The Bottom Line on Kyoto

ECONOMIC BENEFITS OF CANADIAN ACTION

PREPARED BY
Tellus Institute
MRG&Associates

FOR
David Suzuki Foundation
World Wildlife Fund

The Tellus Institute is a non-profit research and consulting organization promoting equitable and sustainable resource management and development. Its head office is located at 11 Arlington Street, Boston, MA 02116-3411, USA. For information on the Tellus Institute, visit www.tellus.org

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Executive Summary

Canadians are in general agreement on the need for a responsible, concerted and vigorous response to the reality of climate change. A recent report from the Canadian Manufacturers & Exporters calls climate change "the most challenging environmental issue facing the world this century." Through UN treaty negotiations, the Canadian government helped develop the 1997 Kyoto Protocol and its greenhouse gas emission targets.

Now that the United States has withdrawn from the Kyoto Protocol, it is essential that Canada demonstrate leadership on this issue, particularly since Canadian ecosystems, industries and infrastructure are already suffering from the damaging effects of climate change. Unfortunately, some industrial lobbies and some provincial governments led by Alberta are urging Ottawa to follow the U.S. example, claiming that vigorous measures to reduce emissions will kill jobs and hurt consumers.

In January 2002, the David Suzuki Foundation and the World Wildlife Fund decided to test the claims put forward by the Canadian opponents of Kyoto. They contracted the Tellus Institute to conduct an economic analysis based on proposals from Canada's National Climate Change Process (NCCP). This federal process had brought together government, industry and independent organizations and generated hundreds of ideas on how to reduce emissions.

In conducting this analysis, we examined and modelled domestic policy proposals selected from the NCCP. This package of policies, if implemented as proposed, would achieve more than half of Canada's reduction target under the Kyoto Protocol. Looking out to 2012, we also found that the economy would continue to grow, and that the proposed emission reduction policies would in fact yield net economic benefits for Canada over and above the "business as usual" scenario. These benefits include:

- A cumulative net economic savings of $4 billion across the economy reaching $1.6 billion per year or $47 per capita in 2012.
- The net addition of an estimated 52,000 jobs in the economy generally, due to the redirection of consumer spending away from fuel and electricity and toward other goods, services, activities and investments.
- A $135 average annual gain in household income related to the creation of new jobs; and a $2 billion increase in the national GDP beyond that projected in the business as usual scenario.

The same policies would produce significant health and environmental co-benefits related to better air quality, improved public health and reduced damage to natural ecosystems, infrastructure and private property. While these co-benefits did not figure in this study, recent analysis suggests that an annual emissions reduction of only 68 million tonnes of greenhouse gases, a little more than half of the reductions found here, would yield approximately $1.2 billion in avoided health damages alone.[1]

This report is not designed to serve as a plan for action, but the analysis concludes that Canadians can obtain significant benefits from re-examining and redesigning the way we use energy. It would seem logical to begin implementing this shift as soon as possible, beginning with speedy ratification of the Kyoto Protocol.

The Scientific Background, International Policy and Canada's Response

Analysis of ice core samples from Antarctica has shown that today's concentrations of atmospheric carbon dioxide are 23 per cent higher than at any time in at least 420,000 years. This increase has occurred very quickly. In the mid 1950's, when scientists began to consistently measure carbon dioxide content in the atmosphere, they found concentrations of between 315 and 318 parts per million over most parts of the globe.[2] That figure has since risen to 370 parts per million due to fossil fuel use and the destruction of forests, and it continues to rise as a result of these human activities. Climatologists now predict that the build-up of carbon dioxide and other greenhouse gases will trigger an average temperature increase of between 1.1 and 3.1 degrees Celsius as early as 2040, with regional increases (for example in Canada's Arctic) averaging 10 degrees or more.

As the climate warms, globally averaged precipitation increases. There are also likely to be changes in soil moisture content, increases in sea level and an increased incidence of extreme weather events, floods and droughts.[3] The insurance industry has already catalogued the increase in natural disasters over the past half century. Ecological impacts of climate change are also already underway – for example, the reduction and thinning of Arctic ice has reduced feeding opportunities for some polar bear populations, reducing their rate of reproduction.

The Intergovernmental Panel on Climate Change (IPCC), set up by the United Nations and the World Meteorological Organization, has concluded that in order to stabilize carbon dioxide concentrations at 1990 levels, immediate emission reductions of 60 per cent would be necessary. Governments and advisory groups worked through the 1990s to plan a course of action, and devised the Kyoto Protocol in 1997. This protocol requires industrial nations to reduce their collective average emissions of greenhouse gases to 5.2 per cent below 1990 levels during the period 2008 – 2012. On a per capita basis, Canada is one of the largest producers and consumers of fossil fuels, and one of the largest per capita emitters of greenhouse gases in the world. In the Protocol, Canada agreed to reduce greenhouse gas emissions to six per cent below 1990 levels by that period.

To help Canada meet its Kyoto target, the federal government created the National Climate Change Process (NCCP). This initiative established 16 separate multi-stakeholder processes, known as Issue Tables. The proposals put forward by these Tables provided most of the data used as inputs to the economic model used in this study.

The Analytic Approach

Information on the National Climate Change Process is available on the NCCP website (www.nccp.ca). Tellus gathered data on the emissions and cost impacts of the policies from this website, from further discussion with NCCP participants and from independent estimates where there were gaps in this information. The selected policies were then analyzed as a group, with overlapping effects and "double counting" eliminated. For a "base case" – the projection of future business as usual trends in the absence of the policies – we used the latest Natural Resources Canada forecast.

The macro-economic impacts of the policies on the broader economy – household income, employment and GDP – were derived from IMPLAN, a widely-used economic model that analyzes interactions between different sectors of the economy.

The Selected Policies

The following policy proposals provided the basis for the modeling exercise.

Building Policies:

- National programs to make single-family housing, multi-unit housing and commercial and public buildings more energy-efficient.
- Improved national standards for equipment and appliances used in commercial, institutional and residential buildings.
- Priority tax treatment for capital investment in highly energy-efficient equipment and facilities.
- Enhanced energy efficiency incentives for new commercial buildings.

Transportation Policies:

- Year-by-year improvements in automobile fuel efficiency standards.
- Transit infrastructure improvements and improved transit service.
- Measures to promote telecommuting, car sharing and ride sharing.
- Incentives to move inter-city travellers from cars to buses.
- Assignment of user-pay costs to users of "free" or low-priced parking.
- Enforcement of speed limits to reduce fuel consumption.
- Fuel efficiency training and preventive maintenance at trucking firms.

Municipal Policies

- Capture and flaring of landfill methane.
- Comprehensive municipal programs to reduce, re-use, recycle and compost.

Electricity Policies

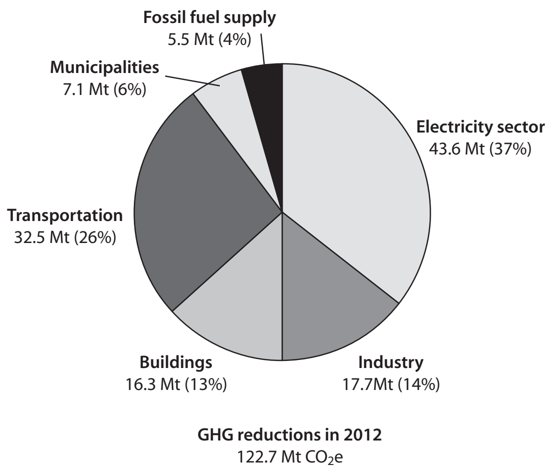
- A national cap and allowance trading system for emissions from electricity production; five per cent of electric power to come from clean renewable sources by 2010.

Industry Policies

- Measures to promote local co-generation of heat and electric power.
- Measures to reduce methane emissions in the oil and gas industry.

Forecast Emission Reductions and Canada's Kyoto Commitment

In negotiating the Kyoto Protocol, Canada agreed to achieve a 6 per cent cut from 1990-level greenhouse gas emissions during the period 2008-2012. The Government of Canada has estimated that this amounts to a 240 megatonne reduction from projected business as usual levels in 2012. Taken together, the policies selected for review in this study would reduce emissions by an estimated 123 megatonnes by 2012, or more than half the amount prescribed in the Kyoto Protocol.

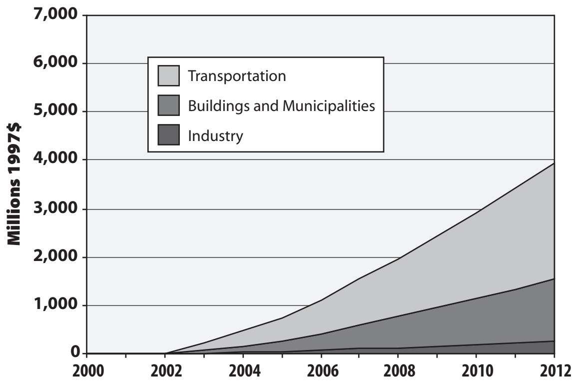


Source of Emission Reductions in 2012

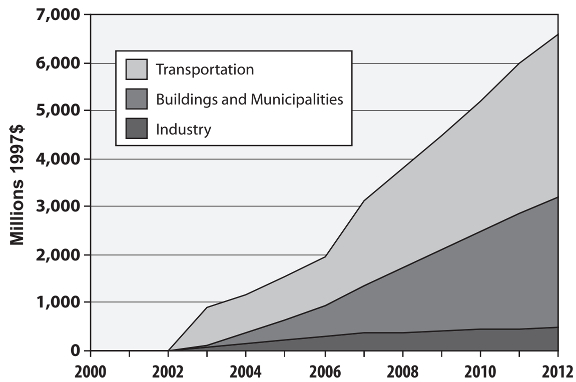
Most of these emission reductions are due to reduced energy consumption, either through the use of more efficient or cleaner technologies, or through changes in the types of fuel consumed. Fossil fuel consumption would drop by 7 per cent by 2012 due to the policies under analysis, with half that drop due to reduced oil consumption and 40 per cent related to less coal use. Among other benefits, reduced dependence on oil would help shield the Canadian economy from international price shocks

Consumption of electricity would continue to rise, although at a much slower rate than currently projected.

