Council of Energy Ministers




Moving Forward on Energy Efficiency in Canada: A Foundation for Action

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Introduction

Canadians know that we are fortunate to have diverse sources of energy, but only recently have they come to recognize the additional potential in reducing the energy we waste. Using energy wisely to make sure our energy supplies go further yields significant benefits for all Canadians. Consumers can benefit from significant dollar savings, pollution is reduced, and business and industry can realize increased profits and productivity.

Governments can play a vital role in advancing energy efficiency, as investors in programs that stimulate actions, and as policymakers and regulators who help shape the marketplace and reduce barriers to action.

This foundation document represents the collaborative efforts of provincial and territorial governments and the federal government, with important input from a wide cross-section of representatives from outside government, including non-governmental organizations and industry. Major energy-using sectors of the Canadian economy were examined, including industry, transportation and the built environment. While primarily a tool for governments to show leadership, it also describes many technologies and best practices available for all stakeholders, and highlights the important roles that other organizations play in promoting energy efficiency in all sectors of the Canadian economy.

1 Overview: A Foundation for Action

Energy Efficiency – Addressing our growing energy needs

Energy efficiency and conservation are two effective ways to help meet our future energy needs and reduce the necessity and timing for new energy development. Energy efficiency can assist Canada to expand its economy while managing its energy demands. The energy efficiency industry already employs thousands of Canadians who manufacture and sell efficient products and technologies. More jobs can be created in businesses such as the manufacture of ENERGY STAR® windows, the design, construction and sales of certified green buildings built to specified environmental standards and for the retooling of industrial processes to reduce energy waste.

Canadians require energy for heat, light, transportation, cooling, and power for equipment. Between 1990 and 2004, the demand in Canada for energy has increased by 23%[1] . This increase has largely been driven by the growth in both population and economic activity (as measured by Gross Domestic Product [GDP]). Canada's population grew by 15% between 1990 and 2004. Over the same period, GDP increased by 48%. Figure 1 shows the link between the key drivers and the growth in the energy demand in Canada.

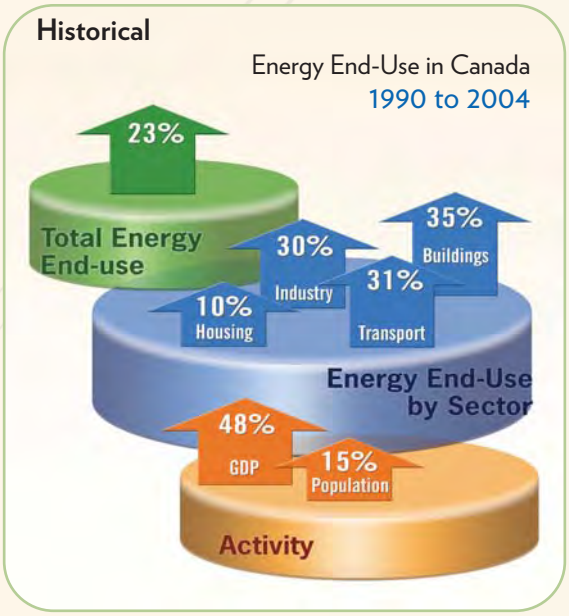

Figure 1: Between 1990 and 2004, total energy use in Canada rose by 23%, while energy use in every sector increased at a different rate. The increase was attributable mainly to increases in GDP and population over the same time period.

Over this same period, Canada's energy efficiency improved by an estimated 14%. If there had not been significant on-going improvements in energy efficiency in all end-use sectors, energy use would have increased by 36%, instead of the actual 23%[2]. These energy savings of about 903 petajoules are roughly equivalent to removing 13 million cars and light trucks from the road[3] . This improvement, resulting from energy efficiency measures undertaken since 1990, saved Canadians more than $14 billion in 2004[4], about 10% of our energy bill, and lowered greenhouse gas emissions by about 54 megatonnes.

1 Energy Efficiency Trends in Canada: 1990 to 2004, Natural Resources Canada (2006).
2 Ibid
3 The energy savings are measured from the energy used by consumers across all sectors of the economy (e.g., the energy used to heat and cool homes). This excludes the energy required to transform one energy form into another (e.g. coal to electricity), the energy used to bring energy supplies to the consumer (e.g. pipeline), and energy used by industries as feeders to their production (e.g. natural gas used in chemical production).
4 Energy Efficiency Trends in Canada: 1990 to 2004, Natural Resources Canada (2006).

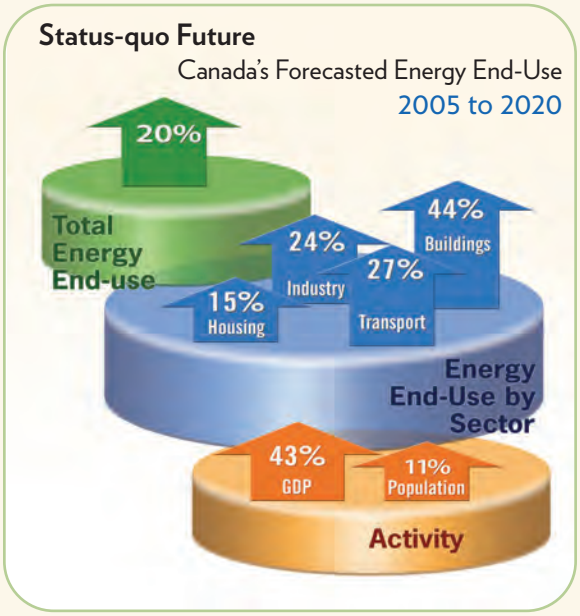

Figure 2: Between 2005 and 2020, total energy use in Canada is expected to rise by 20%, while energy use in every sector is expected to increase at different rates. The increase will be attributable mainly to increases in GDP and population.

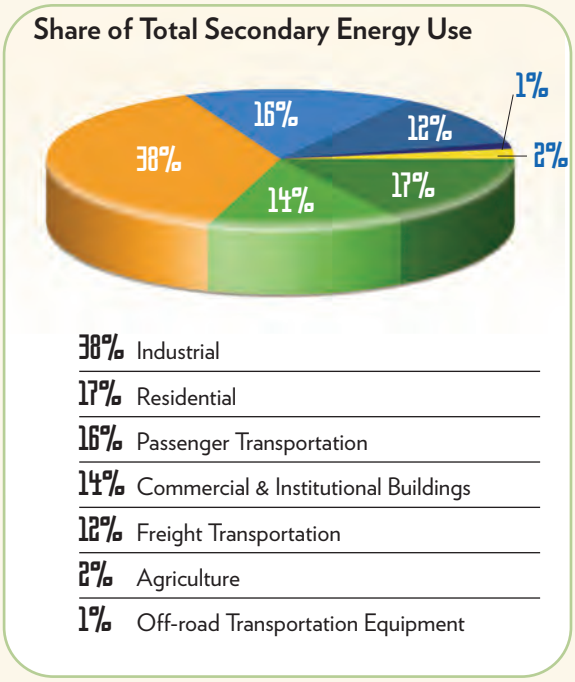

Figure 3: Share of Total Secondary Energy Use[6] by Sector (2004)

Looking ahead, in the absence of significant changes in behaviour, energy demand is expected to continue to grow as the Canadian population and economy continue to grow. Population is forecasted to increase by 11% between 2005 and 2020 while GDP is expected to grow by another 43%. This population and activity growth is expected to contribute towards a 20% increase in energy use between 2005 and 2020[5]. Figure 2 presents other major drivers likely to contribute to the growth in energy demand in Canada.

Growing demand for energy imposes a number of costs on the economy:

- **Environmental:** Energy development and use accounts for over 80% of greenhouse gas emissions in Canada as well as smog pollutants such as nitrogen oxides and sulphur dioxide.
- **Energy security:** The supply of electricity relative to demand is a serious concern for some regions.
- **Economic and social:** Rising energy demand coupled with energy price increases[7] over the last decade puts pressure on consumers, especially low income Canadians, as well as on some manufacturers, who are also squeezed by a strong Canadian dollar and slow growth in selling prices for their commodities.

Energy efficiency is one means to address rising energy demand and the costs associated with it. Energy efficiency allows Canadians to reduce the waste of energy and get more heat, light and power out of the energy we use. Energy efficiency encourages the use of better technologies - both new and emerging - and better energy use practices in the way we heat our homes, cool our buildings, move ourselves and manufacture and transport our goods. Energy efficiency and conservation results in:

- Fewer emissions of greenhouse gases and pollutants while providing Canadians with the services they need.
- Extending the life of existing energy supplies and slowing the need for new supplies, usually at significantly lower cost.

5 Canada's Energy Outlook: The Reference Case 2006, Natural Resources Canada, 2006.
6 Energy used by final consumers for residential, agricultural, commercial, industrial and transportation purposes.
7 The International Energy Agency estimates a crude oil price of $47/bbl in the short term that could be as high as $86/bbl by 2030.

- Strong economic growth with less energy use.
- Potential relief from rising energy prices.
- Improved competitiveness of Canadian industry.
- A robust and growing industry involved in the research, development and implementation of energy efficiency products and services.

A Commitment to Energy Efficiency

Energy efficiency is important to Canada's federal, provincial and territorial energy Ministers - the Council of Energy Ministers. CEM jurisdictions all share an interest in energy efficiency although their primary objectives may differ. For some, reducing energy use to prevent different forms of pollution is paramount, particularly greenhouse gas and smog emissions. For others, conserving electricity and other energy supplies is a primary motivator. Social and economic development opportunities are also important – helping Canadians cope with higher energy prices, supporting cost-saving productivity improvements as well as the local employment opportunities that result from increasing investments in energy efficiency.

Taking action on energy efficiency can directly benefit organizations. A growing number of Canada's health care facilities are reducing costs by improving their energy efficiency and directing the savings at patient care. A municipality that cuts energy waste by 10% can offer more services. Energy efficiency building retrofits improve a building's value, contribute to its longevity and create productivity-enhancing improvements. In general, energy efficiency investments support infrastructure renewal across all sectors of the economy.

Progress in realising energy efficiency opportunities has already been made between 1990 and 2004, as suggested previously by the $14 billion in energy savings in 2004[8] (resulting from energy efficiency measures undertaken since 1990). However, there are significant additional benefits to be achieved, which are more important than ever, in light of increasing demand for environmental protection, continuing concerns about electricity supply in some regions and forecast energy price escalation. Incremental action is required now in order to make Canada a greener, more sustainable, more productive and more competitive economy. Many of our key trading partners are taking aggressive steps to save energy.

