
The GPI Greenhouse Gas Account

Part of what enters the human economy in the form of resource consumption leaves the economy in the form of waste. Just as our natural resource base is finite, so the waste assimilation capacity of the ecosystem is also finite. When we exceed that capacity, waste may produce air, water and soil pollution, and threaten the life-support services provided by the ecosystem. Our well-being as a society and that of our children is therefore dependent on how wisely and efficiently we manage *both* our resource harvesting *and* our waste management.

Basic Principles

The GPI Greenhouse Gas Account is based on four fundamental principles that run throughout the Genuine Progress Index as a whole, and that illustrate the overall approach of the new measures of progress. While these principles may seem obvious, they are not yet accepted in conventional accounting systems, and are therefore explained in some detail here.

1) *The Context: Ecology and Economy*

Conventional economic theory sees the human economy as a closed system in which firms produce and households consume. That assumption is the basis for calculating the GDP and economic growth rates on which we currently base our assessments of prosperity and social well-being.

A 1998 GPI report, *The Economic Value of Unpaid Housework and Child Care in Nova Scotia*, has already exposed a fundamental flaw in that conventional assumption by demonstrating clearly that households *produce* as well as *consume*. If the productive work done by households were replaced for pay in the market economy, it would add \$8.5 billion a year to the provincial GDP. Currently that vital unpaid work is uncounted and invisible in the standard economic statistics, and thus “value-less” and “worthless” in our measures of progress, even though it contributes directly to our standard of living and quality of life.

But the conventional assumption is flawed in an even more fundamental way. The human economy is not a closed system. It exists as a sub-system within, and is completely dependent upon, an encompassing ecosystem that provides vital life-support services to the human economy, including climate regulation, pollination, nutrient and hydrological cycling, waste filtration and assimilation, and the range of products provided by natural resources. As stated above, the heat and matter that enter the human economy from the ecosystem also *return* to the ecosystem, partly as waste. The capacity of the ecosystem to absorb that human waste in turn affects the functioning of the human economy.

These fundamental flaws in our national accounting system are now universally acknowledged. We still adhere to an outdated 60-year-old accounting system, devised at a time when natural resources were thought to be limitless and ecosystem services “free” and infinite, only because the new accounting systems are still being developed. Statistics Canada, in line with new recommendations by the UN, OECD, World Bank, and the internationally recognized *System of National Accounts*, is now taking its first steps toward integrated environmental and economic accounting through its new Canadian System of Environmental and Resource Accounts (CSERA).

The CSERA bring natural resource accounts for the first time into the national balance sheets, and resource and waste flows into the input-output tables. Climate change is regarded as the most important environmental issue of the next century, and it is therefore appropriate that Statistics Canada has designated greenhouse gas emissions as the first set of emissions to be included in the national input-output tables. In addition, the CSERA is developing a set of Environmental Protection Expenditure Accounts (EPEA) on the basis of which analysts will be able to recalculate a “green GDP” or “net domestic product” that subtracts pollution abatement expenditures and clean-up costs from the GDP.

In short, there is no doubt that integrated environmental-economic accounting will be the basis of the new economy of the next millennium. This is a principle reason that Statistics Canada has designated the Nova Scotia Genuine Progress Index as a pilot project for Canada, providing a unique opportunity for this province to be a leader in charting the new course.

2) *Cost-Benefit Analysis*

The explicit recognition that the human economy depends on ecosystem services leads the Nova Scotia GPI to assign full value to the province’s natural resources, and to recognize the full range of services they provide as *benefits* to the economy. In the same way, wastes from the human economy that cannot be successfully absorbed and assimilated by the ecosystem are recognized as *costs*. These costs can be calculated either as *damage costs*, calculating the actual pollution and waste impacts on the human economy in terms of losses incurred, or as *remediation costs*, such as clean-up and restoration expenditures.