Costs and Benefits



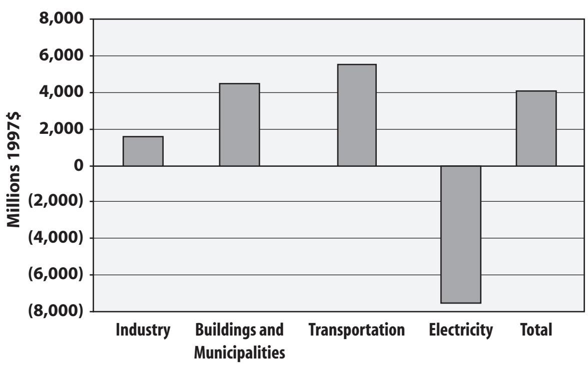
Costs for Demand Sectors



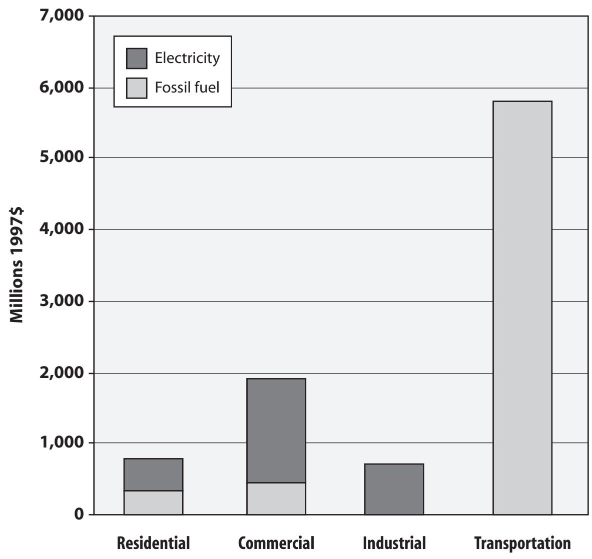
Benefits for Demand Sectors

The demand-side policies analyzed – that is, those policies that are intended to reduce demand for energy – would involve almost $4 billion per year in costs by 2012, mostly related to the capital cost of energy-efficient technology. Benefits, however, would rise over time to about $6.5 billion per year, mostly in the form of savings on energy bills. The undiscounted net benefits of the demand-side policies, therefore, would be close to $2.6 billion in 2012. Applying a five per cent discount rate, the net present value of benefits would be $11.5 billion for the period from 2002 to 2012.

The supply-side policies – those that affect the generation of electricity – would result in net costs to the electricity sector, but would significantly reduce emissions. Integrating the supply and demand-side policies, the total undiscounted net benefits would be $1.6 billion in 2012. With the five per cent discount rate, the cumulative net present value of benefits from demand plus supply-side policies would be about $4 billion from 2002 to 2012.



Cumulative Net Benefits to Economy (present value)



Annual Savings in Energy Bill by Sector, 2012

Employment Impacts

Implementation of the proposed policies would produce a net gain of about 52,000 jobs in the Canadian economy by 2012. These benefits are spread widely across all sectors of the economy – including construction, transportation, manufacturing, services, and agriculture. This would produce an average wage/salary gain of $135 per household in Canada, and a net increase in the GDP of $2 billion. These new jobs would result both from investment in energy-efficient technologies and from energy savings that would be achieved by firms and households and then re-spent in every sector of the economy. All of the gains noted here are over and above the economic growth that would occur in the absence of the policies under review.

These employment gains will not be uniformly distributed. We conclude that the selected policies would generate their most positive economic impacts in construction, with 18,600 new jobs created. Most other sectors would benefit to varying degrees. The energy sector would experience the most negative impacts, and lose about 4,000 jobs. Since some jobs will be lost in certain sectors, attention should be given to providing transitional assistance to workers, such as training to work with new technologies and in other industries. However, it should be noted that continuing job losses in the energy sector can be expected in any case, from corporate consolidation and productivity gains. From 1990 to 1998, a period of rising oil and gas production and electric power generation, the energy sector shed more than 80,000 jobs, including more than 7,000 in oil and gas production in Alberta.[4]

Position papers from industrial associations have warned that emission reduction policies would hurt consumers and create unemployment, particularly in light of the U.S. decision not to support Kyoto.[5] This study reaches the opposite conclusion, predicting that the economy will meet and exceed business as usual growth forecasts, consumers will be better off and many more jobs will be created than lost.

Further Steps

The Issue Table policies considered here achieve about half of Canada's commitment under the Kyoto Protocol. In our view, Canada could also pursue other cost-effective or low-cost domestic policies to further reduce emissions. These include:

- Establishing an overall emissions cap for the largest industrial emitters and a trading system for emission allowances.
- Pursuing further energy efficiency policies with regard to buildings and transportation to encourage broader deployment of the best available technologies.
- Using methane from landfills to generate electricity, rather than flaring it.
- Setting standards and incentives for municipalities to achieve compact, energy-efficient development.
- Promoting fuller utilization of co-generation opportunities by industry and for commercial and residential district energy systems.
- Increasing the requirement for the development of renewable sources of electricity.
- Establishing financial and regulatory incentives to shift freight transportation away from highways and on to railroads.

Leadership on Climate Change

On balance, the opportunities for Canada are very positive. Realizing this, many corporations and communities have moved out ahead of the federal government. Petroleum, chemical, automobile and parts manufacturing, steel and aluminum production, forestry, pulp and paper, mining – in virtually every sector of the economy, leading-edge companies have surpassed Canada's Kyoto target. Some municipal success stories are international role models. Overwhelmingly, these companies and communities are reducing emissions at less cost than expected, with significant economic and social benefits.

I. The Analytic Approach

Estimating the costs and benefits of the emission reduction policies (Policy Case) required information on incremental investments and savings. The costs, savings, energy consumption changes and emission reductions for each measure were taken from the Issue Table analyses of the National Climate Change Process (NCCP), supplemented where necessary by Tellus analysis. The NCCP information is available on its website.[7] We adjusted the costs or emission reduction information from the Tables where needed to provide input for the macro-economic analysis or to account for the effects of combining policies. In most cases, the impact of policies from the Table analysis has been delayed by two to three years to account for the delay in potential start date of policies. Other adjustments are described below.

General Approach to Policies

Business as Usual (BAU) Case: The BAU case (Base Case) used in this analysis for energy estimates refers to the forecast reported in *Canada's Emission Outlook: an Update* (CEOU) (Natural Resources Canada 1999). In January 2002, the Analysis and Modelling Group of the NCCP released revised emissions projections showing a higher than expected growth in emissions. When calculating the contribution of the policies in this analysis to meeting the 'Kyoto Gap,'[8] we have used the most recent estimate of the gap (240 Mt of GHG emissions.[9]). However, all other aspects of this analysis rely on the projections from the CEOU, which is the BAU case that was used for the Issue Tables' analyses.

Interactions of Policies: The Issue Tables generally analyzed policies individually, while this analysis considers the policies as a group. When applied together, policies within a sector can affect one another. For example, combining private passenger vehicle fuel efficiency with increased public transit leads to lower energy savings and emission reductions than the sum of the individual policies, since the benefit of driving a more fuel efficient car will not be captured by someone who has switched to transit. Similarly, diverting waste from landfills and capturing methane from landfills both target the same emissions, so applying the policies together leads to lower emission reductions and lower capital costs than applying the policies separately. We accounted for such interactions by estimating the interaction of policies on the costs, energy consumption and emission reductions.

Costs and Savings: Costs and savings information came directly from the Issue Tables, except in cases when fuel and capital were aggregated in the Tables' output. It is essential to separate these costs in order to estimate the macro-economic impacts. Thus, in these cases, we multiplied the energy savings by fuel price to estimate the fuel bill savings of households, businesses and industry. We then calculated capital cost as the difference between the net cost, provided by the Issue Tables, and calculated fuel savings. This allows overall costs to match the analysis from the stakeholder process, while generating required information for our cost analysis. When calculating resource costs, we applied a discount rate of 5 per cent to costs in future years; we did the same when converting the capital costs of equipment into annual amounts over its lifetime. The 5 per cent discount rate reflects a societal perspective, which supports a long-term view more appropriate for national policy than the short-term perspective reflected in private interest and loan rates.

Fuel prices: The fuel prices used in the analysis are the same for both the Base Case and the Policy Case. Although policies have the potential to affect energy prices by changing energy demand and/or energy production, we estimated that such impacts would be small.[10] In Canada prices for fossil fuels tend to follow world market prices rather than depend on changes in domestic demand. Both Base and Policy Case prices are based on the CEOU reference values (MK Jaccard and Associates/Energy Research Group 2000).

Description of Policies and Methods

The following policies provided the basis for our economic modeling. Information on the Issue Tables measures is available at www.nccp.ca. The summaries presented here are derived from that website, from printed Issue Table reports, and from additional sources as described. These polices do not represent the preferred emission reduction options of the David Suzuki Foundation or the World Wildlife Fund.

Building and Appliance Efficiency

National energy-efficient housing retrofit program

This measure includes financial incentives such as tax credits, access to financing, home energy audits, energy performance labeling, home renovator training and certification, sales force training and community based delivery agents. Items include removal of the Goods and Services Tax, Provincial Sales Tax, or Harmonized Sales Tax, and accelerated depreciation of capital costs in rental housing.

National standards and an energy performance labeling program for equipment and appliances used in residential buildings

This includes new minimum efficiency standards, beginning in 2004, for products including heating ventilation and air conditioning equipment, major appliances, domestic hot water heaters, lighting, windows and doors, motors and gas fireplaces.

Commercial building retrofit program

A package of financial and tax incentives to promote the renovation and retrofit of commercial buildings including warehouses, offices, hospitality and retail. This would involve enhancement and expansion of private-sector building programs modeled after the Toronto Better Buildings Partnership (BBP) and Energy Innovators Plus.

Multi-unit residential retrofit program

Similar to the program for commercial buildings, only directed towards residential multi-unit rental housing such as high-rise apartment buildings. Our analysis considered existing multi unit residential buildings only and does not apply to new multi-unit residential buildings.

A public buildings initiative

A renovation and retrofit program aimed at municipally owned or funded buildings including schools and health care facilities. This involves refocusing, enhancement and expansion of the Federal Buildings Initiative and the spin-off program for municipal buildings as well as the New Brunswick Building Initiative.

Expanded and updated national minimum energy performance standards and a labeling program for equipment and appliances used in commercial and institutional buildings

Products include windows, commercial space heating, electric baseboards, distribution transformers, washers, refrigeration and cooking equipment, commercial service water boilers, fluorescent lamps and ballasts, chillers and large air conditioners.

Energy-efficient tax incentives

Faster tax write-offs for the capital cost of energy-efficient equipment, construction and renovations as well as exemption from GST and PST.

Expansion of the commercial new building incentive program

This program is aimed at improving the lifetime energy performance of new commercial buildings by enhancing the energy efficiency of buildings during construction. It includes increased incentives and additional access to national and regional financing mechanisms, e.g green loans and mortgages, a National Green Loan Fund and provincial/municipal revolving funds.

Buildings Methodology: The net costs and emission reductions were taken from the Buildings Table, with capital costs and fuel cost savings broken out using the method described above.