This foundation document highlights some of the technologies and practices that can deliver energy savings throughout all regions of the country and key areas of the economy. They range from newly-emerging super efficient technologies to the well-known but underutilized.

This document also provides a menu of policy instruments or tools to realize the multiple benefits of energy efficiency, including environmental protection, energy security,

Energy Efficiency Targets - Quebec, Ontario, Manitoba, B.C., and PEI

- **Quebec's 2006 energy and climate change strategies place a strong emphasis on energy efficiency. All forms of energy will contribute to this objective : an energy efficiency target for electricity double from a target of 4.1 terawatt-hours by 2010 to 8 terawatt-hours by 2015; a natural gas target more than triple, increasing from 96.9 million cubic metres by 2008 to 350 million cubic metres by 2015; and for the first time, a target was set for the petroleum products sector - 2 million tonnes oil equivalent by 2015, equal to just over 10 % of Quebec's current annual consumption.**
- **Ontario has a conservation target of a 6,300 megawatt (MW) reduction in peak electricity use by 2025.**
- **Manitoba plans to reduce electricity use by 842 MW by 2017.**
- **B.C.'s target is to acquire 50 per cent of BC Hydro's incremental electricity resource needs through conservation by 2020.**
- **PEI has a target over 2006 – 2010 to reduce the intensity of peak electricity demand in 2010 to its 2004 level; a 5% reduction. It also will reduce peak electricity demand by 2015 by 5% below 2004 levels.**

8 Energy Efficiency Trends in Canada; 1990 to 2004, Natural Resources Canada (2006).

productivity, competitiveness, affordability and technology development. The perspective of each jurisdiction will dictate which energy efficiency tools and which actions are the priority in the short, medium and long term. This document is meant to be equally useful to all jurisdictions, allowing them to meet their own policy objectives while contributing to the national energy efficiency potential at the same time.

While primarily a tool for CEM governments to show leadership for the rest of the economy and to shift public attitudes towards energy use, the foundation document also serves to identify the roles other parties can play to realize their own energy efficiency benefits. Energy consumers in all sectors, municipal administrations, utilities, energy boards, professional associations, manufacturers and others can all contribute to achieving the energy efficiency potential in Canada. In addition, manufacturers and suppliers of energy efficiency-related goods and services are a source of prosperity, innovation and export earnings that can only grow in importance as demand for energy efficiency increases worldwide.

In short, this document provides a range of tools for realizing Canada's energy efficiency potential. Figure 4 outlines the key elements that are critical to achieving results.

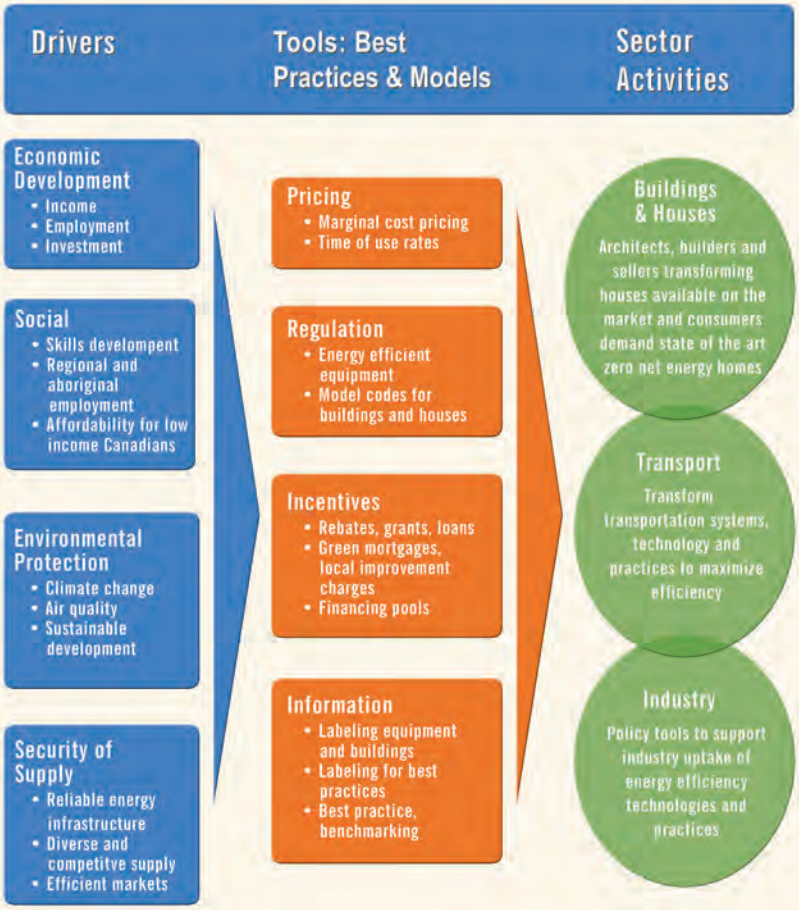

Figure 4: Key Elements of the Energy Efficiency Potential

The Role of Technology

As older equipment is replaced, new technologies introduce substantial energy savings. Today's generation of refrigerators use one quarter of the energy of the 1970s version. A new secondary loop refrigeration technology integrated into the heating and ventilation system can allow a supermarket to reduce synthetic refrigerant use by 75% and total energy consumption by 18%. On average, cars sold in 2005 are 8% more fuel efficient than in 1990, and 35% more efficient than those sold in 1979. Energy-efficient lighting available to consumers today allows them to use 50-75% less energy to meet their lighting needs than with incandescent bulbs. If all conventional heating systems were made high efficiency, then their consumption would be reduced by 30%. Further, technology can fundamentally change the way Canadians use energy. For example, combined heat and power systems produce electricity on site and use the heat generated from that process to heat the building. This technology has more than doubled the energy efficiency of conventional generation systems, while further reducing transmission losses, increasing energy security, reducing peak power demand, providing backup in case of grid outages and can be integrated with renewable energy sources. Finally, with the introduction of new technologies such as dehumidification kilns, the Canadian lumber industry could reduce, on average, its energy consumption by approximately one-third.

Energy efficiency is becoming increasingly important to the world at large. The G8 countries recently committed to implement national energy efficiency programs and advance international cooperation, notably on efficiency standards, as well as sustainable buildings, improvements in industry and labelling for new cars[9]. The International Energy Agency supports strengthening building codes, standards for reduced standby power for electronic equipment to one watt, and phasing out inefficient lighting[10]. In 2006, the Commission of the European Communities[11] released an Action Plan covering energy efficiency priorities for appliances, buildings, transportation and energy generation. The Intergovernmental Panel on Climate Change[12] reported that buildings represent the greatest opportunity for considerable reductions in CO_2 emissions, with net economic benefits. Energy efficiency in buildings will play a critical role in addressing the opportunities within this sector.

Energy efficiency is also important for our largest trading partner, the United States. In January 2007, President Bush signed an Executive Order, "Strengthening Federal Environmental, Energy, and Transportation Management" outlining goals for federal agencies. Measures include reducing the fuel consumption of petroleum products by federal agencies by 2% annually through the end of fiscal year 2015 and increasing the total fuel consumption that is non-petroleum-based by 10% annually relative to agency baselines for fiscal year 2005, and ensuring that new construction and major renovation of agency buildings comply with the Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings. California set new car emissions standards to increase fuel efficiency and reduce emissions by 30% by 2016. In 2006, the state and the California Clean Energy Fund awarded a $1 million grant to the University of California (Davis) to create the nation's first university-based Center on Energy Efficiency to focus on advancing innovation and bringing energy efficiency products, services and practices to the state's marketplace.

Energy Efficiency, Fuel Switching and Renewable Fuels

This foundation document will address energy efficiency (meeting needs with less energy) as well as energy conservation (reducing needs, thereby requiring less energy). Concepts that are often addressed alongside energy efficiency, usually when environmental and energy security objectives are key, are fuel switching and the substitution of renewable energy for conventional forms. These will be included where they are linked with efficiency and where they do not divert from the efficiency focus (e.g., domestic solar hot water heaters). The development of renewable power for commercial purposes is excluded.

The Potential for Energy Efficiency in Canada

A number of recent studies have addressed the potential for energy efficiency improvements. While these studies vary in methodology, and are therefore difficult to compare, they all support the fact that there is significant potential for energy efficiency improvements. Some of the recent studies that support the potential identified herein are:

9 The G8 Group consists of the U.S., Britain, France, Japan, Germany, Canada , Italy and Russia.
10 The International Energy Agency acts as energy policy advisor to 26 member countries in their effort to ensure reliable, affordable and clean energy for their citizens.
11 The Commission, consisting of 27 representatives from each European Union country, proposes legislation on which the European Parliament and the Council decide, is responsible for implementing common policies, administers the budget and manages the Union's programmes.
12 The Intergovernmental Panel on Climate Change was established in 1988 by the World Meteorological Organization and the United Nations Environment Programme to assess scientific, technical and socio-economic information relevant to the understanding of climate change, its potential impacts and options for adaptation and mitigation.

- A 2006 study assessed how consumers would make energy choices, in light of different levels of program support from governments. It indicated energy conservation, efficiency and renewable energy can reduce the growth of energy demand between 16% and 56% by 2025[13].

- The National Round Table on the Economy and the Environment released a long-term climate change study in 2006 that examined how technologies could reduce emissions[14]. It suggested that energy efficiency could achieve approximately 40% of their goal of a 60% reduction in greenhouse gas emissions, more than any other single source. With two exceptions, the technologies assessed are already available for adoption in Canada.

- A paper in Ontario covering the residential, commercial/institutional and industrial sectors, 2005 to 2025, concludes that electricity savings potential from energy efficiency would be in the 3% to 13% range, as compared to the reference case without any new market intervention[15].

- A 2002 BC Hydro study focused on technologies that are commercially viable, or would be, by the year 2005. It demonstrated that electricity demand could be reduced by 11% to 15% per year for the residential, commercial and industrial sectors by 2016[16].

Barriers to Energy Efficiency

The potential for energy efficiency is often defined as the energy that can be saved from profitable investments - from the energy user's financial perspective or from the view of society – the economic perspective. In reality, decisions about energy use are not typically based on straight financial returns, even for businesses. This results in scores of unimplemented energy efficiency investments.

