Prospects for a Low Carbon Society:

The Case of Canada

Ralph D. Torrie[1]
Toronto, Canada

Paper prepared for:
Japan-UK Joint Low Carbon Society (LCS) Research Project
Third Workshop, Tokyo, February 2008

The Current Situation and Recent Trends

Greenhouse gas emissions in Canada are currently about 750 Mt CO2e, of which 82% or about 600 Mt CO2e originates with the production and consumption of fossil fuels, and the remaining 150 Mt CO2e is from agricultural, industrial and waste management sources, broken down as shown in Figure 1. With a population of 33 million, per capita emissions are therefore in the range of 23 tonnes, among the highest in the world. There are many reasons for this relatively high per capita emission level, chief among them being the role of production and export of energy intensive commodities, including fossil fuel itself, in the Canadian economy.

Figure 1. GHG Sources in Canada, 2005 (Total Emissions 750 Mt CO2e)

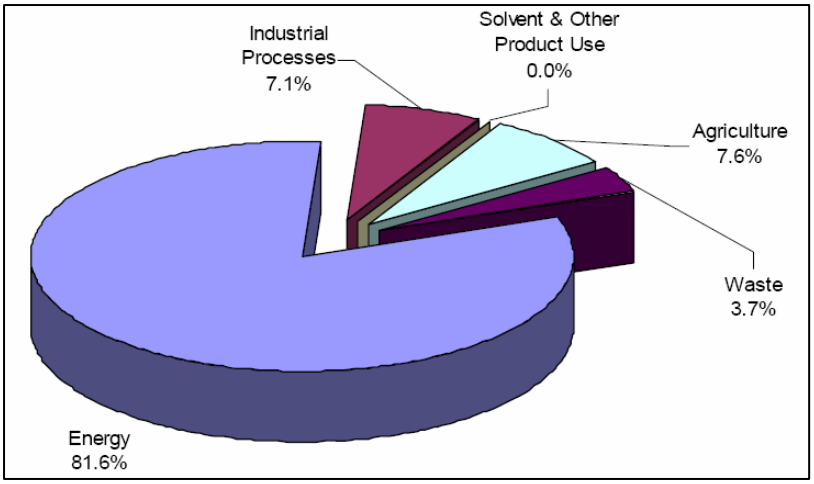


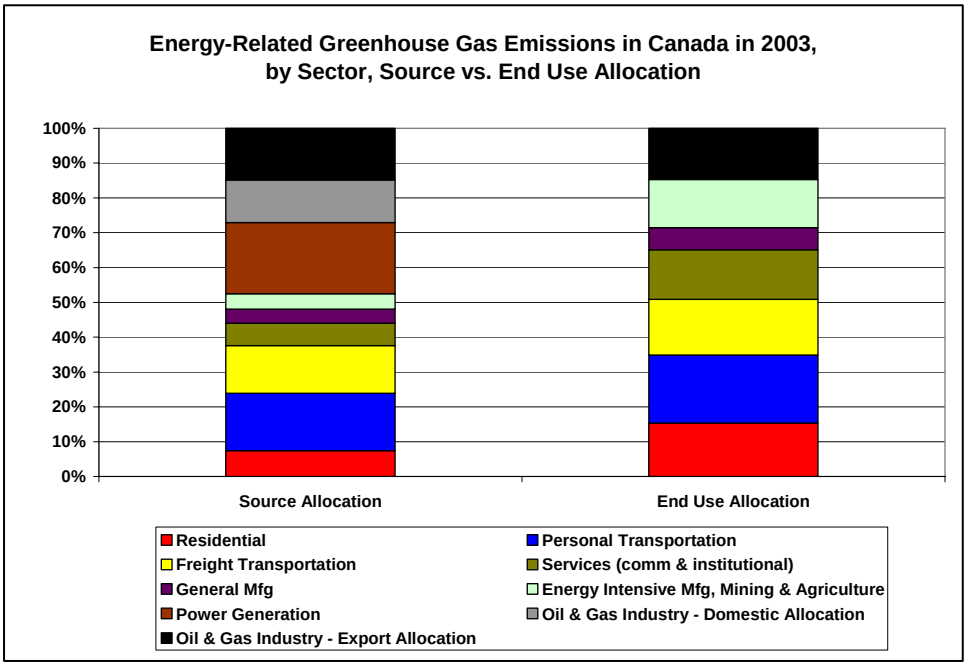
Figure 2 illustrates two alternatives for allocating the energy-related emissions. In the Source Allocation, emissions are attributed to their sources, so there is a segment called Power Generation which reflects the greenhouse gas emissions that take place at fossil-fired power plants. The emissions of the Oil and Gas production industry are partitioned into two segments, one representing the portion of this industry's emissions that result from producing

[1] Ralph D. Torrie, Vice President, ICF International, Suite 808, 277 Wellington Street West, Toronto, Ontario, Canada, M5V 3E4. Email: rtorrie@icfi.com. Web: www.icfi.com.

and supplying the domestic market for oil and gas fuels, and one representing the portion that corresponds to the emissions related to the production of oil and gas fuels for export. In the Source Allocation frame, the emissions for the final demand sectors (i.e. residential, commercial, manufacturing, transportation) reflect only the emissions from the end use consumption of oil and gas fuels.