Transportation Policies

Passenger Transportation

Corporate Average Fuel Efficiency standards
By 2012, the fuel efficiency averaged over all new vehicles would be 8 litres/100 km, rather than 8.8 litres/100 km as estimated without this standard. Given fleet average targets, each manufacturer will have the flexibility to provide consumer choice while reducing fossil fuel consumption through improved energy efficiency.

Enhanced transit services
This measure will increase the frequency of transit services and provide expanded services as well as improved safety and convenience. Improvements could be implemented by 2010 and last through 2020. Modeling is based on a ten-minute reduction in vehicle travel times in the three largest metropolitan areas (Toronto, Montreal and Vancouver) and a five-minute reduction in other urban areas.

Transit infrastructure improvements
Projects would come on line by 2010 and operate through 2020 for modeling purposes. For Toronto, Montreal and Vancouver, projects would include commuter rail, light rail, incremental heavy additions, and grade-separated bus lanes. For other metropolitan areas, projects include light rail lines, commuter rail, and grade-separated bus lanes.

Tax-exempt transit pass
Employees can either receive tax-exempt transit benefits from the employer or purchase monthly transit passes through the employer using pre-tax income. This requires the federal government to change the income tax laws. The proposal is aimed at encouraging a shift from auto to urban transit use and is already widely supported by the public and by transit agencies. It could be implemented immediately and remain in effect indefinitely.

Telecommuting
This measure, designed to reduce automotive emissions, includes an aggressive education and outreach program and mandatory telecommuting programs (as appropriate) for offices with more than 50 employees. The strategy would be implemented by employers and enforced by provincial governments.

Car sharing
This involves facilitation of car co-ops in which members share joint access to a fleet of vehicles located in their neighbourhood. Members pay a one-time registration fee and user fees based on kilometres driven and time used. Car sharing programs would be implemented by the private sector including non-governmental organizations. In large metropolitan areas the program would include incentives, priority parking and transit discounts for members.

Mandatory ride sharing
Employers with more than 50 employees would be required to participate in a ride sharing program that includes carpool matching, preferential parking and a guaranteed ride home. Strategies for government would include public outreach, partnering with the private sector, municipally based ride sharing programs and incentives.

Inter-city bus subsidy
This measure requires a subsidy to intercity bus carriers in order to reduce bus fares to below the variable cost of single-occupant automobile travel (a $0.05/pkm subsidy subject to a maximum fare of $0.07/pkm is assumed). It would amount to a 42 per cent subsidy for representative origin-destination city pairs. The auto-bus cross elasticity is assumed to be in the range 0.03 to 0.12. In addition, a latent demand equal to 1 per cent of the total intercity travel demand (for all modes) is assumed to be satisfied at the new price level.

Parking pricing
Applying parking charges to all major urban centres could generate emission reductions of up to 8 megatonnes if a charge of $2 per trip were applied to all commuting trips in all major urban areas.

Enforcement of current speed limits
Vehicle fuel consumption increases at higher speeds. By enforcing current speed limits for all traffic, greenhouse gas emissions are reduced by 4.2 megatonnes at a cost of $10 per tonne. This includes a cost of $800 million over 20 years to boost enforcement. Provincial enforcement agencies would be responsible for implementing this measure.

Heavy Duty Freight Transportation

Improved training for drivers of heavy trucks to enhance fuel-efficient driving practices
Trucking fleets would implement driver training programs addressing fuel efficiency and GHG emission reduction emphasizing best practices and return on training investment. Material would be developed under the NRCan Fleet Smart-Smart Driver program. The program would employ existing in-house trainers and training organizations.

Reduce heavy-duty truck idling
Through operator training, trucking fleets would reduce the amount of total engine idling time in their fleet. Some fleets may then elect to acquire technologies to help them address this issue.

Preventive maintenance program for heavy-duty trucks
Trucking fleets would implement a preventive maintenance program similar to Quebec's PEP program. Provincial regulations would drive the rapid take-up of this program, as demonstrated in Quebec.

Transportation Methodology: For most policies, the net costs and emission reductions came directly from the Transportation Table analysis, with capital costs and fuel cost savings separated using the method described above. We included all costs that were identified by the Table (capital, fuel, parking costs, administration costs, infrastructure costs, training). However, we excluded time costs to private vehicle owners (e.g. from speed limit enforcement) as these costs can not be included in the jobs and GDP analysis. In addition to the Table's policies, we estimated the effects of fuel efficiency standards that are slightly higher than the analysis considered by the Transportation Table. The Table analyzed the effects on a fuel economy standard that increases by 2 per cent per year. This was increased to a 3 per cent improvement per year when our analysis indicated net benefits from the increase (see Appendix A).

Municipalities

Landfill methane capture and flaring
This measure targets methane gas emitted from Canadian landfills. It provides for the sharing of capital infrastructure funding for capture and flaring systems, on a dollar for dollar basis, with municipal governments and other landfill owners.

Municipal waste diversion
Through legislation, provinces and territories would mandate municipal governments to achieve a national target of 50 per cent waste diversion through waste reduction, re-use, recycling and composting. Some communities have already met this target on a local basis. Special arrangements would be made for rural and remote communities.

Municipalities methodology: The costs for the two municipal policies were taken directly from the Municipality Table analysis. The two policies have a significant overlap in emissions reductions. The capture of landfill methane depends on the amount of waste and the mix of organics in the waste, while the other policy, diverting 50 per cent of waste going to landfills, directly impacts the amount and type of waste. To account for this, we decreased the reductions associated with landfill flaring by the ratio of waste diverted.

Electric Utilities

Emission reduction targets for electric utilities While many individuals and companies may have limited options for how they meet their energy needs, electric utilities have some practical and economic advantages. For example, there are a variety of ways to generate electricity, with highly varying environmental impact profiles. Likewise, utilities have the ability to directly influence and reduce energy consumption through creative rate design, incentive programs and direct appeals to customers. Rate-based regulated monopoly utilities have access to capital at exceptionally favourable rates, which allows them to build low emission infrastructure with a high probability of achieving economic returns. Overall, utilities are well placed to meet a sectoral cap on emissions that goes well beyond the Kyoto target, while continuing to provide profits to shareholders and rate stability to their customers. As such, utilities' emissions are capped at 70 Mt of GHG emissions in 2012 (25 per cent reduction below 1990 levels). The cap will be combined with an auction for emission allowances that can be traded between electric generators.

National renewable portfolio standard of 5.5 per cent by 2010

As part of the utility cap on emissions electric utilities would be required to ensure that at least 5.5 per cent of Canada's total electric power was provided from new renewable energy technologies (sources built after 2000). Utilities would be able to trade portions of their quota among themselves, enabling the most economically efficient achievement of the target.

Electric Utilities Methodology – The electricity policies combined analyses from the Analysis and Modelling Group (AMG) of the NCCP with additional analysis by Tellus. The AMG analysis (Haloa Inc 2000, MK Jaccard and Associates / Energy Research Group 2000) accounts for the electric generating capacity, generation, cost, and emissions impacts of decreased electricity demand due to industrial and building efficiency policies and tighter emissions limits on the sector. The Electricity Table analyzed the effects of a Renewable Portfolio Standard, but the information available on the NCCP website was not sufficient to include the results of that analysis in our policy package. Tellus utilized the technology characteristics of power plants that had been used for the Electricity Table analysis to directly estimate capital costs, fuel savings and emissions reductions.

Industry Policies

Industry policies based on increased co-generation and cost-effective reduction opportunities

Over the past decade industrial energy efficiency has improved by about 1 per cent per year. Assuming that industry acts rationally, cost-effective actions will continue to move industry in this direction. In particular, if barriers to implementing combined heat and power co-generation projects are removed, significant emission reductions will be achieved since these projects would serve the economic interests of many firms. In large industries with high heat loads, constraints on co-generation were relaxed for modeling purposes and their penetration permitted freely. If the electricity generation exceeded industry demand, it was considered to be sold to the grid.

Upstream oil and gas

For the oil and gas industry, a variety of methane reduction measures were evaluated as part of the Industry Table process. Assuming that industry would invest in methane reduction if the saved natural gas is worth $2.50 per gigajoule, significant emission reduction measures become cost-effective. This would reduce methane flaring, support the enhancement of leak detection and repair programs, and trigger changes in the design of processing plants and other oil and gas production processes.

Industry Methodology – Only a few industry groups analyzed specific policies for the Table process, and these were not available on the NCCP website. For the policies included in our analysis we used a report produced for the Analysis and Modelling Group.[11] This report looked at measures across all industrial groups, based on results from a detailed technology-based model. The report, with supplemental information directly from the authors, provided estimates for capital, operating and maintenance and fuel costs, fuel consumption changes, and GHG emission reductions that were directly input into the cost benefit analysis. For this analysis, we used the co-generation and enhanced voluntary initiatives measure. This measure leads to energy and GHG emission reductions following the investments that are most likely to be chosen by industry using medium-term cost-efficiency for decisions. This measure is considered the best approximation for the policies described in the preceding text.

Further reductions from decreased fossil fuel demand – The extraction, processing and distribution of fossil fuels generates GHG emissions. We estimated the effects of decreased fossil fuel demand on these emissions based on relationships estimated from the CEOU and from emission factors for fugitive emissions obtained from Environment Canada. The CEOU reports the GHG emissions from the upstream oil and gas industry by type of process. We calculated the number of tonnes of GHG emissions per unit of production for oil and gas separately. This value was then used to estimate the GHG emission reductions associated with demand reductions for oil and natural gas. For coal emissions, we used the fugitive emission factors from *Canada's Greenhouse Gas Inventory: 1997 emissions* (Environment Canada 1999). The report provided emission factors by province; we used the Alberta emission factors.[12]

Macroeconomic Analysis

The economic impacts were estimated using data derived from IMPLAN (Impact Analysis for Planning), a widely used input-output (I-O) model[13] that analyzes interactions between different sectors of the economy. IMPLAN tracks the changes in each sector's demand and spending patterns, caused by changes in fuel consumption and energy technology investments owing to the policies, and the changes induced in other sectors' levels of output (and the inputs required).

IMPLAN has been used extensively in the United States and is well suited to adjustments to various levels of analysis – national, state, multi-county, or county. For this analysis, we used infor-mation from Statistics Canada to set the appropriate parameters in the model.

IMPLAN has been used by the United States Department of Agriculture, the United States Forest Service and by over 500 other clients in the United States. Recently IMPLAN has been used to estimate the macro-economic impacts of energy efficiency and other climate change mitigation policies in reports for the World Wildlife Fund and the American Council for an Energy Efficient Economy. The analytical approach used here is similar to that in Geller, DeCicco and Laitner (1992), Laitner, Bernow and DeCicco (1998), Goldberg *et al.* (1998), and Bernow *et al.* (1999 and 2001). These reports can be reviewed for further discussion of methodological issues.

