GPI Atlantic

Genuine Progress Index for Atlantic Canada / Indice de progrès véritable - Atlantique

MEASURING SUSTAINABLE DEVELOPMENT

APPLICATION OF THE GENUINE PROGRESS INDEX TO NOVA SCOTIA

THE ENERGY ACCOUNTS *for the* NOVA SCOTIA GENUINE PROGRESS INDEX

EXECUTIVE SUMMARY

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Introduction: Energy and the GPI Framework

Energy is essential to all life on earth. Whether as nourishment to sustain individual organisms or as fossil fuels to run modern societies, every activity on earth is dependent on a constant, abundant, reliable source of energy. An interruption to modern energy supplies can have serious consequences for economy and society, jeopardizing current standards of living. But the intensive use of energy, especially that obtained from fossil fuels, is also the primary cause of a number of environmental, social, and economic concerns. Current energy production and consumption patterns have been linked to global climate change, local health impacts, and regional impacts such as air and water pollution, damage to marine and other wildlife, land-use conflicts, security implications, resource depletion, and soil contamination. Until recently however, attention has been given predominantly to developing new fossil fuel based energy sources and securing existing ones, with little regard for the health and environmental impacts these create. The benefits of abundant supply were considered to outweigh the social and environmental costs of maintaining that abundance. When those costs are included in the equation, as in this study, the current model is seen to be unsustainable.

The failure to count full benefits and costs, and thus to evaluate energy supply and demand accurately and comprehensively, stems largely from the fact that 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 the economic growth rates on which we currently, and mistakenly, base our assessments of prosperity and social wellbeing. In addition to ignoring production of goods and services and capital items that traditionally have no market value, 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 completely dependent upon, an encompassing ecosystem that provides vital life-support services to human society. The energy 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 waste in turn affects the functioning of the human economy. The conventional view that ignores the dynamic interaction between the human economy and the encompassing ecosystem on which the economy depends helps perpetuate our unsustainable energy system.

By contrast, the GPI accounts acknowledge the reality of that dynamic interaction and define wealth more broadly to include valuations of natural capital, social capital, and human capital in addition to the conventional produced capital. This report starts with physical indicators of progress towards a sustainable energy sector and examines trends over time to assess whether energy use is becoming more or less sustainable. An economic valuation of some of the full costs of energy use follows the presentation of these indicators; but the underlying physical indicators, rather than the economic valuation, provide the direct means to track progress. This is because environmental restoration measures such as greenhouse gas and pollutant reductions are defensive expenditures that may be interpreted either as compensation for past damage or as positive investments in natural capital. Measures of genuine progress therefore always rely on the underlying physical indicators on which the economic valuations are based.

While the GPI is being developed here as a macro-economic and social measurement instrument that can establish benchmarks of progress for Nova Scotia, the GPI method also has practical utility at the micro-policy or project level. 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 promote optimal economic efficiency. At the micro-level, the GPI can therefore be used to evaluate program effectiveness in a more comprehensive way than conventional instruments that account only for market interactions. Thus, the methods outlined in this report can also be used to assess whether particular policies designed to implement the recommendations noted above and to move the province towards a more sustainable energy system are working or not.

GPI Energy Accounts

The GPI Energy Accounts are organized in nine chapters:

- Chapter 1 provides an overview of the GPI approach as it applies to energy, examines sustainability principles, and defines sustainable energy.
- Chapter 2 provides a snapshot of the current energy system in Nova Scotia.
- Chapter 3 is an overview of the social, economic, and environmental impacts of energy use.
- A discussion about indicators, indicator frameworks, and indicator selection criteria used in this report is contained in Chapter 4.
- Chapters 5-7 provide detailed discussions and time series for some of the indicators identified in Chapter 4 and for some of the impacts discussed in Chapter 3, They also provide some information on additional economic and institutional aspects of energy use.
- Using the data presented in Chapters 5-7, Chapter 8 provides estimates on the monetary costs of our current energy choices.
- Chapter 9 is the most important chapter for policy makers and concerned citizens as we summarize the main findings of the report and make recommendations on three levels: first, how to improve and expand this report on genuine progress in the energy sector in the future; second, to identify where more research is needed and where new data need to be collected in order to track sustainability in the energy sector more effectively; and third, to point towards policy actions that can achieve greater energy sustainability.

