The starting point of this study is the question: what should we do and what barriers and obstacles do we need to overcome if we want our society to become sustainable 50 to 100 years from now?

This chapter explores what we really mean by a sustainable society. It starts with some basic definitions, including a seminal concept - the Conserver Society - that was developed in Canada thirty years ago. A relatively new notion is that of sustainable communities, which is best illustrated by the QUEST initiative, a model of an integrated community energy system. We then review a number of recent reports and projects that offer clear indicators and metrics of what a sustainable society might look like. We find that sustainability is not a theoretical concept, but a measurable approach with well defined quantitative performance indicators of how to manage our economy and our society.

Annex A contains a comparative analysis of several scenarios, projections, and modeling exercises of some of these visions, focusing specifically on targets to reduce greenhouse gas emissions.

Annex B presents a list of some of the most influential literature and reports on sustainability of the past three decades, as selected by a panel Canadian environmental leaders.
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Part 1: The evolution of sustainability concepts and visions

One of the first references to sustainable development was in the 1980 IUCN’s “The World Conservation Strategy: Living resource conservation for sustainable development”, which was picked up and made popular seven years later in the report *Our Common Future* by the World Commission on Environment and Development chaired by Gro Brundtland. This was followed by other reports by United Nations agencies and conferences, including UNCED, the Rio Conference on Environment and Development in 1992, culminating in "Agenda 21".

One towering figure who has consistently asserted that we have the technology to become more sustainable if only we chose to use it, is Amory Lovins, currently operating from Colorado’s Rocky Mountain Institute. In 1976, in one of his earliest *Soft Path* analyses, he showed that Canada could operate at the same level of economic activity and use only one quarter of its energy and fossil-fuel consumption. A key principle of his approach is “second law efficiency” which is based on the Second Law of Thermodynamics and should be reflected in the design of energy systems.

This law of nature states that it is important to consider not only the quantity of energy required in end use but also the quality of that energy. The price for getting this wrong is using up too much of the energy resource. For example, industrial processes that require high temperature heat produce waste heat at low temperature that can still be used to perform useful tasks such as warming houses and buildings. This is also known as energy cascading, and when used systematically throughout the plant, or a community, can lead to dramatic overall energy savings. Conversely, using electricity generated by coal, oil or gas to provide space heating is a particularly wasteful way of using energy because of the complete mismatch between the very high quality of energy supplied and the very low quality needed. It is like using a racehorse to pull a child’s wagon. The concept is to match the quality of energy to the most appropriate task. While many people understand the concept intuitively, there is still a very long way to go before it is systematically used across the economy.

Another principle also advocated by Lovins that should govern the design of energy systems is the "whole system approach". A simple example is a building. The whole system approach to its energy consumption takes into account not only the furnace and heating system, but also all the other aspects of the building that affect its thermal performance, including lighting, HVAC (heating, ventilation, and air conditioning), water and hot water, all appliances, the building shell including walls, windows and roof, as well as patterns of occupancy. When all these systems are carefully balanced, the building can be made comfortable with very little energy consumption.

A good example is offered by the new "net zero energy" houses currently being demonstrated by CMHC. These houses are not only designed for maximum efficiency and conservation in their own operation, but also have the capacity to generate heat and electrical power through renewable energy systems and make them available for use elsewhere.

Much of the earlier environmental literature falls into works focused on trying to raise awareness of the problems facing the environment and addressing pollution of air, land and water, the impacts of pesticides and the resulting loss of animal species including fisheries, as
well as water shortages worldwide. It is only in the past decade or so that climate change has taken centre stage as the dominant issue, largely because of the work of the International Panel on Climate Change.

Other works advocate alternative models of society and communities and more responsible behaviour, starting with Schumacher's "Small is Beautiful", work by Herman Daly, and most recently, Canada’s own Peter Victor.

In essence, these works question the continued emphasis on economic growth and advocate a new paradigm based on good stewardship, reducing consumption of resources and materials and maximizing recycling and reuse.

Three years ago, Lord Stern of the UK made a compelling business case that not changing and allowing climate change to continue unabated will be dramatically more painful than if we bite the bullet and do change our way of living. His calculations suggest that the costs of change will not be unaffordable.

It is not surprising, therefore, that some of the earlier works on reducing the scale of consumption, especially of energy and fossil fuels, have taken on a new urgency and relevance, as the climate change challenge takes on more prominence in the public debate.

The latest missive to alert us to the urgency of the challenge is a recent joint letter by two formidable politicians, former US Secretary of State Madeleine Albright, and former Canadian Minister of Foreign Affairs Lloyd Axworthy. In recent public statements they draw attention to the situation in the Arctic, pointing out that the rate at which the Polar ice cap is melting is 30% faster than predicted only a few years ago.

The Conserver Society

The Conserver Society study by the Science Council of Canada was a groundbreaking piece of work published 30 years ago. It helped shape much of this debate and in a sense already contained the critical characteristics of what a sustainable society might be. The concepts of reducing waste and doing more with less is particularly relevant today and has not lost any of its impact over the intervening decades. The following are the definition of a Conserver Society as presented in the original report:

The concept of a Conserver Society arises from a deep concern for the future, and the realization that decisions taken today, in such areas as energy and resources, may have irreversible and possibly destructive impacts in the medium to long term.