Input-output models were initially developed to trace supply linkages in the economy. Thus, the impacts generated from the policy scenario depend on the structure of the economy. For example, I-O models can show how increasing purchases of more efficient lighting equipment, more efficient cars, high efficiency motors, modular combined-heat-and-power plants, or biomass energy not only directly benefit their respective producers, but also benefit those industries that provide inputs to the manufacturers. I-O models can also be used to show the benefits from indirect economic activity that occurs as a result of these transactions (e.g., banking and accounting services, among others) and the re-spending of energy bill savings throughout the economy. Therefore, spending patterns for energy have an effect on total employment, income (i.e., wage and salary compensation), and GDP.

For each sector of the economy, multipliers were used to compute the impacts of the incremental expenditures. These multipliers identify the employment or economic activity generated from a given level of spending in each sector. Changes in expenditures were matched with appropriate multipliers.

For instance, employment multipliers show the number of jobs that are directly and indirectly supported for each one million dollars of expenditure in a specific sector. For this analysis, a job is defined as sufficient wages to employ one person full-time for one year.

The analysis in this study includes several modifications made to the methodology of merely matching expenditures and multipliers. First, it was assumed that 85 per cent of the efficiency investments would be spent within Canada. While efficiency upgrades are traditionally carried out by local contractors and dealers, the analysis recognizes that foreign suppliers and contractors may also be involved.

Second, we made an adjustment in the employment impacts to account for future changes in labour productivity in specific sectors. Utilizing data from Statistics Canada, Labour Productivity and Related Variables (Statistics Canada 2002), we developed productivity trends for our analysis. These trends suggest that productivity rates are expected to vary among sectors. Annual productivity gains are forecast to range from a very small decline in the logging and forestry sectors to 6.4 per cent annual productivity gain in electrical and electronic equipment manufacturing.[14]

Third, we assumed that 80 per cent of the investment upgrades would be financed by bank loans carrying an average 10 percent real interest rate over a five-year period. No parameters were established to account for changes in interest rates as less capital-intensive technologies (i.e., efficiency investments) are substituted for conventional supply strategies, or in labor participation rates. Although the higher cost premiums associated with the efficiency investments might be expected to increase the level of borrowing in the short term, and therefore, interest rates, this could be offset somewhat by avoided investments in new power plant capacity, exploratory well drilling and new pipelines. Similarly, while increased demand for labour may tend to increase the overall level of wages (and potentially lessen economic activity), the employment benefits from the scenario are relatively small compared with the national level of unemployment.

Fourth, for the residential, commercial and industrial sectors we included the policy administration costs as estimated by the Buildings Table and Transportation Table. No program or marketing expense was included for the industrial sector or electricity sector. We assume low costs to reducing barriers to co-generation and for legislative policies in the electricity sector. The analysis took account of the fact that the electric sector carbon cap and trade system would involve government auctioning of carbon allowances to electricity suppliers. Our analysis assumed: (1) purchases of the requisite allowances by utilities from the government, (2) payments for the corresponding higher costs of electricity by households and businesses, and (3) a return of the revenues collected by the government to households and businesses. In the transportation sector, we assume transit subsidies for users and a parking tax (with a return of the revenues collected by the government to households and businesses) to encourage higher participation rates.

II. Results

Meeting Kyoto Commitments

The Kyoto Protocol provides an international framework and a tangible first step towards achieving the 60-80 per cent greenhouse gas emission reductions that scientists say are necessary to achieve climate stability. The policies in the Domestic Policy Case begin to reverse the trajectory of Canadian GHG emissions from their current rapidly rising path. Figure 1 shows that between 2000 and 2012, annual GHG emissions would decline by 5 per cent rather than increase by the 13 per cent projected in the BAU Case, and would thus be about 15 percent lower in 2012.

By 2012, we estimate the domestic policies will lead to reductions in annual GHG emissions of almost 123 megatonnes compared to the BAU Case. The Government of Canada has estimated that Canada needs to reduce emissions by 240 Mt to meet its commitments for the Kyoto Protocol. Thus, the domestic policies considered in this analysis account for over half the required reductions.

The source of the emission reductions in 2012 is shown in Figure 2. Emissions are grouped according to the sectors to which policies are directed. For example, emissions from the electricity sector are reduced due to both demand reductions from the

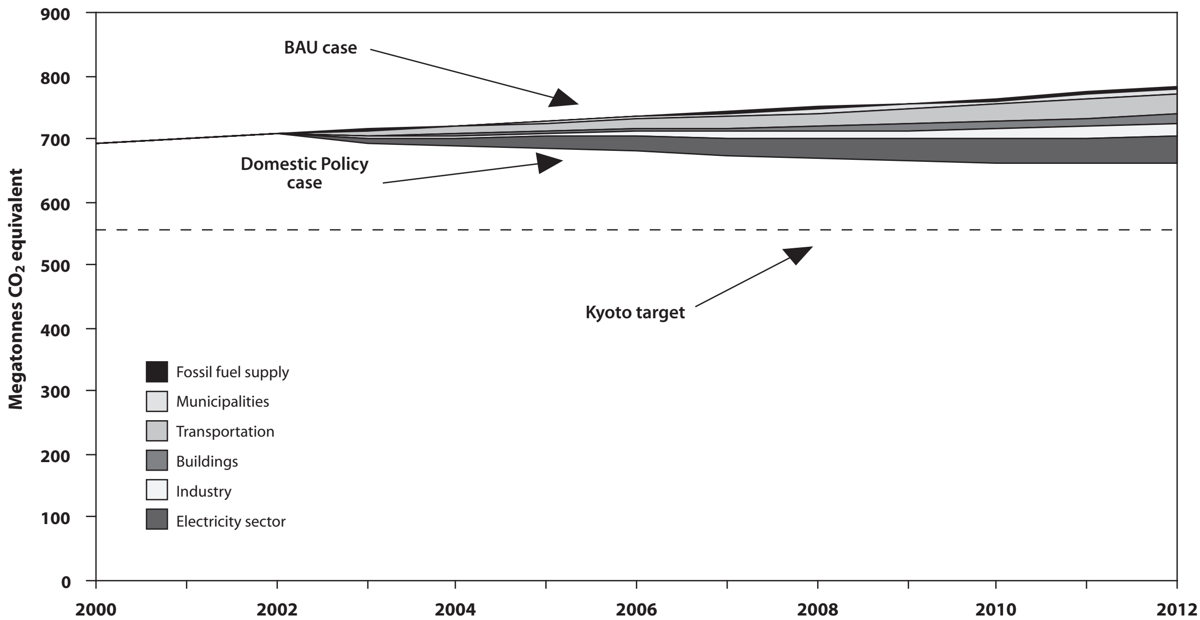


Figure 1 *GHG emissions, 2000 to 2012*

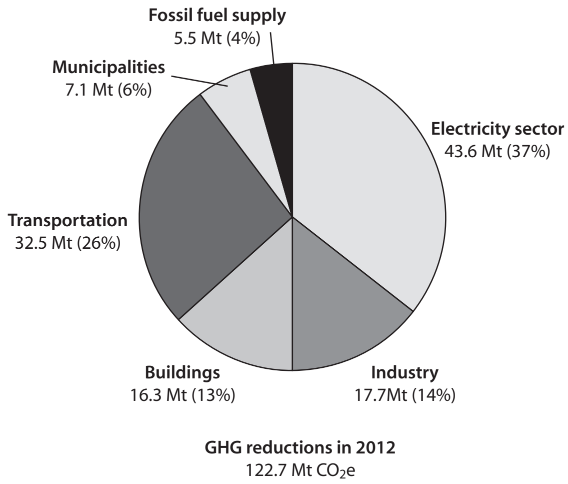


Figure 2 *Sources of Emission Reductions in 2012 through the Domestic Policy Case*

buildings and industrial sectors and the electricity sector policies that promote fuels with lower GHG emissions. For presentation purposes, we have allocated the emission reductions due to electricity demand reduction policies to the buildings and industrial sectors, following the method used in the Table analysis (and presented on the NCCP website). In the case of fossil fuel supply, however, we explicitly show the effects of the various sectoral policies that reduce fossil fuel consumption and therefore reduce GHG emissions from production and distribution.

Emission reductions are greatest for the electricity and transportation sector policies, but the other sectors also contribute significantly.

Energy Impacts

Most of the emission reductions reported in the previous section result from changes in energy consumption, reduced consumption and changes in the types of fuel consumed. The energy reductions are caused by changes in capital investments (e.g. purchasing more energy-efficient equipment) and lead to changes in energy costs (e.g. decreased costs due to lower fuel consumption or increased use of renewable energy). The energy impacts of the selected policies are described below while their costs and benefits are reported in the following section.

Figure 3a shows how the policies would affect the annual consumption of fossil fuels, which declines by 9 percent between 2000 and 2012, rather than increasing by 10 percent as in the BAU Case. About 50 per cent of the overall decrease in 2012 is from a reduction in oil consumption, resulting from higher vehicle efficiency, improved freight practices and increased public transit. Decreased oil consumption saves money and reduces the vulnerability of citizens and the economy to oil price shocks. Coal and natural gas account for 40 per cent and 10 per

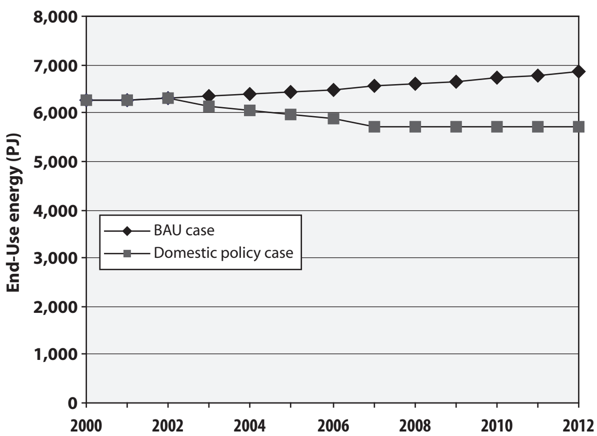


Figure 3a *Fossil Energy Use: Base and Policy Cases*

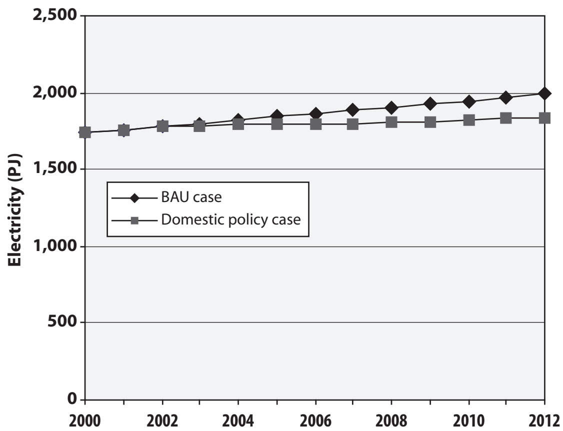


Figure 3b *Electricity Sales: Base and Policy Cases*

cent of the reductions respectively. Natural gas demand decreases due to demand reduction but increases due to fuel switching from coal, limiting the overall reductions in consumption relative to other fossil fuels. Overall reductions in fossil fuel consumption lead to greater reductions in primary energy consumption since less energy production is required. These additional reductions are included in Figure 3a.