In contrast, in the End Use Allocation frame, there is no Power Generation sector as these emissions have been prorated to the final demand sectors, as have the domestic portion of the oil and gas industry emissions. The portion of the oil and gas emissions attributed to production for export is the same in both the Source Allocation and End Use Allocation frameworks.

Figure 2

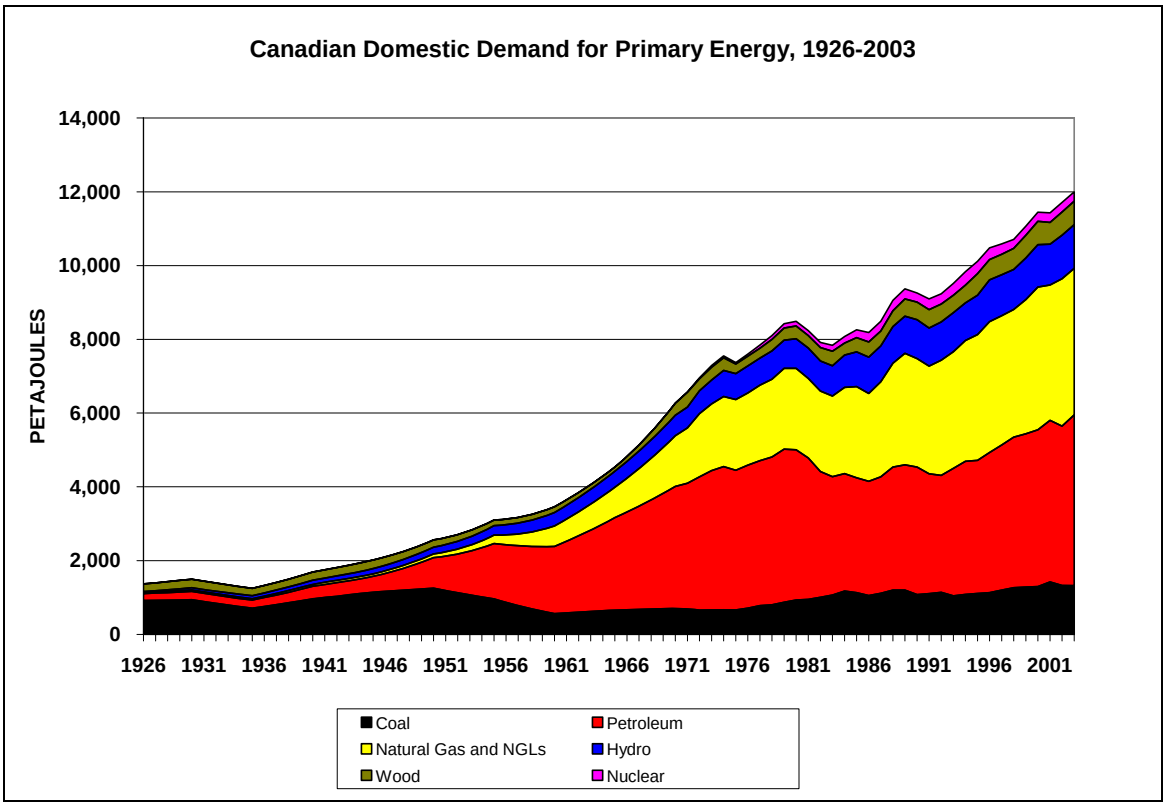


The Source Allocation view is particularly useful for portraying the extent to which energy-related greenhouse gas emissions originate with the energy industry itself. Power Generation and Oil and Gas Production constitute about half of Canada's total energy-related greenhouse gas emissions. The End Use Allocation framework is particularly useful for illustrating the importance of transformative technologies and strategies on the demand side of the energy commodity equation, where we understand many of the deepest and cheapest emission reduction opportunities can be found.

The long view of domestic demand for primary energy in Canada is shown in Figure 3.[2] The bottom three layers of this chart – for coal, oil and gas – reflect the exponential growth of fossil fuel production and consumption in Canada throughout the 20th century. Energy-related greenhouse gas emissions have tracked this growth in fossil fuel consumption, as shown in Figure 4, which also shows the relative growth of population and Gross Domestic Product over this same period.

[2] The data shown are for primary energy, including power plant inputs, but net energy exports (primarily of oil and gas) have been omitted so that the chart reflects only the primary energy use of the Canadian economy.