The term energy in this report refers principally to the power used by Nova Scotian society for electricity, heat, and industrial processes. Transportation is also a fundamental component of the energy sector but is not discussed extensively in this report, as it has been presented separately in the **GPI***Atlantic* Transportation Accounts.

Energy Overview

As in most parts of the world, energy demand in Nova Scotia is heavily dependent on fossil fuels. Almost 70% of demand in the province is for oil products while electricity (mostly from coal) accounts for 21%. Some indigenous resources are used here, such as biomass for heating and hydro for electricity, but these amount to less than 10% of final demand. All of the province's oil is imported and only a small portion of the province's electricity is generated with domestic fuels. Although the province has some natural gas reserves that have been tapped since 1999, production has been in decline for the past three years and only a small fraction of the gas is used domestically. Domestic coal production declined substantially in the 1990s and amounted to only 32 kilotonnes in 2003. Imported coal is the dominant fuel used to generate electricity, representing about 75% of the fuel mix in 2001. While significant domestic coal reserves remain, these are not currently being extracted, primarily for economic reasons. In addition, the damage to land, water, and air from coal extraction and combustion make this an undesirable fuel from an environmental point of view.

Currently about 9% of electricity in the province is generated from renewable energy sources - mainly hydro and tidal power and more recently some wind. Hydro power is not expected to expand significantly because the best sites have already been used. Nova Scotia's geography and climate provide a favourable wind regime. However, wind only produces a fraction of a percent of the province's primary energy. Similarly, geo-thermal and solar energy remains untapped with only a handful of mine-water systems in the Springhill area, some residential heat-pumps, and a few homes and businesses using solar applications. Wood provides heat for an estimated 100,000 homes in Nova Scotia while a number of large industrial and institutional facilities use wood for heating and energy needs.

End use demand is attributable to (in descending order) the transportation, residential, industrial, commercial, public administration, and agricultural sectors. Energy demand in Nova Scotia declined rapidly in the early 1980s due to the 1970s oil crises. The fact that energy use levels in Nova Scotia have remained below the highs of the 1970s is a positive indicator from the perspective of sustainability. However, since 1991 end use energy demand has increased 10%. Although data are suppressed for the total amount of energy used in the province, it appears that at the current per capita energy use level, Nova Scotians are among the highest energy users in the world, well above the average for OECD nations.

The current dependence on non-renewable and polluting fossil fuels in Nova Scotia indicates a highly unsustainable energy system. Sustainable energy is defined in this report as an energy system that provides "adequate energy services for satisfying basic human needs, improving social welfare and achieving economic development throughout the world without endangering the quality of life of current and future generations of humans or other species." In addition, a sustainable energy system is one based on replenishable resources with a minimised waste stream that does not exhaust the absorptive capacity of the biosphere. In general, a sustainable energy system includes the following components:

- Reducing demand for and dependence on conventional energy supplies (i.e. fossil fuels and nuclear energy) through changes in consumption patterns, including changes in individual, household and social behaviour and more efficient use of energy;
- A greater reliance on renewable sources of energy;
- Using cleaner sources of conventional energy, such as natural gas, as a bridging fuel and developing ways to reduce the impact of more polluting sources.

From the perspective of the principles of sustainability and particularly of inter-generational equity outlined in this report, it is clearly not ideal to rely on non-renewable energy sources to any extent, as current consumption habits are *ipso facto* denying future generations a source of cheap energy and a feedstock for a host of products. However, a "cold turkey" switch to complete reliance on renewable energy sources is also not possible or realistic. Therefore, the key mark of a sustainable energy system in the present, which honours the principle of inter-generational equity, is the continued use of non-renewable energy supplies at such a rate as allows their gradual replacement by affordable and renewable alternatives.

