been used as a site for testing alternative fueled buses. A local firm, Kraus Group, specializes in the design and manufacture of refueling equipment for petroleum and alternative fuels. It supplies fuel dispensers for propane, natural gas and hydrogen to markets around the world (MCEC, IISD, 2001).

The universal use of hybrid electric vehicles could reduce Manitoba's CO₂ emissions by 1.5 million tonnes annually. More dramatically, the use of low-cost hydro-electricity to produce low-carbon hydrogen fuels could be viable in Manitoba before almost any other jurisdiction. The complete conversion of Manitoba vehicles to fuel cell technology would require the equivalent of the Conawapa (1200 MW) project as a source of electricity for hydrolysis to produce hydrogen. However, the result would be complete energy self-sufficiency for vehicle fuels (Manitoba, 2004c).

Transportation demand management is also promoted through Resource Conservation Manitoba and the province partnered with the City of Winnipeg and the federal government in the Winnipeg Sustainable Management Advancing Responsible Transportation (WINSMART) project (Manitoba, 2005). The provincial government encourages ethanol use and its vehicle fleet included 116 E85 vehicles as well as 11 hybrids at the start of 2005. The next generation of gas-electric hybrid vehicles is expected to significantly improve fuel mileage by increasing their use of electricity and plugging the vehicles in for overnight recharging. The low cost of electricity in Manitoba, makes the increased use of electricity for transportation more attractive there than in most other jurisdictions (Manitoba, 2004c). The management of transportation demand and the substitution of less carbon intensive fuels and more efficient vehicles contribute to a reduction in transportation related emissions.

Demand side management is recognized as important and the success of the Power Smart program operated by Manitoba Hydro in raising public awareness is being enhanced through the creation of a new agency in 2004, initially called Efficiency Manitoba. This agency is responsible for the promotion of efficiency across multiple uses rather than having separate agencies promoting electricity, water and building envelope efficiency. The promotion of product stewardship is included as part of its mandate. This comprehensive approach to efficiency has earned the province the top ranking in the country for energy efficiency according to the Canadian Energy Efficiency Alliance (Manitoba, 2005).

The efficiency of new building construction creates a legacy for generations to come, so Manitoba has increased efficiency standards for new commercial and public buildings. New buildings showcase innovative designs and technology with new buildings at Red River College, the Mountain Equipment Co-op store, Smith Street seniors' residence with its 20 storey solar wall and the new Manitoba Hydro head office each demonstrating what can be achieved (Manitoba, 2004c).

Beyond Manitoba, the province recognizes growing demand for renewable sources of energy and has plans to increase exports of hydro-electricity to the United States and Ontario. The Conawapa hydro-electric project has been proposed as a major source of electricity for Ontario as an alternative to the coal-fired power plants that the government has promised to close. Both provincial governments (Manitoba, 2003) agreed to explore the potential 1500 MW project, termed the Clean Energy Transfer Initiative, and then take it to the next phase of detailed technical studies (Manitoba, 2004b). The creation of a Clean Fund in the 2005 federal budget is expected to provide a financial mechanism to enable the east-west expansion of the electricity grid to proceed (Canada, 2005).

Manitoba has also taken a leading position in supporting the Kyoto Protocol. Its decision to support the Protocol in 2002 strengthened the resolve of the federal government to move ahead with its ratification of the protocol in December 2002. Manitoba signed a memorandum of understanding on climate change priorities with the federal government that included renewable energy development, energy efficiency, greenhouse gas emission reductions, carbon sequestration in agriculture and forestry, public education and awareness, research and development (Manitoba, 2005). Manitoba is also a partner in the federal government's One Tonne Challenge to promote a 20% reduction in personal emissions.

The prominence of agriculture as a source of one-third of the province's greenhouse gas emissions, makes it an industry requiring detailed attention. Two-thirds of these emissions are from agricultural soils while manure management accounts for 12% and enteric fermentation for 22% (MCEC, IISD, 2001). During the 1990-2000 decade emissions from the soil were reduced while those from manure management and fermentation rose (Table 1). Initiatives to reduce emissions include: increased zero tillage practices to reduce soil emissions and farm equipment use, reduced summer fallow and the associated emissions, improved grazing strategies, and the conversion of croplands to wetlands and wildlife habitats (MCEC, IISD, 2001). These practices store and absorb carbon instead of releasing it into the atmosphere. Crop nutrient management, livestock nutrient management and manure management are also important. Large scale composting has been demonstrated as

an effective technique and is being promoted for wider adoption (Collins, 2004). The development of bio-fuels from the processing of grains, garbage and trees has already been noted.

New technologies are also being developed that can reduce agricultural fuel consumption. The McLeod harvester is being developed to harvest grain while reducing energy consumption and emissions. Instead of driving a heavy conventional harvester around the field with its thrashing and screening mechanisms, a light weight vehicle brings the grain to stationary equipment where the grain is separated from the straw and chaff. The grain is then stored or sold while the concentration of biological waste material can be used as a source for bio-fuels (Collins, 2004).