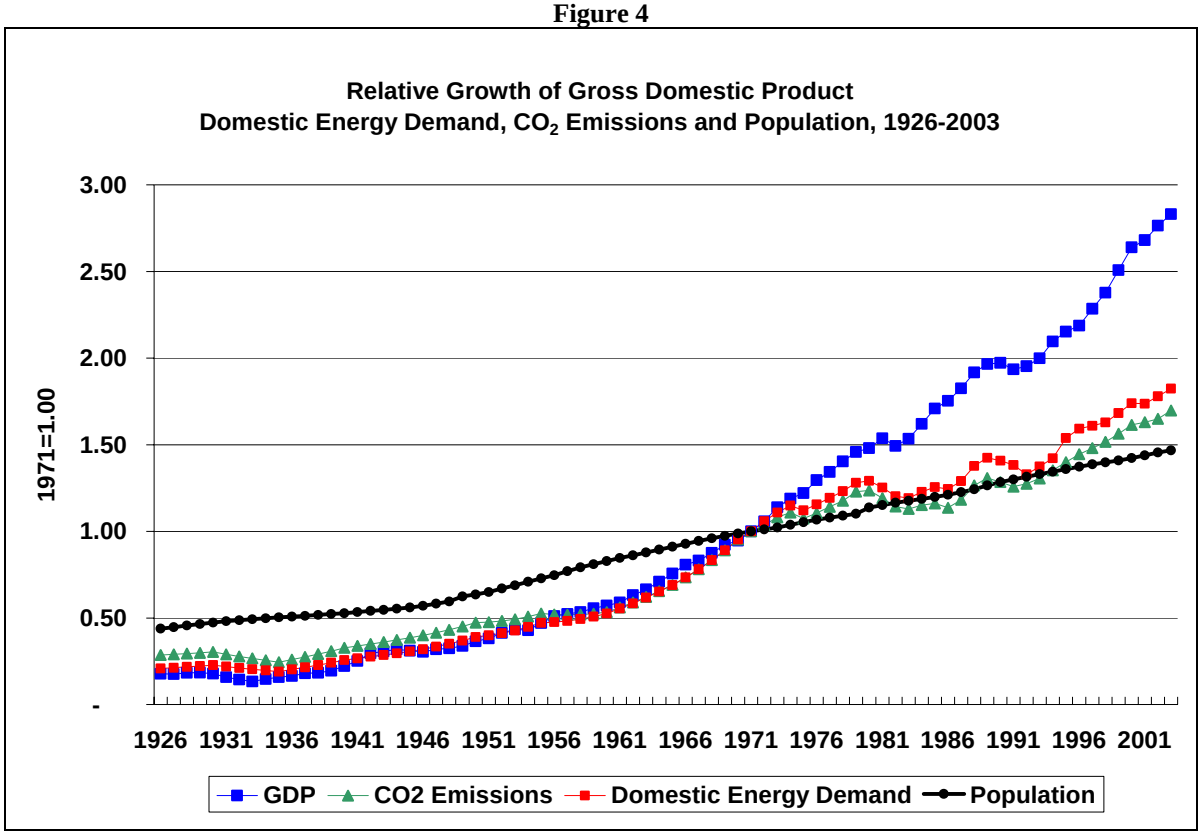
Figure 3



The challenge represented by the goal of a low carbon society is evident; it represents a dramatic reversal in a 100 year pattern of increasing fossil fuel consumption and related emissions. Growth in population and economic activity has driven energy consumption and greenhouse gas emissions up for decades, although there are moderating factors at work. There has been a gradual but longstanding reduction in the greenhouse gas intensity of Canadian energy use, reflecting the progressive shift from coal to oil to natural gas. In addition, the development of hydropower resources (and to a lesser extent nuclear power) has allowed several Canadian provinces to produce electricity with lower levels of greenhouse gas emissions than in jurisdictions dependent on fossil fuel-fired power plants.

The second and more important moderating influence on greenhouse gas emissions growth has been the ongoing improvement in the energy productivity of the economy, as measured by the value of economic output generated per unit of energy consumption. Particularly during the past 30-40 years, growth in energy consumption has been moderated by shifts in the output of the Canadian economy from primary to secondary manufacturing and from manufacturing to services, from a move to higher value added production in the primary processing industries, and from increased technological efficiency of fuel and electricity consumption. As is the case with all the OECD economies, for the past thirty years the decoupling of energy commodity and economic growth -- in other words energy productivity improvement -- has been far and away the largest source of energy security and moderated emissions and environmental stress from the energy system, outweighing the impact of fuel switching and commodity supply growth.