The GDP, by contrast, makes no such distinction between benefits and costs, and actually counts pollution as a contribution to economic growth and prosperity. The *Exxon Valdez*, for example, contributed far more to the U.S. economy by spilling its oil than if it had delivered its cargo safely to port. The massive cleanup costs, replacement of lost fuel, ship repair, legal fees, media production, and an array of damage expenditures all added to the GDP and made the economy grow. In the same way, crime, accidents, resource depletion, and natural disasters all contribute to the GDP.

Our current measures of progress, based on the GDP, make no distinction between economic activities that create benefit from those that cause harm. They therefore send

misleading signals to policy-makers, economists, journalists and the public on our actual state of well-being and prosperity. This is the principle reason that more than 400 leading economists recently urged that the GDP no longer be used as our primary measure of progress.

By contrast to the GDP, the GPI regards crime, pollution, accidents and natural resource depletion as costs. The same principle is applied here: The burning of fossil fuels in the human economy has exceeded the capacity of the ecosystem to absorb the emitted greenhouse gases. Canada's commitment under the Kyoto Protocol to reduce emissions to 6% below 1990 levels derives from international recognition that further atmospheric accumulations may produce serious and potentially catastrophic costs to the human economy.

Like crime and pollution, greenhouse gas emissions are therefore counted in the GPI as costs. Unlike the GDP, which always sends the message that "more" is "better," the GPI recognizes that *less* crime, *less* pollution, and *less* greenhouse gas emissions are a more accurate indicator of prosperity, well-being, economic sustainability, and "genuine progress," than increased costs in these areas. Unlike the GDP, the GPI goes up when crime rates, pollution, and greenhouse gas emissions decrease. Cost-benefit analysis, as used in the GPI, therefore corresponds far more closely to common-sense perceptions of well-being than a current accounting system like the GDP that simply counts all expenditures as economic benefits.

In calculating the economic costs of greenhouse gas emissions, the GPI does not make its own calculations for the likely impact of climate change on Nova Scotia, or for potential remediation costs within the province. Instead, the GPI simply uses existing conservative, and widely accepted estimates of dollar costs per tonne of carbon emitted, and multiplies this unit cost by the quantity of carbon emitted in the province. Because *global* impacts of climate change will affect Nova Scotia just as Nova Scotia emissions affect global climate change, it makes more sense to use such global cost estimates for carbon emissions than to derive separate unit cost estimates for the province.

3) *The Precautionary Principle*

It is now internationally accepted that lack of scientific certainty cannot delay action to avert potentially irreversible damage. This is called the "precautionary principle" and is explicitly written into both federal and provincial environmental legislation. Thus Part One, section 2 (b) (ii) of the Nova Scotia Environment Act states:

The precautionary principle will be used in decision-making so that where there are threats of serious or irreversible damage, the lack of full scientific certainty shall not be used as a reason for postponing measures to prevent environmental degradation.

The relevance of this vital principle for greenhouse gas emissions is clear. There is no absolute certainty that climate change is caused by the greenhouse gas emissions that are

one of the by-products of fossil fuel combustion. But the probability of a link is sufficiently strong in the eyes of the 2,000 scientists appointed by the United Nations to the Inter-governmental Panel on Climate Change (IPCC) that the international community has committed itself to significant reductions in greenhouse gas emissions.

The principle flows directly from the principle of “sustainability” that is the unifying framework of the Genuine Progress Index. One of the essential components of any definition of sustainable development is that we live in such a way that the next generation will not be worse off than we are. This refers, among other things, to our resource consumption and waste production. From this perspective, the precautionary principle is simply viewing climate change from the perspective of our children rather than ourselves. If we are uncertain of the potential impact of climate change on the world that our children will inhabit, then we will act now to reduce any possible future damage rather than to put our children at risk.

The precautionary principle has long been standard operating procedure for the insurance industry, which assesses premiums in accord with potential likelihood of loss based on probability rather than causal certainty. For example, young male drivers may be assessed higher premiums, though most will not have accidents. Just as good driving records will eventually lower premiums, it is similarly argued that if the connection between greenhouse gas emissions and climate change is eventually disproved, fossil fuel reserves will still be available to be burned.