Urban waste is also a source of emissions and Winnipeg's Brady landfill is being studied for the capture of methane that could be used to generate 7 MW of electricity and reduce annual greenhouse gas emissions by 500,000 tonnes (Manitoba, 2004c).

From more efficient construction to effective management and capture of energy resources from waste, Manitoba offers a broad range of clean energy options.

The zero GHG emission option

Manitoba's comprehensive set of policies offers more than clean energy options. The potential for new investment of \$C10-15 billion and the creation of 100,000 person years of employment highlights the economic development opportunities being pursued (Manitoba, 2004c). In contrast to the old pattern of concentrated investment and employment in a single mega-project, with its accompanying boom and bust cycle, the long list of projects offered in a distributed generation future creates employment and opportunities in northern, rural and urban communities alike. The system also offers improved price stability by reducing dependence upon fossil fuels and greater self-reliance.

The consequences of this promotion of clean energy development, investment and employment creation are also significant for Kyoto Protocol compliance. Manitoba's total annual emissions are 20 MtCO_{2eq} (Table 1) while the projects discussed in the 2004 Budget's 'Clean Energy, Climate Change and Economic Development' appendix offer potential reductions of 20-25 MtCO_{2eq}. Improvements in agricultural and forestry management of 'carbon sinks' are also estimated to reduce emissions by 5 MtCO_{2eq} below 1990 levels. Finally, the export of hydro-electricity from existing plants allows neighbouring states to reduce their coal-fired generation of electricity for an estimated annual avoidance of 10 MtCO_{2eq} emissions. This energy trade effectively offsets half of Manitoba's emissions. A single project (Conawapa) proposed for electricity to offset Ontario coal-fired stations could have a similar annual impact of 7 MtCO_{2eq}. Clearly, Manitoba has the potential not only to become a 'net zero GHG' emitter, but to become a 'net carbon-positive' region (Manitoba, 2004c). The desire to establish carbon trading operations in Winnipeg is a logical fit as the province moves toward a future as a clean energy test case (MCCTF, 2001).

Comparing Manitoba to Ontario

The diverse set of options considered in Manitoba can be reviewed to consider their suitability in other jurisdictions. Although Ontario has ten times the population and aggregate GHG emissions of Manitoba, its per capita emissions were slightly lower than those in Manitoba during the 1990s (Table 2).

Instead of examining the details of Ontario's energy policies here, a brief outline is provided and then the comparison with Manitoba presented. Changes in Ontario energy policy have been driven more by the need to address electricity supply issues than climate change alone. Aging nuclear reactors, coal-fired plants' contribution to poor air quality, growing demand and high levels of debt created pressures for change (Rowlands et al., 2004). In 1997, the oldest nuclear plants at Pickering and Bruce were taken off line to address safety concerns. The Harris government restructured the industry by ending the monopoly of Ontario Hydro and dividing its separate functions into separate firms. A market was created but the resulting price volatility caused public concern so the Eves government moved to a fixed price of \$C0.044 / kWh for small consumers. The new McGuinty government promised to close the coal-fired stations by 2007 to address air quality and climate change issues (Duncan, 2004). However, the cost of bringing the first Pickering nuclear station back on line more than doubled initial estimates (Etcheverry et al. 2004). Generation capacity remained constrained with the old coal-fired plants to be closed and the nuclear plants being expensive to refurbish.

A few wind turbines were introduced, including the highly visible urban turbine on Toronto's waterfront. A request for proposals for additional renewable energy projects or conservation initiatives was issued in 2004 (Duncan, 2004). Responses far exceeded the capacity advertised, with the result that wind accounted for nine of the ten projects chosen to proceed. At the same time, the growing demand for electricity by Ontario consumers was being met with increased imports from Quebec and the United States. The blackout of August 2003 highlighted

the fragility of the system. The government called on local utilities to create demand side management programs in a bid to create a culture of conservation. Some of these objectives are shared with the neighbouring government in Manitoba, so a review is made of the two provinces' respective greenhouse gas emissions per capita (Table 2).

The biggest difference between Ontario and Manitoba greenhouse gas emissions is related to agriculture (Table 2). Although Ontario has a substantial agricultural industry, its relative importance is much greater in Manitoba and the lower per capita emissions in Ontario are not surprising. The bio-fuel options being pursued in Manitoba are also of interest in Ontario and investments in ethanol plants have also taken place. However, the much larger demand for transportation fuels in Ontario means that each plant has a much smaller impact on overall emissions. Within the agricultural industry, innovations in fuel efficiency of equipment, new feed stocks from ethanol industry by-products and waste management systems all offer potential reductions in emissions.

