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ecoENERGY
an ecoACTION initiative

Improving Energy Performance in Canada



Report to Parliament Under the *Energy Efficiency Act*
For the Fiscal Year 2007-2008



Canada

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Minister's Foreword

I am pleased to introduce the 2007/08 Report to Parliament on Natural Resources Canada's energy efficiency and alternative energy programs.

Energy efficiency is the easiest, most affordable and most effective way for families and businesses to control their energy costs and reduce greenhouse gas emissions. During fiscal year 2007/08, our Government strengthened energy efficiency regulations under the *Energy Efficiency Act* (EEA) by giving Canadians new opportunities to control their energy costs and contribute to a healthier environment. We introduced energy performance standards for seven additional products, including light bulbs, and set higher standards for four other products already covered by EEA regulations. As these new regulations come into effect, Canadians can be confident that the products they buy and use every day are among the most energy-efficient in the world.

These new energy-efficiency regulations complement the suite of ecoENERGY programs launched by our Government in 2007. This investment of \$3.6 billion is already helping Canadians use energy more efficiently, boost renewable energy supplies and develop cleaner energy technologies.

For example, ecoENERGY Efficiency is helping Canadians make their homes, buildings, industries and vehicles more energy-efficient. ecoENERGY for Renewable Power is encouraging the production of clean electricity for our homes and businesses from renewable sources including wind, biomass, low-impact hydro, geo-thermal, solar photovoltaic and ocean energy. We are pleased that our Government's ecoENERGY Technology initiative is supporting the development of new, cleaner-energy technologies.

These measures, and others like them, are at the heart of our Government's practical, balanced approach to addressing climate change and reducing air pollution. Our ecoENERGY initiatives have been extremely successful and are continuing to support the efforts of Canadians to reduce emissions. By helping homeowners, businesses and industry make wise energy choices, these initiatives continue to provide both immediate and long-term environmental and economic benefits.

Canadians have made it clear that the health of our environment is a top priority. As the details of this Report to Parliament demonstrate, our Government is responding with real action to address their concerns.

The Honourable Lisa Raitt, P.C., M.P.
Minister of Natural Resources



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Executive Summary

Canadians spent approximately \$152 billion in 2005 on energy to heat and cool their homes and offices and to operate their appliances, cars and industrial processes. Several factors contribute to Canadian energy demand: a vast geography, a northern climate with extreme seasonal variations in temperature and an economy founded on an abundance of natural resources.

Types of Energy Use

The two general types of energy use are primary and secondary. Primary use represents Canada's total consumption, including energy required to transform one energy form to another – such as coal to electricity – and energy required to deliver energy to consumers. Secondary use is energy consumed for residential, commercial/institutional, industrial, transportation and agricultural purposes.

Key highlights in energy use include the following:

- Between 1990 and 2005, the latest year for which figures are available, primary energy use increased by 27 percent.
- In 2005, secondary use accounted for 69 percent of primary energy use and produced 66 percent (495 megatonnes [Mt]) of Canada's total greenhouse gas (GHG) emissions. This last figure includes emissions produced by utilities in meeting the demand for electricity.
- Without the energy efficiency improvements made to buildings and equipment and the changes in the behaviour of energy users during the past several decades, the increases in energy use would have been much higher.

The industrial sector consumed the most energy, accounting for 38 percent of total secondary energy use in 2005. Transportation was second (29.5 percent), followed by residential (16.5 percent), commercial/institutional (14 percent) and agriculture (2 percent).

Promoting Energy Efficiency

Natural Resources Canada (NRCan) promotes energy efficiency and the use of alternative energy as a means to reduce GHG emissions and save money. NRCan uses a broad range of policy instruments, including leadership, information, voluntary initiatives, financial incentives, research and development, and regulation.

The *Energy Efficiency Act*, which came into force in 1992, provides for the making and enforcement of regulations concerning minimum energy performance levels for energy-using products, the labelling of energy-using products and the collection of data on energy use. The *Energy Efficiency Regulations* are described in Chapter 2.

Energy Intensity / Energy Efficiency

As explained in Chapter 1, although energy intensity is sometimes used as a proxy for energy efficiency, there is a difference between the terms. It is important to understand this difference when comparing Canada with other countries.

Energy efficiency refers to how effectively energy is being used for a given purpose. For example, providing a similar (or better) level of service with less energy consumption on a per-unit basis is considered an improvement in energy efficiency.

Energy intensity is the amount of energy use per unit of activity. Examples of activity measures in this publication are households, floor space, passenger-kilometres, tonne-kilometres, physical units of production and constant dollar value of gross domestic product. Energy intensity is a broader measure, capturing not only energy efficiency but also other impacts on energy consumption, such as weather variations, market behaviour and changes in the structure of the economy.

Evidence of Change

As explained in this report, recent growth in energy use is primarily due to increased activity in various sectors. However, this growth would have been much greater without improvements in energy efficiency.

As reported in Chapter 1, energy efficiency improvements made between 1990 and 2005 are estimated to have reduced GHG emissions by almost 64 Mt and decreased energy expenditures by \$20.1 billion in 2005.

Between 1990 and 2005, the residential sector recorded a 25 percent improvement in energy efficiency. The figures for the transportation (19 percent), industrial (13 percent) and commercial/institutional (9 percent) sectors demonstrate that improvements in energy efficiency are being made throughout the economy.

Through improvements in energy efficiency, Canadians can reduce their energy bills and achieve important environmental goals. Over the short term, changes to less GHG-intensive fuels (e.g. from coal to natural gas) can help reduce GHG emissions. However, over the long term, reducing GHG emissions further will require more widespread use of alternative energy.

Canada is a world leader in the production of renewable energy, with almost 16 percent of its primary energy supply coming from renewable sources in 2005.

Engaging Canadians

To maximize the effectiveness of its initiatives, NRCan engages a growing number of partners from the private and public sectors. Dozens of co-operative agreements are in place with a broad range of businesses, community groups and other levels of government.

These initiatives engage Canadian society, along with every sector of the economy, in new and more efficient approaches to secondary energy use and in the development and deployment of renewable energy sources.

This report provides an overview of the work being done in each sector and highlights NRCan's efficiency and alternative energy (EAE) programs and lists their key achievements for the 2007–2008 fiscal year. Program entries for market transformation programs also include quantitative performance indicators in graph or table format. A list of NRCan's EAE initiatives and expenditures appears in Appendix 1.

Introduction

NATURAL RESOURCES CANADA'S EFFICIENCY AND ALTERNATIVE ENERGY PROGRAMS

According to the International Energy Agency, if energy efficiency policies had not been introduced 30 years ago, today's worldwide energy consumption would be 50 percent higher.¹

Gains in energy efficiency have substantial benefits for society, the economy and the environment. Energy efficiency can add to the global security of energy supplies by reducing the need for energy. It saves consumers and businesses money by decreasing their energy bills without disruptions to their daily routine, and it can increase access to energy services by reducing their effective cost.

In particular, greater energy efficiency is used as a strategy to reduce carbon dioxide and other greenhouse gases (GHGs) and thereby help reduce the effects of climate change.

Natural Resources Canada (NRCan) emphasizes the promotion of energy efficiency and the use of alternative energy (i.e. alternative transportation fuels and renewable energy) as ways to reduce GHG emissions and improve the Canadian economy.

A complete list of NRCan's efficiency and alternative energy (EAE) initiatives in 2007–2008 is in Appendix 1. These initiatives engage Canadian society and all major sectors of the economy in new and more advanced approaches to secondary energy use – i.e. to the consumption of energy in the residential, commercial/institutional, industrial and transportation sectors.

NRCan's EAE initiatives are managed by the following:

- the Office of Energy Efficiency (OEE), which delivers market transformation initiatives to improve energy efficiency and the use of alternative transportation fuels
- CanmetENERGY and the CANMET Mineral Technology Branch, which deliver EAE research, development and demonstration (R,D&D) initiatives
- the Office of Energy Research and Development, which coordinates NRCan's energy research and development activities
- the Electricity Resources Branch, which delivers market transformation initiatives for renewable energy
- the Science Branch of the Canadian Forest Service, which undertakes research and development (R&D) in the use of forest biomass for energy

In its efforts to improve energy efficiency and increase the use of alternative energy, NRCan emphasizes partnership and co-operation with stakeholders, such as other levels of government, the private sector and nongovernmental organizations.

With this approach, the demand side of the energy market moves toward more energy-efficient capital stock, production processes and operating practices without reducing service or comfort levels. On the supply side, Canada participates in developing technology for tapping renewable energy resources and alternative transportation fuels and in increasing the energy efficiency of energy production.

¹ International Energy Agency, *Mind the Gap: Quantifying Principal-Agent Problems in Energy Efficiency*, 2007.

POLICY INSTRUMENTS

NRCan's key policy instruments are as follows:

- regulation
- financial incentives
- leadership
- information
- voluntary initiatives
- research, development and demonstration

Regulation

The *Energy Efficiency Act* gives the Government of Canada the authority to make and enforce regulations. Regulations primarily establish performance and labelling requirements for energy-using products and for doors and windows that are imported or shipped across provincial borders.

Financial Incentives

NRCan uses financial incentives to encourage end-users of energy to adopt energy efficiency and renewable energy technologies and practices. NRCan also offers financial incentives for wind energy, ethanol plants, natural gas vehicles and refuelling infrastructure.

Leadership

Leadership means setting an example for other levels of government and for the private sector by increasing energy efficiency and the use of alternative energy in the Government of Canada's operations.