The necessity for a Conserver Society follows from our perception of the world as a finite host to humanity, and from our recognition of increasing global interdependence. A Conserver Society is on principle against waste and pollution. Therefore it is a society which

- promotes economy of design of all systems, i.e., "doing more with less";
- favours re-use or recycling and, wherever possible, reduction at source;

• questions the ever-growing per capita demand for consumer goods, artificially encouraged by modern marketing techniques, and
• recognizes that a diversity of solutions in many systems, such as energy and transportation, might in effect increase their overall economy, stability, and resiliency.

In a Conserver Society, the pricing mechanism should reflect, not just the private cost, but as much as possible the total cost to society, including energy and materials used, ecological impact and social considerations. This will permit the market system to allocate resources in a manner that more closely reflects societal needs, both immediate and long term.

The QUEST vision
A relatively new concept that has emerged during the course of reviewing different models and approaches to sustainability is the sustainable community based on an integrated energy system, as well as other social and economical principles.

The “citiesPLUS” project for Vancouver embodied that integrated, whole system approach. From an energy systems perspective, however, the QUEST group has advanced more than anyone in this country. The QUEST vision is illustrated on the following page.

The following are the core elements of the Quality Urban Energy System Technology or QUEST:
• Low resource consumption per capita: energy, water
• Maximum recycling, re-use
• integrated whole-systems design of communities
• Integrated decision-making

QUEST initially started with informal discussions led by Lloyd Axworthy and Mike Harcourt involving a coalition of key leaders in government, industry and finance to explore how to move sustainability agenda forward, influence policy and industry activity. This is very much an ongoing process, with meetings once or twice a year.
Some Possible Features of an Integrated Energy Future…

Key Features of Integrated Urban Energy Systems

In an integrated system approach to land-use, energy, transport, water and waste management, greater emphasis is placed upon achieving efficiency for the systems as a whole, and upon creating systems that are more resource efficient, adaptable, resilient and sustainable. This includes:

- Clustered, higher density, self-reliant, mixed use developments of energy efficient housing, commercial space and industry which facilitate implementation of more efficient, accessible and affordable energy, water, waste and transportation infrastructures.

- District energy / utility grids and cascading of energy use between industrial, commercial and residential applications.

- Smaller scale urban energy systems, distributed more widely, located closer to and within buildings, integrated with elements of buildings, and integrated with other infrastructure systems.

- Increasing contribution from multiple local energy sources: solar; geothermal; energy from landfill and municipal, agricultural and forestry waste; wind; hydro; supplemented by larger scale electricity and gas grids as necessary.

Examples in Canada and around the world show that compared to a traditional approach, over 50% reduction in grid energy use can be achieved using an integrated approach.

Part 2: The physical metrics of a sustainable society

This section moves beyond qualitative principles of what is sustainable or what a conserver society should be and explores a number of examples that illustrate how sustainable objectives can be described quantitatively. While sustainable development has traditionally included the three dimensions of social, economic, and environmental, the first two dimensions lie outside the scope of this paper, despite their importance, and will be dealt with in other parts of the Making it Happen project. The present document focuses exclusively on the physical dimension, e.g. energy, water, waste production including greenhouse gas generation. It pays particular attention to greenhouse gas reductions as a way of mitigating the impacts of climate change and global warming.
Summary of our first panel on sustainability goals and metrics

A panel of subject matter experts and practitioners was convened on November 18, 2008 to analyze different visions and develop a synthesis of them. There was a general agreement among the experts who reviewed various goals and metrics, that there is a minimum number of physical goals or metrics that would form a sustainable society. These include the following:

- Dramatic reduction in energy intensity and energy use per capita over 50 and 100 years. This would include energy from transportation.
- Dramatic reduction of greenhouse gas emissions per capita.
- Move to zero waste generation over 50 and 100 years.
- Dramatic reduction in water usage, and wastewater generation.
- Preservation of and where possible an increase in green spaces.

Key targets/results of Kyoto and Beyond

One project that has attracted our attention is Kyoto and Beyond: The low-emission path to innovation and efficiency, a study prepared by Ralph Torrie for the Suzuki Foundation. His hypothesis is simple: some 160 energy-saving technologies that are already available in the marketplace could reduce energy generated greenhouse gas emissions by 60% by the year 2030 if they are deployed through all critical segments of the Canadian economy. The two graphs below summarize his argument. The analysis is compelling because it demonstrates the theoretical possibility of maintaining a reasonable level of economic activity and growth while dramatically reducing our greenhouse gas emissions.

Figure 52. Population, GDP and Greenhouse Gas Emissions in the Low Emission Scenario

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2 Workshop # 1 on Goals and Metrics of Sustainability (Appendix 4 and 5)
Such a dramatic reduction obviously raises the question of how realistic it is. The *Making it Happen* project addressed this when it examined the barriers facing the housing sector. While Torrie’s exercise is very much a paper study, it establishes a theoretical point in GHG reduction that can be reached if 160 technologies can be deployed throughout the housing, commercial, industrial, transportation and energy sectors. By all accounts this is considered to be a very thorough analysis based on the latest available economic data and technologies at the time (2001-2002). The challenge is to discover what it will take to make it happen.