Consumers tend to regard energy use as a byproduct of their daily activities – driving a car, living in a house. Information about ways to save on energy costs, while helpful, may not be enough to trigger action. Other barriers include lack of financing, perceptions of risk and lack of access or availability of new technologies and the absence of specific, usable information. Too often, consumers, including governments in their own operations, overlook the operating cost reduction that offsets the upfront capital costs associated with making an investment in energy efficiency.

Businesses and the public sector also tend to under-invest in energy efficiency despite more analytical decision-making processes. Barriers to investment include those identified above, and in addition, efficiency investments have to compete against other uses for capital and equity, and efficiency investments with good returns may not be adopted when compared with more fundamental requirements (e.g. meeting payroll requirements) or better returns from other investments (e.g. expanding product lines).

Some barriers represent market failures. Where electricity users pay the average cost of power instead of the cost of production, for example, the price incentive to conserve is lost. The party who invests in an efficiency project may not always benefit. For example, landlords pass on energy costs to their tenants; thereby, neither has an incentive to improve the energy use in the buildings.

Overlooking the "Second Price Tag"

If the 1st price tag is the cost of equipment, the 2nd price tag is the operating cost of the life of the equipment. Consumers who choose an incandescent bulb, for example, over a compact fluorescent, are reacting to the fact that the latter can cost as much as 6 times more than the former. However, the energy costs of the compact fluorescent are five times lower than for the incandescent. Also, the compact fluorescent bulbs last up to 10 times longer. Thus, the higher upfront cost is quickly recovered in operating savings. This situation is applicable to thousands of efficient products and is a major barrier to increased efficiency.

13 Demand Side Management Potential in Canada: Energy Efficiency Study, May 2006, Marbek Resource Consultants Ltd. and M.K. Jaccard and Associates Inc. The study did not consider the transportation or energy producing sectors.
14 Advice on a Long-Term Strategy on Energy and Climate Change, June 2006, National Round Table on the Environment and the Economy.
15 Ontario's Integrated Power System Plan – Discussion Paper 3: Conservation and Demand Management, and Discussion Paper 2: Load Forecast, 2006, Ontario Power Authority.
16 Electricity Conservation Potential Review, 2002, BC Hydro.

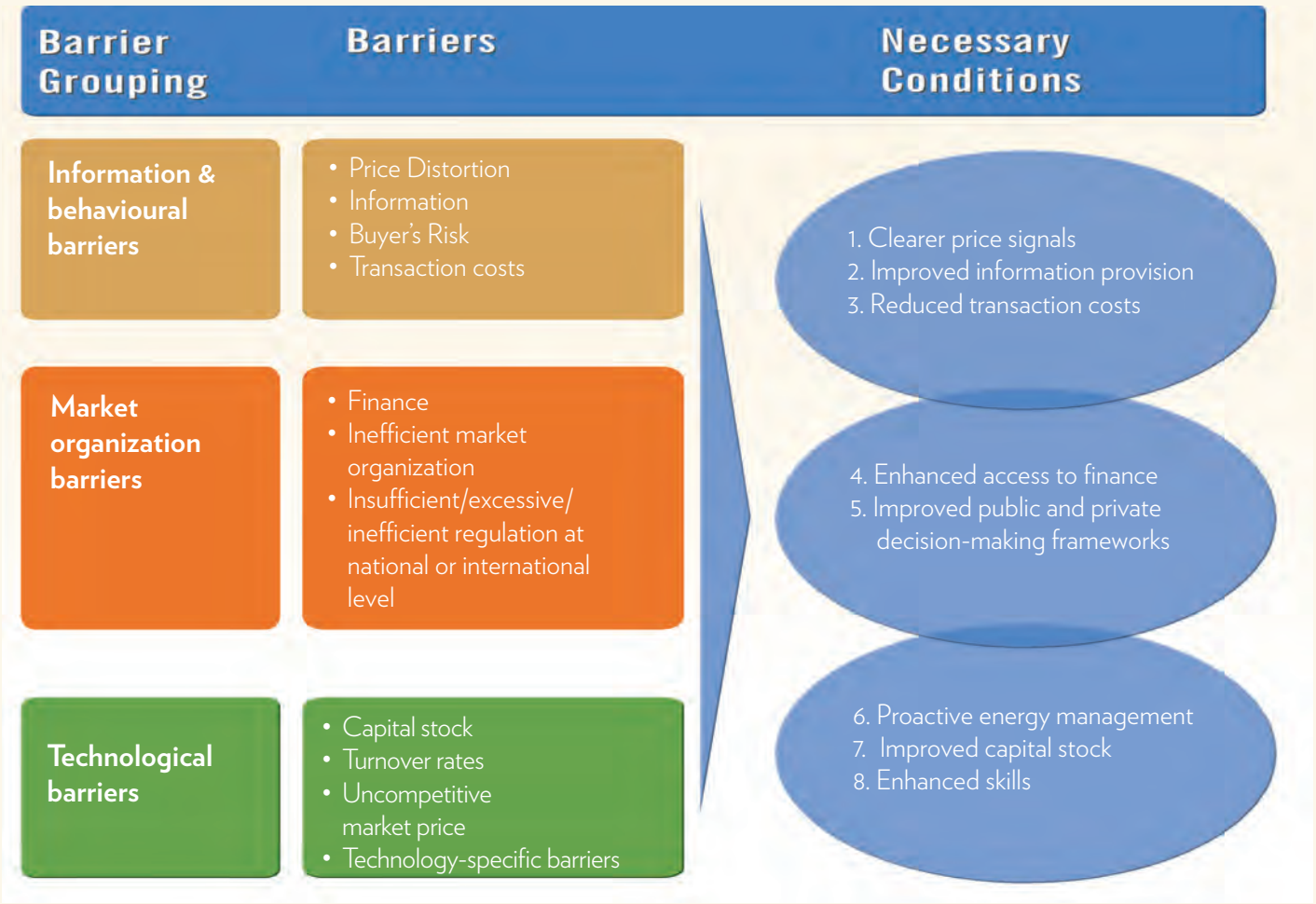

Figure 5: Addressing Barriers to Achieving Energy Efficiency Potential

Tools described in this document are intended to address the barriers identified in Figure 5 to help transform the way we use energy in all sectors of the economy.

Principles for Energy Efficiency

CEM jurisdictions agree on the value of principles as a guide to the development of energy efficiency policies and programs[17]. The principles are based on collective experience with the intention that they will be used to design and implement effective energy efficiency policies and programs. For the complete list of principles, please see Annex I.

Organizations That Shape Energy Use in Canada

Governments and public and private utilities, building on public policy, play a vital role in advancing energy efficiency, as investors in programs that stimulate actions and as policymakers and regulators that help shape the marketplace. Utilities, governments and government agencies can establish demand-side management programs that encourage industry, urban planners and energy consumers to conserve and reduce energy demand. Public and private utilities, with access to billing and energy use data, have a unique relationship to energy users and can be important players.

17 The above principles have been adapted from those developed in 2006 by the Energy Efficiency Working Group, Energy Sector Sustainability Table.

Provinces and territories have the ability to set the institutional framework for demand-side management, regulate energy utilities through public utility commissions, and regulate energy efficiency standards for building designs, building components, and energy-using equipment. In addition, provincial fiscal and resource policies can help shift investment and purchasing behaviour toward energy efficiency. Finally, provinces and territories can stimulate the marketplace with their own equipment purchasing, and building and vehicle leasing policies.

The federal government also sets energy efficiency standards for equipment that is sold across jurisdictions, including motor vehicles. It plays a key role in establishing consistent approaches for efficiency rating systems, labelling schemes, training and information services across Canada. It can also facilitate energy efficiency activities through capital cost allowance tax breaks, consumer rebates, and incentives.

Municipalities and local administrations can shape communities' energy use, particularly for transportation, given the land-use planning impacts on commuting distances and complete communities. In addition, communities enforce building code standards on behalf of provinces and territories and thus, have a large impact on influencing the construction industry. Similarly, First Nations influence planning and managing transportation and building code standards on, and in some cases, off First Nation land.

The energy efficiency goods and services market is an emerging clean energy industry. Recent studies of energy efficiency potential in Canada have identified substantial markets for expanded investment in energy efficiency. This industry is expected to respond to the growing awareness of needs of the energy consuming market, the promotions and support of all orders of government and utilities and to the evident business opportunities. The efficiency industry includes the manufacture, distribution and sales of efficiency related products, the design of efficient buildings and manufacturing systems, energy auditing and advisory services, specialized financing, and research and technology development. These business opportunities are not limited to the domestic efficiency market but advanced goods and services are exportable in large measure. Market and policy conditions in the United States and other countries are creating considerable growth in this area.

Municipal Administration Leadership on Energy Efficiency

- **200 municipalities have used the Federation of Canadian Municipalities' Green Municipal Fund to develop community energy plans and to launch energy efficiency projects.**
- **151 municipalities with the Partners for Climate Protection (PCP) program are at various stages of a five milestone framework designed to educate and empower municipalities to reduce greenhouse gas emissions. 33 municipalities have set both corporate and community energy efficiency targets.**
- **The American municipal experience is illuminating - 167 American cities, including Seattle, whose mayors recognize the prominence of energy efficiency, are at various stages of taking action on climate change through the Cities for Climate Protection program, the U.S. equivalent of the PCP program.**

The interest in energy use and energy efficiency is much wider than governments and utilities. Professional and industry associations, financial institutions, education and non-governmental organizations, private corporations and companies and retail outlets all influence energy use through their actions and practices. For example, professional architectural associations can profoundly impact the nature of the design and operating efficiency of the built environment. Many associations foster professional development, facilitate design workshops and seminars, sponsor incentive programs, offer educational opportunities at national and regional conferences, and lobby for sustainable building practices. Corporations and companies can contribute in three ways: by improving energy use in their own operations, by demonstrating leadership to others and by participating in the business opportunities afforded those who move to more sustainable business models. Some retail outlets, for

example, are educating their customers and making them more aware of what they can do to lead more energy-efficient lifestyles.

To improve significantly the way in which energy is used in Canada, it will be necessary to employ a range of tools that are flexible, affordable and timely and invite participation from interested parties. Most importantly, it will require more take-up of more tools by more parties, including those not typically identified as energy efficiency influencers. Figure 6 describes some well known tools as well as more innovative instruments that could be effective, some with little or no incremental financial outlay. Further, tools for specific sectoral applications are described in further chapters.