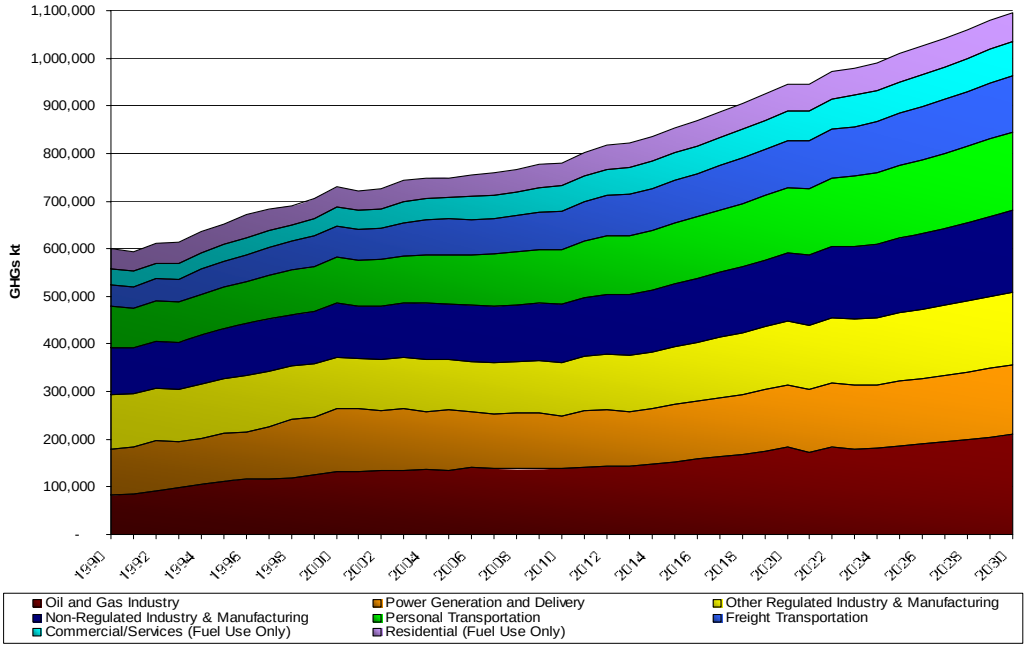
Figure 4



Canadian policy efforts at both the national and provincial level to reduce greenhouse gas emissions have been ineffectual to date. Under the Kyoto Protocol, the Canadian government committed to reducing emissions to six percent below 1990 level by the 2008-2012; currently, emissions are 25% above 1990 levels, or fully a third above the Kyoto target of 564 Mt CO2e. Given the capital stock turnover rates of energy-using technologies, there is no prospect for Canada meeting its Kyoto target, and this is now widely acknowledged. In fact, in the absence of effective federal and/or provincial mitigation policies, Canadian GHG emissions are on a course that will see them raise to 950 Mt CO2e or more by 2020, at which point they will be 58% above 1990 levels and 68% above the original Kyoto target of 565 MtCO2e.

One typical such projection is shown in Figure 5, based on economic growth averaging 2.1% over the projection period. Expansion of petroleum production from the Athabasca oil sands, mostly for US and other export markets, is a primary driver of growth in both economic output and greenhouse gas emissions. Current production from the oil sands is about a million barrels per day but will double in the next few years as over a dozen new projects come on line, and it is generally projected that production will redouble by 2020 to four million barrels per day. Mining and in situ extraction production techniques will be about equally important in this expansion; both are energy and greenhouse gas intensive. The projection of future emissions is sensitive to economic growth rates and in particular to growth in the oil and gas production sectors; at a growth rate of about 0.6% per year in economic output, greenhouse gas emissions growth flattens out.

Figure 5.
Historical (1990-2005) and Projected Greenhouse Gas Emissions in Canada (Source: ICF International)



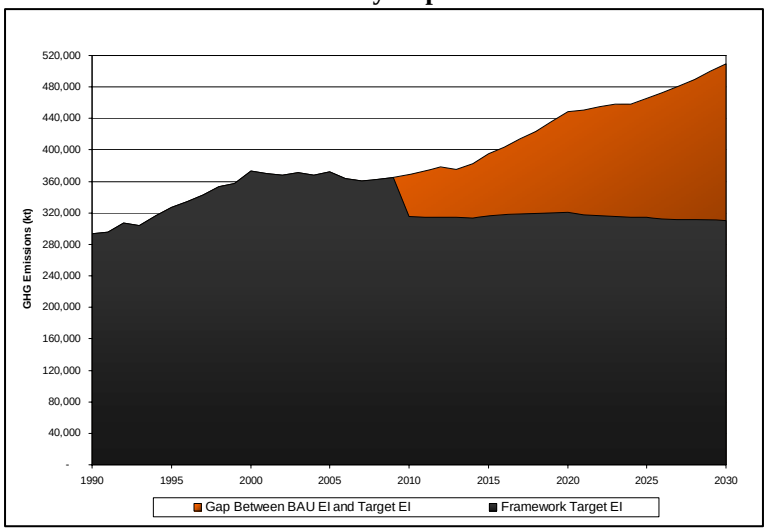
The current federal government has committed to reducing emissions to 20% below 2006 levels, or to about 600 Mt (i.e. 1990 levels) by 2020, and to much deeper reductions, on the order of 50% or more, by 2050. Some provinces have declared similar targets, but to date neither the federal nor the provincial governments have implemented or announced policies the would come close to achieving the espoused targets, targets which themselves fall short of what would be required to put Canada on a path to a low carbon society by mid-century.

The most significant policy announced to date (but not yet implemented) is the federal government's Regulatory Framework, a scheme that would cap the emissions *intensity* of the most emissions-intensive industries. There are still many details yet to be determined, but in broad terms the policy would require the regulated industries (power plants, oil and gas producers, industrial chemicals, cement, refining, steel, primary metals, etc.) to reduce the intensity of their greenhouse gas emissions by 18% by 2010 (relative to 2006), and then by an additional two percent per year after that for at least another four years. The policy allows for trading among the regulated industries, as well as for a limited role for domestic and international offsets. If successfully implemented, it is estimated that the Regulatory Framework would reduce emissions in 2020 by about 100-120 Mt CO2e, as shown in Figure 6.