**Case study: University of Ottawa three-fold energy efficiency improvement, 1974-2008**

This example is the result of careful, detailed application of continuous improvement in energy efficiency and environmental controls. It achieved total energy reduction at a time when the University of Ottawa campus experienced rapid growth. The following graphs clearly show that the surface area and population of the University has at least tripled since 1974, while total energy consumption has remained constant or even fallen slightly. This indicates that the efficiency of energy intensity has improved by a factor of three over that period.
This dramatic improvement was the result of thousands of individual actions. The first set (late 70s and early 80s) involved deploying centralized controls and turning things off on a schedule as well as implementing common-sense procedures such as eliminating the simultaneous heating and cooling of the same space. Actions taken in the 90s were dominated by water efficiency, heat recovery, total cost of ownership (i.e. evaluating the purchase criteria for new pieces of equipment based on life-cycle costing that included energy consumption rather than just initial purchase price) and lighting. Actions since the year 2000 focused more on re-engineering of processes like compressed air, chilled water systems and whole building systems. The university has also embarked on a number of peak management programs with utilities and other major clients.

The major lessons learned from this approach is that dramatic energy savings (and corresponding GHG emission reductions) can be achieved, but these require thousands of small, incremental decisions and physical adjustments. This can only be achieved through consistent leadership. In the words of Pierre de Gagné, Assistant Director of Engineering and Sustainable Development at the University, the key success factors for this effort include:

1. A clear champion
2. To ensure that changes are accepted and optimized, it is essential to obtain buy-in from users and operations groups. Addressing group dynamics is 80% of the challenge. His favorite question to operators is “Why can’t we do this?”
3. Assembling highly skilled and motivated people. This involves the best design and supplier professionals and the best operators.

4. Buying and installing cheaper but second-rate technology is never sustainable. Life cycle costing where the total cost of ownership (including energy consumption over the life of the equipment) is optimized, helps motivate operators and suppliers.

5. There is a consistent need to follow-up and follow through during the problematic early stages at start up to show that “we care that everything works as intended.”

6. Measure success through tracking key indicators and adjust design or other parameters through post commissioning, if required.

The challenge is to extend this approach from one university campus to the entire economy, and achieve the same, integrated approach across the fragmented governmental silos of this country.

**McKinsey illustration of urban economic footprint**

McKinsey Corporation developed a multi-dimensional analysis of sustainable development targets, including not only carbon dioxide emission levels, but water usage, garbage generation, and air pollution as well. The spider-web diagram provides an interesting comparison of major cities around the world.
Greater Vancouver: Cities Plus and sustainable communities

In terms of sustainable communities, the Greater Vancouver sustainable planning exercise of “Cities Plus” comes closer to the definition of sustainable development, including not only the environmental, but also the social and economical dimensions, as shown in the two figures below⁴.

**Place:**
Natural Habitat and Green Space Systems

**People:**
Cultural Systems  
First Nations Systems  
Health and Well-Being Systems  
Social Equity Systems

**Infrastructure:**
Agri-Food Systems  
Communication Systems  
Energy Systems  
Housing and Buildings Systems  
Materials Systems  
Mobility Systems  
Water Systems

**Governance:**
Decision Support Systems  
Economic Development Systems  
Governance Systems  
Human Security Systems  
Land Use Systems

Focusing exclusively on the energy slice of the Cities plus vision, this is how it describes their current (2003) and future (2101) performance and targets:

**Existing Energy System for Greater Vancouver (Cities⁴Plus)**
Except for the SkyTrain and electric trolley buses, transportation needs in Greater Vancouver are served almost exclusively by petroleum products. Natural Gas is the prime fuel for space heating and industrial processing. 91% of electricity is from large hydro facilities and 9% is generated from a gas

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fired thermal electric plant. Energy is used on a “once through basis,” with little or no cascading, and heat from power generation is wasted.

**Backcasting Greater Vancouver Energy System 2101**

Our goal is that by 2100, fossil fuel use has been largely eliminated. Electricity is the prime energy source for transportation with expansion of fixed rail and trolley bus systems and the production of hydrogen as the energy carrier to power fuel cells. Biofuels are common and energy use is integrated. Distributed Combined Heat and Power (CHP) is used for industrial, commercial, and residential applications and space heating is largely derived from ground or water source heat pumps and from rejected heat from industry. Although the population has more than doubled, energy use remains almost constant due to aggressive demand reduction. Using a life cycle approach, emissions have dropped to about 6% of current levels -- a factor 10 improvement over the present day.

**A comparison of projections for selected GHG reduction targets**

We also carried out an analysis of the various studies that generated scenarios, models, or desirable targets for future greenhouse gas reductions.