If, on the other hand, greenhouse gas emissions are partially responsible for the warming of the planet, as seems highly likely, then failure to act now could have catastrophic consequences for the planet and the next generation. Therefore the world community, including Canada, has recognized that simple prudence, and responsibility to future generations, demands immediate and concerted action.

The Nova Scotia GPI recognizes climate change as the number one environmental issue of the next generation, and therefore accepts the precautionary principle as the starting point of the greenhouse gas accounts. For that reason, as an index of *sustainable* development, with a long-term perspective, the GPI counts any reduction in greenhouse gas emissions in the province as a benefit that raises the index.

Though Nova Scotia is a small player on the world stage, whose actions may have limited effect, Nova Scotians are also global citizens obligated to do their part in tackling a global crisis. Beyond that, the power of example cannot be underestimated, and there is no reason the province cannot lead the way, as a model of responsibility, in reducing greenhouse gas emissions, and urging other jurisdictions to follow suit.

4) Full Cost Accounting

As explained earlier, the Genuine Progress Index is not intended as an academic exercise but as a practical policy-relevant tool that can assist policy makers in assessing the long-term benefits and costs of alternative development and investment options. While the GPI

is being developed here as a macro-economic measurement instrument that can establish benchmarks of progress for Nova Scotia, we have decided to take this particular component of the index to demonstrate the utility of the GPI method at the micro-policy level.

There is a wide range of potential greenhouse gas emission reduction strategies. How are policy makers to determine the most cost-effective means available that will yield multiple long-term benefits to society with a minimum of cost and hardship? Unlike conventional assessment tools that are not capable of factoring long-term social and environmental impacts into the cost-benefit equation, the GPI is based on “full cost accounting” principles that are essential to optimal economic efficiency. In 1992, the Nova Scotia Round Table on Environment and Economy urged that full cost accounting be adopted as the essential basis of any strategy of sustainable development for the province. But this has not yet happened. Here are two contemporary examples:

The casino proposals were assessed according to up-front income likely to be generated. Potential long-term social costs, including increased police and criminal justice expenditures, counselling costs, and impacts on families, small business and the health system were not included in the cost-benefit equation. Similarly, the most recent federal State of the Environment report pointed out that local farmers cannot grow a lettuce for the price at which supermarkets sell imported California lettuce, because the full costs of subsidized transportation, energy use, greenhouse gas emissions, pollution, soil degradation and erosion through monoculture farming and other impacts are not taken into account at the cash register.

To the degree that social and environmental impacts are not included, the market economy will function inefficiently, since there are no built-in incentives to reduce energy and transportation costs, social expenditures, or pollution clean-up costs. Instead, these costs are often borne by the taxpayer, sometimes generations later, as we are now experiencing with the Sydney Tar Ponds and Halifax Harbour.

“Polluter pay” principles, now widely accepted in Europe, are an important step towards full cost accounting that encourages production efficiency and reduces the clean-up cost burden on future generations. From that perspective, full cost accounting is an essential investment in the future. The Nova Scotia Environment Act, Part One, section 2 (c) affirms “the polluter-pay principle, confirming the responsibility of anyone who creates an adverse effect on the environment to take remedial action and pay for the costs of that action.” The GPI can help make this section of the Act a reality.

The GPI recognizes that there are three stages in the implementation of full cost accounting. The first step, which the GPI attempts to accomplish, is the incorporation of social and environmental benefits and costs into the central accounting system and measures of progress.

The second step, which will follow naturally, is the translation of these benefits and costs into the tax and financial structures, so that beneficial activities are rewarded and harmful

ones discouraged. An example is the gradual shift, in some European countries like Denmark, from payroll taxes (which dampen useful economic activity) to pollution, carbon and other “green” taxes, which penalize activity that produces long-term costs. A consequence of the GPI forest account would certainly be changes in the tax structure to reward sustainable harvesting practices and penalize unsustainable ones.