The cost and the extent to which the emission reductions would be achieved in the regulated industries themselves, as opposed to various forms of offsets, will depend on yet-to-be-announced rules of the game, but the effective result would be an initial reduction of emissions form these industries (when the 18% reduction kicks in), followed by a sustained period in which the ongoing intensity reductions would offset output growth in the regulated industries. As difficult this policy is proving to finalize and implement, the 100-120 Mt CO2e of reductions

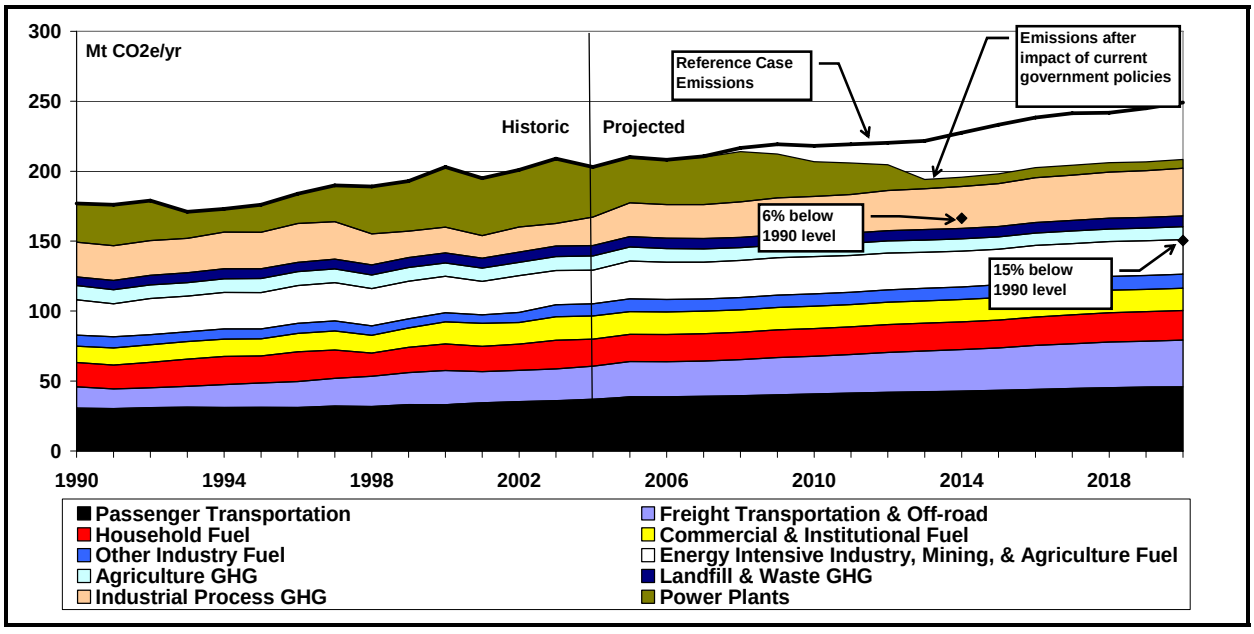
it would achieve falls well short of the roughly 350 Mt CO2e it would take to bring emissions in 2020 down to 1990 levels, let alone put them on a path toward a low carbon society.

Figure 6. Canadian Greenhouse Gas Emissions from Regulated Industries in the Proposed Regulatory Framework: Reference Projection vs. Effective Emissions Level after Implementation of the Intensity Cap



Another significant policy initiative, this one taken at the provincial level, is the commitment by the Province of Ontario to phase out *all* coal-fired electricity generation by 2014. If successfully implemented, this will constitute perhaps the single most effective GHG reduction policy measure taken to date by any North American government. Power plant emissions drop by 85% from 46 Mt CO2e in 2003 to less than 7 Mt CO2e by 2014 when the last of the coal plants is retired.

Figure 7. Greenhouse Gas Emissions in the Province of Ontario, Reference Projection and Emissions after Phase-Out of Coal Power and Other Current Policies



There is without doubt a growing priority being given to greenhouse gas mitigation policy development at both the federal and provincial levels in Canada. Like the federal government, several provinces have targeted bringing emissions down to 1990 levels or lower by 2020, but in general the policies and programs for achieving these targets are still under development, or have yet to be specified at a level of detail that would support assessment of their likely effectiveness. Meanwhile, high oil prices have increased already intensive development activities in the oil and gas production sector, and in particular in the emissions-intensive oil sands. Finally, Canada has been and will be deeply affected by U.S. government policy with respect to greenhouse gas mitigation, policy which seems poised for a reversal.

Nevertheless, in the context of the low carbon society, it must be noted that even the most aggressive of the North American policies for greenhouse gas mitigation (e.g. California) fall far short of the reductions and the rates of reduction that would be necessary to get on track for 50%+ reductions in emissions by 2050, if we can take that as a rough benchmark of the low carbon society criterion.