Indicators of Energy Sustainability

Measurement is needed to determine if our energy system is moving us towards or away from a healthier society, a cleaner environment, and a more robust economy, and also to identify what institutional decisions in the energy sector are achieving or hindering the attainment of these objectives. This study identified and assessed 30 indicators to measure progress in the energy sector in Nova Scotia. The indicators were grouped into the following categories: socio-economic, health and environment, and institutional. Only two of the 30 indicators (particulate matter and mercury emissions) are showing clear signs of progress towards sustainability based on the definition of sustainability presented, and even in those two cases, emissions levels remain unacceptably high.

Socio-Economic Indicators

Approaches to energy service delivery must allow economic activities to continue without harming human health or the environment. The types of energy used and produced, where it comes from, its costs, the jobs created, and the reliability and affordability of supply, are all important factors to consider when examining the relationship between energy and economy. The indicators developed for this section are summarised in Table E1.

Table E1. Overview of socio-economic indicators

Area of Concern	Indicators
Energy production and supply	1. Current energy mix - total units per year by primary fuel type 2. Units of primary energy produced in the province vs. units of imported energy by fuel type 3. Percent of electricity generated from renewable sources, natural gas, and other fuels
Energy consumption (by end use and fuel type)	4. Total energy consumption by fuel type 5. Total energy consumption by end use
Energy efficiency	6. Equipment efficiency 7. Building efficiency 8. Process efficiency (in industry) 9. Electricity generation and transmission efficiency (I.e. Improve the input:output ratio in energy production and use in all these areas.)
Employment	10. Number of person months employed on energy-related jobs (by industry – direct and indirect employment) 11. Number of person months lost due to energy industry accidents
Affordability	12. Percentage of households living in fuel poverty
Reliability	13. Number of household hours per year without power 14. Business hours lost due to power failure

There is a serious lack of data at the provincial level concerning the socio-economic aspects of energy production and use, including total primary energy, fuel poverty, energy efficiency, subsidies, and employment costs and benefits. The limited available information in these areas suggests the following trends: In terms of affordability and security, energy prices over the last two decades remained relatively stable until recent oil price increases revealed the vulnerability of dependence on imported supplies that will become increasingly insecure, costly, and unstable with the impending advent of peak oil production. Despite a paucity of information on energy efficiency in the province, the available data suggest that minimal progress has been made over the last two decades. There was insufficient information to identify trends for the other socio-economic indicators, and improved data collection and monitoring are needed to assess the socio-economic sustainability of the energy system accurately.

Health and Environmental Indicators

The production and consumption of energy, regardless of the source, always has some impacts on human health and the environment. However, not all forms of energy have equal effects, with some sources having far fewer or less intense impacts than others. Choices between different energy options require that advantages and disadvantages be accurately weighed, and indicators provide a key means of doing that. The environmental and health indicators developed in this report are presented in Table E2. Air pollutant and greenhouse gas (GHG) emissions were the only ones that could be fully developed based on existing data sources. Although most pollutant emissions from the energy sector have been decreasing over the long term, Nova Scotia remains one of the highest per capita emitters of all these pollutants in the OECD. High domestic emissions combine with transboundary pollution to produce continued acid deposition damage to forests and waterways and incidences of elevated ground-level ozone in the province.

Table E2. Summary of selected health and environment trends (pollutant and GHG emissions) for the energy sector

Indicator	30-Year Trend	10-Year Trend	Movement Towards Sustainability[c]
CO emissions total[a]	Unknown	Unknown	?
TPM emissions total	Decreasing	Decreasing	Yes
SO_x emissions total	Decreasing	Increasing	No
NO_x emissions total[b]	Decreasing	Increasing	No
VOCs emissions total[a]	Unknown	Unknown	?
Mercury emissions total	Unknown	Decreasing	Yes
GHG emissions total	Unknown	Increasing	No

Notes: a) Changes in emissions estimates attributable to changes in data reliability make actual trends unclear. b) Recent emission increases following historical declines indicate new measures are needed to ensure continuing improvement. c) "Sustainability" is used here in a relative sense only to indicate the directionality of trends. It is not used here to signify that current emissions levels are sustainable by any more absolute standard.