<table>
<thead>
<tr>
<th>Source</th>
<th>Baseline Date</th>
<th>Target</th>
<th>Target Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kyoto and Beyond, 2002</td>
<td>2004</td>
<td>50%</td>
<td>2030</td>
</tr>
<tr>
<td>NRTEE, 2006</td>
<td>2003</td>
<td>60%</td>
<td>2050</td>
</tr>
<tr>
<td>Toronto, 2007</td>
<td>2004</td>
<td>80%</td>
<td>2050</td>
</tr>
<tr>
<td>Japan, 2008</td>
<td>2000</td>
<td>70%</td>
<td>2050</td>
</tr>
<tr>
<td>Pembina, 2008</td>
<td>1990</td>
<td>25%</td>
<td>2020</td>
</tr>
<tr>
<td>Cities Plus, 2006</td>
<td>1999</td>
<td>&lt;= 1 tonne/capita/yr or 81.8% (our calculations)</td>
<td>2040</td>
</tr>
</tbody>
</table>

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5 Kyoto and Beyond - The low-emission path to innovation and efficiency, Canada, October 2002, [http://www.davidsuzuki.org/files/Kyoto_72.pdf](http://www.davidsuzuki.org/files/Kyoto_72.pdf)
6 Kyoto and Beyond, p.1, 11 and table 26, p 117
8 NRTEE, p.6
9 NRTEE, p.81
12 Japan, p.14
14 CitiesPLUS Indicators and Targets for Greater Vancouver; Website: [http://www.citiesplus.ca/index.html](http://www.citiesplus.ca/index.html)
15 Cities Plus, the baseline data is set at 7.7 tonnes of CO2e per capita per year (p.3). Data found in the NRTEE Report (p.64) sets the Canadian population at approximately 30 million in 1999. Data is confirmed by this source: [http://www.sustreport.org/signals/canpop_ttl.html](http://www.sustreport.org/signals/canpop_ttl.html)
Table 1 offers a sample of targets for GHG reductions for the Canadian and other economies and the residential sector in particular, as found in various reports in Canada and elsewhere. The first observation to note is the variation between the different targets. The key variables are the baseline year (the starting point), the target year (the endpoint), and the underlying assumptions of the projection. For additional detail and further comparisons, see Annex A.

We did not have the time or resources in this phase of the project to go back to the original calculations/models of each of the studies in order to reduce them to a common basis. Table 1 shows a preliminary picture of the final data from each of the sources. It is noted that it would be a useful exercise to go into greater depth and look at all the assumptions and inputs used in each of the analyses.

In considering these studies, it is important to distinguish between forecasts (what we think will happen in a specified time period), a target (what we would like to happen and are aiming for) and a scenario, (what might happen if certain things occur.) In this instance, the Torrie “Beyond Kyoto” study is very much a scenario, i.e. this will happen to GHG emissions, if these 160+ technologies are fully deployed.

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16 Cities Plus, the target is set at <=1 tonne CO2e per capita per year (p.3). Data found in the NRTEE Report (p.64) estimates the Canadian population to grow to approximately 42 million by 2040. Data is confirmed by this source: [http://www.sustreport.org/signals/canpop_ttl.html](http://www.sustreport.org/signals/canpop_ttl.html). The Percentage of Reduction is calculated by a reduction from 231 tonnes of CO2e per year to 42.
Annex A: Analysis and comparisons of GHG reduction targets from various sources

Federal Targets

The Government of Canada has developed a framework to reduce greenhouse gas emissions and air pollution as set out in its Turning the Corner Plan. The framework does not include targets specific to the residential sector, the main focus of our workshop. The Government of Canada’s targets are: 20% reduction of GHG by 2020 and 60-70% by 2050, calculated according to the 2006 baseline (or 3% below the 1990 baseline)17

Presented below is a sample of targets for GHG reductions for the Canadian economy as a whole, and the residential sector in particular, as found in other reports in Canada and elsewhere.

Table A-1 presents results from Canadian and other studies. The first thing to note is the apparent lack of consistency among the different targets. The key variables are the baseline year (the starting point), the target year (the endpoint), and the underlying assumptions of the projection.

We did not have the time or resources to go back to the original calculations/models of each of the studies in order to reduce them to a common basis. Table C-1 offers a preliminary picture of the final data from each of the sources. It is noted that it would be a useful exercise to go into greater depth and look at all the assumptions and inputs used in each of the analyses.

---

17 The Government of Canada expresses its 2020 target as 20% below the 2006 emission level (see Environment Canada, Turning the Corner: Regulatory Framework for Industrial Greenhouse Gas Emissions (Ottawa: Government of Canada, 2008). This target can be re-expressed relative to the 1990 level based on emissions data from Environment Canada’s National Inventory Report (Pembina Report)
### Table A-1: Comparison of various energy-based Carbon Dioxide Reduction Targets, All Sectors

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Base line Date</td>
<td>Target Date</td>
<td>Base line Date</td>
<td>Target Date</td>
<td>Base line Date</td>
<td>Target Date</td>
</tr>
<tr>
<td>Energy use All Sectors</td>
<td>Achieving energy-related CO2 emissions target, unless noted</td>
<td>2004 50%&lt;sup&gt;18&lt;/sup&gt;</td>
<td>2030</td>
<td>2003&lt;sup&gt;19&lt;/sup&gt; 60%&lt;sup&gt;20&lt;/sup&gt;</td>
<td>2050</td>
<td>2004 6%&lt;sup&gt;21&lt;/sup&gt;</td>
<td>2012 Kyoto</td>
</tr>
</tbody>
</table>