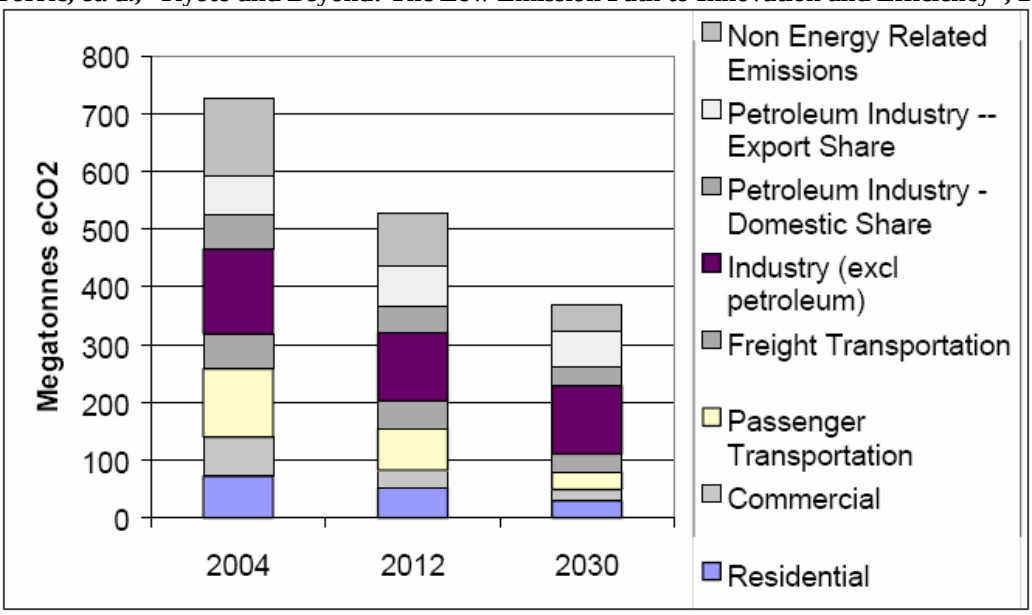
There has been a tendency in greenhouse gas response policy to put forward the same instruments for increasing energy efficiency or for increasing the amount of renewables or low carbon/no carbon fuels in the mix that were put forward in the 1980's when the public policy objectives were quite different. The promotion of energy efficiency and alternative energy in the 1980's was essentially intended to achieve a combination of security and economic efficiency objectives and had little to do with environmental imperatives. The improvement in energy efficiency and the increase in the renewable and low carbon energy that will be necessary to achieve the low carbon society go far beyond the incremental objectives of energy security and "least cost" energy policy of the 1980's, and it seems unlikely the policy instruments for promoting efficiency and renewables in the 1980's will be sufficient for achieving deep carbon reductions on a 2050 time scale.

Low Emission Scenarios for Canada

The first low emission scenario for Canada was developed for the David Suzuki Foundation and focused on what it would take to cut Canada's greenhouse gas emissions by 50% by 2030,[3] as illustrated in Figure 8. Utilizing a standard, bottom-up, end use focused methodology; the analysis systematically evaluated the technological potential for reducing emissions in Canada with existing and economically feasible technologies. By far the most important conclusion from the study was that the key to achieving deep and sustainable reductions in greenhouse gas emissions is on the demand side of the energy economy, and it also introduced to the policy debate in Canada the idea the low emission future could bring with it significant economic benefits.

[3] Ralph Torrie et. al., "Kyoto and Beyond: The Low Emission Path to Innovation and Efficiency", David Suzuki Foundation, Vancouver, October 2002. Available on line at www.torriesmith.com.

Figure 8. A Low Emission Scenario for Canada
(R. Torrie, et. a., "Kyoto and Beyond: The Low Emission Path to Innovation and Efficiency", 2002)