The final step, still in the future, is the reflection of social and environmental benefits and costs in the actual market price structure, so that the consumer actually pays the true cost of the products purchased. That will not only increase market efficiency by encouraging producers to reduce energy and other costs, but also decreases the burden on taxpayers and the need for external regulation of the market.

The GPI greenhouse gas account uses just one example to demonstrate full cost accounting procedures in practice applied to one particular policy option. It examines the potential for reducing greenhouse gas emissions by a 10% modal shift in the freight sector from road to rail, taking into account a wide range of costs and benefits, including property and fuel taxes, registration, license and toll fees, infrastructure costs (capital and maintenance), policing and administrative expenditures, costs of air pollution and greenhouse gas emissions, accident costs, and costs of fossil fuel depletion.

The GPI study finds that taking all these costs and benefits into account would reduce Nova Scotia carbon emissions by 13,700 tonnes a year and yield a net average benefit or saving of \$10.7 million a year to the province. The study demonstrates how the cost-benefit analysis, including social and environmental impacts, can be applied to alternative greenhouse gas emission reduction options to identify “no-regrets” measures that will yield the highest net benefit to Nova Scotia society.

The GPI Greenhouse Gas Account itself is divided into **five sections**:

- an educational introduction;
- an assessment of the potential impact of climate change on Nova Scotia;
- an inventory of provincial greenhouse gas emissions by sector and emission trends over time, including an economic cost assessment of current emissions;
- an overview of emission reduction options for households, government and business; and a summary of data gaps and recommendations;
- a detailed 67-page appendix demonstrating the application of a full cost-benefit accounting analysis for one of these options, as described above.

1) Educational Introduction

Several components of the Genuine Progress Index are self-explanatory to the general reader. No one, for example, needs convincing that crime is an immediate cost, or that voluntary work provides direct benefits to our quality of life. Climate change, on the other hand, may seem like a distant concept removed from the everyday concerns of

Nova Scotians. Any initiative by government to reduce greenhouse gases therefore requires education and mobilization of the public to generate widespread support. Nova Scotians are, after all, being asked to take local action to respond to a global. Emission reductions will require changes in lifestyle for ordinary citizens. On the other hand, the opportunity exists for Nova Scotia to become a model for responsible action that other jurisdictions could follow.

Recognizing this educational need, the GPI introduction will review the accepted wisdom on greenhouse gases and climate change, in layman's terms and suitable for dissemination to the general public. This section, not described in detail in this summary, will explain:

- the basic science of global warming and the “greenhouse effect”;
- the types of greenhouse gases and their principal sources;
- historical trends in global surface temperatures and atmospheric greenhouse gas concentrations since pre-industrial times;
- the predictions of the Intergovernmental Panel on Climate Change (IPCC) for the 21st century;
- the potential global impacts and effects of the predicted warming; and
- Canada's commitment to international agreements to reduce emissions in the years ahead.

2) Potential Impacts of Climate Change on Nova Scotia

Global climate change models are not yet regarded as good predictors of particular regional impacts. Nevertheless, the GPI study draws on the best available expert assessments, including Environment Canada's 1997 analysis, *Climate Change and Climate Variability in Atlantic Canada*, to indicate potential impacts of global warming on Nova Scotia. In accord with the aim of the GPI project as a whole, emphasis is placed on possible socioeconomic effects.

The insurance industry has expressed particular concern over the economic costs of climate change, particularly due to an increase in extreme weather events, and is therefore also a source for the GPI study. According to the World Disasters Report, natural disasters were more damaging in 1998 than any other year on record, causing \$90 billion of damage worldwide. The Institute for Catastrophic Loss Reduction (ICLR) in Canada has identified hurricanes, erosion, and storm surges as the major climate change concerns for Nova Scotia, resulting in potential coastal flooding, sewer backup, and flooding at the municipal level.