Figure 3b shows how the growth in electricity sales from 2000 to 2012 in the Domestic Policy Case is decreased to 6 per cent rather than the 15 per cent growth of the BAU Case. Electricity sales still increase in the 12 year horizon, but if the policies are continued and expanded over time the trajectory could be reversed to a downward trend.

Electricity

Figures **4a** and **4b** show the source of electricity generation in the BAU and Domestic Policy Cases. Coal generation drops significantly as natural gas, which has lower GHG emissions, plus wind and biomass generation increase. Reductions in electricity demand due to buildings and electricity policies reduce generation requirements by about 3 per cent in 2012.

Figures **5a, 5b** and **5c** show the effects on energy consumption by sector due to the domestic policies. The industrial energy reductions are relatively low for several reasons:

1. Co-generation leads to increased use of fossil fuels in the sector (though decreases electricity purchases).
2. Part of the emission reduction is due to practice changes in the upstream oil and gas industry, such as reducing leaks, which may not directly reflect changes in energy consumption.

The buildings sector shows moderate decreases in energy consumption with declines of 10 per cent in fossil fuel consumption and 8 per cent in electricity consumption in 2012 compared with BAU consumption. The transportation sector has the most significant reductions. The combined policies lead to a 20 per cent drop in transportation energy consumption from BAU levels in 2012.

Costs and Benefits

Demand-side Policies

Demand-side policies result in consumers using less energy to meet their needs. Figures 6a and 6b show the net costs and benefits of all the demand-side policies affecting the industrial, buildings and municipalities, and transportation sectors. As

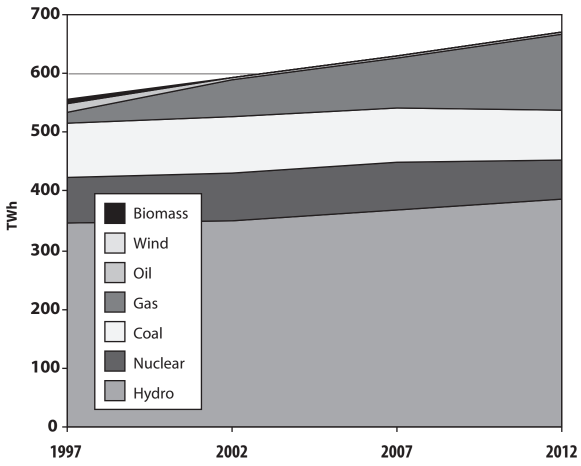


Figure 4a *Electricity Generation – BAU Case*

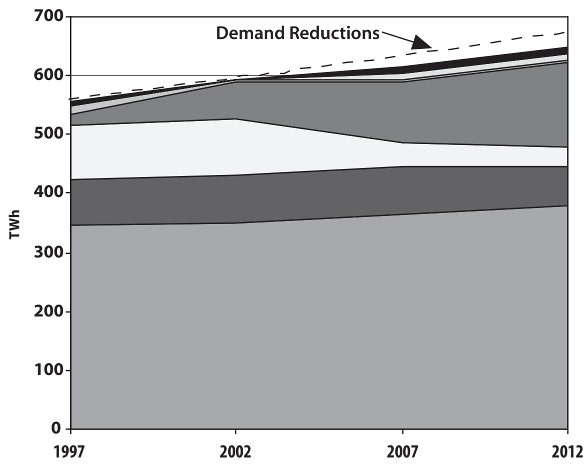


Figure 4b *Electricity Generation – Policy Case*

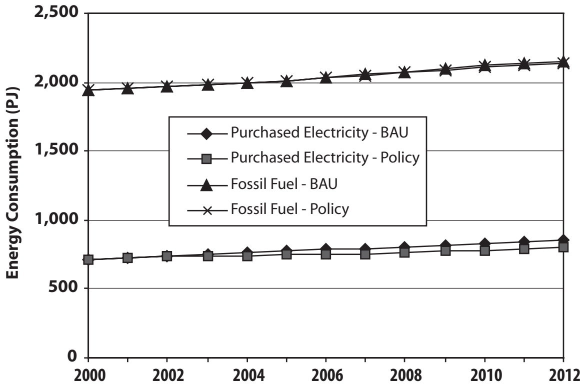


Figure 5a *Industrial Sector Energy Consumption*

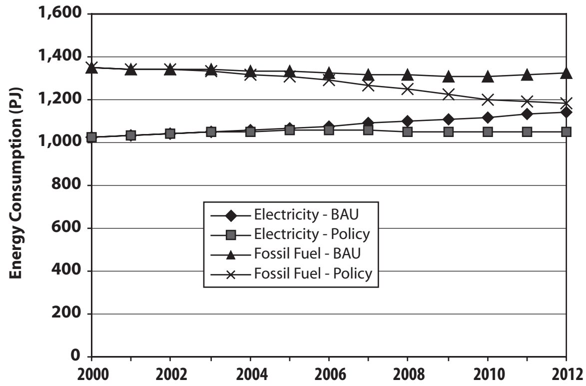


Figure 5b *Buildings Sector Energy Consumption*

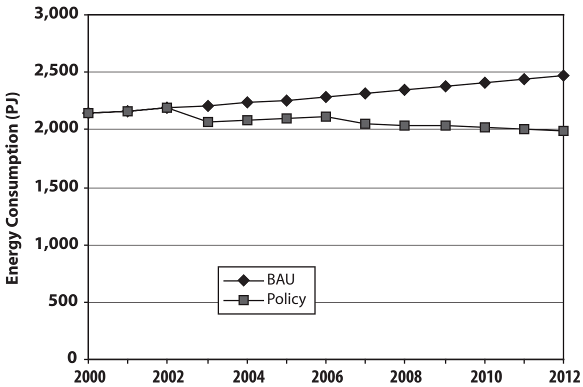


Figure 5c *Transportation Sector Energy Consumption*

Figure 6a demonstrates, the annual, undiscounted costs – increased capital costs for more efficient equipment (annualized over the life of the equipment) plus administration costs for programs – increase to almost $4 billion per year by 2012. However the benefits, predominantly energy bill savings, rise to about $6.5 billion per year, as shown in figure 6b. The transportation sector dominates both the costs and benefits with the industrial sector playing a relatively small role.

Figure 7 shows the undiscounted net benefits of the demand-side policies increasing to an annual level of $2.6 billion by 2012, about $76 per capita.

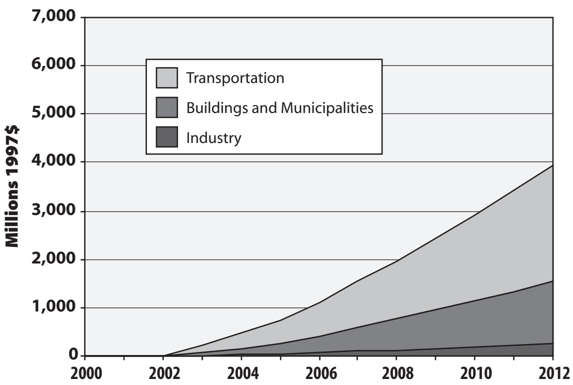


Figure 6a *Costs for Demand Sectors*

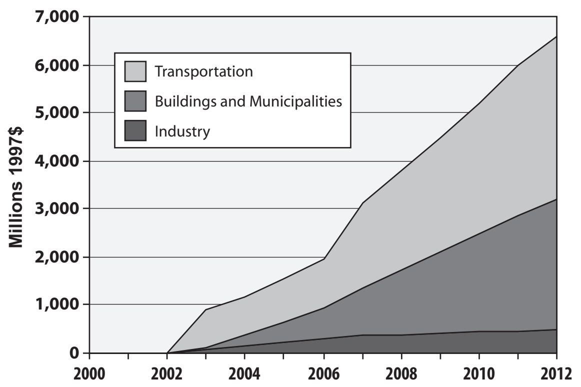


Figure 6b *Benefits for Demand Sectors*

Buildings and municipalities enjoy the greatest net benefits in 2012 as the larger costs and benefits of the transportation sector balance each other to limit overall net benefits.

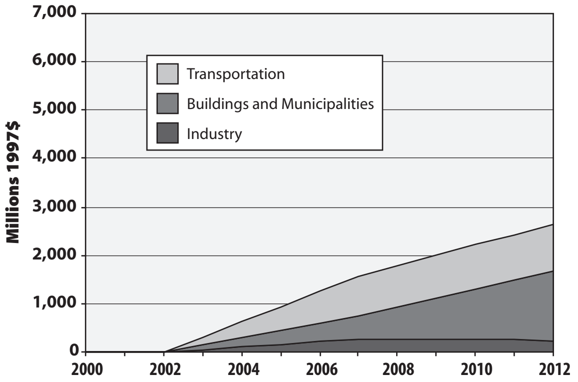


Figure 7 *Net Benefits for Transportation, Buildings and Municipalities and Industrial Sectors*

When the net benefits are summed up over the period 2002 to 2012, using a 5 per cent discount rate for future years, the cumulative net present value of savings for these sectoral policies is $11.5 billion. Figure 8 shows the cumulative net present value for each of the demand sectors.

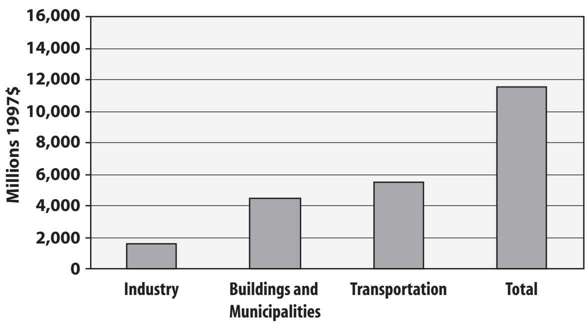


Figure 8 *Cumulative Net Present Value, 2002 to 2012, of Benefits for Demand Sector Policies*

Electricity supply policies

Supply polices affect the way electric utilities generate electricity. The previous figures of costs and benefits exclude the policies for the electricity sector but include the benefits of reduced electricity supply through the lower expenditures on electricity. However, there are also costs and benefits for the cap and trade and the renewable portfolio standard policies. Figure 9 presents the cumulative net present value benefits of these policies for the period 2002 to 2012, using a 5 per cent discount rate.