Information

NRCan disseminates information to consumers, using methods ranging from broad distribution to individual consultations with clients. This increases awareness of the environmental impact of energy use and encourages consumers to become more energy efficient and make greater use of alternative

energy sources. One particular outreach program targets youth as the energy consumers of the future and undertakes joint initiatives in the education sector. Other information activities include publications, exhibits, advertising, toll-free telephone lines, conferences, Web sites, workshops, training, building design software and promotional products.

Voluntary Initiatives

Companies and institutions work with NRCan voluntarily to set and achieve energy efficiency objectives. NRCan's voluntary EAE initiatives target large consumers of energy in the commercial/institutional and industrial sectors and organizations whose products are major factors in energy use. The initiatives involve industry-government agreements and, for groups of large industrial energy users, commitments to develop energy efficiency improvement targets and action plans. NRCan provides support to assist and stimulate action by companies and institutions on energy efficiency, including developing standards, educational material and training.

Research, Development and Demonstration

Ongoing improvement in energy efficiency is contingent on improvements and innovations in technology. NRCan's EAE initiatives support the development and dissemination of more energy-efficient equipment, processes and technologies and alternative energy technologies. R,D&D also provides the scientific knowledge needed to develop the technologies, codes, standards and regulations required for the sustainable use of energy.

NRCan provides national leadership in energy science and technology (S&T) by undertaking research in its own laboratories and contracting research activities to other organizations. These initiatives are the only federal interdepartmental S&T investment funds that focus on the energy sector and its economic and environmental effects.

FIGURE INT-1

Moving the Market

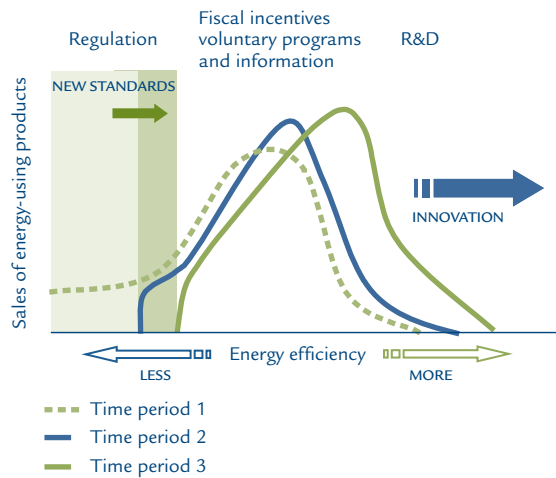


Figure INT-1 shows how these policy instruments work together to increase energy efficiency, i.e. how they help to reduce the amount of energy required to complete a task or obtain a certain level of service. Energy performance regulations eliminate less efficient products from the market. Fiscal incentives, voluntary programs and information activities increase the number of people and organizations taking advantage of existing opportunities to use energy more efficiently. R&D increases the opportunities for achieving higher levels of efficiency in a particular type of energy use.

MEASURING PROGRESS

The primary goal of NRCan’s EAE initiatives is to change energy consumption patterns and thereby generate environmental and economic benefits. Part of assessing program progress and performance involves considering both program delivery and program effectiveness.

NRCan monitors and tracks the following three aspects of program delivery:

- program outputs
- program outcomes
- market outcomes

Program outputs are the items produced regularly, such as information and marketing materials, demonstration projects, financial incentives and regulations. Program outputs are designed to lead to **program outcomes** – namely, changes in the behaviour of groups targeted by a program. These groups may be either energy users or producers of energy-using equipment or structures.

For example, program outcomes occur when consumers purchase more energy-efficient appliances than they would have if there were no program. Other important factors that influence consumer behaviour include product price, household income, personal taste and government and non-government programs.

Because program outcomes can directly affect the amount and type of energy consumed in the market, they contribute, in part, to observable **market outcomes**. Market outcomes ultimately reflect the impacts of NRCan programs on changes in energy efficiency, energy intensity, GHG emissions and the use of alternative energy. In this sense, achievement of a targeted market outcome, or observable progress toward a market outcome, serves as an indicator of program effectiveness.

An example of a program outcome leading to a market outcome is a householder’s purchase of a more energy-efficient appliance, resulting in reduced use of electricity. Depending on what source of electricity is involved and how the utility changes its electricity-generating methods to meet the change in demand resulting from reduced electricity use, this could also lead to a decline in GHG emissions.

DATA COLLECTION AND ANALYSIS

In 1991, NRCan launched the National Energy Use Database (NEUD) initiative to help the Department improve its knowledge of energy consumption and energy efficiency at the end-use level in Canada and to support its analytical expertise. The NEUD initiative plays a number of crucial roles directly

related to NRCan program activities. However, its most important role is to secure the development of a reliable, Canada-wide information base on energy consumption at the end-use level for all energy-consuming sectors.

The NEUD initiative consists of several broad components that typically involve conducting large- and small-scale surveys of energy use in the transportation, industrial, commercial/institutional and residential sectors. The surveys gather information about the stocks and characteristics of energy-using equipment and buildings, observing Canadians' behaviour with respect to energy use and monitoring the adoption of new technologies in the marketplace.

In 2007–2008, work was initiated to collect and analyse energy data on the commercial and residential sectors. The data will form the basis for reports explaining how and where energy is used in each of those sectors. Data on the transportation and industrial sectors continue to be collected on a quarterly and annual basis, respectively.

The NEUD initiative also produces a comprehensive energy use database with accompanying publications to explain Canada's overall energy use and energy efficiency trends. All NEUD initiative reports are available to the public, free of charge, both in hard copy and online at oee.nrcan.gc.ca/statistics.

The NEUD initiative also contributes to the development of energy end-use data and analysis centres (DACs) across Canada. Three DACs have been set up so far: the transportation centre at Université Laval in Québec, Quebec; the industrial centre at Simon Fraser University in Burnaby, British Columbia; and the buildings centre at the University of Alberta in Edmonton, Alberta. The DACs are mandated to improve the accessibility and comparability of existing data about trends in energy consumption and their impact on environmental quality.

GHG EMISSIONS AND CLIMATE CHANGE

Climate change is a global challenge arising from the continuing buildup in levels of anthropogenic (human-produced) GHGs in the atmosphere in addition to naturally occurring emissions. GHGs are composed of a number of gases, and the main source of anthropogenic emissions is the combustion of fossil fuels. Substantially reducing GHG emissions is a challenge, particularly given Canada's highly industrialized and resource-based economy. Solutions require a multifaceted, coordinated domestic response and a high level of co-operation among all nations.

IN THIS REPORT

This fifteenth annual *Report to Parliament* focuses principally on EAE initiatives that address secondary energy use. Trends in energy use and GHG emissions in Canada for the residential, commercial, industrial, transportation and renewable energy sectors are discussed in Chapter 1. Chapter 2 discusses equipment regulations under the *Energy Efficiency Act* and equipment-labelling activities. Chapter 3 describes the suite of ecoENERGY and related programs and lists key 2007–2008 achievements. Chapter 4 explains energy S&T programs, and Chapter 5 outlines NRCan's involvement with renewable energy sources and use. The sixth and final chapter describes domestic and international co-operation in EAE.

Appendix 1 contains information about NRCan's EAE expenditures. Appendix 2 contains detailed information about the figure data presented in this report. Calculations of the estimated GHG savings in this report are based on Environment Canada's standardized emissions factors as described in its publication *Canada's Greenhouse Gas Inventory*. The emissions factor for electricity was based on the provincially weighted average of marginal fuel sources across the country.

Trends in Energy Use

INTRODUCTION

Canadians enjoy an abundance of energy from a variety of sources. This comparative advantage in the supply of energy helps Canadians deal with the economic disadvantages of small domestic markets, long distances, rugged geography and a relatively harsh climate. It also fosters the development of industries with a particularly strong energy demand.

Canadians spent about \$152 billion in 2005 on energy to heat and cool their homes and offices and to operate their appliances, vehicles and industrial processes. This amount represented 14 percent of the country's gross domestic product (GDP).²

ENERGY USE AND GREENHOUSE GAS EMISSIONS

Energy use is of two general types: primary and secondary. Primary energy use encompasses the total requirements for all users of energy, the energy required to transform one energy form to another (e.g. coal to electricity) and the energy used to bring energy supplies to the consumer. Secondary energy use is energy used by final consumers for residential, commercial/institutional, industrial, transportation and agricultural purposes.

Primary energy use represents the total requirements for all users of energy, including secondary energy use. In Canada, the increase in primary energy use reflects changes over several decades in energy-consuming equipment and buildings and in the behaviour of energy users. Primary energy use increased by 27 percent between 1990 and 2005, from 9740 petajoules³ (PJ) to 12 369 PJ.

Secondary energy use accounted for 69 percent of primary energy use in 2005, or 8475 PJ. It was responsible for 66 percent (495 megatonnes [Mt]) of total greenhouse gas (GHG) emissions in Canada, including indirect emissions – those produced by electric utilities to meet end-use electrical demand.

From 1990 to 2005, secondary energy use increased by 22 percent. At the same time, the Canadian population grew by 17 percent, and GDP increased 51 percent. Thus energy use grew less rapidly than the economy but more rapidly than the population.

² Data in this chapter are presented for 1990–2005. Readers are encouraged to consult the Office of Energy Efficiency Web site to view data updates as they become available.

³ One petajoule equals 1×10^{15} joules.