Effective Combination of Policy Tools in British Columbia

The Energy Plan released by British Columbia in 2007 demonstrates how governments can combine a variety of policy tools to improve energy use:

- **Code and standards to set minimum performance standards.**
- **Utility responsibility and authority for significant demand side management including targets, rate instruments and facilitation.**
- **Leadership by example through improving BC's own operations**
- **Outreach to shift attitudes and influence consumer behaviour.**

Public Sector Leadership

Ontario's new Energy Conservation Leadership Act provides the authority for the province to require its public sector organizations to prepare energy conservation plans and report progress. While not a costly administrative or incentive measure, this requirement is expected to have an important impact in instilling an efficiency culture across the public service that will lead to sustained reductions in energy waste. Studies show that simply focusing on energy use results in savings.

The benefits and costs of implementing the tools illustrated vary widely and cannot be estimated here because costs are highly dependent on specific applications, including: sectoral and regional coverage, length of implementation, and technology eligibility. CEM jurisdictions can select their own tools and evaluate their benefits and costs accordingly.

Examples of Energy Efficiency Programs in Canada

- New Brunswick's Expanded Existing Homes Upgrades Program offers homeowners a grant of up to $2,000 or an interest free loan of up to $10,000 to make energy efficient improvements to their home.
- Under Manitoba's Green Building Policy, government funded projects in the province will have to be Leadership in Energy and Environmental Design (LEED) Silver – a high performance level in an environmental building rating system.
- A government-funded long-term care facility being built in the City of Corner Brook, Newfoundland has achieved a LEED Silver Standard. This building will be the benchmark for public sector buildings in the province wherever it is achievable.
- Alberta's adoption of the LEED Silver standard for design of new government-funded buildings will reduce the environmental impacts of new buildings and help conserve energy. In addition, energy retrofit of over 200 provincial government facilities since 1995 has already resulted in annual savings of $6 million from lower utility costs.
- The Government of Nunavut has launched its Energy Management Plan to retrofit government owned buildings in Iqaluit to make them more energy efficient. A private sector company is investing $10,000,000 to retrofit 29 percent of the Government's owned building stock and will recoup the cost from energy savings over the next three years.
- In continuing efforts to lead by example, Saskatchewan's Energy and Climate Change Plan released in 2007, committed the province to expanding purchases of green power, improving the emission standard for government vehicles, developing a new efficiency code for government buildings, and ensuring sustainable practices are a part of all government planning.
- In Nova Scotia, the City of Halifax has instituted a Bus Rapid Transit (BRT) system. This project established two BRT corridors from outlying areas to downtown Halifax. These corridors are equipped with transit priority traffic signals and queue jump lanes, allowing transit to have a competitive edge over vehicular traffic at certain signalized intersections. The new buses offer an attractive fare and are fitted with extra amenities such as padded seating and air-conditioning. Public reception has been overwhelmingly positive and the service has been oversubscribed, resulting in plans to significantly expand the service.
- The Northwest Territories' Energy Efficiency Incentive Program encourages residents to buy the most energy efficient products by providing rebates for energy efficient home heating, home appliances, home renovations and personal transportation such as : eligible outboard motors, snowmobiles and vehicles.
- The Yukon government offers a broad range of incentives to help consumers reduce their energy consumption. Both homeowners and rental property owners are eligible for low-cost energy evaluations, interest-free loans for energy efficiency upgrades and rebates on high efficiency appliances. Through its storefront Energy Solutions Centre, it also provides training for building designers and trades people.
- The federal government's ecoENERGY Retrofit program provides financial support to homeowners, small and medium-sized businesses, public institutions and industrial facilities to help them implement energy saving projects that reduce energy-related greenhouse gases and air pollution, thereby contributing to a cleaner environment for all Canadians.

Example of Energy Efficiency in the Energy Industry

Collaboration among the energy industry, non-government organizations, the Alberta government and the Alberta Energy and Utilities Board has contributed to reduce solution gas flaring in Alberta to date by 71.5 % since 1996 and solution gas venting by 56.4% since 2000. These reductions represent annual energy savings of over 250 petajoules, sufficient energy to heat more than 2 million Canadian homes for a year.

Figure 6: Tools to Advance Energy Efficiency

Federal Government	Targets for sustainable resource stewardship Coordinated, central source of information Measurement and reporting of energy demand trends Model codes for buildings Regulations for equipment and vehicles (international and inter-provincial shipments) Financial transfers with energy-related conditions Fiscal incentives (taxes, rebates, grants, accelerated depreciation) Financial pools – revolving funds Procurement of goods, leasing of buildings and vehicles Capacity building Research, development, demonstration and commercialization of technologies
Provincial and Territorial Government	Targets for sustainable resource stewardship Coordinated, central source of information Education curriculum Energy codes for buildings Regulations for equipment (sales within jurisdiction, production of goods) Rating and labelling Financial transfers with energy-related conditions (to institutions, municipal and local administrations) Fiscal incentives (tax exemptions, rebates, grants) Enabling legislation and institutional framework for utility demand-side management Regulatory framework for tradesperson training/qualifications Financial pools Procurement of goods, leasing of buildings and vehicles Research, development, demonstration and commercialization of technologies Capacity Building Provincial/territorial transport and vehicle regulations
Municipal and Local Administrations	Targets for sustainable resource stewardship Community energy plans Information – particularly for the construction industry Enforcement of provincial regulations for buildings Fiscal incentives (property tax rebates, rebates, grants) Zoning and land use requirements Brownfield redevelopment Transportation planning Local improvement charges Leadership on energy efficiency for local infrastructure
First Nations	Targets for sustainable resource stewardship Codes for buildings (e.g. housing department) Land use and transportation planning on and off reserves Financial incentives Community energy plans
Public and Private Utilities, Commissions, Agencies and Crown Corporations	Targets for sustainable resource stewardship (triple bottom line) Stepped, time-of-use and marginal cost pricing/rates Smart / Advanced meters Demand-side management programs (information, incentives, capacity building) Renewable energy/cogeneration Research, development, demonstration and commercialization of technologies Measurement and reporting of energy demand trends Mandated demand-side management targets and rate-base sourcing of program costs
Professional and Industry Associations	Energy-related training and certification for professionals, such as engineers, architects, technicians Information – direct outreach to members, conferences, journals Development and demonstration of technologies Researching and communicating best practices for energy management Accounting standards that reflect life-cycle costing and facilitate energy savings-financing Incorporation of energy costs in property valuation
Private Corporations and Companies	Adopt new technologies and best practices in own operations Leadership on energy efficiency Educate employees and influence them to take action
Financial Institutions	Green mortgages– energy efficiency mortgages and location efficiency mortgages Financing pools Investors
Retailers	Consumer education and awareness Price incentives
Education Organizations	Research, development, demonstration and commercialization of technologies Building up labour pool for energy efficiency sector Leadership on energy efficiency for institutional buildings Measurement, reporting Centres of Excellence Energy efficiency in curricula (e.g. MBA, engineering, and architecture)
Non-governmental Organizations	Independent research on program design, performance, opportunities Media engagement Public education

Cross-cutting Opportunities – Reducing Waste

Energy is wasted as it is converted from primary sources into the energy that is sold (eg: oil to gasoline and natural gas to electricity). Energy is also wasted as it is converted into useful services such as heat and light. Much of the energy we purchase is wasted in this latter fashion. Moving Forward on Energy Efficiency in Canada focuses on reducing energy waste and getting as much service as possible out of all our energy sources.

Waste energy can be captured from one sector for use in another sector. Also, actions can be taken in one sector to reduce energy use in another sector. Cross-cutting opportunities such as these can be overlooked because they require an integrated approach, typically involving multiple players, not just the energy user but also neighbouring energy users, utilities and governments. For example, community forms that have mixed end uses and high density reduce the demand for personal transportation because more people can meet more of their needs through transit, walking and cycling. Other examples of cross-cutting opportunities include:

- Cogeneration – where heat and power are produced simultaneously, for example, the waste heat from an industrial or building boiler is used to make electricity for use or sale.

- Heat recovery – waste heat from chillers or industrial processes is used for heating and/or cooling. For example, a commercial building is located near an industrial park in order to use the waste heat to meet their own low grade heat and energy requirements.

- Integrated on-site processing – from raw materials to more completed or finished products - to reduce transportation costs. Examples include processing lumber into furniture or pre-fabricated building products in one facility. Compact packaging for consumer products also reduces shipping load sizes and weights, therefore reducing transportation energy use.

- Community and sustainable energy planning – integrates the needs of all sectors and can be used to find ways to use waste energy appropriately and to incorporate innovative energy systems. These plans should include smart planning for compact, mixed use communities where land-use planning designates higher density nodes reducing transportation requirements and allowing more efficient transportation such as public transit, and is conducive to walking and cycling.

Identifying opportunities to reduce energy waste is a relatively new field – requiring further research, development and demonstration. However, many untouched and significant savings opportunities are realizable with a more coordinated, systematic approach to energy efficiency planning and program delivery.

Cross-Cutting Actions in Canada

- **The Markham, Ontario district energy system and cogeneration plant connect a number of buildings and high-technology industries to a district heating, cooling and electrical supply with a very high reliability rating.**
- **The 42 storey Shaw Tower in Vancouver heats residential units in the upper floors from the commercial office chillers in the lower floors.**
- **The City of Yellowknife's Community Energy Plan was published in March 2007 with energy saving and emission reduction targets for government operations and the entire community by 2014.**
- **Planning for the southeast False Creek area in Vancouver incorporates principles of energy efficient design, developed at the highest density possible while meeting livability and sustainability objectives, ensuring goods and services are within walking distance and housing that is linked by transit and in proximity to local jobs.**
- **A program in Québec supports the clean-up of contaminated industrial lands and "brownfield" development of mixed use neighborhoods such as "Angus Shops" in Montréal that includes over 1000 dwelling units in townhouses and low-rise condominium apartments, a supermarket, industrial mall and biotechnology centre.**
- **30% of total electric power generation in Alberta is produced by co-generation. This represents almost 2,700 megawatts of electric power. An additional 1,000 megawatts have been proposed for development in Alberta by 2010.**

2 The Built Environment

Scope

The Built Environment addresses all buildings, housing, infrastructures, fixed equipment and communities.