Although the two policies in the electricity sector yield net costs over the 10 year period, they also result in large GHG emission reductions (see figure 2 in section II). Also note that the change in electricity prices associated with the entire package of policies is estimated to be less than 1 per cent of BAU electricity prices for the residential sector (as prices will be increased by the electricity supply policies but lowered by the demand policies).

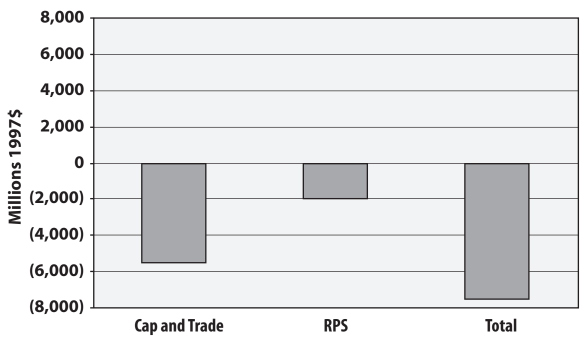


Figure 9 *Cumulative Net Present Value of Benefits in Electricity Sector*

Integration of Supply and Demand Policies

Figure 10 shows the cumulative net present value benefits from all sectors from 2002 to 2012. The combined actions lead to cumulative net present value benefits of about $4 billion between 2002 and 2012. In 2012 the annual, undiscounted net benefits are estimated at $1.6 billion per year, or $47 per capita.

The large net benefits realized by the demand-side efficiency policies in achieving GHG reductions, create the "economic space" that allows greater GHG reductions from the supply-side policies, which have the effect of switching the economy to less carbon-intensive energy resources at some net cost. This is important to meet the challenges of climate protection and technological progress. Thus the entire policy package achieves overall economic benefits while accelerating GHG mitigation and the transition to non-fossil energy supply technologies and resources.

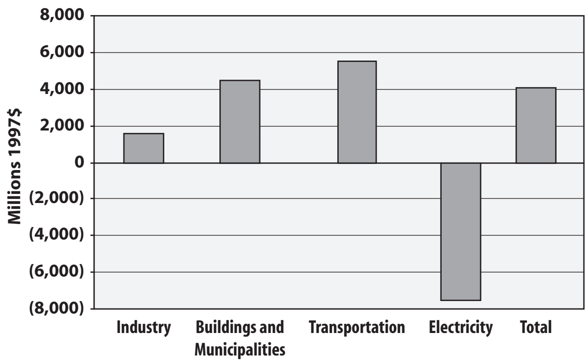


Figure 10 *Cumulative Net Present Value Benefits – All Sectors*

Expenditures on Energy

Most of the net benefits are due to savings in expenditures on energy. Figure 11 presents the annual reductions in energy bills by sector and energy type in 2012.[15] Residential and commercial sectors show a split between electric and fossil fuel savings. The energy bill savings for industry are mostly related to electricity since co-generation decreases electricity purchases while increasing fossil fuel consumption. Industry achieves relatively small reductions in fossil fuel consumption due to energy-efficiency. Transportation shows the largest savings, about $170 per person in 2012.

Employment and Income Impacts

The study finds that implementation of the Domestic Policy Case could lead to a net annual employment increase of 52,000 jobs by 2012, while

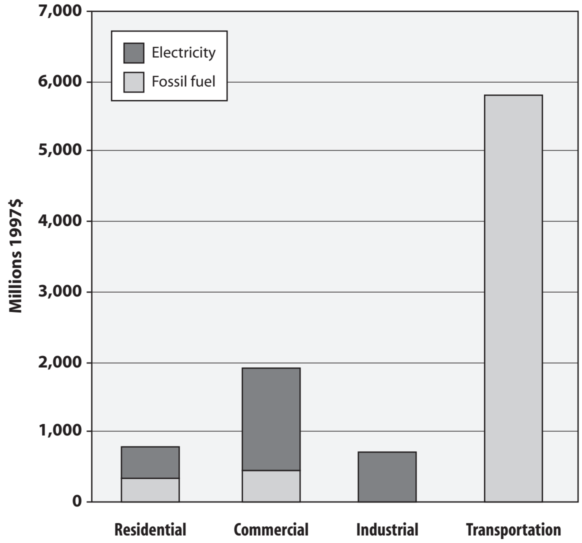


Figure 11 *Annual Savings in Energy Bill by Sector, 2012*

increasing overall national GDP and incomes. These benefits are spread widely across all sectors of the economy – including construction, transportation, manufacturing, services, and agriculture. These benefits derive from using energy resources more efficiently and cost-effectively, commercializing cleaner technologies, and recycling the revenues of an electric sector carbon cap and trade system to households and businesses.

Figures 12a, 12b and 12c show the positive macro-economic impacts of the Domestic Policy Case – overall increases above the BAU Case in jobs, in incomes per household (which complements household energy bill savings), and in GDP. In 2012, there would be an additional $135 per household increase in annual wage and salary earnings ($1.9 billion total), while about 52,000 net new jobs are created, relative to the BAU Case. At the same time, GDP is projected to be about $2 billion above the BAU Case in 2012. Major contributions to these employment benefits arise from purchases of energy-efficient equipment and the re-spending of net energy bill savings by businesses and households. While these increases are significant, the impacts are relatively small in comparison to overall economic activity. For instance, increasing Canada's

GDP by $1.2 billion in 2012 represents only 0.1 percent of the $1.1 trillion (1997$) projected GDP for that year.

As might be expected, some industries within the energy sector would not share in the economic benefits from this transition as the economy's reliance on carbon-intensive fossil fuels declines. Therefore, while there would be widespread gains to workers throughout the economy, a *just transition* to a technologically and environmentally advanced economy would offer policy assistance and support to workers who would otherwise be dislocated during the beginnings of this transition. At the same time, energy suppliers that experience net employment losses could offset some of these potential losses by moving aggressively into the energy efficiency and renewable energy businesses and assisting their workforce in transitioning to these new fields. For example, some existing electricity suppliers could accelerate the shift towards providing energy-efficiency services, renewable energy and co-generation. Similarly, natural gas and oil suppliers could shift towards providing alternative fuels such as those derived from biomass, wind and solar resource, a trend already underway in some integrated energy firms.

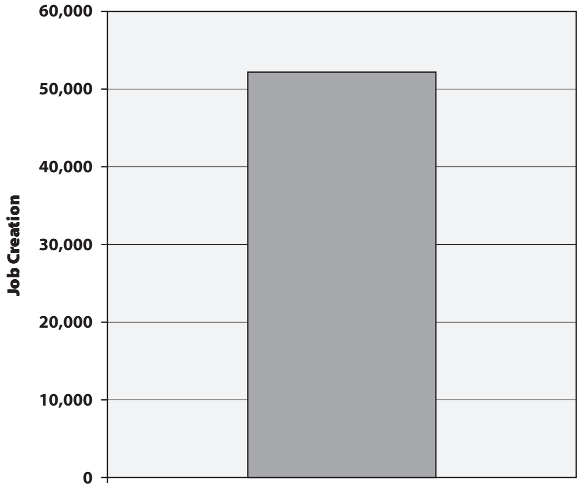


Figure 12a *Job Impacts*

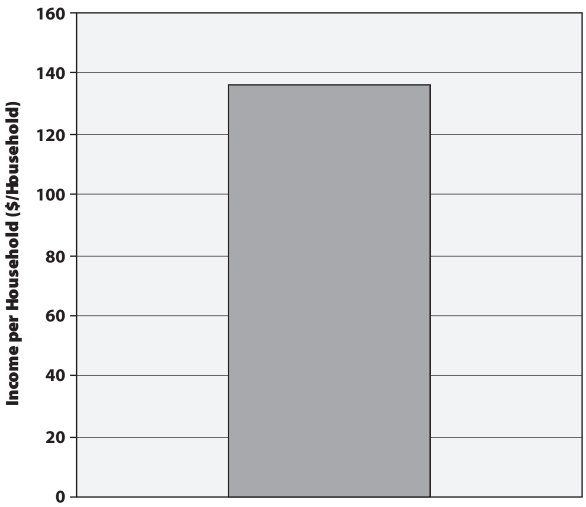


Figure 12b *Income Impacts*

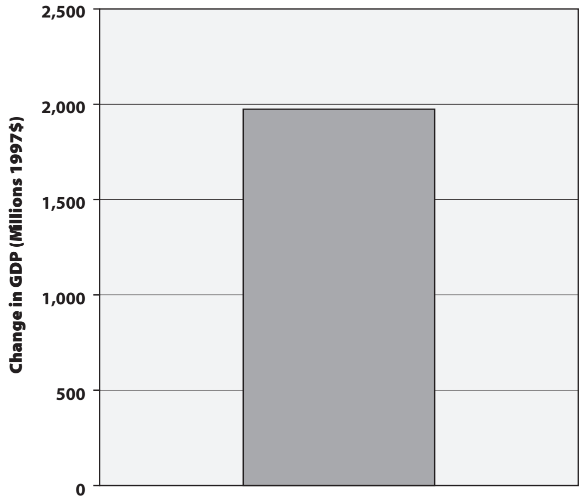


Figure 12c *GDP Impacts*

The analysis tracks expenditures on energy-efficient technologies that reduce consumption of high carbon fuels. These expenditures create incomes and jobs for the manufacturers and workers who produce equipment and for the industries and workers who supply and service those producers. They also reduce the energy bills of offices, firms and households who utilize the more efficient technologies. The re-spending of these energy bill savings creates additional income and jobs for the industries, services and suppliers for which these savings are spent. These newly created jobs significantly exceed job losses in the traditional energy supply sectors.

The analyses took account of the recycling back to households and business of the revenues derived from government auctions of emission allowances to electricity suppliers and from the parking tax. The results of these interactions are captured through appropriate sectoral multipliers (jobs, income, and GDP per dollar of output).