As demonstrated in Figure 1-1, the industrial sector was the largest energy user, accounting for 38 percent of total secondary energy use in 2005. The transportation sector was the second largest energy user at 29.5 percent, followed by the residential sector at 16.5 percent, the commercial/institutional sector at 14 percent and the agricultural sector at 2 percent.

FIGURE 1-1

Secondary Energy Use by Sector, 2005

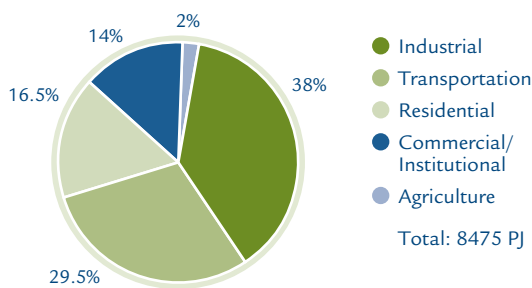
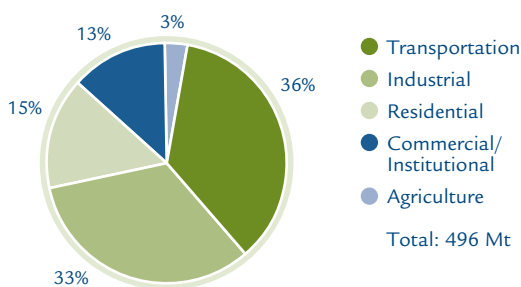


Figure 1-2 illustrates the distribution of GHG emissions by sector. This report deals with energy-related GHG emissions, which comprise carbon dioxide (CO₂), methane and nitrous oxide. CO₂ accounts for most of Canada’s GHG emissions. All subsequent references in this report to CO₂ and GHGs include emissions that are attributable directly to secondary energy use and emissions that are attributable indirectly to electricity generation, unless otherwise specified.

FIGURE 1-2

GHG Emissions From Secondary Energy Use by Sector, 2005



ENERGY INTENSITY AND ENERGY EFFICIENCY

The term “energy intensity” refers to the amount of energy use per unit of activity. Energy intensity is sometimes used as a proxy for energy efficiency because it is a simple calculation for which data are readily available. However, this measure can be misleading because, in addition to pure energy efficiency, intensity captures the impact of other factors that influence energy demand, such as weather variations and changes in the structure of the economy.

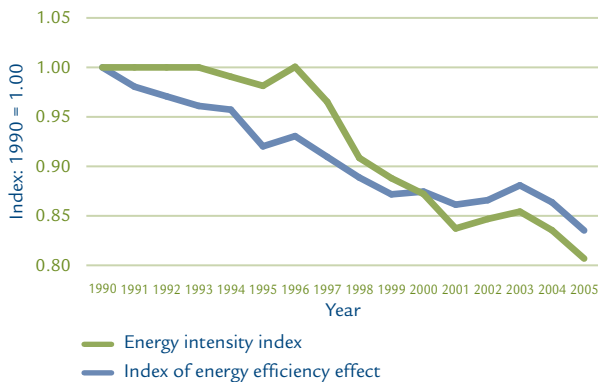
Energy efficiency refers to how effectively energy is being used for a given purpose. For example, providing a similar (or better) level of service with less energy consumption on a per-unit basis is considered an improvement in energy efficiency.

To properly gauge changes in energy efficiency over time, differences in economic structure and weather need to be normalized or factored out of the intensity calculation. Natural Resources Canada’s (NRCan’s) Office of Energy Efficiency (OEE) applies an internationally recognized factorization analysis technique – the Log-Mean Divisia Index 1 Methodology – to isolate the impact of energy efficiency on changes in Canadian energy use.

Figure 1-3 compares, for Canada, an index of annual variation in energy intensity with the OEE’s index of changes in energy efficiency over 1990 to 2005. As illustrated, Canada’s energy intensity and efficiency improved over this period. The reduction in energy intensity reflects an overall improvement in energy efficiency or how effectively energy is being used in producing one unit of GDP. At the same time, the improvement in energy efficiency indicates how effectively energy is being used to provide a certain level of service or output.

FIGURE 1-3

Energy Intensity and the Energy Efficiency Effect, 1990 to 2005



TRENDS IN ENERGY EFFICIENCY

NRCan regularly publishes *Energy Efficiency Trends in Canada*, which reports on changes in energy use and GHG emissions and the contributions of the following key factors to these changes (see Table 1-1):

- Increases in sector **activity** lead to increased energy use and emissions. In the residential sector, for example, an increase in the number of households results in increased energy use.

- Fluctuations in **weather** lead to changes in space-heating and space-cooling requirements. A colder winter or a warmer summer can lead to increased energy use.
- A shift in the **structure** of activity toward more energy-intensive components of activity leads to increased energy use and emissions. For example, if the distribution of activity in the industrial sector shifts from forestry to the iron and steel industry, industrial energy use will increase because the former sector is less energy intensive than the latter.
- **Service level** refers to the penetration rate of electrical devices and equipment, e.g. the use of auxiliary equipment in commercial/institutional buildings and appliances in homes or the amount of floor space cooled.
- **Energy efficiency** effect indicates how effectively energy is being used, i.e. the degree to which less energy is being used to provide the same level of energy service. Energy efficiency gains occur primarily with improvements in technology or processes. An example of such an improvement would be replacing incandescent lights with compact fluorescent lamps.

TABLE 1-1

Explanation of Changes in Secondary Energy Use, 1990 to 2005

	Sectors					Change (%)
	Residential	Commercial/ Institutional	Industrial	Transportation	Total*	
1990 energy use (PJ)	1286.2	867.0	2721.8	1877.9	6952.1	
2005 energy use (PJ)	1402.2	1153.0	3209.4	2501.8	8475.1	
Change in energy use (PJ)	115.9	286.0	487.6	624.0	1523.0	21.9
Explanatory factor (change due to)						
Activity	353.1	246.6	1166.0	750.4	2516.1	36.2
Weather	5.5	25.2	n/a	n/a	30.8	0.4
Structure	7.1	-1.2	-331.1	186.8	-138.4	-2.0
Service level	71.0	91.8	n/a	n/a	162.9	2.3
Energy efficiency	-320.9	-75.4	-347.3	-352.4	-1096.0	-15.8
Other factors		-1.0		39.2	47.7	0.7

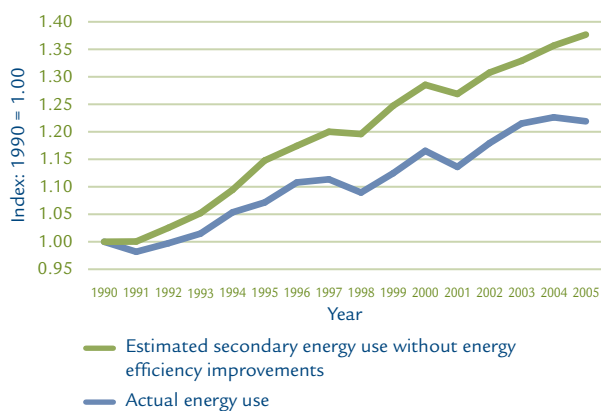
*Total also includes energy use for agriculture.

In this report, changes in energy efficiency are the net result after allowing for changes in energy use due to activity, weather, structure and service level. However, other factors, such as individual consumer choice, may affect energy use and are not captured by the above standardized factors. The effects of activity, weather, structure and service level may overstate or understate the “actual” change in energy use and energy efficiency improvements.

Between 1990 and 2005, secondary energy use in Canada increased from 6952 to 8475 PJ. Without improvements in energy efficiency, increases attributable to activity, weather, structure and service level would have led to an energy increase of 38 percent. However, as a result of a 16 percent (1096-PJ) improvement in energy efficiency,⁴ actual secondary energy use increased by only 22 percent (to 8475 PJ). This improvement in energy efficiency is estimated to have reduced GHG emissions by almost 64 Mt and decreased energy expenditures by \$20.1 billion in 2005. The change in energy use between 1990 and 2005, actual and without energy efficiency improvements, is shown in Figure 1-4.

FIGURE 1-4

Secondary Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005



⁴ Based on the OEE Index.

TRENDS IN RENEWABLE ENERGY

Canada is a leader in the production of renewable energy, with 16 percent of its primary energy supply coming from renewable sources in 2006. Although renewable energy is often associated with electricity, renewable energy sources also produce thermal energy (heat) and transportation fuels. Renewable energy sources in Canada include water, wind, solar, geothermal and biomass.

Canada has a significant renewable electricity supply due primarily to the widespread use of hydroelectricity. In 2005, about 60 percent of Canada’s electricity generation was provided by conventional and small hydroelectric plants, which generated more than 358 terawatt hours (TWh) of electricity, up from 337 TWh in 2004. Small hydro plants (less than 50 megawatts [MW]), with installed generating capacity of 3421 MW, provided about 2 percent of the total electricity generation in Canada.

Non-hydro renewable sources accounted for an estimated 2 percent of Canada’s total electricity generation. Biomass (waste and virgin biomass and landfill gas) is the main non-hydro renewable energy source in Canada. However, wind energy is growing rapidly, with an increase in capacity from 139 MW in 2000 to 1459 MW in 2006. Solar photovoltaic energy also experienced high rates of capacity growth – about 20 percent annually between 1993 and 2006 – although it started from a low baseline. In 2006, 20.5 MW of solar photovoltaic systems were installed in Canada, representing an increase of 3.7 MW over the previous year.