Context

Residential Sector[18]

Despite strong growth in the number of houses, Canadians' appetites for larger houses and an increase in overall energy use, the energy use per household actually decreased by 12% over the last decade or so[19]. There are more than 12 million dwellings in Canada, representing a total annual energy bill of about $6 billion. Efficiency gains in building practices, heating systems and equipment since 1990 are responsible for energy savings of more than $4 billion for this sector in 2004[20].

There have also been significant gains in efficiency in the major appliance stock over 1990-2004, so that absolute energy use dropped even though there are 33% more appliances than there were in 1990[21]. However, these gains have been overshadowed by a 75% increase in the number of small and, generally unregulated, pieces of equipment that populate modern Canadian homes such as DVDs, high definition televisions and video cameras.

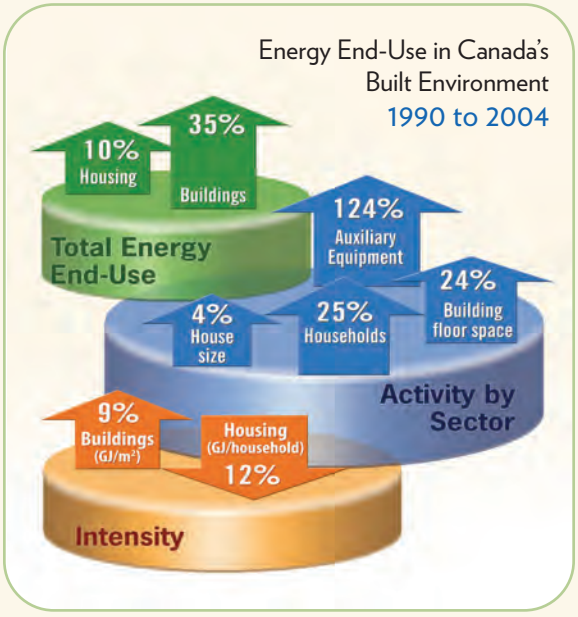

Figure 7: From 1990 to 2004, the number of households in Canada increased and house sizes rose. The total energy consumption of the housing sector rose , but because of efficiency gains, the energy use per household actually dropped by 12%. In the Buildings sector, floor space grew between 1990 to 2004, and the energy consumption by area also rose, resulting in an energy demand growth of 35% in the sector.

Progress in Energy Efficiency

The number of high efficiency new homes labelled in Canada increased fourfold from 2002 to 2006. These homes use 25-30% less energy on average than typical new homes – and are more comfortable for their occupants.

18 Single detached homes, single attached homes, apartments and mobile homes.
19 Energy Use Data Handbook, 1990 and 1998 to 2004, Natural Resources Canada (August 2006)
20 Energy Efficiency Trends in Canada, Natural Resources Canada (August 2006)
21 The State of Energy Efficiency in Canada, Report 2006, Natural Resources Canada

Commercial and Institutional Sector[22]

Unlike the residential sector, the energy intensity of about 450,000 commercial and institutional facilities across Canada increased over 1990-2004, meaning that the energy efficiency investments that took place were not robust enough to counter the overall increase in energy use. Energy demand in this sector grew by over 35% over the last decade or so with the growth driven by increases in floor space and in the use of auxiliary equipment like computers and printers.

Looking forward to 2020, the expected growth in the Canadian economy, as well as continued growth in commercial floor space (39%) and in the number of households (20%), will continue to put upwards pressure on the demand for energy.

Approach

The approach for the Built Environment is based on a strategy to transform the way Canadians build, buy and use homes, buildings and communities with respect to energy use – a process called market transformation. Actions aimed at alleviating barriers to energy efficiency outlined in Chapter 1 need to be introduced or expanded, and partnerships between jurisdictions, utilities, industries and non-government organizations will be vital. Success is achievable using:

(1) energy efficiency technologies and practices that are available for adoption today,
(2) emerging technologies that will be ready in the near future,
(3) continued Research, Development and Demonstration (R, D&D) for appropriate technologies to achieve substantial energy efficiency gains, and
(4) a menu of tools and technologies that jurisdictions can select for implementation.

22 Trade, finance, real estate, public administration, education, health care and commercial services.

Key Tools, Technologies and Practices

Within the built environment, provincial and territorial governments and municipal administrations can play the important role of incorporating energy efficiency into provincial and territorial policy statements, municipal plans, and community energy plans. Federal government integration of efforts into existing federal programs, such as Infrastructure Canada's Integrated Community Sustainable Plans, can increase the market penetration of energy efficiency and renewable energy technologies within Canadian communities. From the regulatory perspective, the federal government can expand its equipment and appliances standards, research, development and demonstration, as well as integrating greater levels of energy efficiency in model energy codes for buildings to support provincial and territorial efforts .

Jurisdictions can prioritize and choose from the following tools (among others) to achieve their short and long term objectives. The tools listed in each section could be used in combination for maximum effectiveness, as illustrated by the B.C. example provided in Section 1.

Upgrade – Model National Energy Codes for Buildings

At the initiation of the Council of Energy Ministers, the Canadian Commission on Building and Fire Codes decided in 2007 to upgrade the Model National Energy Code for Buildings (1997) to a higher level of energy efficiency by 2012. If an energy code were updated to 25% above current levels and if it were adopted by all provinces and territories, it could result in significant energy and pollution savings and these would persevere over buildings' lives which can be 40 years or more. This is an excellent example of the power of intergovernmental collaboration on one of the most effective tools to improve building energy efficiency.

Tools to Support Improvements In Energy Efficiency for the Built Environment

Policy/Regulation	Periodically enhance the Model National Energy Code for Buildings, regulatory instruments for houses, and energy efficiency standards for equipment to conform to best practices.
	Mandate minimum energy efficiency requirements for buildings and houses.
	Develop and implement energy performance rating and labeling for equipment, houses and buildings.
	Mandate commissioning and re-commissioning standards for buildings, supported by training and certification of building managers and operators.
	Encourage municipalities to implement policies to improve urban form design, density and integrated planning.
Research, Development and Deployment	Conduct R, D&D for leading edge 'market-ready' and 'pre-market' technologies and practices that could lead to significant energy consumption reduction and a shorter commercialization time. Create a network of university and college researchers in energy efficiency. Address barriers (technical, financial, regulatory, risk) to accelerate technology transfer and support adoption.
	Integrate systems and develop tools to ensure energy is used optimally by equipment, houses, buildings, neighbourhoods and entire communities, including renewable technology integration.
Capacity Building	Strengthen the capacity of the building industry and building managers to understand, adopt and deliver energy-efficient best practices.
	Develop energy efficiency and renewable energy curriculum programs for universities, colleges and technical schools.
Leadership	Demonstrate government leadership through procurement policies and best practices for the adoption and implementation of energy efficient and renewable energy products and buildings.
	Encourage municipalities to adopt policies to limit urban sprawl.
Information	Increase knowledge of stakeholders and consumers through information and awareness-raising campaigns, consultation and development of decision-making tools for industry professionals.
Market Stimulation	Encourage and reward the accelerated adoption of energy efficient best practices and equipment, buildings, houses, and renewable energy technologies using fiscal and tax incentives, and other financial and economic instruments.

By 2030, communities could meet energy demand through the integration of energy systems, making the best use of local on-site renewable sources interconnected with the public energy distribution systems. Community energy plans could enhance the capacity of municipalities to implement energy efficiency and renewable energy at the community level, and support smart growth principles to reduce and limit urban sprawl, lower infrastructure costs, make transit more viable, increase walkability and green spaces, and improve overall quality of life. Neighbourhoods could be designed and developed following sustainable neighbourhood principles, capitalizing on energy opportunities and synergies available at the neighbourhood level (e.g. energy cascading where waste energy can be used for such needs as district systems, solar optimization, and seasonal storage for use throughout the year as needed).

New buildings and houses could incorporate the most energy efficient insulation and air tightness systems; windows and doors; new buildings system integration through commissioning; lighting and daylighting technologies; heating, ventilation and air conditioning equipment, and high performance metering, monitoring and control systems. The energy performance of these new buildings and houses could also be improved through on-site generation using a combination of conventional and renewable energy, e.g., using combined heat and power systems and solar photovoltaic technology. Ground source heat pumps, solar thermal energy and/or micro-cogeneration systems, including fuel cells, would be used as the primary source of space heat and hot water needs, with buildings and houses being interconnected within a community to share electricity and heat in an optimum way. In order to accomplish this, individual homes, buildings and communities could be designed in an integrated fashion both at the outset and during major upgrade or retrofit opportunities.

Energy efficiency of existing buildings and houses could be improved by incorporating a high degree of new technologies when refurbishing, with design tools available to optimize technology selection. Building system integration includes re-commissioning of all equipment to reap savings, from optimizing energy systems, metering and control systems, automated building diagnostics systems, fault detection software, and highly trained building operators. Existing houses could be retrofitted with the best in class ENERGY STAR® qualified furnace/air conditioning systems, heat pumps, advanced wall insulation, exterior insulated sheeting, fully insulated basements and attics, and high efficient windows, doors and lighting. Where feasible, buildings and houses would also use renewable energy technologies, incorporate on-site generation and be interconnected with other buildings and houses within the community.

Increasing the energy efficiency levels of regulated equipment through support for technology development and deployment, and eliminating the least efficient models through performance-based regulations, could also contribute to overall energy efficient improvements within the building and housing stock.

3 Industry

Scope

The industrial sector can be divided into two groups: the energy consumers (mining, manufacturing[23], and construction); and the energy producers (upstream oil and gas, heavy oil upgrading and electricity generation).

Context[24]

Industry is currently the dominant energy user in Canada, accounting for 48% of primary energy demand in 2004 and generating 29% of economic output ($303 billion in GDP). Overall energy intensity improvements of 9% since 1990 resulted in annual fuel savings of $3.1 billion and avoided greenhouse gas emissions of almost 30 Mt per year. Energy efficiency in industry can substantially reduce costs and provide enormous productivity, environmental and other non-energy benefits.