It is not scientifically possible at this stage to link particular local events with climate change. But intense floods this summer in Antigonish and in Oxford, Nova Scotia, most recently causing \$3 million in damage to roads in Cumberland County alone, may possibly be a sign of things to come. Similarly, in light of IPCC predictions of an increase in the frequency and intensity of droughts world-wide, it would not be prudent to dismiss the possibility that the three straight years of drought experienced by Nova Scotia farmers

may be linked to global warming. Nova Scotia farm losses in 1999 are already \$35 million, and are expected to reach \$50 million before the end of the year.

Certainly lower rates of precipitation and milder winters, predicted by climate change models, have already made an impact on the agricultural sector in the province and the Nova Scotia Federation of Agriculture newsletter recently warned that climate change may already be a reality for Nova Scotia farmers. Three of the last five seasons in Atlantic Canada have been the hottest on record, and the other two were the second and fourth warmest ever recorded. The spring of 1999, the warmest on record, was 2.8 degrees above normal, and summer rainfall in the Annapolis Valley was less than half the seasonal average.

Again, it must be emphasized that these floods, heat waves, and drought years may well be natural aberrations. But the precautionary principle, discussed above, insists that possible warning signs be taken seriously and that action to forestall potentially catastrophic climate change effects not be delayed. Indeed, 13 large insurance companies have already joined to create a new Risk Prediction Initiative, and the ICLR has teamed up with other organizations in a Natural Hazard Risk Assessment Committee to assess potential regional risks due to climate change.

The GPI study therefore reviews existing evidence to assess potential impacts of climate change in Nova Scotia in the following areas:

- *Temperature and Precipitation:* Aside from the drought conditions discussed above, there has been a decrease in snow cover in the Atlantic region since 1971, and many rivers are at all-time low levels.
- *Extreme Weather.* Of greatest concern for Nova Scotia is possible increased hurricane and cyclone activity. Hurricanes have proven among the costliest natural disasters, both to human life and property, and evacuation costs alone have been estimated at \$660,000 per mile of coastline in the United States. Since Nova Scotians are also Canadian taxpayers and pay insurance premiums to national insurance companies, they share the economic burden of extreme weather events elsewhere in the country. The Quebec ice storm alone cost \$1.5 billion; and government insurers in Canada paid over \$2.8 billion in 1998 for claims due to natural disasters. An increase in extreme weather events due to global warming, predicted by the IPCC, will increase premiums and damage costs. As noted above, an increase in extreme weather events, natural disasters, and catastrophic losses is good for the GDP and economic growth, since cleanup and replacement costs are, perversely, counted as economic gain.
- *Nova Scotia Coastal Zone.* Low-lying regions around Yarmouth, the Bay of Fundy, and Halifax Harbour have been identified as particularly vulnerable to a combination of sea level rise, higher tides and changes in storm intensity and frequency. The Tantramar Marshes, the Truro flood plain, and sections of the southern and eastern shores are also susceptible to flooding, erosion, or increased coastal instability. Saltwater infiltration of groundwater, threats to communication links, and

overtopping of dykes due to storm surges are also predicted in some areas. The construction of new dykes and the raising of existing ones will be costly. A sea-level rise of 75 cm has been predicted for Halifax over the next 100 years.