As described in Chapter 5, NRCan is carrying out two initiatives, ecoENERGY for Renewable Power and ecoENERGY for Renewable Heat, to increase the use of small-scale renewable energy in Canada.

TRENDS IN RESIDENTIAL SECTOR

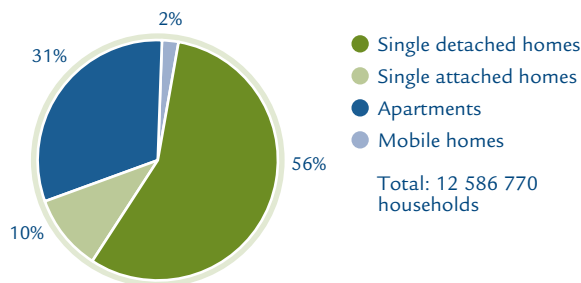
Energy Use and Greenhouse Gas Emissions

The residential sector includes four major types of dwellings: single detached, single attached, apartments and mobile homes. Energy is used in dwellings for space heating and cooling; water heating; and the operation of appliances, electronic equipment and lights. In 2005, this sector accounted for 17 percent (1402 PJ) of secondary energy use and 15 percent (73.8 Mt) of GHGs emitted in Canada.

Most dwellings in Canada are single detached houses. The next largest type of dwelling is apartments, followed by single attached dwellings and mobile homes (see Figure 1-5). The OEE's ecoENERGY Retrofit – Homes and ecoENERGY for Buildings and Houses programs aim to improve the energy efficiency of single detached and attached houses.

FIGURE 1-5

Canadian Households by Type of Dwelling, 2005



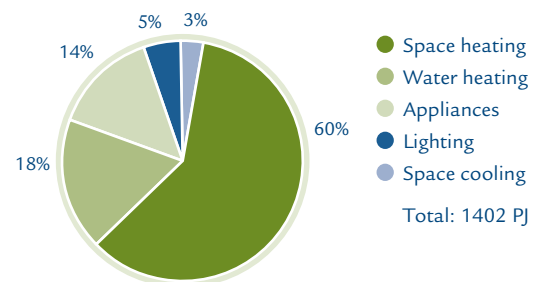
Between 1990 and 2005, residential energy use increased by 9 percent, or 116 PJ. For the same period, GHG emissions increased by 6 percent. GHG intensity decreased 14 percent despite the average household operating more appliances, becoming larger and increasing its use of space cooling. Space and water heating constituted 78 percent of residential energy use, followed by operating appliances, lighting and space cooling (see Figure 1-6).

Five main factors influenced residential energy use between 1990 and 2005 – activity, weather, structure, service level and energy efficiency effect:

- Activity – The increase in the number of households and the size of dwellings (the principal measures of residential activity) increased energy use by 28 percent (353 PJ).
- Weather – The winter in 2005 was similar to the winter in 1990 but summer temperatures were much warmer, and the result was a 0.4 percent (5.5-PJ) increase in energy use in 2005.
- Structure – The relative share of households by dwelling type (single detached, apartments, etc.) changed over the period. This change contributed to an increase in energy use of 0.6 percent (7 PJ) in 2005.
- Service level – The increased market penetration rate of appliances and increased floor space cooled by space-cooling units increased energy use by 6 percent (71 PJ).
- Energy efficiency effect – Improvements to the thermal envelope of houses and to the efficiency of residential appliances and space- and water-heating equipment led to an overall gain in energy efficiency and decreased energy use by 25 percent (321 PJ).

FIGURE 1-6

Residential Energy Use by End-Use, 2005

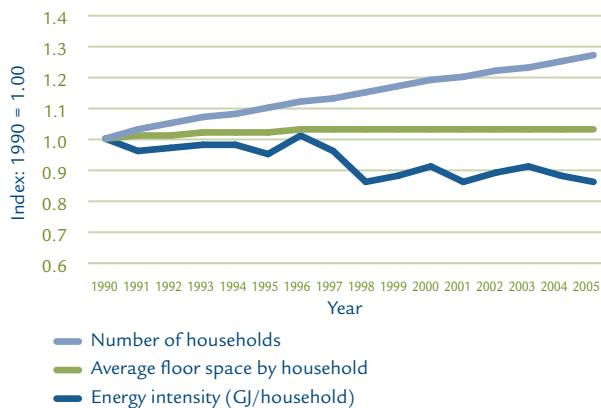


Growth in residential energy use was driven in large part by growth in activity. This growth in activity – specifically, growth in total floor space and number of households – was due to the increase in the average size of newly constructed houses, the rising population and the trend toward fewer individuals per household (see Figure 1-7).

These increases were partially offset by significant improvements in energy efficiency. Structural changes also contributed to growth in energy use, because more individuals tended to live in single detached homes and the relative share of individuals living in apartments declined. Similarly, service level increased energy demand, because more Canadians cooled their homes during the summer months in 2005 than in 1990 and Canadians operated more appliances in 2005 than they did in 1990.

FIGURE 1-7

Number of Households, Average Floor Space by Household and Energy Intensity Indexes, 1990 to 2005



Energy Efficiency

The change in residential energy use between 1990 and 2005 and the estimated energy savings due to energy efficiency measures are shown in Figure 1-8. Overall energy efficiency upgrades – including improvements to the thermal envelope (insulations, windows, etc.) and more energy-efficient appliances,

furnaces and lighting – resulted in significant monetary savings for each Canadian household. The 25 percent improvement in energy efficiency between 1990 and 2005 translated into \$6.1 billion in energy savings in 2005. Figure 1-9 shows how energy consumption differs for houses built in different periods, reflecting improvements in building construction. Figure 1-10 shows how average energy consumption of new appliances has improved, by comparing 1990 and 2005 models.

FIGURE 1-8

Residential Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005

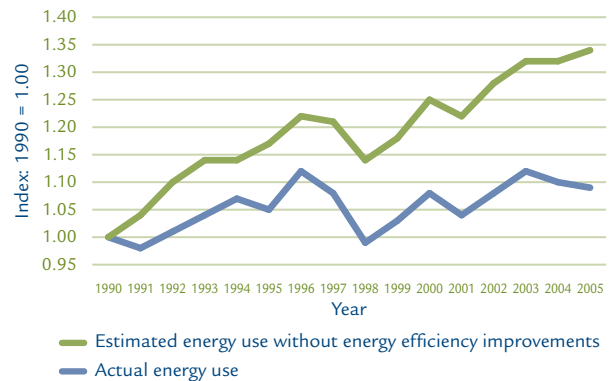
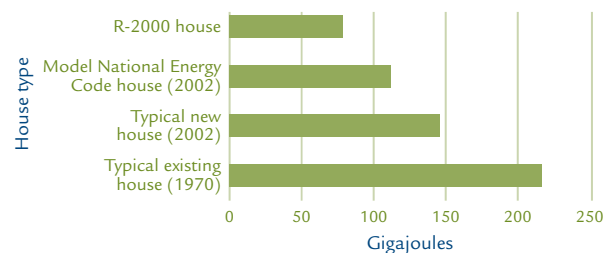


FIGURE 1-9

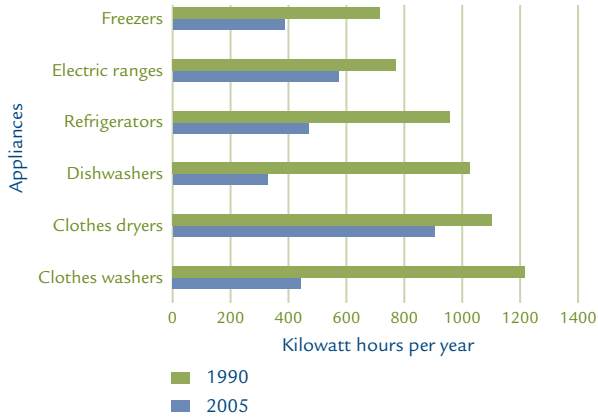
Annual Heating Consumption for Houses* Constructed to Different Standards



* 198-m² one-storey, single detached house heated with natural gas, Ottawa, Ontario

FIGURE 1-10

Average Energy Consumption of New Electric Appliances, 1990 and 2005 Models



NRCan carries out the following initiatives to increase energy efficiency in the residential sector:

- ecoENERGY Retrofit – Homes
- ecoENERGY for Buildings and Houses
- Clean Energy Systems for Buildings and Communities
- ecoENERGY for Equipment (see Chapter 2)

TRENDS IN COMMERCIAL/ INSTITUTIONAL SECTOR

Energy Use and Greenhouse Gas Emissions

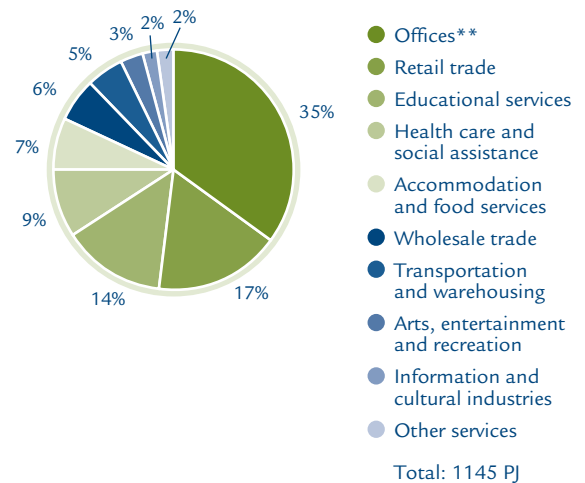
The commercial/institutional sector includes activity related to trade, finance, real estate, public administration, education and commercial services, including tourism. This sector uses energy mainly for space and water heating, operation of auxiliary equipment, space cooling, lighting, motive power for such services as pumping and ventilation in buildings, and street lighting.