High energy-related air pollutant emissions in Nova Scotia are due primarily to two factors: the dominance of coal-fired electricity generation and the use of wood for home heating. The use of coal is largely responsible for the elevated emissions of sulphur oxides (SO_x), nitrogen oxides (NO_x), mercury (Hg), and to some extent GHGs. Nova Scotia's per capita SO_x emissions from stationary energy sources alone are seven times the level of the rest of the country and four times higher than the OECD average *total* SO_x emissions from all sources. Wood combustion produces elevated emissions of carbon monoxide (CO), total particulate matter (TPM), and volatile organic compounds (VOCs). As a locally available renewable source of energy, wood may be a desirable source of energy from a sustainability perspective. However, provincial and federal standards are needed for wood burning devices in order to reduce harmful emissions that not only affect local ambient air quality but may also lead to poor indoor air quality. Although there are technical solutions for some of the impacts of coal burning, there are many impacts from the mining stage, to the release of greenhouse gases, to the disposal of toxic ash that currently have no or only partial solutions.

The indicators noted here represent only those for which enough information is available to track trends. Unfortunately, the effects of our energy use on land and water quality, on land use, on terrestrial and aquatic ecosystems, and on peoples, soils, water and air in other countries remains largely unknown due to lack of research and data in these areas. Some of these other impacts are broadly discussed in Chapter 3.

Institutional Indicators

Institutional indicators provide a means for institutions to assess how well they are managing the interactions between the economy, society and the environment and how they themselves measure up against the sustainability goals and targets that they propose for society as a whole. They also provide the enabling framework for sustainable development, because they assess the effectiveness of the underlying rules and organizational structures that direct society in a sustainable direction. Institutional indicators related particularly to governmental action in the energy field cover four areas – leading by example, creating societal change, reporting, and evaluating (see Table E3).

It is hoped that the development of these institutional indicators will strengthen the role of the Nova Scotia government both in setting the rules and targets for a sustainable energy system and in ensuring that these rules and targets are implemented, supported by financial instruments, and enforced when necessary.

Table E3. Summary of institutional indicators for the energy sector

Area of interest/concern	Indicators
Institutional	
Leading by example	Internal government efforts to promote sustainable energy: • Green energy procurement • Ensuring energy efficient government buildings
Creating societal change	Regulatory, educational and fiscal measures: • Incentives for sustainable energy use and disincentives for excess consumption and unsustainable use • Efforts to educate the public about sustainable energy options • Enforcement of regulations and standards
Reporting	Overseeing energy sector activities while ensuring transparency and equity: • Target setting and progress reporting • Level of indicator development
Evaluation	Efforts to monitor and improve how government addresses energy concerns: • Integration within government departments and among levels of government

While some policies in Nova Scotia do address the impacts of energy production and use on the larger economy, on society, and on the natural environment, many policies are also outdated and require reassessment. Moreover, there is a void in terms of data and indicator development for these important institutional factors. The evidence that does exist indicates that provincial and federal governments have thus far made inadequate effort to address the heart of our unsustainable energy system, including high and increasing demand levels, and the dominance of limited, polluting, and non-renewable fossil fuels.

The Full Cost of Energy

Environmental or "full-cost" accounting attempts to provide a more accurate and comprehensive picture of the full or true costs of economic activity by assigning explicit value to externalities. For example, some of the effects of pollutant emissions on health and on changes in environmental quality can be assessed in pecuniary terms if there are demonstrated impacts on health care expenditures, productivity losses, pollution cleanup expenses, lost recreational opportunities, and other such costs. Other environmental externalities include oil spills that contaminate water and cause wildlife destruction; degradation of habitat and soil erosion due to poor forestry practices; and acid drainage from coal mines.