<sup>18</sup> Kyoto and Beyond, p.1, 11 and table 26, p 117  
<sup>19</sup> NRTEE, p.6  
<sup>20</sup> NRTEE, p.81  
<sup>21</sup> Toronto, p.1  
<sup>22</sup> Japan, p.14  
<sup>23</sup> Pembina, cover page, “Canada to meet a GHG target consistent with climate science: 25% below the 1990 level by 2020. In comparison, the Government of Canada’s current GHG target for 2020 is a reduction of 3% below the 1990 level.”  
<sup>24</sup> Cities Plus, the baseline data is set at 7.7 tonnes of CO2e per capita per year (p.3). Data found in the NRTEE Report (p.64) sets the Canadian population at approximately 30 million in 1999. Data is confirmed by this source: [http://www.sustreport.org/signals/canpop_ttl.html](http://www.sustreport.org/signals/canpop_ttl.html)  
<sup>25</sup> Cities Plus, the target is set at <=1 tonne CO2e per capita per year (p.3). Data found in the NRTEE Report (p.64) estimates the Canadian population to grow to approximately 42 million by 2040. Data is confirmed by this source: [http://www.sustreport.org/signals/canpop_ttl.html](http://www.sustreport.org/signals/canpop_ttl.html). The Percentage of Reduction is calculated by a reduction from 231 tonnes of CO2e per year to 42.
### Table C-2: Comparison of various energy-based Carbon Dioxide Reduction Targets, Residential Sector

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<td></td>
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<td>Target Date</td>
<td>Target Date</td>
<td>Base line Date</td>
<td>Target Date</td>
<td>Base line Date</td>
</tr>
<tr>
<td>Energy use Residential</td>
<td>Reduce GHG, or CO2, emissions below 1990 levels, unless noted</td>
<td>2004</td>
<td>60%</td>
<td>2030</td>
<td>2003</td>
<td>55%</td>
<td>Excl. Urban Planning</td>
</tr>
<tr>
<td>Allocation</td>
<td>Residential contribution to emissions</td>
<td>10%</td>
<td>15%</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

---

26 Kyoto and Beyond, Table 26, p. 117. 59.51% represents KT eCO2 savings as follows: 71,999 Kt eCO2 by 2004; 52,139 Kt eCO2 by 2012; 29,151 Kt eCO2 by 2030.
27 NRTEE, Appendix A: “Top-line scenario projections”, or “Business as usual (BAU) scenarios” (p.56), estimate the residential consumption at 176 Mt eCO2 (Figure 3.8 not found, see p.63) with potential savings of 27 (Space heating), 12 (Lighting, equipment, appliances), 28 (Shell efficiency), 0.3 (AC efficiency), and 10.9 Mt eCO2 (Water and Fuel), for a total reduction of 78.2 attributable to the Residential sector only, pages 108 to 114.
28 Urban Form and Planning would also affect the Transportation sector and is therefore not included in these calculations, p.106.
33 8% from 1990 levels, re-expressed in 2004 levels is equivalent to a reduction of 26.6% (based on emissions data from Environment Canada’s National Inventory Report).
34 Cities Plus, “% of Building Stock Meeting or Exceeding LEED Platinum Standards or Equivalent (%); Baseline: 0% in 2001; Target: =>90% by 2100”, p.12.
35 Kyoto and Beyond, Figure 7, p.17.
36 NRTEE, Pie Chart on p.15.
Kyoto and Beyond, 2002, p. 11

Figure 1. Global CO₂ Concentrations (ppmv)

Low carbon futures are empowering. By its very nature, the 50% target widens the constituency of interested parties and engages people in a way that the lower, incremental targets cannot. The 50% cut brings with it air quality, public health, and economic development benefits that the lower targets do not. The low carbon futures have positive surprises, not negative ones. Our