In 2005, the commercial/institutional sector accounted for 14 percent (1153 PJ) of secondary energy use and 13 percent (65.3 Mt) of GHG emissions in Canada. Between 1990 and 2005, commercial/institutional energy use (including street lighting) increased by 33 percent, or 286 PJ. However, GHG emissions from the sector rose by 37 percent in the same period. The increase in use of GHG-intensive fuels, such as heavy oil and light fuel oil, explains why GHG emissions grew at a faster pace than energy use.

To highlight energy use in commercial/institutional activities, the following analysis excludes energy use for street lighting. The commercial/institutional sector comprises many activity types (see Figure 1-11). In 2005, offices accounted for 35 percent of the sector’s energy demand. Retail trade, educational services, health care and social assistance, and accommodation and food services accounted for another 47 percent of that demand. NRCan initiatives address all major activity types.

FIGURE 1-11

Commercial/Institutional Energy Use by Activity Type*, 2005



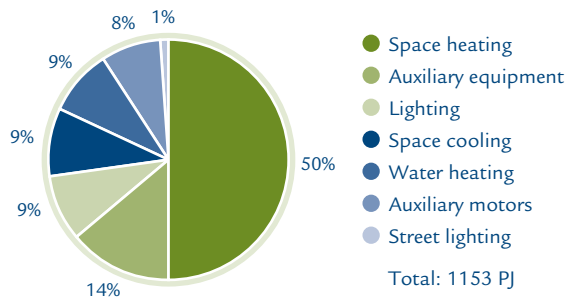
* Excludes street lighting

** “Offices” includes activities related to finance and insurance; real estate and rental and leasing; professional, scientific and technical services; and public administration.

Energy is used for six purposes in commercial/institutional activities. As illustrated in Figure 1-12, in 2005, the largest of these was space heating, which accounted for more than half of energy use in the sector. Five of the remaining six uses of energy accounted for between 8 and 14 percent of energy demand in the sector.

FIGURE 1-12

Commercial/Institutional Energy Use by Purpose, 2005



Five main factors influenced commercial/institutional energy use between 1990 and 2005 – activity, weather, structure, service level and energy efficiency effect:

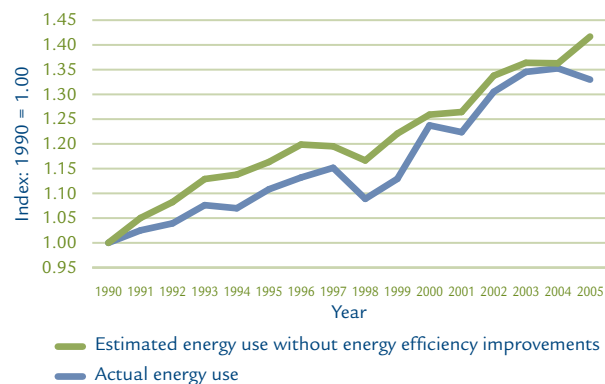
- Activity – More floor space increased energy use in the sector by 28 percent and caused a 247-PJ increase in energy use.
- Weather – The winter of 2005 was similar to the winter of 1990, but the summer was warmer than in 1990. The net result was a 3 percent increase in energy use (25 PJ) for space cooling.
- Structure – The impact of structural changes (mix of building types) was marginal but produced a decrease of 1 PJ in energy use.
- Service level – An increase in the service level of auxiliary equipment (e.g. computers, photocopiers) and space cooling caused an 11 percent increase in energy use (92 PJ).
- Energy efficiency effect – A 9 percent improvement in energy efficiency saved 75 PJ of energy.

Energy Efficiency

Gains in energy efficiency were made through improvements to the thermal envelope of buildings (insulation, windows, etc.) and increased efficiency of energy-consuming items, such as furnaces, auxiliary equipment and lighting, which slowed down the rate of increase in energy use. Without improvements in energy efficiency, energy use in the commercial/institutional sector would have increased by 41 percent. However, between 1990 and 2005, actual energy use increased by only 32 percent, resulting in energy savings of \$1.6 billion in 2005. The change in energy use between 1990 and 2005, as well as the estimated energy savings due to improvements energy efficiency, are shown in Figure 1-13.

FIGURE 1-13

Commercial/Institutional Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005



NRCan carries out the following initiatives to increase energy efficiency in the commercial/institutional sector:

- ecoENERGY Retrofit – Small and Medium Organizations
- ecoENERGY for Buildings and Houses
- Clean Energy Systems for Buildings and Communities
- ecoENERGY for Equipment (See Chapter 2)

TRENDS IN INDUSTRIAL SECTOR

Energy Use and Greenhouse Gas Emissions

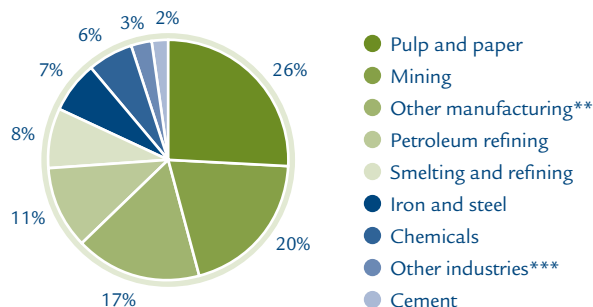
The industrial sector includes all manufacturing industries, all mining activities (including oil and gas extraction), forestry and construction. However, it excludes electricity generation. This sector uses energy in industrial processes as a source of motive power and to produce heat or generate steam.

Overall, industrial energy demand in 2005 accounted for 38 percent (3209 PJ) of secondary energy use and 33 percent (164 Mt) of GHG emissions (including electricity-related emissions). Between 1990 and 2005, actual industrial energy use increased by 18 percent (488 PJ). This increase was caused by a 44 percent increase in industrial activity, measured as a combination of physical units of production, gross output and GDP.

In the industrial sector, energy was consumed primarily in pulp and paper production, mining, petroleum refining, and in the smelting and refining industries. Pulp and paper production alone accounted for approximately 26 percent of total industrial energy demand in 2005 (see Figure 1-14).

FIGURE 1-14

Industrial Energy Use by Subsector – Including Electricity-Related Emissions*, 2005



*The above subsectors reflect the current definitions in the *Report on Energy Supply-demand in Canada*.

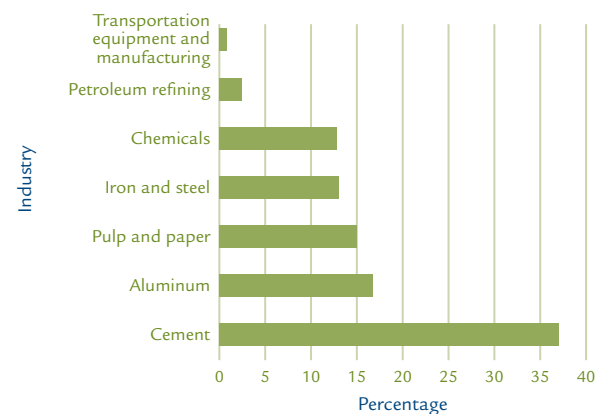
**“Other manufacturing” comprises more than 20 manufacturing industries.

***“Other industries” includes construction and forestry.

In most industries, energy purchases accounted for only a small portion of total expenditures. However, for some relatively energy-intensive industries – cement, aluminium, pulp and paper, iron and steel, and chemicals – this share was higher than 12 percent (see Figure 1-15). For cement, in particular, the share was as high as 37 percent.

FIGURE 1-15

Cost of Energy to Manufacturing Industries as a Percentage of Total Production Cost, 2005



Between 1990 and 2005, industrial GHG emissions, including electricity-related emissions, increased by 16 percent. Excluding electricity-related emissions, industrial GHG emissions increased by 8 percent. Most of this increase in direct GHG emissions occurred in the upstream oil and gas industry. The mining, manufacturing and construction industries, however, achieved a 9 percent decrease in GHG emissions.

Three main factors influenced industrial energy use between 1990 and 2005 – activity, structure and energy efficiency effect:

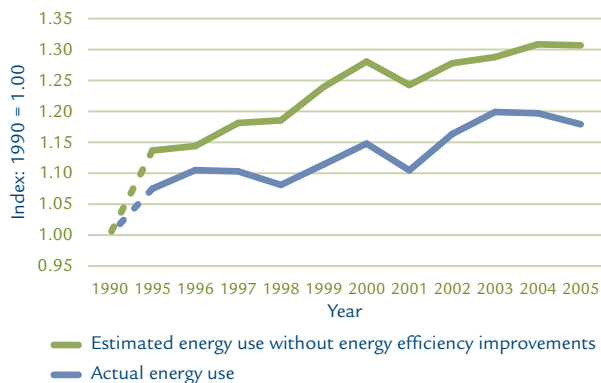
- Activity – Increases in the physical units of production, gross output and GDP contributed to a 43 percent increase in industrial activity, resulting in a 1166-PJ increase in energy use.
- Structure – The shift in the mix of activity toward less energy-intensive industries caused a 331-PJ decrease in energy use.
- Energy efficiency effect – Owing to a 13 percent improvement in energy efficiency, the industrial sector avoided 347 PJ of energy use.