The economic valuation of Nova Scotia's energy system in this report was only able to produce monetary dollar values for a limited number of currently unaccounted impacts, including greenhouse gases (GHG) and a number of air pollutants. A number of other important costs were not included in the valuation either because physical data were not available or because costing methodologies were not sufficiently developed. Potential valuation methods and examples of monetary estimates have been referenced and described where relevant for affordability, energy security, resource consumption and depletion, subsidies, employment and land use.

Total damage costs resulting from air pollutant and GHG emissions attributable to energy use in Nova Scotia were calculated to lie between $617 million (low estimate) and $4 billion (high estimate) in 2000, depending on assumptions and methodologies used. These are presented in Table E4. As the higher-end estimates include the costs of shocks, catastrophic damages, and massive produced and natural capital infrastructure loss, such as occurred recently in Hurricane Katrina, it is not difficult to see that the potential climate change damage costs attributable to greenhouse gas emissions, as predicted by some scientists and economists, can be very high.

Table E4. Nova Scotia Energy-related Air Pollutant and GHG Damage Cost Estimates, 2000

Pollutant	Emissions (tonnes)	Low Estimate		High Estimate	
		$C2000/tonne	Damage Costs	$C2000/tonne	Damage Costs
CO	52,782	$2	$105,560	$6	$316,690
TPM	14,467	$2,120	$30,670,040	$5,180	$74,939,060
SOx	146,621	$1,380	$202,336,980	$10,500	$1,539,520,500
NOx	30,547	$1,410	$43,071,270	$12,450	$380,310,150
VOCs	11,474	$2,000	$22,948,000	$8,240	$94,545,760
Hg	0.267	$8,180,400	$2,184,160	$11,521,500	$3,076,240
GHG	13,750,000	$23	$316,250,000	$137	$1,883,750,000
Total			**$617,566,000**		**$3,976,458,000**
Per Capita			**$661**		**$4,257**

Notes: Monetary estimates for damage costs were adjusted for inflation and converted to Canadian dollars from the foreign currencies used in the literature. The first column heading "pollutant" applies literally to the first six categories of emissions but not to the seventh (GHGs). Cost estimates for GHGs are the net present value of projected climate change damage costs attributable to greenhouse gas emissions, but the latter are not literally considered a "pollutant."

Full-cost accounting is a challenging endeavour that may yield results that are contentious, complex and incomplete, and that vary considerably depending on the assumptions employed. Costs will vary from place to place because there are many national and regional variations that affect the full value of energy choices. Because of these and other challenges, a "full" cost accounting of energy production and use in Nova Scotia is simply not possible at this preliminary stage, and this report is only able to point to a few key costs of energy that are not considered in conventional accounting mechanisms. Despite the uncertainties and the preliminary nature of the data in this report, this initial attempt at economic valuation is a vitally important exercise, since not assigning a value to non-market goods and services implies that they have zero monetary worth (which is highly inaccurate).

Conclusions and Recommendations

The evidence presented in this document shows quite clearly that Nova Scotia is not making significant or adequate progress towards sustainability in its energy system, and that the production and use of energy are the leading causes of a number of serious environmental problems. But energy is also a vital component of a healthy society and vibrant economy. Balancing the tradeoffs between environmental health, social wellbeing, and economic development is not an easy task but one that must be undertaken if we are to protect the environment and the health and wellbeing of Nova Scotians. Based on the principles of sustainability established in this report, the evidence makes it clear that the Nova Scotia energy system does not:

- Achieve inter-generational equity since non-renewable resources are being depleted at faster rates than they can be replaced by other energy sources, thereby depriving future generations of 'cheap' energy sources;
- Respect the carrying and absorptive capacity of the earth, since per capita air pollutant and greenhouse gas emissions and other wastes resulting from the energy sector in Nova Scotia are extremely high by OECD standards, and are causing serious and potentially irreversible damage to land, air, and water;
- Adhere to the precautionary principle, since where there are threats of serious or irreversible damage, lack of full scientific certainty is often still used as a reason for postponing measures to prevent environmental degradation;
- Internalize negative externalities, since polluters do not generally pay for the damage they create;
- Take both qualitative and quantitative integrity into consideration since the current system is not concerned to leave both ample supplies and high quality forms of energy for future generations. Sustainability requires that energy sources are matched both in scale and in energy quality to end use needs so that both quantity and quality are ensured;
- Adequately address both the supply and demand side in energy management. Suggested and enacted regulatory measures are incomplete and fail to ensure that both producers *and* consumers of energy take responsibility for the consequences of their actions and of their consumption patterns by reducing overall energy demand and providing the remaining consumption needs through environmentally and socially benign processes.