- *Fisheries.* Climate change is expected to impact the distribution of fish species, migration patterns, arrival times, recruitment success, and growth rates, through physiological effects, and changes in disease, food availability and predator abundance. Paradoxically, global warming is predicted to produce colder, denser, less saline water off Nova Scotia in the long run as Arctic ice caps melt, possibly altering the course of the Gulf Stream, and reducing the population of certain fish species. The GPI study notes that extremely limited knowledge of ocean response, fish life-cycles, and environmental influences on fish, prohibits definitive predictions of the effects of climate change on the fisheries. The importance of the fisheries both to the Nova Scotia economy and to the viability of coastal communities makes further research in this area imperative.
- *Agriculture.* Global warming could increase some crop yields, weeds, and pest populations. Higher carbon dioxide levels will help fertilize plants and weeds, and milder winters will allow pests currently eliminated by the cold to survive. Pests of particular concern to Nova Scotia if winters become milder are the gypsy moth, the cereal-leaf beetle, and the tarnish plant bug. Drier weather would increase the need for irrigation, a costly enterprise. The 1998 drought cost between \$30 and \$50 million in lost crops and livestock, and 1999 farm losses are expected to reach \$50 million by year end. A range of estimates for Canada as a whole predicts a decrease in agricultural value of between 0.04% to 0.2% of national GDP annually in the event that atmospheric carbon dioxide concentrations double during the next century as predicted. For Nova Scotia this would mean an annual loss of \$5.3 to \$26.4 million, less than that actually experienced by farmers in the last two years.
- *Ecosystems and Water Resources.* The GPI report summarizes potential impacts of an intensified hydrological cycle on Nova Scotia, as predicted by climate change models. Predicted costs include falling lake and groundwater levels, lower levels of dissolved oxygen in rivers and lakes, stresses on freshwater fish populations, and runoff damage to human infrastructure, including dams, bridges and water supply. Predicted benefits include a major reduction in river ice jams. Wetlands, bird migrations patterns, and wildlife habitat are all highly sensitive to climate change.
- *Forestry.* The IPCC predicts that global warming will increase forest fire losses by 140% globally, with \$1.8 billion of annual damages to OECD countries alone. Environment Canada predicts that the Canadian forest industry will suffer, as new northern forest ranges will not mature fast enough to compensate for predicted southern range declines. Soil organic matter, an important CO₂ sink, will also decompose faster as temperatures rise, decreasing the carbon sink value of forests and releasing carbon into the atmosphere. Forest productivity in Atlantic Canada is expected to increase by 15-16% under current climate change models, but fire, insect and disease outbreaks are also expected to increase.

- The GPI report also summarizes predicted climate change impacts on *air pollution*, *energy*, and *human health* in Nova Scotia. This includes an expected increase in vector-borne diseases, air pollutants, and water-borne diseases, with respiratory problems and allergies likely to become more severe.
- The GPI study also notes that climate change is expected to produce up to 150 million *environmental refugees* world-wide by 2050, forced from their homes by sea-level rise, soil degradation, flooding, erosion, and drought. Just as Kosovo and East Timor produce costs for Canadian taxpayers, so disaster relief, refugees and other overseas impacts of climate change will produce costs here. In short, since Nova Scotia is not isolated from the world, global warming costs cannot be assessed solely by the direct impact of climate change on Nova Scotia alone.

3) Nova Scotia Greenhouse Gas Emissions

This section of the GPI study, assessing provincial emission trends by sector, is the basis for establishing actual benchmarks of progress for the greenhouse gas component. These benchmarks are set in relation to three standards, beginning with the most relative:

- a) Any improvement is gauged by an annual decrease in greenhouse gas emissions from previous years. A decline in emissions makes the GPI go up, and an increase makes it go down.
- b) Progress is also assessed in relation to Canada's commitment under the Kyoto Protocol to reduce emissions by 6% below 1990 levels in the period 2008-2012. This translates into a decrease of 13.9% from 1995 levels.
- c) Even the Kyoto standards will not prevent an increase in atmospheric greenhouse gas concentrations nor turn back global warming trends. An "absolute" or long-term standard of sustainability must therefore be related to the global capacity of forests, soils and oceans to absorb three to four billion tons of carbon annually, about half the current emissions.

Some sample data follow: On a per capita basis, Canadians, including Nova Scotians, are among the highest emitters of greenhouse gases in the world. In 1995 Nova Scotia greenhouse gas emissions were 18,600 Kt of carbon dioxide equivalents, fairly stable since 1991, when emissions were 18,800 Kt. Nova Scotia emissions are currently 19 tonnes per capita, compared to 21 tonnes per capita nationally. Thirty percent of provincial emissions come from mobile sources.