Energy Efficiency

The change in energy use between 1990 and 2005 and the estimated energy savings attributed to energy efficiency are shown in Figure 1-16.

FIGURE 1-16

Industrial Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005



Energy efficiency improvements in the form of more efficient capital and management practices are important factors in managing energy use and decreasing energy intensity. Between 1990 and 2005, energy efficiency in the industrial sector improved 13 percent. In 2005, Canadian industry saved \$3.9 billion in energy costs. This gain was largely the result of improvements in energy intensity, representing the shift toward less energy-intensive activities. However, the energy savings from the energy efficiency improvements made by some industries were offset by increases in consumption by the upstream oil and gas, fertilizer and forestry subsectors.

NRCan carries out the following initiatives to increase energy efficiency in the industrial sector:

- ecoENERGY Retrofit – Small and Medium Organizations
- ecoENERGY for Industry
- Clean Energy Systems for Industry
- ecoENERGY for Equipment (see Chapter 2)

TRENDS IN TRANSPORTATION

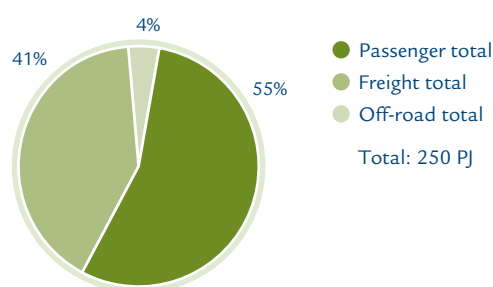
Energy Use and Greenhouse Gas Emissions

In 2005, transportation was second to the industrial sector in terms of energy use, accounting for 30 percent (2502 PJ) of Canada's total secondary energy use and the largest portion of Canadian end-use GHG emissions at 36 percent (177.5 Mt). Transportation accounts for a greater share of GHG emissions because the main fuels used by the sector are more GHG-intensive than those used in other sectors of the economy.

The transportation sector consists of three subsectors: passenger, freight and off-road. In 2005, passenger and freight transportation accounted for 55 percent and 41 percent of transportation energy use respectively, while off-road represented only 4 percent (see Figure 1-17). Owing to limitations in the available data and the small percentage it accounts for, the off-road subsector is not analysed in further detail.

FIGURE 1-17

Transportation Energy Use by Mode, 2005



The passenger subsector has three modes: road, rail and air. The freight subsector, as defined by NRCAN, is composed of road, rail, air and marine modes. Within these two subsectors, road transport uses the most energy, accounting for 78 percent of total transportation energy use in 2005.

All of NRCAN's transportation energy use programs focus on the energy used in road transportation. Total transportation energy use increased by 33 percent (624 PJ) between 1990 and 2005. Within the transportation sector, passenger transportation energy use increased by 16 percent (188 PJ), while freight transportation energy use increased by 61 percent (391 PJ).

Three main factors influenced transportation energy use between 1990 and 2005 – activity, structure, and energy efficiency effect:

- **Activity** – Increases in population, air transportation and economic activity (e.g. free trade) caused increased transportation activity.⁵

⁵ Measured as passenger-kilometres for passenger transportation and tonne-kilometres for freight transportation.

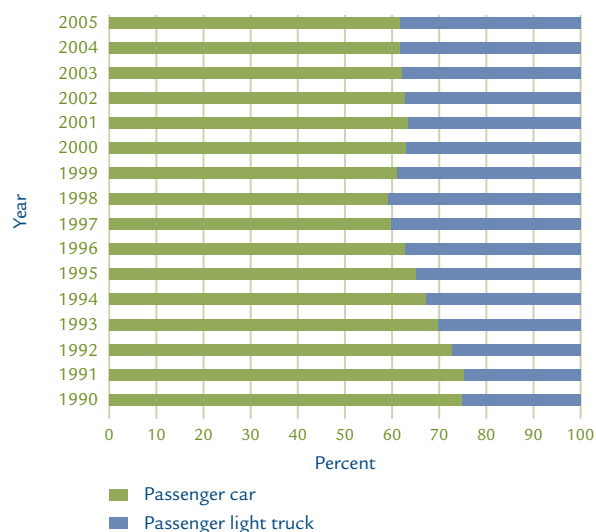
The change in activity increased transportation energy use by 40 percent (750 PJ). Contributing to this increase were the freight and passenger segments, which increased by 52 and 48 percent respectively.

- **Structure** – Shifts between modes of transport within both the freight and passenger segments caused an increase of 10 percent in transportation energy use (187 PJ). Specifically, an increase in international trade and customer requirements for just-in-time delivery and the popularity of minivans and sport utility vehicles (SUVs) contributed to a rise in energy use.
- **Energy efficiency effect** – Improvements in the energy efficiency of passenger and freight transport decreased energy use by 19 percent (352 PJ).

Figure 1-18 shows how the market share of new light trucks increased in the 1990s, reflecting the increase in popularity of minivans and SUVs. Recently, however, this trend seems to have stabilized, with the share of light trucks remaining steady over the past few years. The higher share of heavier and more powerful passenger vehicles has had a significant effect on the increase in passenger energy use.

FIGURE 1-18

Market Shares of New Passenger Car and Light Truck Sales, 1990 to 2005

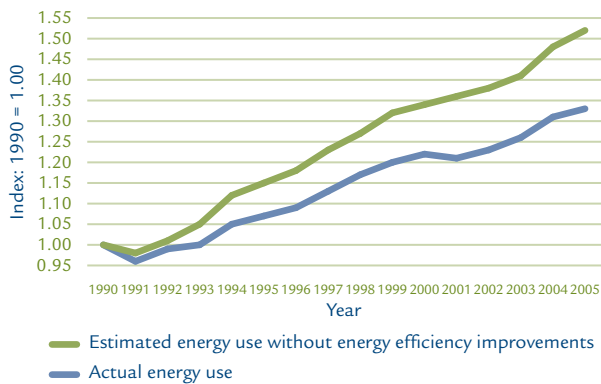


Energy Efficiency

Without improvements in energy efficiency, increases attributable to activity and structure would have led to an increase in transportation energy use of 50 percent. However, between 1990 and 2005, actual energy use increased by only 33 percent. During this period, energy efficiency in the transportation sector improved by 19 percent, leading to a savings of \$8.5 billion in 2005. This change in energy use between 1990 and 2005 and the estimated energy savings due to energy efficiency improvements are shown in Figure 1-19.

FIGURE 1-19

Transportation Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005



Figures 1-20 and 1-21 illustrate an improvement in trucking energy intensity despite an increase in average activity from 1990 to 2005. Improved fleet practices, caused by an increase in the competitiveness of the transportation sector and by the introduction of electronic engines, have improved fuel efficiency in medium- and heavy-duty trucks.

FIGURE 1-20

Average Activity per Truck, 1990 to 2005

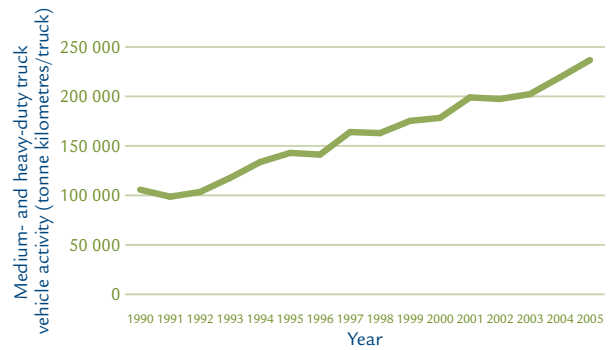
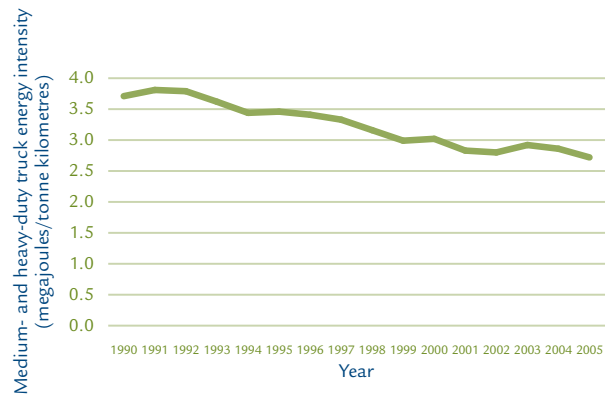


FIGURE 1-21

Trucking Energy Intensity, 1990 to 2005



NRCan carries out the following initiatives to increase the efficiency of motor vehicle use:

- ecoENERGY for Personal Vehicles
- ecoENERGY for Fleets
- Clean Transportation Energy

TRENDS IN ALTERNATIVE AND RENEWABLE FUELS

Alternative and Renewable Fuels

Alternative fuels are fuels used for transportation other than petroleum-based gasoline and diesel. Some alternative transportation fuels, such as ethanol and biodiesel, are renewable; others, such as propane and natural gas, are non-renewable. Other possible alternative transportation fuels include next-generation biofuels, coal-to-liquids, electricity and hydrogen.

“Renewable fuel” is a broad term covering a range of fuels made from renewable energy sources that are naturally replenished in a relatively short period. The sources include biomass, hydropower, geothermal energy, wind energy and solar energy.

Biofuels is a well-known category of renewable fuel and can be produced from a variety of sources. Two commercially available biofuels are ethanol and biodiesel. Conventional ethanol is produced from sugars or starches, and biodiesel production typically uses vegetable oils and animal fats. In Canada, ethanol is typically produced from corn and wheat, while canola oil, soy oil and tallow are relevant biodiesel feedstocks.