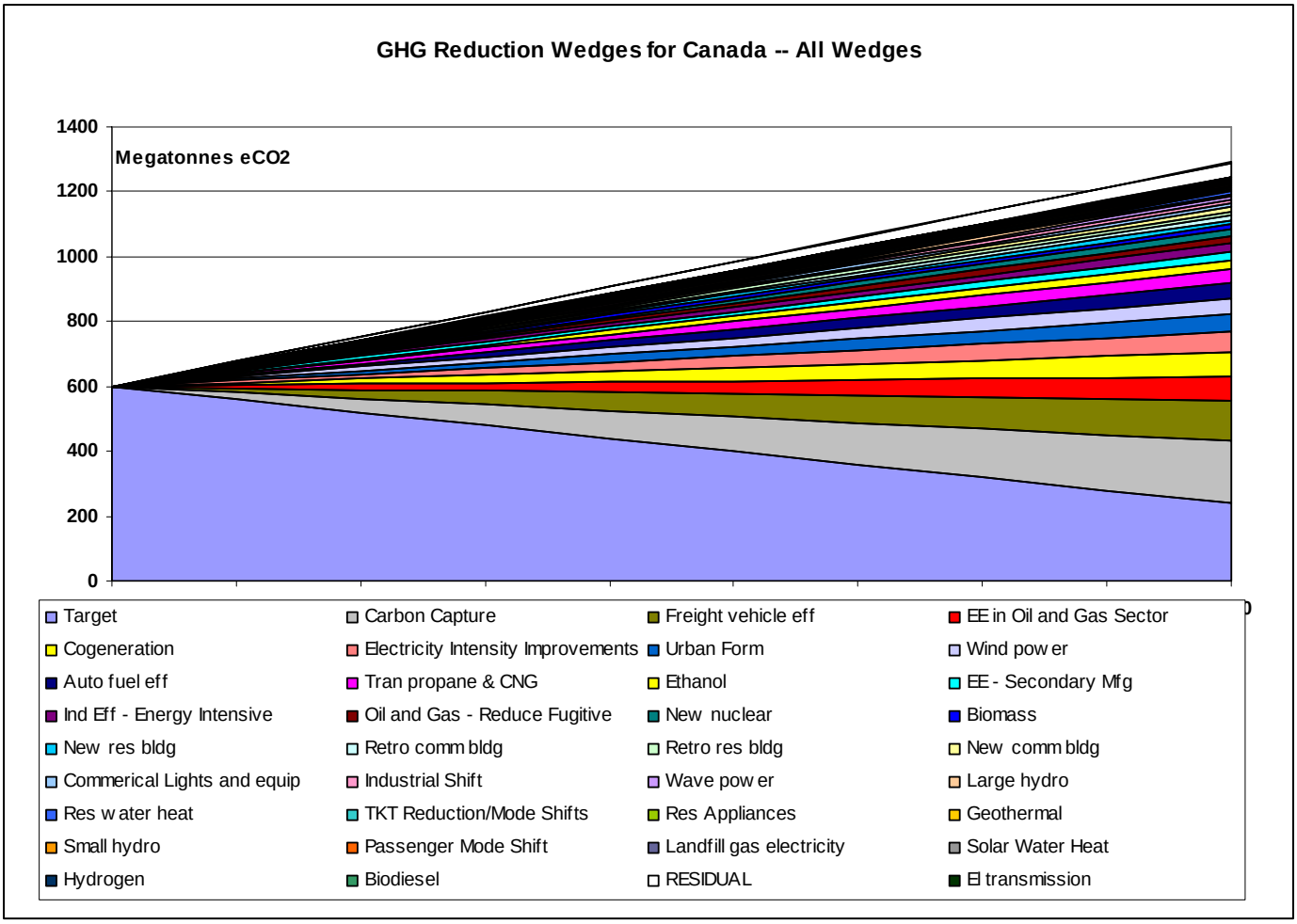


The National Round Table on the Environment and the Economy subsequently sponsored a more detailed "bottom-up" analysis of the technological potential for a deep emission reduction in Canada, this time for a 60% reduction from current levels by 2050.[4] The results were published in the form of a modified Socolow wedge, as shown in Figure 9. Based on this work, the National Round Table developed an advisory note for the government that began to set out the road map to a low emission future for Canada.[5] The key findings of the NRTEE Advisory began to shape the emerging policy for a low carbon society for Canada:

- A low emission future for Canada is possible with domestic solutions, but can be achieved only if energy is used more efficiently and if energy is emitted while emitting less carbon. Improvement in energy efficiency is key to the low emission future.
- Canada's growing oil and gas production sector could be compatible with a low emission future, but only if carbon capture and sequestration can be perfected.
- Increased deployment of cogeneration and renewable electricity will be needed to transform the power sector to a low emission regime, along with clean coal technology incorporating CCS.
- There is an urgent need for a long term policy signal to give the private sector the confidence it needs to bring GHG considerations into investment decisions
- Air pollution and other co-benefits of GHG emission reduction measures are important to both the implementation and the acceptance of the low emission future.

[4] Ralph Torrie et. al., "Energy-Related Greenhouse Gas Emissions in Canada in 2050: A Low Emission Scenario", ICF International for NRTEE, Ottawa, 2006.
[5] National Round Table on Environment and the Economy, "Advice on a Long Term Strategy on Energy and Climate Change", Ottawa, June 2006.

Figure 9. GHG Reduction Wedges for Canada
(From Ralph Torrie et. al., "Energy Related Greenhouse Gas Emissions in Canada in 2050 – A Low Emission Scenario", prepared for the National Round Table on Environment and the Economy, Ottawa, 2006)



Work is continuing on refining our understanding of what a low emission future would like for Canada, and the policies and programs that would get us there. Recent work has coupled macroeconomic models with multi-sector energy and emissions models in order to evaluate the economic impacts of greenhouse gas reduction policies. While the policies typically subjected to such analysis fall short of those that would be required to achieve deep emission reductions, they do indicate that the net economic impacts of the portfolio of GHG reduction policies currently in vogue in North America (e.g. carbon cap-and-trade; efficiency standards for buildings, cars and appliances; renewable portfolio standards, etc) will have modest and possible net positive impacts on employment, net output and per capita disposable income, even without, even without valuing the environmental damage avoided by the lower emissions.

Conclusions and Strategic Directions

The roadmap to a low carbon society has begun to take shape in Canada, first in the form of an understanding of the changes in the way we use and produce energy that will have to take place, and more recently in the form of a debate over the policy responses to get there.