Kyoto and Beyond, 2002, table 26, p. 117

<table>
<thead>
<tr>
<th>SECTOR</th>
<th>DATA TYPE</th>
<th>INDICATOR</th>
<th>UNITS</th>
<th>2004</th>
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<th>2030</th>
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<tr>
<td></td>
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<td>Total Emissions</td>
<td>Mt eCO₂</td>
<td>727,445</td>
<td>528,864</td>
<td>368,270</td>
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<tr>
<td>ALL SECTORS</td>
<td></td>
<td>Population</td>
<td>thousands</td>
<td>31,600</td>
<td>33,000</td>
<td>37,100</td>
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<td></td>
<td></td>
<td>GDP</td>
<td>billions of 1990$</td>
<td>655</td>
<td>605</td>
<td>1,225</td>
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<td></td>
<td></td>
<td>Per capita GDP</td>
<td>1990$</td>
<td>21,954</td>
<td>23,968</td>
<td>33,019</td>
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<tr>
<td></td>
<td></td>
<td>Emissions per capita</td>
<td>tonnes of eCO₂</td>
<td>23.3</td>
<td>15.7</td>
<td>9.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Emissions per 1990$ of GDP</td>
<td>kg eCO₂ per 1990$</td>
<td>1.05</td>
<td>0.66</td>
<td>0.30</td>
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<td></td>
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<td>Residential</td>
<td>Mt eCO₂</td>
<td>71,969</td>
<td>52,130</td>
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<td></td>
<td>Commercial</td>
<td>Mt eCO₂</td>
<td>67,976</td>
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<td>Passenger Transportation</td>
<td>Mt eCO₂</td>
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<td></td>
<td></td>
<td>Freight Transportation</td>
<td>Mt eCO₂</td>
<td>60,129</td>
<td>48,061</td>
<td>31,908</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Industry (exc. petroleum)</td>
<td>Mt eCO₂</td>
<td>145,326</td>
<td>117,761</td>
<td>117,499</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Petroleum Industry - Domestic Share</td>
<td>Mt eCO₂</td>
<td>50,280</td>
<td>46,418</td>
<td>32,336</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Petroleum Industry - Export Share</td>
<td>Mt eCO₂</td>
<td>67,033</td>
<td>69,205</td>
<td>62,040</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non Energy Related Emissions</td>
<td>Mt eCO₂</td>
<td>136,009</td>
<td>92,400</td>
<td>45,500</td>
</tr>
<tr>
<td>ELECTRICITY PRODUCTION</td>
<td></td>
<td>Emissions (incorporated in sector totals)</td>
<td>Mt eCO₂</td>
<td>114,357</td>
<td>42,756</td>
<td>15,544</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total Grid Electricity Production</td>
<td>PJ</td>
<td>1,915</td>
<td>1,628</td>
<td>1,243</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grid Electricity Emissions</td>
<td>Mt eCO₂</td>
<td>64%</td>
<td>78%</td>
<td>92%</td>
</tr>
</tbody>
</table>

Percent Renewables | 64% | 78% | 92% |
Toronto’s Change is in the Air, 2007, p.1

TORONTO’S GREENHOUSE GAS AND SMOG EMISSION REDUCTION TARGETS

Toronto’s reduction targets for greenhouse gas emissions, from the 1990 levels of approximately 22 million tonnes per year for the Toronto urban area, are:
- 6% by 2012 (The “Kyoto target”)
- 30% by 2020
- 80% by 2050

The reduction target for locally generated smog causing pollutants is 20%, from 2004 levels, by 2012 for the Toronto urban area.

Japan’s Scenarios for a Low Carbon Society, 2008, p.3

<table>
<thead>
<tr>
<th>Potential of 70% carbon abatement, cost and sectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Satisfying the prerequisites mentioned above, a 70% CO₂ emission reduction below the 1990 level can be achieved by reducing 40% the energy demand and by introducing low-carbon energy supply.</td>
</tr>
<tr>
<td>5. The annual direct cost related to a CO₂ emission reduction of 70% by 2050 would range between JPY 7.0 and 9.9 trillion, which would account for around 1% of the estimated GDP in 2050.</td>
</tr>
<tr>
<td>6. The energy demand-side emission reductions could be accomplished by combining a shrinking population scenario with promoting rational energy use, energy conservation and improvements in energy efficiency, while allowing the per capita GDP growth at 1-2% towards 2050.</td>
</tr>
<tr>
<td>7. Estimated reduction rates of sectoral energy demand (relative to the 2000 value) are as follows, where the range of reductions varies due to different scenarios in 2050:</td>
</tr>
</tbody>
</table>
  * Industrial sector: reduction of 30-40% due to structural changes and introduction of energy-saving technologies. |
  * Passenger transportation sector: reduction of 80% due to proper land use, and improvement in energy efficiency and carbon intensity. |
  * Freight transportation sector: reduction of 50% due to better logistics management and improvements in the energy efficiency of vehicles. |
  * Household sector: reduction of 40-50% due to rebuilding and diffusion of high-insulated houses and introduction of energy-saving house appliances. |
Pembina’s Vision for reducing GHG emissions

The Pembina Institute has considered how to assemble a policy package that would support reducing Canadian greenhouse gas emissions by 25% below 1990 levels by the year 2020.

The Pembina Institute and the David Suzuki Foundation have therefore commissioned M.K. Jaccard and Associates Inc. (MKJA) to conduct an economic modeling study of government policies that will allow Canada to meet a GHG target consistent with climate science: 25% below the 1990 level by 2020. In comparison, the Government of Canada’s current GHG target for 2020 is a reduction of 3% below the 1990 level.

Page 17

Table 5: Emissions reductions in 2020 by sector and region (Mt CO₂e) from BAU to Policy “Canada goes further”