Gasoline vehicles manufactured since the 1980s can use up to 10 percent ethanol in gasoline, and many diesel vehicle manufacturers include the use of 5 percent or higher biodiesel blends. Under development are next-generation biofuels, such as cellulosic ethanol. These biofuels could be made from non-conventional sources, such as agricultural residues, forest residues and waste materials.

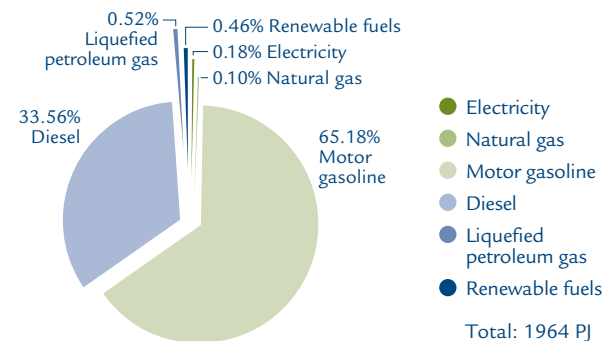
Renewable Fuels Production

Renewable fuels production in Canada has increased since the emergence of ethanol in Manitoba in the 1980s. Between 2000 and 2006, domestic renewable fuel production capacity increased by more than 200 percent, from 207 million litres to 656 million litres annually. For 2008, ethanol production is estimated to be 1.3 billion litres.

In 2005, renewable fuels used in the transportation sector represented less than 0.5 percent of fuel used, as shown in Figure 1-22. The renewable fuel consumed was predominately ethanol blended with gasoline in lower-level ethanol blends.

FIGURE 1-22

Shares of On-Road Transportation Fuel, 2005



The federal regulation being developed will require an average annual renewable fuel content of at least 5 percent based on the volume of the gasoline pool, commencing in 2010, and at least 2 percent renewable content in the distillate pool by 2012.

NRCan carries out initiatives to increase the use and production of renewable and alternative fuels under the following programs:

- ecoENERGY for Biofuels
- Ethanol Expansion Program
- Sustainable Development Technology Canada's NextGen Biofuels Fund™

Equipment Standards and Labelling

INTRODUCTION

Natural Resources Canada's (NRCan's) wide range of energy efficiency initiatives includes standards and labelling programs that are based on the requirements of Canada's *Energy Efficiency Regulations* (the Regulations).

The *Energy Efficiency Act* of 1992 gives the Government of Canada the authority to make and enforce regulations that prescribe standards and labelling requirements for energy-using products that are imported to Canada or shipped across provincial borders for lease or sale. The *Energy Efficiency Regulations* came into effect in February 1995, after extensive consultations with provincial governments, affected industries, utilities, environmental groups and others. Since then, the Regulations have been amended a number of times.

The performance standards contained in the Regulations and accompanying labelling requirements and programs make a major contribution to the government's Clean Air Regulatory Agenda (CARA). Regulations have now been established for more than 30 products that consume 71 percent of the energy used in the residential sector in Canada and 50 percent of the energy used in the commercial/institutional sector.

Regulated products include major household appliances, water heaters, heating and air-conditioning equipment, automatic icemakers, dehumidifiers, dry-type transformers, electric motors, commercial refrigeration and some lighting products. The Regulations apply to these products

even if they are incorporated in a larger unit or machine that is not regulated. As announced by the Government of Canada in October 2006, the Regulations will be amended to prescribe standards for 20 new products and increase the stringency of existing standards for 10 products by 2010.

NRCan regularly amends the Regulations to strengthen the minimum energy performance requirements for prescribed products when the market has achieved a higher level of efficiency. The Regulations are also amended to add new products, harmonize minimum energy performance requirements with those of other jurisdictions and update testing methodologies and labelling requirements. In addition, regulations can be established for gathering market data on the energy performance of certain types of equipment. For example, the data gathered for gas fireplaces is used to support programs developed by the industry and NRCan and its partners for gas fireplace performance.

Before amending the Regulations, NRCan conducts studies to determine how the proposed change will affect the market. A key criterion for amending the Regulations is that the change must have a significant positive impact on consumers and the environment. Stakeholders are consulted on all proposed changes to the Act and the Regulations, as well as on their practical application in the marketplace.

The Act and the Regulations also support labelling initiatives. These are designed to help consumers and the commercial/industrial procurement community identify and purchase energy-efficient equipment that will save them money and reduce greenhouse gas (GHG) emissions over the life of the product.

The Act and the Regulations require that an EnerGuide label be displayed on major electrical household appliances and room air conditioners. For appliances, the EnerGuide label shows the estimated annual energy consumption of the product in kilowatt hours and compares it with the most and least efficient models of the same class and size. The EnerGuide label for room air conditioners indicates the model's energy efficiency ratio and provides a comparative bar scale.

The EnerGuide label is also used voluntarily by manufacturers and suppliers of residential oil and gas furnaces, vented gas fireplaces, central air conditioners and air-to-air heat pumps. In this case, the EnerGuide rating for a specific product is published on the back page of the manufacturer's brochure. These ratings include the annual fuel utilization efficiency rating for oil and gas furnaces, the fireplace efficiency rating for gas fireplaces and the seasonal energy efficiency ratio for central air conditioners.

The ENERGY STAR® Initiative in Canada works with and complements the Regulations and comparative EnerGuide label. The internationally recognized ENERGY STAR symbol is a simple way for consumers to identify products that are among the most energy-efficient on the market. Products that are prescribed in the Regulations and are also part of the Initiative must meet levels of energy efficiency significantly above the minimum performance levels set out in the Regulations to qualify for the ENERGY STAR symbol. As higher-performance products penetrate the market, their efficiency levels trigger the development of new minimum energy performance standards.

STANDARDS

As a world leader in the use of energy efficiency standards, NRCan is committed to harmonizing standards and labelling requirements with those developed in other jurisdictions. Harmonization reduces barriers to trade and sustainable development by improving the flow of energy-efficient products within Canada and around the world. This practice minimizes the regulatory burden on manufacturers and avoids confusion for consumers.

For example, the performance requirements in the Regulations are similar to those in several Canadian provinces that regulate energy-using equipment manufactured and sold within their borders. This similarity is achieved because governments support and participate in the development of national, consensus-based performance standards by accredited standards-writing organizations, such as the Canadian Standards Association.

Such standards include testing procedures that are used to determine a product's energy performance and are usually referenced federally and provincially. NRCan works closely with provinces throughout the regulatory process to ensure that the federal and provincial standards regimes are harmonized to the maximum extent possible. Because the North American market is highly integrated, Canada's energy performance requirements for many products are similar to regulations in the United States.

Canada is an active participant in international and regional forums, such as the Asia-Pacific Economic Cooperation Energy Working Group, the North American Energy Working Group and the Asia-Pacific Partnership on Clean Development and Climate, which are important for regional co-operation on harmonization issues. Trade and investment liberalization and facilitation are high on the agenda of these working groups.

NRCan supports Canadian representation on committees of the International Organization for Standardization and the International Electrotechnical Commission. It also supports the national and international policy work of the Standards Council of Canada.

COMPLIANCE AND ENFORCEMENT

The Regulations outline a number of responsibilities for dealers who import to Canada, or ship from one Canadian province to another, any prescribed energy-using product. NRCan is committed to securing voluntary compliance but can use enforcement measures when necessary.

NRCan emphasizes self-monitoring, reporting, voluntary compliance and collaboration. However, the Act prescribes specific enforcement measures when dealers violate the law. Enforcement activities include preventing the importation of non-compliant products to Canada, preventing the sale or lease of non-compliant products in Canada and imposing fines. Violators can also be fined under the Administrative Monetary Penalty System of the Canada Border Services Agency for not providing required information on the prescribed product at the time of import; serious violations can be prosecuted.

To monitor compliance with the Regulations, NRCan captures information from energy efficiency reports and import documents. Section 5 of the Act requires dealers to provide energy efficiency reports when they market a new product model. The required information includes the energy performance of each model, the name of the testing agency and the size category, as described in Schedule IV of the Regulations.

The Regulations require that, when importing a regulated product into Canada, dealers provide specific product information on customs documents for all shipments (i.e. type of product,

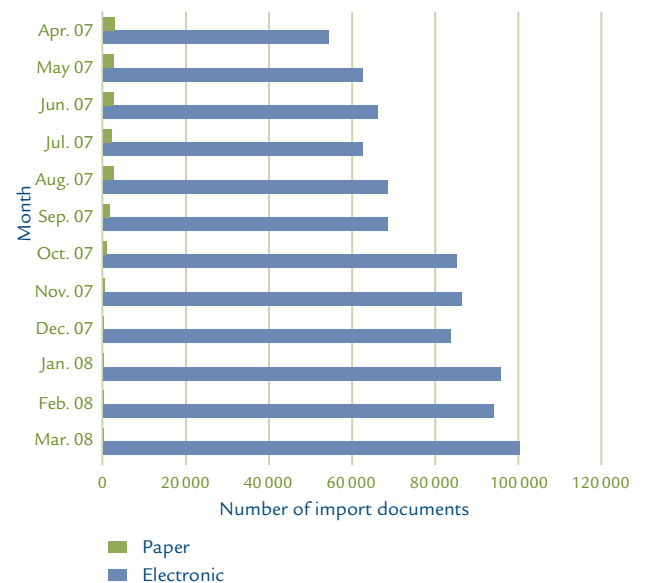
brand name, model number, name and address of dealer and purpose of import). A customs document contains less information than an energy efficiency report, but there is enough to allow NRCan to verify that there is a matching energy efficiency report. NRCan can then confirm that all products entering Canada meet the required energy performance levels and can take action when necessary.