With regard to the technological shape of the low emission future, there are a number of key elements that must be achieved:

- ✓ New residential and commercial buildings constructed with best available energy design and technology
- ✓ Retrofit all existing buildings (except where technically not feasible) for 30-50% improvements in energy efficiency
- ✓ Double and redouble the fuel efficiency of passenger vehicles.
- ✓ Double or triple the fuel efficiency of trucks.
- ✓ Efficiency standards for office equipment, home appliances, motors, lighting to ensure rapid deployment of the new technologies
- ✓ Cogeneration of heat and power as standard practice going forward
- ✓ Continued rapid deployment of wind and other renewable electricity options
- ✓ Continued development of environmentally sustainable biofuels, commercialization of lignocellulosic ethanol technology
- ✓ Emission caps on energy-intensive industry to encourage innovation for more efficient production technologies
- ✓ More efficient utilization of industrial process heat
- ✓ Eliminate landfill methane emissions
- ✓ Alternative industrial processes for non-energy industrial GHG emission sources
- ✓ Low emission techniques and technologies for agriculture
- ✓ Reforestation and afforestation programs to alleviate net Canadian emissions on a 50 year time frame.
- ✓ Carbon capture and storage technology successfully deployed, especially in the oil and gas production industry.

Other insights from our work in Canada on low emission scenarios:

- ➢ Greenhouse gas reduction policies must be comprehensive. There is no single wedge of the greenhouse gas emission pie that can shoulder more than a fraction of the overall challenge of reducing society's emissions to much less than half today's levels. Every source sector must be addressed.

- ➢ An integrated approach is mandatory. There are very strong interactions between different greenhouse gas reduction measures, and it is important to understand these interactions in order to set the most effective priorities. The total emission reductions from a set of measures will typically by 40% less than the sum of the individual measures considered, due to supply/demand, inter-sectoral and economic feedback effects.

- ➢ Long lived capital stock is a priority to avoid lost opportunities. Affecting today's investment decisions is an urgent necessity for the achievement of low emission futures decades hence.

- ➢ Co benefits are crucial. The air quality and other benefits of greenhouse gas emission reduction measures are important on many levels. GHG reduction measures usually deliver superior technology (e.g. high performance buildings) that can be worth more to the investor than the GHG reduction. More efficient technology enhances competitiveness and GHG reduction measures create employment across a broad spectrum of skills and professions.

- Emission reductions are consistent with some exogenous trends in Canadian society – these synergies can be exploited to promote lower emissions (urban redensification, refurbishment of post-War infrastructure, higher value added industrial production)

- Cap-and-trade initiatives tend to target the most energy intensive sectors of the society that are most able to manage the transaction costs associated with such schemes. But because energy is a relatively high factor cost for these sectors, these are also the sectors that are most likely to have already adopted low cost measures for energy efficiency and emission reduction. At the same time, research indicates that the largest reservoir of low cost and even negative cost emissions exists on the demand side, dispersed among millions of vehicles, buildings and devices that are generally excluded from cap-and-trade initiatives and are also often disallowed as offset options under such trading schemes under the additionality argument. Cap-and-trade initiatives that target energy intensive industry without facilitating offset investments in the low cost reservoir run the risk of failing to deliver on their central promise of minimizing the overall cost of achieving the environmental objective.

- There is a particularly important role for local governments in the transition to the low carbon society. It is conservatively estimated that at least 50% of greenhouse gas emissions in Canada come under the direct or indirect control of local government, and this is true in many countries. The transition to a low emission future cannot be achieved without the engagement of local governments, and this implies the need for much greater capacity in city halls to identify how local policies, plans and by-laws affect the level of greenhouse gas emissions in the community.

- Most agree that a backdrop of rising prices will be necessary to facilitate the transformation to a low carbon future, but that price alone is unlikely to bring about sufficient change fast enough to achieve deep reductions in emissions by 2050. A consideration of the relative importance of energy commodity prices in each of the technological areas listed above, as compared with non-price factors in decision making, leads to the conclusion that a full spectrum of policy approaches will be required to achieve deep reductions, and also that bending the emission curve down will require that those policies be more innovative and aggressive than has been the case to date.

There is a large variation in the types of barriers that stand in the way of more rapid and widespread deployment of the technologies and techniques we need to bring about the low carbon society, but in general these barriers are neither technological nor fundamentally economic. More often there weaknesses in the logistical or financial infrastructure needed. For example, a combination of front-end costs and a dearth of skilled and available labour hold back the acceleration of building retrofits, suggesting the need for financing and manpower training and certification. The development of more fuel efficient trucks is held back by a risk-averse manufacturing sector with limited R, D&D resources, suggesting the need for market development policies. For technologies such as home appliances and office equipment, where the energy costs are a small contributor to the total cost of ownership and operation, well designed performance standards can be the most effective, and the most cost effective, policy approach.

The "geology of low emissions is complex" – for each of the key wedges needed to bring about low emission futures, a unique policy approach is needed that targets the particular barriers to deployment for that option.