Table 2. Annual GHG emissions in Manitoba and Ontario, t CO_{2eq} / capita

	Manitoba			Ontario		
	1990	1995	2000	1990	1995	2000
Energy	11.3	11.4	11.6	13.1	12.1	14.6
Stationary	4.3	3.7	4.7	8.1	7.1	9.0
electricity	0.5	0.2	0.9	2.6	1.7	3.7
fossil fuel	0.0	0.0	0.0	0.6	0.5	0.6
manufacturing	0.9	0.7	1.0	2.2	1.9	1.8
commercial	1.3	1.4	1.5	0.9	0.9	1.1
residential	1.5	1.3	1.2	1.7	1.8	1.6
other	0.1	0.1	0.1	0.1	0.3	0.2
Transportation	6.5	7.3	6.5	4.8	5.0	5.5
aviation	0.4	0.5	0.5	0.3	0.3	0.4
road	3.7	4.0	4.0	3.6	3.8	4.1
railway	0.6	0.5	0.3	0.2	0.2	0.2
other	1.8	2.3	1.7	0.7	0.7	0.8
Industrial	0.4	0.3	0.4	2.6	2.5	1.6
Agriculture	6.0	6.2	6.0	1.1	1.1	1.0
Waste	0.4	0.5	0.5	0.7	0.7	0.7
Other	0.0	1.3	0.1	0.0	0.1	0.0
Total	18.1	19.7	18.6	17.4	16.5	17.9

Source: Environment Canada, 2005

Ontario's manufacturing industries account for larger per capita emissions than those in Manitoba (Table 2). Emissions from industrial processes and the stationary energy used in manufacturing were much greater in Ontario. The trend of declining emissions over time is expected to continue as higher energy prices and government incentive programs along with higher depreciation rates on renewable energy equipment combine to encourage industry to make investments in energy efficient equipment.

Energy usage accounts for the largest share of greenhouse gas emissions in both provinces with Ontario's per capita emissions in 2000 (14.6 t CO_{2eq}) exceeding those in Manitoba (11.6 t CO_{2eq}) by 3 tonnes. The rise in emissions from stationary sources in Ontario's electricity industry is explained by the increased reliance upon coal-fired plants when the oldest nuclear plants were withdrawn from service in 1997. The government's intention to close these plants by 2007 will significantly reduce emissions, however, the question of what will replace them remains. Conservation initiatives are aimed at reducing demand by 5% by 2007, but new investment is also required (Duncan 2004). One option discussed previously is hydro-electricity from Manitoba.

The debate over how to fund a National Clean Energy Grid, including an upgrade to the 300 MW Manitoba – Ontario electricity interconnection was offered at least a partial answer in the federal 2005 budget. In comparison, the Manitoba – US interconnection has a 2,250 MW capacity (Manitoba 2004c.) A new Clean Fund of \$C1 billion over five years was announced 'to encourage cost-effective programs and actions that reduce greenhouse gas emissions' (Canada 2005, p.3.). In addition, a \$C250 million Partnership Fund was announced for projects best achieved through cooperation between the federal and provincial or territorial governments and the Canada Strategic Infrastructure Fund was renewed. The Manitoba-Ontario grid inter-connection is expected to meet the guidelines governing these funds.

Transportation in general, and road vehicles in particular, are major sources of emissions in Ontario. The initiatives to promote hybrid vehicles and the next generation of hybrids and fuel cell vehicles in Manitoba are thus of direct interest to Ontario. Ontario is home to the largest portion of Canada's automotive industry and boasts significant research expertise in the area. However, rather than wait for results from other provinces, initiatives are underway to create a Québec-Ontario Hydrogen Corridor that extends the work at the Hydrogen Village in Mississauga and Hydrogen Airport in Montreal.

Improvements to building envelope efficiency may also follow as the Ontario building code is reviewed and some new projects seek to highlight their energy efficiency.

CONCLUSIONS

Manitoba demonstrates the ability of sub-national governments to lead the creation of policies and implementation of projects to reduce greenhouse gas emissions. Rather than rely on federal government decisions, the provincial government commissioned studies and created a task force to consult with Manitobans on climate change. A new unit (Energy Development Initiative) was created to promote clean supply options and another unit (Efficiency Manitoba) to promote conservation. Many opportunities were reviewed and the 2004 budget identified projects that could not only supply clean energy and address climate change, but also stimulate investment and employment creation throughout the province at the same time.

The magnitude of Manitoba's plans were highlighted when their target was not set at a 6% reduction in emissions (Canada's target under the Kyoto Protocol). Even the longer term target of the UK to reduce emissions in the post-Kyoto period by 50% by 2050 was modest by Manitoba standards. Projects were identified that would take the province beyond a net zero GHG emission position to being a 'net carbon positive' jurisdiction.

The larger magnitude of emissions and corresponding need for reductions in Ontario and other jurisdictions is based on many of the same types of emissions as found in Manitoba. As a result, many of the proposals for innovation and new clean energy technology in Manitoba can be applied to Ontario and other jurisdictions. The combination of local initiatives and clean energy exports and carbon trading offer many opportunities for governments as they move to see who will be the first to achieve the position of a net-zero GHG emission province.

NOMENCLATURE

MtCO_{2eq} million tonnes of CO₂ equivalent
t CO_{2eq} tonnes of CO₂ equivalent

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