Table 1: *Macroeconomic Impacts of Domestic Policy Case by Sector, 2012*

	Net Change in Jobs	Net Change in Wage and Salary Compensation (Million1997$)	Net Change in GDP (Million1997$)
Construction	14,000	$450	$560
Other Services	13,600	$240	$350
Transportation Equipment	5,400	$440	$740
Finance, Insurance, Real Estate	5,000	$320	$1,150
Fabricated Metal	4,100	$180	$250
Business Service	3,900	$150	$240
Health and Social Service	2,100	$60	$80
Machinery (except electrical mach.)	2,000	$110	$110
Wholesale	1,600	$80	$140
Agricultural, Fishing, and Related Service	1,500	$10	$90
Other Manufacturing	1,500	$80	$90
Education	1,200	$60	$70
Primary Metal	700	$70	$110
Mining and Related Services	700	$40	$130
Electrical and Electronic Equipment	500	$50	$120
Rubber and Plastics	300	$20	$20
Trans, Communication, other Utilities	200	$10	$20
Textiles	100	$10	$0
Logging and Forestry	100	$10	$10
Chemicals	100	$10	$30
Paper and Allied Products	0	$0	$10
Refined Petroleum and Coal	–200	–$20	–$280
Retail	–800	–$20	–$40
Crude Petroleum and Natural Gas	–1,000	–$150	–$1,130
Government	–1,400	–$90	–$250
Electric and Nat Gas Utilities	–2,900	–$190	–$650
Total	**52,300**	**$1,930**	**$1,970**

III. Comparison With Other Studies

Recently, several studies have considered the costs and benefits of policies aimed at reducing national GHG emissions or energy consumption. We compared the results of the most relevant recent studies that provided the detail required for meaningful comparison. These results are shown in Table 2. The studies chosen were:

1. NCCP Roll-Up. As a final step in the process, two models were used to integrate the results of the Issue Table analysis into a variety of scenarios (Haloa Inc 2000, Energy Research Group/ MK Jaccard and Associates 2000a) and these integrated results were evaluated to estimate the macro-economic impacts on the Canadian economy (Informetrica 2000). For our comparison we looked at the results from two of the scenarios. (In Canada-Alone, all of the emission reductions needed to meet the Kyoto commitment will come from domestic actions. In the International Scenarios, Canada is able to meet some of the commitment by purchasing emission reductions on a world market. The results from the two models differed slightly as shown by the range of numbers.
2. *The American Way to the Kyoto Protocol* (Bailie et al. 2001a) – Tellus was commissioned by WWF to estimate the energy, environment and cost impacts of policies to reduce carbon in the United States. This study was supplemented by a second study to estimate the macro-economic impacts (Bernow et al 2001).
3. *Scenarios for a Clean Energy Future* (DOE/NREL 2000) – This report, prepared for U.S. Department of Energy by the national laboratories, analyzed the GHG and economic impacts of sets of energy policies for the United States. The process involved intense review by sectoral experts and input from a wide range of interested groups.

Table 2: *Comparison of Results from Relevant Studies in 2010 or 2012*

NCCP Roll-up	% Primary Energy Reduction from base case in 2010 or 2012	% GHG reductions reductions from base case in 2010 or 2012	Cost of Saved GHG (\$/tonne CO_2) Average	Cost of Saved GHG (\$/tonne CO_2) Marginal	Annualized Cost Per Capita \$/person	GDP Change	Job Increase
Canada -Alone	15% – 18%	24%	\$11 – \$35	\$56 – \$120	\$45 – \$150	–1% – –2%	–0.4% – –0.9%
International	9% – 15%	14% – 17%	–\$13 – –\$37	\$38	–\$40 – –\$90	–0.5% – –1.5%	0.2% – –1.0%
Current Study	**8%**	**16%**	**-\$10**	**\$40**	**-\$47**	**0.1%**	**0.3%**
American Way to Kyoto	11%	24%	-\$34	\$108	-\$67	0.4%	0.5%
Clean Energy Future (Advanced Scenario)	11%	18%	–\$68	n/a	-\$160	0.0%[16]	n/a

The reported results from the studies were adjusted as needed to put them on a reasonably comparable basis and should be considered indicative. For example, US dollars have been converted to Canadian using 0.65 exchange rate, the 2010 results from other studies are compared to the 2012 results from this study and the cost of saved GHG is calculated as the cumulative net present value of costs divided by the cumulative net present value of emission reductions (the NCCP results use a 10 per cent discount rate while the other studies use a 5 per cent discount rate). For studies that achieved some emission reductions from purchasing credits internationally, we only looked at the emission reductions and costs that occurred domestically (however, the job impacts for the NCCP results do include the impact of government spending to obtain these credits). The studies apply different policy start dates and no adjustment has been made to account for that.[17]

The primary energy reductions and GHG emission reductions indicate that this study is broadly consistent with, although not as far-reaching, as the other studies. The lower energy and GHG emission reductions reflect the limits of the specific set of policies analyzed in this study compared with the larger universe of promising policies. As described further in the next section, there are several options for achieving even greater reductions through additional domestic policies or international means. The low net benefits per tonne of GHG emissions or per capita compared with the studies from the United States indicate that further domestic actions in Canada could be implemented with greater net benefits to the economy. The costs are similar to the international scenarios from the NCCP analysis, but this study indicates net GDP gains and slightly greater job gains (0.3 per cent rather than 0.2 per cent). One potential reason for the differences is the inclusion of the permit costs in the NCCP estimates. We did not include these in our estimates since it appears more reductions could be achieved domestically with net benefits to the economy. Moreover, the NCCP analysis was based on a permit price of \$38/tonne CO_2 while recent studies indicate the price could be much lower.[18]

IV. Further Steps

The policies considered in this analysis achieve over half of the reductions required to meet Canada's commitment under the Kyoto Protocol. Several options exist for meeting the remaining reductions. These include implementing other domestic cost-effective measures, or, on a limited basis, using some of the international mechanisms to supplement domestic actions.

Potential domestic polices that are likely to be cost-effective or low-cost include:

1. Applying a GHG emissions cap and trade program for large industrial emitters – The Industry Report for the AMG estimated a 33 Mt reduction of GHG emissions, achieved at a net benefit to the economy. These additional 15 Mt might be achieved through programs focused on more energy-efficient generic technologies such as pumps, fans or conveyors, on industry-specific technologies such as black liquor or wood gasification in pulp and paper, coal bed methane capture in mining, oxy-fuel burners in metal smelting, or for maintenance procedures that improve energy use. Cost effective savings from these technologies or actions have been shown for Canada (Energy Research Group/MK Jaccard and Associates 1999a, 1999b, and 2000b). Studies from the United States indicate large cost-effective savings in the industrial sector due to more energy-efficient technologies (DOE/NREL 2000, Martin et al. 2000). While the Canadian industrial mix and energy consumption in industry vary from American industry, some of the savings identified in these studies could lead to cost-effective savings and should be considered.
2. Pursue more energy efficiency policies. The Table analysis indicated more energy-efficiency policies in the buildings and transportation sectors than were included in this analysis. The cost-effective policies could be advanced by policies that encourage or require action and the low cost policies could be funded through mechanisms such as a small charge on electricity or gasoline. The charge would be designed to have little effect on the total cost of energy but the revenue raised could be applied directly to energy efficiency policies.
3. Using the methane captured from landfill to generate electricity, rather than just flaring the gas. The Municipalities Table indicated that an additional 0.6 Mt of GHG emission reductions could be obtained from this policy.
4. Requiring energy consumption to be included as part of community urban planning and development. Research by the Municipalities Table showed net benefits for increasing compact or nodal development. While the emission reductions are low in the short term, the long-term reductions are significant. This type of policy needs to be started well in advance of the emission reduction requirement and should be considered in light of future commitment periods. The Municipalities Table estimated GHG reductions of 2 MT in 2012.
5. The policy to increase co-generation in the industrial sector only considered removing current barriers for this technology. Other policies could focus on encouraging further deployment of this

technology and also of co-generation district energy systems for the commercial and high-density residential sectors.

6. Increasing the emission cap or renewable requirements for the electricity sector could lead to even more reductions. The policy levels implemented here lead to about 40 Mt of emission reductions. Increasing the levels for each policy by 25 per cent could lead to an additional 10 Mt of reductions.
7. The continuing growth in greenhouse gas emissions in the freight transport sector reflects a substantial shift from the use of railroad transport to the use of trucks, partly driven by the movement to 'just in time' delivery. Responsible public policies, using financial and regulatory incentives, could reverse this trend and take advantage of the energy efficiency inherent in rail freight movement. These policies would also address other outstanding issues arising from the road freight sector such as the public costs of building and maintaining highways, health impacts of increased regional air pollution, and highway safety issues.

These additional policies were not included in this analysis due to lack of readily available information to integrate them into a cohesive package. However, estimates of the individual effects of the policies indicate that substantial additional GHG reductions and further net benefits to the economy could still be possible. Thus Canada could likely go further than halfway towards meeting its Kyoto target with domestic policies and still come out with net economic benefits.

Canada could also supplement domestic policies with emission reductions obtained through the international mechanisms of the Kyoto Protocol. Recently, Tellus estimated a world price of C$3/tonne$CO_2$e for emission credits from various international trading mechanisms (Bailie et al. 2001). Although the cost of these international options appears low, buying these credits does not provide the additional benefits that domestic energy-efficiency policies yield, such as health benefits from reductions in local air pollutants and local expertise in manufacture, installation and use of high efficiency or renewable energy technologies.

This analysis has shown large net benefits to the economy and to Canadian citizens from a set of targeted domestic policies. Lower energy bills, increased jobs, pollution reduction and technology progress can be enjoyed over the next decade through implementation of such policies. As the government develops its plan to meet its GHG emission reduction commitments under the Kyoto Protocol, additional analysis can help identify other policies and measures to meets its remaining emission reduction requirements.

Appendix A – Transportation Fuel Efficiency Modeling

The transportation sector is modeled using a stock-turnover method for determining the fuel economy characteristics of the Canadian fleet of automobiles. This model is based on models that Tellus has used for other clients, such as the World Wildlife Fund and the International Council for Local Environmental Initiatives (ICLEI). Similar stock turnover models are also used by the US Energy Information Administration to make predictions about transportation energy use.

The numbers of new vehicle sales and vehicle stock, the new vehicle efficiency, and the average distance traveled per vehicle, are provided by the Natural Resources Canada report, Canada's Emissions Outlook: An Update (CEOU).[19] To calibrate the spreadsheet model to the CEOU data, we assumed no retirement of vehicles until that vehicle is the oldest remaining in the stock. Each year's stock is composed of the new vehicle sales of its own year's models as well as all the previous years' existing vehicles, where existing vehicles are estimated according to the following relationship:

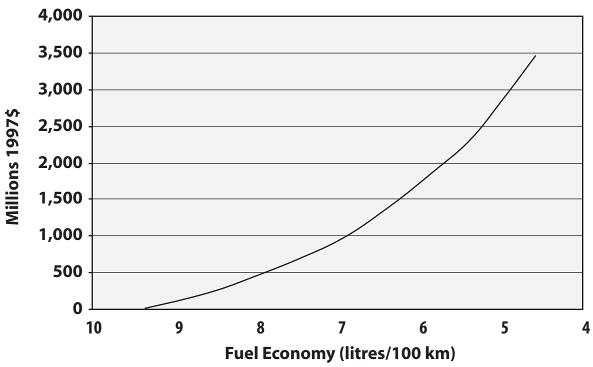
$$Stock_t = New\ Sales_t + New\ Sales_{t-1} + \ldots + f \leftrightarrow New\ Sales_{t-N}$$

Where $Stock_t$ is the stock of vehicles in year *t*,
$New\ Sales_t$ is the number of cars sold in year *t*,
N is the number of model years that compose $Stock_t$ (typically 14), and
f is the fraction of cars sold in year (*t-N*) that survive to year *t* such that the two sides of the equation reach equality.