<table>
<thead>
<tr>
<th>Sector</th>
<th>BC</th>
<th>AB</th>
<th>SK</th>
<th>MB</th>
<th>ON</th>
<th>PQ</th>
<th>ATL</th>
<th>Sum</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>2.1</td>
<td>5.6</td>
<td>0.8</td>
<td>0.6</td>
<td>15.3</td>
<td>3.0</td>
<td>1.1</td>
<td>28.5</td>
<td>8%</td>
</tr>
<tr>
<td>Commercial</td>
<td>2.1</td>
<td>3.6</td>
<td>0.9</td>
<td>0.7</td>
<td>11.3</td>
<td>2.3</td>
<td>1.6</td>
<td>22.5</td>
<td>6%</td>
</tr>
<tr>
<td>Personal Trans.</td>
<td>4.1</td>
<td>3.0</td>
<td>0.8</td>
<td>0.8</td>
<td>10.6</td>
<td>7.0</td>
<td>2.0</td>
<td>28.3</td>
<td>8%</td>
</tr>
<tr>
<td>Freight Trans.</td>
<td>10.5</td>
<td>10.7</td>
<td>2.4</td>
<td>1.3</td>
<td>20.9</td>
<td>9.8</td>
<td>5.7</td>
<td>61.3</td>
<td>17%</td>
</tr>
<tr>
<td>Chemicals</td>
<td>0.1</td>
<td>4.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.5</td>
<td>0.3</td>
<td>0.0</td>
<td>5.0</td>
<td>1%</td>
</tr>
<tr>
<td>Ind. Minerals</td>
<td>1.0</td>
<td>1.0</td>
<td>0.0</td>
<td>0.0</td>
<td>4.1</td>
<td>1.2</td>
<td>0.2</td>
<td>7.5</td>
<td>2%</td>
</tr>
<tr>
<td>Iron and Steel</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>2.0</td>
<td>0.0</td>
<td>0.0</td>
<td>2.0</td>
<td>1%</td>
</tr>
<tr>
<td>Metal Smelting</td>
<td>0.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
<td>0.7</td>
<td>0.1</td>
<td>1.1</td>
<td>0%</td>
</tr>
<tr>
<td>Mineral Mining</td>
<td>0.1</td>
<td>0.0</td>
<td>1.3</td>
<td>0.0</td>
<td>0.1</td>
<td>0.2</td>
<td>0.2</td>
<td>1.9</td>
<td>1%</td>
</tr>
<tr>
<td>Paper Mfg</td>
<td>0.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
<td>0.0</td>
<td>0.3</td>
<td>0%</td>
</tr>
<tr>
<td>Other Mfg</td>
<td>2.1</td>
<td>0.8</td>
<td>0.0</td>
<td>0.2</td>
<td>2.5</td>
<td>1.5</td>
<td>0.3</td>
<td>7.4</td>
<td>2%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.3</td>
<td>1.5</td>
<td>1.1</td>
<td>1.5</td>
<td>1.6</td>
<td>1.0</td>
<td>0.3</td>
<td>7.3</td>
<td>2%</td>
</tr>
<tr>
<td>Waste</td>
<td>4.8</td>
<td>2.6</td>
<td>0.9</td>
<td>0.9</td>
<td>7.1</td>
<td>7.1</td>
<td>2.4</td>
<td>25.8</td>
<td>7%</td>
</tr>
<tr>
<td>Electricity</td>
<td>0.3</td>
<td>26.8</td>
<td>8.7</td>
<td>-1.3</td>
<td>1.5</td>
<td>0.6</td>
<td>2.8</td>
<td>39.4</td>
<td>11%</td>
</tr>
<tr>
<td>Pet. Refining</td>
<td>1.3</td>
<td>1.9</td>
<td>0.3</td>
<td>0.0</td>
<td>4.2</td>
<td>1.6</td>
<td>1.0</td>
<td>10.3</td>
<td>3%</td>
</tr>
<tr>
<td>Pet. Crude Ext.</td>
<td>0.4</td>
<td>93.2</td>
<td>5.3</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
<td>99.0</td>
<td>27%</td>
</tr>
<tr>
<td>NG Ext.</td>
<td>7.3</td>
<td>13.9</td>
<td>1.8</td>
<td>0.1</td>
<td>1.0</td>
<td>0.1</td>
<td>0.9</td>
<td>25.1</td>
<td>7%</td>
</tr>
<tr>
<td>Coal Mining</td>
<td>0.2</td>
<td>0.3</td>
<td>0.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.6</td>
<td>0%</td>
</tr>
<tr>
<td>Ethanol</td>
<td>-0.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>-0.1</td>
<td>-0.1</td>
<td>0.0</td>
<td>-0.3</td>
<td>0%</td>
</tr>
<tr>
<td>Biodiesel</td>
<td>-0.2</td>
<td>-0.5</td>
<td>-0.2</td>
<td>0.0</td>
<td>-0.9</td>
<td>-0.2</td>
<td>-0.3</td>
<td>-2.3</td>
<td>-1%</td>
</tr>
<tr>
<td>Total</td>
<td>36.6</td>
<td>168.5</td>
<td>24.2</td>
<td>4.9</td>
<td>81.9</td>
<td>36.2</td>
<td>18.4</td>
<td>370.7</td>
<td>100%</td>
</tr>
</tbody>
</table>

%  10%  45%  7%  1%  22%  10%  5%  100%
**Climate Systems**

Indicators and Targets

<table>
<thead>
<tr>
<th>Indicator ID</th>
<th>Indicator Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLMTE-1</td>
<td>Per Capita CO2e Emissions (tonnes/capita/year)</td>
</tr>
<tr>
<td></td>
<td>Baseline: 7.7 tonnes/capita/year in 1999</td>
</tr>
<tr>
<td></td>
<td>Target: &lt;=1 tonne/capita/year by 2040</td>
</tr>
</tbody>
</table>

Sample Benchmark Scale:

- **Indicator CLMTE-1: Per Capita CO2e Emissions**
- **Lower is Better**

**Housing and Buildings Systems**

Indicators and Targets

<table>
<thead>
<tr>
<th>Indicator ID</th>
<th>Indicator Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>HO_BLD-1</td>
<td>% of Households Spending 30% or More of their Gross Household Income on Housing (%)</td>
</tr>
<tr>
<td></td>
<td>Baseline: 32.8% in 1996</td>
</tr>
<tr>
<td></td>
<td>Target: &lt;=10% by 2040</td>
</tr>
</tbody>
</table>

| HO_BLD-2     | % of Building Stock Meeting or Exceeding LEED Platinum Standards or Equivalent (%) |
|              | Baseline: 0% in 2001                                                           |
|              | Target: >=90% by 2100                                                          |

**Water Systems**

Indicators and Targets

<table>
<thead>
<tr>
<th>Indicator ID</th>
<th>Indicator Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>W-1a</td>
<td>Per Capita Residential Potable Water Consumption (litres/capita/day)</td>
</tr>
<tr>
<td></td>
<td>Baseline: 340 litres/capita/day in 2001</td>
</tr>
<tr>
<td></td>
<td>Target: &lt;=150 litres/capita/day by 2040</td>
</tr>
</tbody>
</table>
Illustration of Targeted Mega tonnes of GHG per scenario, Residential – Canada

Comparative Graph of Scenario Sample

Relevant information: CEC, Green Building Scenario for 2030, p.59.

- In the Canadian residential sector, roughly 12 MT of CO\textsubscript{2eq} will need to be offset with the use of on-site renewable energy or the purchase of clean power in order for emissions to remain below the AIA/RAIC target levels.
- In the Canadian commercial sector, roughly 11 MT of CO\textsubscript{2eq} will need to be offset with the use of on-site renewable energy or the purchase of clean power in order for CO\textsubscript{2eq} emissions to remain below 1990 levels in 2010, but by 2030 the Deep Green scenario is at par with both the AIA/RAIC scenario and 1990 levels.
Annex B: A bibliography of the most influential recent visions of sustainability

Methodology
This bibliography was compiled with the help of Diane Beckett, by asking leading environmentalists in Canada what they consider to be the most important reports, books, or visions in the last 30 years or so that have shaped their understanding of environment and sustainability.

This modified Delphi technique allowed us to compile this list. To the best of our knowledge, while a lot has been written on the subject, such a systematic compilation of the most influential works has not been performed in this way. The response was enthusiastic. We received replies from academics, community activists, government officials, consultants, NGO staff and political advisers young professionals as well as professionals who were working on sustainability as early as the 1970s. Some contributors even entered into a lively polemic with each other in defending their own choices. But this went beyond the scope of our task at hand.

Some works were referred to repeatedly, as was the Report of the World Commission on Environment and Development "Our Common Future", or the club of Rome's "The Limits to Growth", or E.F. Schumacher's "Small is Beautiful". A major influence whose several works were often referred to is Amory Lovins, now with the Rocky Mountain Institute. The same was true of Lester Brown's work at the Earth policy Institute. But an important player has been the United Nations, which has consistently supported environmental sustainability as early as 1980 in its seminal work "The World Conservation Strategy", and "Agenda 21".

In a sense, the 50 odd works can be classified into some broad categories. There are the works that provide a vision and goals such as the Millennium Development Goals of the United Nations. Some provide insightful understanding of the major risks to environment such as the 1953 "fundamentals of ecology" by Odum, or Rachel Carson's "silent Spring", or the latest report of the International Panel on Climate Change.

Another more interesting stream consists of those that attempt to question the assumptions of our postindustrial economy of the need for growth and use of resources. Among those we find the works of Ivan Illich, Herman Daly, Charles Reich, Jim MacNeill, and most recently Jeffrey Sachs.

Lord Stern of the United Kingdom has made a very compelling business case that sustainable development using fewer resources, fossil fuels and energy, generating less pollution and greenhouse gases actually makes eminent economic sense because the cost of not doing so would be horrendous.

And in a way, many of these works were summarized and emulate anticipated by the seminal 1978 report of the Science Council of Canada "Canada as a Conserver Society"
Publications

Fundamentals of Ecology, E.P. Odum, W. B. Saunders (first published 1953)


Only One Earth, René Dubos and Barbara Ward, Andre Deutsch Ltd (May 25, 1972).


For The Common Good: Redirecting the Economy Toward Community, the Environment, and a Sustainable Future, By Herman Daly and John Cobb Jr., Boston.


The Ecology of Commerce, Paul Hawken, Collins Business (June 3, 1994)


Making it Happen

Background1 - Sustainability: Visions and Metrics


Reports


Earth Charter, October 2000. http://www.earthcharterinaction.org/content/


**Organizations and Projects**


The Otesha Project [http://www.otesh.ca/](http://www.otesh.ca/)

Living Lightly Project, David Chernushenko, [http://www.livinglightly.ca/what-is-living-lightly/resources/](http://www.livinglightly.ca/what-is-living-lightly/resources/)

World Watch Institute, [http://www.worldwatch.org/](http://www.worldwatch.org/)

World Resources Institute, [http://www.wri.org/](http://www.wri.org/)

Sustainable community of **Woking, England**, 2009