The GPI study summarizes emission trends in various sectors. For example, the decline in coal mining has helped reduce provincial emissions, while the popularity of light duty trucks and minivans has increased emissions in the transportation sector. Light duty trucks have a 40% lower fuel efficiency than automobiles, and have almost doubled their market share over the last 15 years. Energy consumption in the residential sector declined significantly until 1996, at which point it began to rise again. Vehicles currently account for about 45% of household greenhouse gas emissions, and space heating for 33%.

Industrial and agricultural sector emissions in Nova Scotia are also examined in some detail in the GPI report, and tables and graphs indicate the sectors with significant increases and decreases in emissions over time. The analysis of sectoral trends is important in order identify cost-effective strategies for emission reductions.

4) Options for Greenhouse Gas Emission Reductions

This section of the GPI report looks to the future, and examines cost-effective strategies for reducing Nova Scotia greenhouse gas emissions in the different sectors. “Best practices” from other jurisdictions are examined for their applicability to Nova Scotia, and successful strategies noted within the province. The GPI study notes the potential for greenhouse gas emission reductions in energy production and use; transportation; agriculture and forestry; and industry; and summarizes actions that can be taken within the home, including those specifically recommended by Nova Scotia Power.

Among specific strategies described in the GPI report is the potential for significant emission reductions through “cogeneration” and “district heating.” The ‘waste’ heat from the Tuft’s Cove Power Station, for example, could supply residential heating and hot water to all of Halifax.

The potential for modal shifts in the transportation sector that can reduce greenhouse gas emissions are discussed in detail, partly because transportation accounts for such a high proportion of greenhouse gas emissions in the province. Examples from other jurisdictions described in this section include the creation of high occupancy vehicle lanes, van and carpooling, telecommuting, integrated land use-transportation planning, increasing public transit ridership, the cashing out of parking subsidies, and road pricing strategies to reduce automobile use.

5) Cost-Benefit Analysis of Alternative Emission Reduction Strategies

As noted above, this 67-page section of the GPI report demonstrates the applicability of the GPI full cost accounting method to specific greenhouse gas emission reduction strategies, to determine the options that will yield the most significant long-term benefits to Nova Scotia. From a practical policy perspective, this is the most important contribution the GPI can make. In a sense, the previous sections constitute the necessary background for this analysis.

The GPI study examines the effects of one particular policy option – a 10% shift of freight from road to rail – on a range of social, economic, and environmental benefits and costs. Using the Halifax to Amherst freight route as a case study, this analysis finds that the modal shift could reduce carbon dioxide emissions by nearly 14,000 tonnes annually. When capital, maintenance, policing and administrative costs are considered along with the “external” costs of accidents, air pollution, fossil fuel depletion, and greenhouse gas

emissions, the study finds a net benefit or saving to Nova Scotians of \$10.7 million annually through this shift.

However, the study is more important for its demonstration of a very useful method for identifying “no regrets” measures that can bring long-term benefit to the province than for the particular results of this analysis. This section of the GPI greenhouse gas account concludes with specific recommendations for further applications of the GPI method to determine the combinations of modal transportation shifts, enhancement of forest sinks, and shifts in energy production and usage that can yield the greatest greenhouse gas reductions at the least cost. Reference is made to the conclusions of other full cost accounting studies that have identified the strategies most worth examining for their applicability to Nova Scotia.

Among the conclusions of the GPI greenhouse gas component is the recognition that Nova Scotia is very well placed to be a leader in promoting and implementing cost-effective strategies to reduce greenhouse gas emissions. If the province accepts this responsibility, with critical global implications, it is very feasible that representatives of other jurisdictions will come to Nova Scotia to study the model developed here. Such a leadership role also has the potential to foster the development of industries producing environmentally friendly technologies, creating jobs that at the same further the stewardship of the environment on which the human economy ultimately depends.