The definition and principles of a sustainable energy system require action on two main levels. First, there must be ample investment in renewable energy development and deployment in order to accelerate sharply the rate of its adoption and use. Equally importantly, the current rate of non-renewable energy consumption must be drastically slowed to delay the advent of peak oil production and the end of cheap non-renewable supplies, and to decelerate and then reverse the serious environmental consequences of fossil fuel combustion including climate change and air pollution. This can be achieved by concerted conservation efforts and sharp efficiency improvements, both of which can also reduce costs or at least absorb gradual price increases.

While acknowledging the improvements (reductions) in energy-related air pollutant emissions over the past 30 years; the small but growing renewable energy industry; and other efforts towards greater sustainability in the energy field outlined in this report, the evidence indicates the need for much more concerted and effective movement towards a truly sustainable energy system. Recommendations to this end have been provided in five areas: data needs; goals and targets; energy supply and demand; institutional actions; and future research.

For many of the social, economic and environmental impacts of energy use there is still little or no adequate data. These gaps make it impossible to assess progress towards energy sustainability fully and properly, and increase the likelihood that policy and economic decisions will be based on inadequate data, information and knowledge; that past mistakes will be repeated; and that existing environmental and social problems will be compounded. While this study attempts to compile and synthesize existing energy-related data for Nova Scotia and thereby to paint a more comprehensive portrait of the energy picture in Nova Scotia, the evidence in this report indicates the need for a much deeper strategic commitment by government and other institutions to collect, analyze and publish essential data on a more regular basis.

Creating a sustainable energy system in Nova Scotia is not unattainable. What is needed is visionary and practical leadership that will establish clear goals towards which we can work that will both increase the portion of energy that comes from renewable sources and decrease overall energy demand. To achieve these two basic goals, concerted action is needed on many fronts. This is not the responsibility solely of governments or the energy industry. Nor does the solution lie only in producing more renewable energy, for renewable energy has social, economic and environmental impacts as well, and there are limits to the amounts that can presently be produced. We must also address demand, which creates responsibilities for individuals, households, businesses and all consumers and users of energy.

In partnership with other sectors, therefore, the evidence points to the need for government to lead on a number of fronts that include the following initiatives:

- An improved data collection and analysis system aiming to fill key data gaps in primary energy, efficiency, affordability, employment, air monitoring, land and water impacts, wood use, mercury emissions, subsidies, and government reporting.
- Establish targets and develop tools to improve efficiency in all areas of energy use including: electricity generation where the use of combined heat power and distributed generation has great potential; improved building and appliance efficiency codes for homes and offices; and new industrial processes and improved industrial technology.

- Establish targets and develop tools to increase substantially the portion of energy in the province deriving from renewable sources in the electricity, heating, and transportation sectors.
- Aim to exceed Kyoto targets for reduction of greenhouse gas emissions in the energy sector and move towards a low carbon future through both supply and demand actions.
- Develop a comprehensive strategy to combat fuel poverty (i.e. finding permanent solutions for those who struggle to- or cannot meet their basic energy needs).
- Establish more ambitious long term reduction targets for all energy-related emissions, using as models the best practices and highest targets that currently exist globally.
- Establish provincial efficiency and emissions standards for wood burning devices and encourage the federal government to do likewise.
- Provide easily accessible information to all citizens and businesses about the impacts of energy choices and ways to reduce demand through conservation and efficiency.
- Use full-cost accounting analyses in relation to all energy related policy, especially major infrastructure and electricity generation decisions such as the construction of new power plants, in order to weigh the true costs and benefits of all energy activities.