Therefore each stock year is composed of a set of cars from different model years, each with its own fuel economy characteristics, which can be weighted to create a stock fuel economy. Vehicles made prior to 1990 (the first year for which data are provided) are assumed to have the same fuel economy characteristics as the average car in the stock of vehicles in 1990. We assumed that the fuel economy values in the CEOU represent the actual fuel economy of that vehicle on the road through the course of its lifetime.

For the Domestic Policy Case, we applied a policy that legislates a 3 per cent per year improvement in new vehicle fuel economy over the previous year, calculated from 2003 onward. By 2012, the average new vehicle fuel economy will be 8 litres/100 km (rather than 8.84 litres/100 km estimated in the BAU case).

For each scenario, we estimated the relative costs and benefits of fuel economy improvements. The distance traveled per car in each year is used with the fleet fuel economy and the number of vehicles in each year's stock to determine the amount of fuel required and the amount of carbon emitted. The cost of fuel economy improvements comes from a National Research Council (USA) report[20] that describes three pathways for fuel economy improvements, each one making more efficient fleets than the one before it. These pathways have different costs associated with their fuel economy improvements. The values for midsize cars were used as representative of an average light-duty vehicle. The costs per increase in fuel efficiency were taken relative to the baseline (in this case, the year 2002), rather than to the increase over the year previous to that in question. Taking cost paths for the three improvement pathways creates a set of relationships to determine the cost of further fuel economy improvements. These relationships are shown in the graph below, which plots the NRC cost curve for fuel economy improvements (capital costs converted to Canadian $ using a 0.65 exchange rate). The costs of each year's fuel economy improvement are then calculated based on each scenario for fuel efficiency gains.



Comparing the above cost curve with other studies indicates that these are in the high range of estimates for cost of achieving the levels of fuel economy improvements considered in this study (Intergovernmental Panel on Climate Change 2001).

Appendix B – Key Parameters for IMPLAN

As mentioned in the main report, industry employment multipliers and changes in labour productivity are key parameters in the IMPLAN model. Employment multipliers show the number of jobs that are directly or indirectly supported for each one million dollars of expenditure in a specific sector. Labour productivity growth are based on trends from 1990 to 1997. Information for these parameters was derived from recent Statistics Canada information (Statistics Canada 2002).

Select Industry Employment Multipliers – 1997

Industry	Employment Multiplier
Agricultural, Fishing, and Related Service	21.6
Business Service	24.7
Chemicals	8.9
Construction	18.8
Crude Petroleum and Natural Gas	7.0
Education	22.4
Electric and Nat Gas Utilities	7.1
Electrical and Electronic Equipment	11.7
Fabricated Metal	14.1
Finance, Insurance, Real Estate	15.4
Government	15.3
Health and Social Service	20.5
Logging and Forestry	16.7
Machinery (except electrical mach.)	13.0
Mining and Related Services	11.4
Other Manufacturing	14.9
Other Services	30.8
Paper and Allied Products	12.6
Primary Metal	10.4
Refined Petroleum and Coal	7.6
Retail	32.0
Rubber and Plastics	12.9
Textiles	14.6
Transportation Equipment	10.2
Trans, Communication, other Utilities	13.4
Wholesale	18.9

Labour Productivity - Annual Growth Rates

Industry	Growth Rate
Agricultural, Fishing, and Related Service	0.011
Business Service	0.023
Chemicals	0.038
Construction	0.000
Crude Petroleum and Natural Gas	0.046
Education	0.023
Electric and Nat Gas Utilities	0.018
Electrical and Electronic Equipment	0.064
Fabricated Metal	0.013
Finance, Insurance, Real Estate	0.023
Government	0.023
Health and Social Service	0.023
Logging and Forestry	-0.001
Machinery (except electrical mach.)	0.022
Mining and Related Services	0.009
Other Manufacturing	0.032
Other Services	0.007
Paper and Allied Products	0.037
Primary Metal	0.040
Refined Petroleum and Coal	0.023
Retail	0.022
Rubber and Plastics	0.042
Textiles	0.031
Transportation Equipment	0.040
Trans, Communication, other Utilities	0.019
Wholesale	0.022

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[6] For example, see the website of the Pew Centre on Global Climate Change, www.pewclimate.org

[7] http://db.nccp.ca/cfmsite/nmd/cfmlpriv/selection.cfm?lang=E

[8] The Kyoto Gap is the difference between the expected level of GHG emissions in the BAU case and the level of emissions that the Canadian Government agreed to achieve as part of the Kyoto Protocol (6 per cent reduction from 1990 levels by 2008-2012)

[9] Information from Environment Canada's Green Lane website, http://www.ec.gc.ca/minister/speeches/2002/020318_t_e.htm

[10] The price effects are limited for natural gas and electricity due to policies having counter-acting effects on fuel consumption and other determinants of price. For example, the electricity demand reductions from the buildings and industrial sectors could lead to somewhat lower electricity prices, owing to decreased capital investments and operating costs, while the portfolio standard could increase electricity prices owing to a shift to more expensive cleaner generation. The annual net cost increase due to these price-offsetting policies is less than 1 per cent of total annual revenue for the sector. Natural gas consumption, and therefore price, increases due to the emission cap policy for the electric sector that causes fuel switching from coal, but decreases due to both the renewable portfolio standard and policies in the industrial and buildings sectors that encourage greater energy efficiency. The net change in natural gas consumption due to the Domestic Policy Case is about 3 per cent decrease in annual demand in 2012 or 1.5 per cent of annual productions. We estimate the change in natural gas price would be small if it changed at all. The oil and gas industry has argued that Canada is a price-taker for energy commodities and the domestic policies will have little effect on world prices. See: "*Energy Politics Cast Pall Over Edgy Oil Patch*" by Brent Jang, Globe and Mail, Wednesday, April 10, 2002

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[12] The majority of coal mining occurs in Alberta and British Columbia, but almost all coal produced in British Columbia is exported and would be unaffected by domestic demand.

[13] Minnesota IMPLAN group, Inc. http://www.implan.com

[14] The productivity gains and the employment multipliers are reported in Appendix B.

[15] The benefits in Figure 11 exceed the benefits shown in Figure 6b because energy taxes are included in Figure 11 to reflect the private perspective but excluded from the economic costs in Figure 6b.

[16] The *Clean Energy Future* report did not directly model the macro-economic impacts of the scenario. Instead the authors examined current market and organizational structures for obtaining energy services and considered successes achieved by past energy policies

and programs. When these considerations were combined with the details of their proposed policies and programs, they concluded that with any changes to markets resulting from the policies "*the aggregate result is a gain in economic efficiency*." (DOE/NREL 2000, p. 1.40) The authors also examined the results of seven leading energy/economic models to estimate the impacts of the economy-wide carbon tax, one of the policies that was included in the study. These studies indicated a range of effects on GDP – from a 0.1 per cent increase to a 0.3 per cent decrease. When combined with the gain in economic efficiency from the other policies (noted above), they estimate that the net effect could be close to zero.

[17] Tellus estimates that changing the start date of policies by 2-3 years can affect estimates of impacts in a particular year in the order of 30 per cent.

[18] See Bailie et al 2001 or Environment Canada "Costs of Kyoto – What We Know" http://www.ec.gc.ca/minister/speeches/2002/020318_t_e.htm

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Further Reading

From the Tellus Institute, www.tellus.org

COAL: America's Past America's Future? President Bush's Plan and the Risk of Global Warming. A study sponsored by the World Wildlife Fund. Stephen Bernow, Michael Lazarus and Sivan Kartha, Tellus Institute, May 2001. An examination of the coal supply chain makes it clear that "clean coal", a major component of President Bush's answer to the US energy problems, is a distant and costly hope compared with the sensible alternatives based on efficiency and renewables that exist today.

Cleaner generation, free-riders and environmental integrity: clean development mechanisms and the power sector. A report in *Climate Policy 1* (2001) pages 229-249. Stephen Bernow, Michael Lazarus, Sivan Kartha and Tom Page. Tellus Institute and Stockholm Environmental Institute. This analysis of the potential carbon emissions impacts of the Kyoto Protocol Clean Development Mechanism (CDM) concludes that while the CDM could induce some legitimate emission reductions, it could also give rise to a considerable amount of spurious emission allowances - from activities that would have taken place even in the absence of the CDM.

The American Way to the Kyoto Protocol: An Economic Analysis to Reduce Carbon Pollution. This study was produced by the Tellus Institute and the Stockholm Environmental Institute (Boston Center) with sponsorship of the World Wildlife Fund. The study team, led by Dr. Stephen Bernow, examined policies and measures to reduce U.S. greenhouse gas emissions over the next two decades. They concluded that the policies would bring overall economic benefits to the U.S.

From the World Wildlife Fund, www.worldwildlife.org

The following reports are available in pdf form on the WWF website.

Habitats at Risk: Global Warming and Species Loss in Globally Significant Terrestrial Ecosystems. Prepared by Jay R. Malcolm and colleagues from the University of Toronto.

Clean Energy: Jobs for America's Future. Analyzes the employment, energy and environmental impacts of implementing a suite of energy efficiency and renewable energy policies.

Climate Change and Extreme Weather Events. P.J Vellinga and W.J. van Verseveld.

From the David Suzuki Foundation, www.davidsuzuki.org

Canadian Solutions: Practical and Affordable Steps to Fight Climate Change. Published in conjunction with the Pembina Institute, this report outlines how Canada can meet its Kyoto targets in practical, affordable ways with many environmental, social and economic benefits.

Taking Credit: Canada and the Role of Sinks in International Climate Negotiations. Examines the science and policies surrounding controversial sections of the Kyoto Protocol on global warming that deal with "carbon sinks."

Taking Our Breath Away: The Health Effects of Air Pollution and Climate Change. Written by three medical and public health experts, this report explores the links between air pollutants and changes in climate, including present and future impacts on Canadian health.

"This analysis has shown large net benefits to the economy and to Canadian citizens from a set of targeted domestic policies. Lower energy bills, increased jobs, pollution reduction and technology progress can be enjoyed over the next decade through implementation of such policies."

Dr. Stephen Bernow, Tellus Institute

"I suggest that our collective objective be to meet our Kyoto targets while not only protecting our competitiveness, but enhancing it .... The Government of Canada addressed fiscal deficits, to avoid leaving a burden for future generations. Likewise, it would be irresponsible to leave an environmental deficit of climate disruptions and pollution for future Canadians."

Prime Minister Jean Chretien, september 2001

ALARIS DESIGN

WWF World Wildlife Fund
Fonds mondial pour la nature

David Suzuki Foundation
Finding solutions