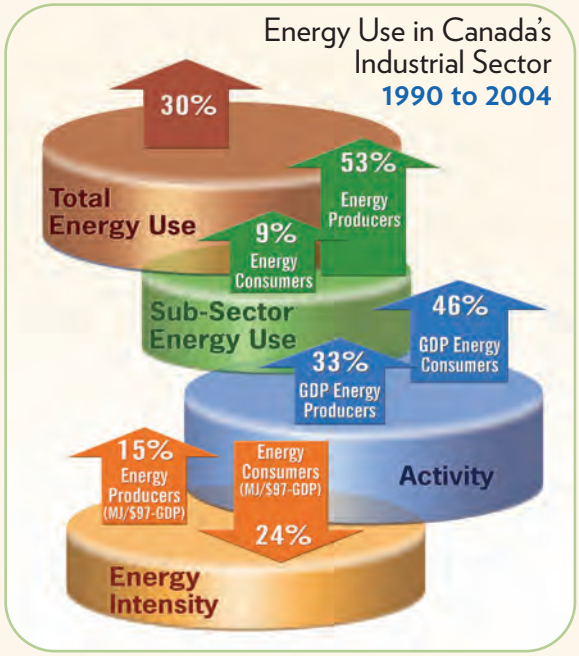

Figure 8: Over the 1990 to 2004 period, energy-related data for Canada's industrial sub-sectors tell very different stories. In the energy consuming industries, the growth in activity outpaced the increase in energy use leading to a 24% improvement in energy intensity while in the energy producing industries, energy use grew at a faster pace than activity, increasing that sub-sector's energy intensity by 15%.

Rock Solid Savings

CVRD INCO (Ontario) reduced its energy consumption by 10% since 1990, while increasing production by 20%. In total, the company has recorded a $60 million reduction in energy consumption since 2000.

Energy Consumers

Between 1990 and 2004, the energy-consuming industries had an extremely positive record of energy intensity during a period of strong growth in output (45%). In 2004, Canada's mining, manufacturing and construction sectors used 24% less energy to produce a unit of product than they did in 1990. This can be explained by investments in energy efficiency, fuel switching and shifts in production from more energy-intensive industries, such as iron and steel, to less energy-intensive industries, such as computer and electronic products. Analysis shows that efficiency investments accounted for over 70% of overall energy intensity improvements[25]. Improvements came from sectors as diverse as textiles and food and beverage (where energy represents less than 10% of overall manufacturing costs), to pulp and

23 Including petroleum refining.

24 Unless otherwise stated, data in this section are based on Natural Resources Canada's Energy Use Data Handbook, 1990 and 1998 to 2004. August 2006.

25 Based on methodology and data used in Natural Resources Canada's *Canada's Energy Efficiency Trends in Canada, 1990 to 2004.* August 2006.

paper, cement and lime (where energy represents between 25% and 50% of overall costs)[26].

Energy Producers

In contrast, the energy-producing industries became 15% more energy intensive between 1990 and 2004. As production rose by 33%, energy use increased by 53%. This increase in energy intensity occurred in both the upstream oil and gas and electricity generation sectors.

In the upstream oil and gas sector, it takes more energy to produce oil and gas today than it did in the past. Conventional oil and gas reserves are increasingly more difficult to access, thus requiring more energy. The more intensive extraction process in the oil sands uses more energy compared to conventional reserves.

In the electricity generation sector, the increased energy intensity results from a decrease in electricity generated from non energy-intensive hydroelectric sources relative to the more energy-intensive coal and natural gas-fired generation.

Looking forward, the environment for industrial energy use will be subject to change:

- The 2007 federal Regulatory Framework for Industrial Air Emissions sets out short-term emission intensity reduction targets for greenhouse gas emissions that will require an 18% emission intensity reduction over 2006 levels by 2010, and a 2% annual improvement thereafter. Under the framework, when interpreted in regulation, firms would be able to choose the most cost-effective way to meet their targets from a range of compliance options including in-house investments in energy efficiency and fuel switching as well as contributions to a technology fund, inter-firm trading, domestic offset, and access to the Clean Development Mechanism. Air pollutants will also be regulated.

- In terms of productivity and innovation, Canadian manufacturers perform on average about half as well as the best of the G7. Our excellence gap is, therefore, 50% of G7 best practice. Canada, in fact, turns in one of the lowest performance ratings of any of the world's major industrial economies when all benchmarks are taken into account[27].

- More energy will be required to extract non-renewable natural resources, like copper, iron ore and oil and gas. As existing reserves are depleted, resources are less accessible and will require more energy to exploit.

Energy efficiency can play a strong role to help industry address these issues, with the additional benefit of providing significant environmental improvements such as reduced greenhouse gas emissions and cleaner air.

Proactive Corporate Culture Leads to Remarkable Results

BP Canada's proactive corporate environmental culture and positive view of energy efficiency have led the company to achieve remarkable results. In recent years, the company has completed more than 400 energy efficiency projects, resulting in emissions reductions of more than 300,000 tonnes of carbon dioxide equivalent per year.

Key Tools, Technologies and Practices

A wide array of tools can be used to improve industrial energy efficiency. These tools can aid industry in the implementation of energy efficient actions through equipment replacement, minimization of process waste, new plant design and construction, the adoption of emerging technologies and management best practices. The following are key tools for use in this sector:

26 Statistics Canada, Annual Survey of Manufactures and Logging. 2006.
27 Canadian Manufacturers and Exporters, 2020, Building our Vision for the Future, 2004, page 19.

Tools to Support Improvements In Energy Efficiency for the Industrial Sector

Policy/Regulation	Develop mandatory minimum performance standards for industrial equipment (e.g. large air conditioners, heat pumps, condensing units, commercial boilers).
	Develop codes and standards for energy efficiency in new industrial plants that integrate equipment and building envelope requirements.
	Develop an energy management best practices rating system.
Research, Development & Deployment	Support the development of new industrial cutting edge technologies (e.g. combustion, insulation, production and plant control).
Capacity Building	Provide energy efficiency training to industrial employees at all levels to improve technical knowledge and shape corporate culture.
	Provide training to industrial energy efficiency service providers to ensure that clients receive current energy efficiency information (eg. consultants, product manufacturers/distributors).
Leadership	Encourage regional/local networks of industry leaders and government officials to examine energy efficiency needs on a regular basis.
Information	Undertake employee awareness campaigns to help employees use energy more efficiently at work, at home and on the road.
	Develop and distribute publications and tools to educate industry about technical, operational and organizational good energy management.
Market Stimulation	Ensure that prices reflect the real cost of energy (e.g. two-tiered pricing, time of use pricing).
	Develop and encourage the use of creative financing mechanisms to improve project economics (e.g. revolving funds, energy performance contracts).
	Place levies and/or taxes on the use of energy.
	Provide financial incentives for projects with long payback periods.
	Provide financial incentives for emerging and cutting-edge technologies.

Pointing the Way to Savings

Some 6000 participants from industrial organizations have used energy-saving tips from a modest workshop program to collectively save $100 million or 10 PJ since 1997. This is enough energy to heat half the homes in New Brunswick. Natural Resources Canada's Office of Energy Efficiency offers the Dollars to $ense workshop series to help organizations find, plan and implement energy efficiency opportunities. For example, a Proctor & Gamble plant started tracking their energy use and created an in-house team which led to the implementation of 80 projects proposed by P&G employees from the shop floor; eliminating pre-filter fans alone saved $158,000 a year.

These tools can be used to support energy efficiency improvements in a number of areas. Studies from two provinces suggest that the largest areas of opportunity for equipment retrofit and replacement are[28]:

- Motors and Motor Driven Systems - The potential exists to save 30% to 60% of the energy consumed by motors by optimizing motor and compressor size, using variable frequency drives and managing air compressor leaks. Motors represent about 20% to 30% of industrial energy use.

- Direct Process Heat - Potential energy savings are estimated at 10% to 35% of energy consumed by direct process heat equipment. Improvements that can be made include heat recovery, boiler upgrades and replacement as well as other process-specific opportunities such as oxy-fuel combustion in the steel industry. This area represents about 20% to 40% of industrial energy use in Canada.

Opportunities for system-wide improvements also exist such as improved monitoring and tracking of energy use and advanced modeling and analysis methods to improve productivity and throughput.

Waste Not, Want Not

Following a process integration study supported by Natural Resources Canada, Maple Leaf Consumer Foods installed a heat exchanger system to capture heat from ammonia gas before the rooftop condensers cool it. The new installation diverts the captured energy to the plant's water supply, where it helps heat a 15,000-litre hot water tank. A monitoring system calculates and records actual energy savings in real time, enabling operators to verify that the heat recovery system is operating correctly. The system has lowered natural gas consumption in the plant's boiler system by 22% and reduced the need for boiler chemicals.

28 Marbek Resource Consultants, Neill and Gunter, Energy Performance Benchmarking & Best Practices in New Brunswick Industrial and Manufacturing Sector, 2006.
Ontario Power Authority, Market Profile and Conservation Opportunity Assessment for Small and Medium-Sized Industry in Ontario, 2006.
Ontario Power Authority, Market Profile and Conservation Opportunity Assessment for Large Industrial Operations in Ontario, 2006.

You can't manage what you can't measure – Lord Kelvin, 1891

Lord Kelvin who invented the Kelvin temperature scale knew that measurement is key to good management - and this applies equally to profit, spending or energy use. Pratt & Whitney Canada Corp. profited from this concept by monitoring and, tracking energy-demand fluctuations with a novel energy tool. Installed at three company plants, the new tool predicts long-term energy consumption and tracks key operational parameters. Since its installation, the tool has led the company to implement 70 energy projects and save over $1 million from the installation of energy-efficient boiler systems; better lighting controls; improvements to Heating Ventilating and Air Conditioning (HVAC) systems; compressed air and other systems; and a high-profile employee awareness campaign.

These technologies can be used by energy consumers and producers alike. There are, however, some improvements that are specific to the energy producers sector:

- Supercritical electricity generation units, which are made of super alloys that can withstand high temperature and pressure, can be used to increase efficiencies of new fossil-fueled generating stations from current levels of 32-34% to 36-40%.

- Gasification technologies can provide the upstream oil and gas sector with hydrogen, heat and electricity by using fuels such as biomass, municipal solid waste and residues from oil refineries instead of natural gas, while achieving efficiencies greater than with the use of natural gas.

The use of a combination of the tools presented here can help industry to make some of the changes illustrated above. Increased action can set the stage for building sustainable energy efficiency improvements and help position energy efficiency as a core business value in the same way that health and safety is a core business value today. Through these changes, energy efficiency can be at the forefront of business decisions for equipment replacement and retrofit of industrial processes, to minimize waste in existing facilities. New industrial plants built to stringent energy efficiency standards, could be energy self-sufficient where possible. Capacity can be built for the development of new energy efficiency technologies. Barriers to energy management can also be minimized.

4 Transportation

Scope

There are five transportation modes: on-road and off-road transportation; air; rail; and marine. They represent approximately 30% of Canada's total secondary energy use. This foundation document focuses on energy efficiency in on-road transportation, which accounts for 78% of transportation energy use, and which is forecast to grow five times faster than the next closest mode, air travel[29].

On-road transportation is divided into two segments:

i) Personal Mobility covers the movement of individuals and the ways in which they meet their personal travel needs (e.g., work, recreation, etc.), and
ii) Commercial/Institutional transportation supports business and the delivery of services.

Context

Transportation energy demand is expected to grow substantially - 90% between 1990 and 2030 - far outpacing growth in other sectors[30]. At this rate, by 2050, transportation will overtake industry to become Canada's highest energy-consuming sector. Personal Mobility accounts for slightly more than half of on-road energy use. It is forecasted that Personal Mobility and Commercial/ Institutional transportation will contribute nearly equally to a 45% rise in road energy use between 2004 and 2030[31].

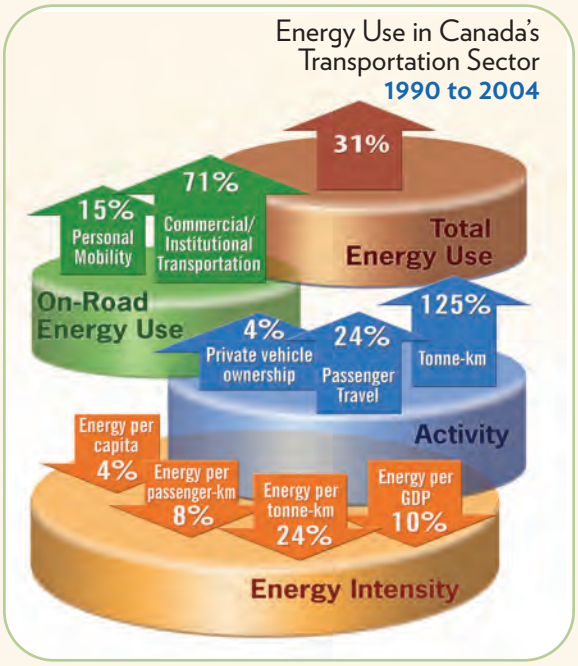

Figure 9: While total energy use in transportation grew by 31%, growth within each sub-sector varied, with Personal Mobility growing at a slower rate than Commercial/Institutional. Growth within Personal mobility was driven by increases in private vehicle ownership and passenger travel rates, while growth in Commercial/Institutional was driven by increases in tonne-km. For both sectors, the impact of growth was partially offset by declines in energy intensity.

29 Extrapolated using data obtained from Natural Resources Canada
30 Ibid
31 Ibid

Population density and personal wealth are the most important determinants of how much transportation energy individual Canadians use[32]. With higher population densities, people typically need to travel shorter distances to meet their needs. Canada's population density is expected to rise from 2.7 to 3.9 people per km^2 between 1990 and 2030[33], with more of the population living in urban areas than currently. However, over the same time period, incomes are expected to grow substantially (62% increase in disposable income between 1990 and 2030)[34]. This means that cars and leisure activities – which often require transportation – become more affordable. As a result, expected increases in vehicle ownership (24% between 1990 and 2030)[35] combined with discretionary travel are expected to put increased pressure on energy used for Personal Mobility which will counteract the impact of increasing population density.

The amount of energy required for Commercial/Institutional transportation depends on three principal factors:

i) **Economic activity** which is expected to continue to rise (157% increase in GDP between 1990 and 2030)[36]. This means that more goods and services will need transport, increasing transportation energy demand. Further, the economy is becoming increasingly reliant on international trade, resulting in transportation over greater distances and corresponding increases in energy use.

ii) **The structure of the economy** As Canada shifts from a manufacturing to a service economy, the nature of commercial transportation may change – in terms of the types of vehicles, activities and goods transported. The impact on transportation energy use is unclear. Rising demand for services, packaged goods and just-in-time delivery could mean lighter loads, but more frequent trips.

iii) **Population density** Finally, as our population density increases, routes at destination points - largely cities - are becoming more congested. Our aging infrastructure, which was designed to accommodate very different patterns of goods movement from those of today, is increasingly challenged to meet the needs of commercial movement in an efficient way.

For Personal Mobility, modest improvements in energy intensity have occurred over the last decade and a half, despite the fact that more Canadians own cars and that passenger travel is increasing. This is primarily due to energy efficiency improvements in cars and light trucks, which mean it takes less energy to travel one vehicle kilometre.

On the Commercial/Institutional side, energy intensity has improved as measured by the GDP (energy per unit of GDP) or the weight of freight hauled (energy per tonne-kilometre). However, these metrics do not provide a complete picture for this sector:

- Institutional and service vehicles (e.g. ambulances, dump trucks, ploughs, taxis, utility trucks) are not used to haul goods. This means they distort the relationship between transportation energy use and tonne-kilometres.

- Using GDP as a measure broadly indicates economic activity - a key driver of transportation energy demand. However, institutional transportation is more dependent on population than economic activity, and for freight, structural changes in the economy towards higher-value goods distort the relationship between transportation energy and GDP.

These issues aside, despite evidence of improving intensity, with aggressive activity growth forecast, it is evident that the job of improving transportation energy efficiency in the future will be particularly important.

Tools, Technologies and Practices

Personal Mobility

In addition to private vehicle travel, Personal Mobility includes the use of buses, public transit, ridesharing, walking and cycling. Because transportation is fundamentally about access, energy use in Personal Mobility is inextricably linked to the way our communities are designed. A variety of actions within the marketplace could occur to improve energy efficiency in personal mobility, such as:

- Strong demand by consumers for energy efficiency in the vehicles they purchase and rent;

32 Extrapolated from the Conference Board of Canada's report: Build it and Will They Drive? Modelling Light-Duty Vehicle Travel Demand
33 Extrapolated using Natural Resources Canada's report: Canada's Energy Outlook 2006
34 Extrapolated from Natural Resources Canada's report: Canada's Energy Outlook 2006
35 Ibid
36 Ibid

- Improved availability of energy efficient vehicles from manufacturers and suppliers and development of special infrastructure as required;
- Improvements in the driving and maintenance practices of drivers, owners and mechanics to obtain optimal energy efficiency performance from vehicles;
- Design of communities and roadways to minimize transportation energy demand;
- Strengthening and/or amending policies that govern how roadways are used to enhance energy efficiency (e.g., mandatory inclusion of bicycle lanes on roadways where beneficial, or stricter penalties to control aggressive driving);
- Replacing energy-intensive private vehicle travel with lower intensity options, such as mass transit, ride-sharing and multi-modal trips. This will require increased availability and use of these options; and
- Increased use of innovative options that reduce overall transportation requirements, including home-based offices, workplace daycare programs, online shopping and telecommunications.

Tools to Support Improvements In Energy Efficiency for Personal Mobility

Policy/Regulation	Mandatory vehicle fuel consumption standards
	Mandatory minimum energy efficiency standards for vehicle equipment (e.g., tires, air conditioning systems)
	Regular mandatory vehicle inspection and maintenance programs
	Municipal/provincial regulations that provide preferential access or waiver of charges for certified efficient vehicles or high-occupancy vehicles (e.g., parking policies, high occupancy vehicle lanes and road tolls, the proceeds of which would be directed to other energy efficiency initiatives)
	Endorsement of Smart Growth policies and engagement of ministries responsible for land use planning policies and municipal acts to encourage implementation
	Building codes that require modal integration (e.g., bike racks and shower facilities, limitations on parking) and inclusion of special infrastructure where/when prudent to support emerging efficient technologies (e.g., plugs and meters to facilitate recharging of electric and/or plug-in hybrid vehicles)
	Policies that limit parking availability and/ or provide preferred access for rideshare program participants or drivers of efficient vehicles
	Introduction and enforcement of anti-idling bylaws
	Stronger enforcement of speed limits and other aggressive driving behaviours
	Provincial licensing requirements that incorporate knowledge of energy efficient driving practices

Research, Development and Deployment	Support for new vehicle technology options that result in energy efficiency outcomes (e.g., driver notification systems, tire inflation monitors, automatic tire inflation devices, econometers, etc.)
	Support for improved vehicle testing procedures in order to capture the effects of technologies that perform better on road than in the test procedure (e.g., cylinder deactivation technology, direct injection and air-conditioning systems)
	Research to gather information on vehicle maintenance habits of Canadians
	Funding for data acquisition to inform public transit planning decisions (e.g., accessibility and market studies to better understand consumer needs and preferences)
	Support for research, development and deployment of road information systems, speed compliance technology and intelligent traffic systems
Capacity Building	Long-term funding for public transit infrastructure
	Certification and energy efficiency training programs for mechanics
	Support for training programs to educate professionals on transportation energy efficiency issues including the development and sharing of "best practices" (e.g., architects, municipal planners and other urban-design decision-makers)
Leadership	Leadership by government and corporate fleets through policies that require purchase and rental of energy efficient vehicles when feasible and energy efficient driver training
Information	Public education programs for adults, youth and new drivers to increase awareness of energy efficiency issues (e.g., the impact of individual behaviours on energy efficiency, maintenance practices including tire inflation, walking and cycling route maps, bicycle safety and proper bicycle stowage on public transit racks, etc.)
	A vehicle rating and labelling program that allows consumers to compare fuel efficiency within and between vehicle classes, to clearly identify the vehicles that are the most efficient – similar to ENERGY STAR®
	Campaigns and voluntary programs with industry to increase the uptake of alternatives to transport such as online shopping, telecommuting, in-house daycare services, on-site training, etc.
	Education and tools to improve understanding and inform personal transportation decisions (e.g., trip planning, modal selection, vehicle lifecycle costs to better inform purchasing decisions
Market Stimulation	Fuel taxes/pricing that better reflect the full cost of transportation, the proceeds of which could be directed toward other energy efficiency initiatives
	Performance-based incentives that encourage consumers to purchase fuel efficient vehicles (e.g., differential vehicle registration, insurance fees based on fuel consumption ratings of the vehicle, partnerships with financial institutions to provide preferred financing rates for efficient vehicles)

	Performance-based incentives that encourage consumers to operate vehicles efficiently (e.g., preferential provincial car insurance rates for rideshare program participants energy efficient drivers, and clients that use alternative modes of transport for work)
	Tax incentives to encourage the development of, and investment in, high density population areas and mixed use developments, both of which make alternatives to private vehicle travel more attractive and feasible
	Transit pricing to ensure transit is a cost-effective option
	Income tax regulations for businesses and individuals to encourage the uptake of alternatives to vehicle-transport such as public transit, teleworking, online shopping, in-house daycare services, on-site training, etc.

Commercial/Institutional Transportation

Information relating to the Commercial/Institutional sub-sector is fragmented, and there is a shortage of Canadian data in particular. As a result, the relative importance of the fuel consumption of non-freight vehicles is not well understood; nor is it possible to prioritize energy efficiency opportunities for non-freight activities. Further research and data collection are the first priorities of an energy efficiency strategy for this sub-sector. The following broad changes would improve efficiency:

- Stronger demand from commercial purchasers for energy efficiency in the vehicles and equipment they purchase and rent;
- Improved availability of energy efficient vehicles, vehicle components and equipment from manufacturers and suppliers and development of special infrastructure as required;
- Optimized configuration of vehicles and equipment to their duty cycle to obtain maximum energy efficiency;
- Improved driving and maintenance practices to obtain optimal energy efficiency performance from vehicles;
- Harmonization of regulations that affect commercial movements, to encourage increased use of technologies and practices that enhance vehicle efficiency;
- The use of complementary transportation and land-use planning, combined with the communications and logistics technologies that minimize the energy requirements of commercial vehicles within urban systems, on highways and at interface centres (loading docks, border crossings); and
- Increased availability of information and wide-scale adoption of best practices by shippers, fleet managers and other transportation personnel to optimize energy efficiency of commercial movement.

Tools to Support Improvements In Energy Efficiency for Commercial/Institutional Transportation

Policy/Regulation	Partnerships with international jurisdictions to coordinate and participate in the development and harmonization of standards for vehicle, engine design and equipment efficiency and fuels and fuel components (insofar as they impact design of efficient engines)
	Harmonization of provincial and federal regulations affecting Commercial/ Institutional transport
	Standards for specific vehicle and equipment components such as tires and refrigeration units
	Policies or incentives to encourage penetration of vehicle technologies that flag efficiency issues (e.g., tire inflation monitors)
	Minimum energy efficiency standards for after-market tires
	Regular mandatory vehicle inspection and maintenance programs that include identification of issues affecting energy efficiency
	Funding criteria for new infrastructure with provisions that would enable freight trucks to carry heavier loads, reducing the number of trips required, and allowing trucks to add efficiency-enhancing equipment that would otherwise entail a weight penalty
	Regulations that provide preferential access or waiver of charges for certified efficient vehicles through road tolls
	Freight-only toll-based infrastructure improvements
Research, Development and Deployment	Funding for data acquisition and research to characterize the Canadian Commercial/ Institutional vehicle fleet, equipment, duty cycles and current vehicle maintenance and identify energy efficiency potential in this sector
	Support for the development and deployment of technology options that result in energy efficiency outcomes (i.e. lightweight materials, auxiliary power units, advanced aerodynamics, driver notification systems, automatic tire inflation devices, econometers, etc.), for example through fiscal and tax policies
	Support for the development and deployment of alternative power technologies and/or substitute means of providing power to accessory equipment, to eliminate the need to idle the vehicle for this purpose, for example through fiscal and tax policies
	Research to identify the energy efficiency potential of a modal shift and the policy analysis required
	Funding support for research, development and deployment of intelligent highway systems
Capacity Building	Creation of a clearinghouse to gather, share and analyze data on energy use in the Commercial/ Institutional transportation sector
	Environmental fleet certification and auditing programs that identify and benchmark energy efficiency opportunities and strategies for improvements to be used by fleet and private mechanics, fleet managers, decision-makers and owner operators

	Partnerships with authorities at interface centres to encourage incorporation of transportation energy efficiency into planning
	Partnerships with shippers and/or rail and marine industry to encourage modal shift and to reduce packaging
	Recognition programs for efficient fleets to showcase best practices
	Training and incentives to optimize logistics, lifecycle and route planning tools
	Mechanism for commercial vehicle operators, including owner-operators, to participate in a potential greenhouse gas emissions offset trading system
	Energy efficiency driver training tailored to specific fleet operations and duty cycles
	Driver certification programs that incorporate energy efficient driving techniques
	Encourage provinces to identify energy efficient driver training as a requirement to secure a Commercial Drivers Licence
Leadership	Leadership by government and corporate fleets through policies that require energy efficient driver training and purchase and rental of energy efficient vehicles when feasible
Information	Energy efficiency labelling programs for vehicle components such as engines, trailers, tires, etc.
	Lifecycle costing tools for purchasers that illustrate full lifecycle fuel costs to better inform purchasing decisions
	Education and training programs for fleet managers and other vehicle purchasers that focus on lifecycle costing tools and best practices for vehicle configurations according to duty cycle
	Public education programs to increase awareness of energy efficient maintenance practices
	Information and training on efficiency best practices for shippers, including supply-chain management, logistics and loading practices
Market Stimulation	Rebates for hybrid vehicles in all vehicle classes
	Business income tax deductions for highly efficient vehicles
	Fuel pricing policies to better reflect the full cost of transportation
	Energy revenues could be directed to other energy efficiency initiatives
	Differential taxes for light duty vehicles and medium/heavy vehicles to pay for the different degrees of impact on infrastructure

High Occupancy Vehicle Lanes

One year after opening the province's first High Occupancy Vehicle lanes on highways 403 and 404, Ontario found a substantial increase in the number of commuters that carpool on these highways. The number of carpoolers rose from less than 20 per cent to nearly 40 per cent during morning peak hours. This represents a significant reduction in energy intensity over single-occupant private vehicle travel.

5 Conclusion

The Council of Energy Ministers' 2007 *Moving Forward on Energy Efficiency in Canada* is the beginning of a new era of co-operation on energy efficiency in Canada. By working together to establish a coordinated and complementary agenda for energy efficiency, federal, provincial and territorial governments will continue to develop real and sustainable energy solutions in their own jurisdictions, and collaborate on cross-cutting initiatives that require a more integrated approach.

To this end, this foundation document provides broad direction for action on energy efficiency, and contains a menu of key policy instruments and tools available to jurisdictions to allow them to meet their own policy objectives while contributing to the national energy potential at the same time. The perspective of each jurisdiction will determine which priority actions are taken in the short, medium and long term.

Canada is already a world leader in energy efficient technologies and practices, and will continue to develop and promote these initiatives. This document highlights a variety of these technologies -- from newly-emerging super-efficient technologies to the well-known but under utilized. Federal, provincial and territorial governments will continue to work with all stakeholders in the Canadian economy to realize the potential of these initiatives, including local and municipal administrations, public and private utilities, industry, financial institutions, aboriginal groups, private corporations, retailers, education organizations, and non-governmental organizations.

ANNEX 1: Principles[37]

- **Address all Stages of Market Transformation:** Opportunities exist at different stages in the energy production and use cycles to identify and maximize efficiencies, from research and development through to full market commercialization of efficient technologies.

- **Start with Price:** Energy prices that reflect full costs will give consumers and investors an incentive to improve energy efficiency. Clear price signals should be the starting point, but price alone is not sufficient.

- **Use Multiple Instruments:** No single tool provides a solution to improving Canada's efficiency of energy use. Rather, a variety of tools, implemented by various orders of government, are required to effect significant change in fundamental energy use.

- **Maximize Efficiency and Effectiveness:** Program resources should be targeted to achieve the greatest efficiency and effectiveness, while taking into account consideration for sectoral coverage and finding the appropriate balance between short-term and long-term efforts. They should be adapted to match each jurisdiction's needs and specific assets.

- **Ensure Equity:** Programs and policies should be designed to benefit all consumers and energy users.

- **Measure to Manage:** Measurement and evaluation are both essential to successful energy efficiency measures. Information is needed to set objectives, measure and report performance and understand trends.

- **Develop Capacity:** Increase the technical and human capacity of the energy efficiency industry to realize improvements.

- **Learn from Experience:** Policies and programs should take into account the wealth of best practice experience gained over the past thirty years. Domestic and international experience also needs to be drawn upon. As markets transform, efficiency programs need to be transformed accordingly.

- **Commit Long Term:** Long term policy and program signals allow markets to transform efficiently, and contribute to institutionalizing a culture of energy efficiency and sustainability.

37 The above principles have been adapted from those developed in 2006 by the Energy Efficiency Working Group, Energy Sector Sustainability Table

Energy-saving Tips for All Canadians

By using energy efficiently and making wise consumer choices, Canadians can save money and help protect the environment.

At Home

- Use energy-efficient light bulbs and appliances. Remember that the ENERGY STAR® logo indicates the most energy-efficient products in each class.
- Use caulking and weather stripping to seal air leaks. You can reduce your home heating and cooling needs by up to 20 percent by getting rid of drafts and leaks around windows, doors, baseboards and attic hatches.
- Lower your thermostat.
- Upgrade the insulation in the walls, basement and attic; doing so can reduce your energy bill by as much as 30 percent.

On the Road

- Save gas by driving the speed limit and keeping your vehicle well- tuned. Buy the most energy-efficient vehicle that meets your needs.
- Drive at the posted speed limit – increasing your cruising speed from 100 km/h to 120 km/h will increase fuel consumption by approximately 20 percent.
- Measure the inflation level of your tires once a month. A single under-inflated tire can increase your vehicle's fuel consumption by up to 4 percent.
- Don't idle. Idling for 10 minutes a day can produce about a quarter tonne of CO_2 emissions each year and cost you about $70 in wasted fuel. If you stop for more than 10 seconds, except in traffic, turn off your engine and save.

At Work

- Buy ENERGY STAR® qualified equipment; this will keep your energy costs and GHG emissions down.
- Turn off your computer (and electronic equipment) when it is not being used for more than one hour.
- Minimize the amount of paper you use because printing, photocopying and faxing use energy. Use e-mail more often — it's quicker, less expensive and healthier for the environment. Also use recycled paper wherever possible.

For more information on conserving energy, contact your local utility, your provincial or territorial government, or visit the Government of Canada's Office of Energy Efficiency web site at **www.oee.nrcan.gc.ca**.