NRCan processed more than 942 441 records (records from April 1, 2007, to March 31, 2008) relating to the importation of regulated energy-using products to Canada in 2007–2008. Figure 2-1 illustrates the volume of import documents received in paper form and electronically per month during the 2007–2008 fiscal year.

More than 855 093 new or revised model numbers were submitted to NRCan for entry into NRCan’s equipment database (records from April 1, 2007, to March 31, 2008) from dealers’ energy efficiency reports.

FIGURE 2-1

Volume of Monthly Import Documents



REGULATORY IMPACT TO DATE FROM THE REGULATORY IMPACT ANALYSIS STATEMENT

In preparing amendments to the Regulations, NRCan analyses the impact of the proposed amendment on society, the economy and the environment. This information is made available through the Regulatory Impact Analysis Statement, which is annexed to the Regulations and published in the *Canada Gazette, Part II*.

It is estimated that Canada's energy performance standards will cause a reduction of 25.6 megatonnes (Mt) in aggregate annual emissions by 2010 (see Table 2-1).

TABLE 2-1

Estimated Impact of *Energy Efficiency Regulations, 2010 and 2020* (aggregate annual savings)

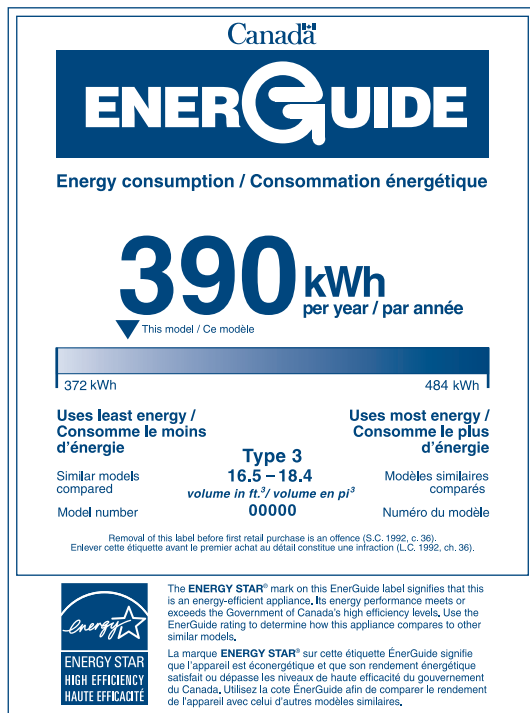
Product (amendment number in brackets)	Energy savings (PJ)		CO ₂ reductions (Mt)	
	2010	2020	2010	2020
Residential appliances (1)	117.20	133.84	13.26	15.60
Lamps – fluorescent/incandescent (2)	11.60	13.40	7.55	9.80
Motors (3)	16.30	17.70	2.03	2.14
Commercial HVAC (4)	6.40	7.50	0.43	0.57
Refrigerators (5)	4.92	10.96	0.49*	1.10*
Ballast/room A/C, PAR lamps (6)	3.96	9.44	0.39*	0.94*
Clothes washers, domestic water heaters, exit signs, chillers (8)	16.20	42.67	1.29	3.61
A/C, commercial refrigeration (9)	1.57	5.35	0.16	0.53
Total	178.15	240.86	25.60	34.29

*Values are different from Regulatory Impact Analysis Statement due to a change in the emission factor to 99.3.

LABELLING AND PROMOTION

Since 1978, the EnerGuide label (see Figure 2-2) has given Canadians an opportunity to compare the energy consumption of appliances. In 1995, with the introduction of the Regulations, placing an EnerGuide label on major electrical household appliances and room air conditioners became mandatory. The label on a product shows how much energy a product uses, allowing the customer to consider the most energy-efficient choice.

FIGURE 2-2
EnerGuide Label



EnerGuide directories that list energy ratings for major appliances and room air conditioners are published annually. They are distributed to consumers, retailers and appliance salespeople. In fulfilling requests for information, electric utilities and provincial governments also distribute the directories. Online directories for all appliances and heating and cooling equipment are published on the Web site of the Office of Energy Efficiency (OEE) and updated monthly.

A voluntary EnerGuide rating program was established in 1997 and included gas furnaces, central air conditioners, heat pumps and oil furnaces. In the fall of 2003, gas fireplaces were added to the EnerGuide rating program, and manufacturers were asked to include EnerGuide ratings for fireplace efficiency in their brochures. These changes coincided with the mandatory requirement in the Regulations to test, verify and report on fireplace efficiency.

Major distributors of these products for sale in Canada report the verified energy performance rating of their products, as tested against the standards in the Regulations. In addition, participants in the voluntary EnerGuide rating program must provide shipment data and aggregate energy efficiency information to track the progress of the program and identify marketplace improvements that can result from labelling.

Given that the equipment products listed above are typically purchased from a brochure or catalogue, a consumer would probably not read the EnerGuide label before making a decision to buy. Accordingly, manufacturers are encouraged to include an EnerGuide rating in product brochures and catalogues, so consumers can compare the efficiency of products when they are in the buying process. To date, manufacturers of 85 percent of eligible products on the market voluntarily participate in the EnerGuide rating program and publish the ratings in their brochures.

Regularly conducted polls indicate that more than 50 percent of Canadians surveyed are aware of the EnerGuide label.

In 2001, responding to public interest in a labelling system that identifies the best performers, Canada officially introduced ENERGY STAR, the international symbol for energy efficiency (see Figure 2-3). Canada signed an agreement with the U.S. Environmental Protection Agency and the U.S. Department of Energy. The OEE is the custodian of the program for Canada. Canada joins other international ENERGY STAR program participants: Australia, New Zealand, Japan and Taiwan, and the European Union, which adopted ENERGY STAR for office equipment.

FIGURE 2-3

ENERGY STAR® Label



ENERGY STAR establishes high efficiency criteria and levels for selected products for the residential and commercial sectors. Product categories are selected on the basis of their technical potential for high efficiency. This is a voluntary program. However, organizations must demonstrate that products meet the eligibility criteria and performance levels. For appliances and heating and cooling products, the criteria are based on the same test standards as those applied under the Regulations. Canada promotes specific product categories for which levels and criteria can be harmonized with those of the United States, including the following:

- major electrical appliances
- heating, cooling and ventilation
- consumer electronics
- office equipment
- windows, doors and skylights (Canadian levels)
- selected lighting products – compact fluorescent lamps (CFLs), fixtures, decorative light systems and solid-state lighting
- selected commercial equipment, including commercial refrigeration products

Canada has also integrated ENERGY STAR with the EnerGuide label for qualified major appliances and room air conditioners, to help consumers identify the best-performing products. While the EnerGuide

label shows how much energy a product uses under normal conditions in one year, the ENERGY STAR symbol on the label identifies the most energy-efficient product. Now that industry-accepted standards of high efficiency have been established, ENERGY STAR has become the criterion to meet for incentive and rebate programs.

ENERGY STAR is used as the basis for incentives by many electrical and gas utilities across Canada. For example, Hydro-Québec promotes ENERGY STAR qualified refrigerators and CFLs as part of its *Mieux Consommer* program and provides incentives for these product categories. Kitchener Utilities, Enbridge Gas and Terasen Gas develop point-of-sale and incentive programs around ENERGY STAR qualified gas-fired heating systems.

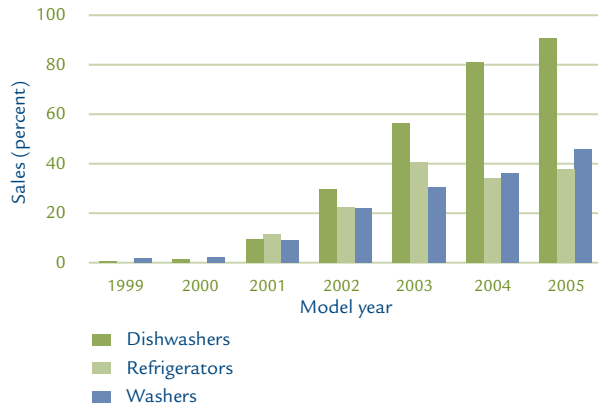
ENERGY STAR is also the qualifying criterion for sales tax exemptions in British Columbia for heating and cooling equipment; in Saskatchewan for the purchase of furnaces, boilers and qualifying appliances (refrigerators, dishwashers, clothes washers and freezers); and in Ontario. Organizations across Canada have used ENERGY STAR as a campaign driver to promote replacement with, or purchase of, higher efficiency products.

Continuous promotion of ENERGY STAR qualified appliances has paid off. Industry statistics for 2005 show an increase in market penetration from almost nil in 2000 to 38 percent for refrigerators and 91 percent for dishwashers (see Figure 2-4). The increase in market penetration indicates growing acceptance of ENERGY STAR as the brand for high efficiency and manufacturers' willingness to raise the efficiency of their products to qualifying levels.

ENERGY STAR specifications and levels are periodically updated as product saturation is reached, to encourage industry to strive for more efficient products and thus maintain the relevance and credibility of the brand.

FIGURE 2-4

ENERGY STAR Qualified Appliances as a Percentage of Total Category Sales in Canada, 1999 to 2005



ENERGY STAR is also well known in the commercial sector, with criteria for products ranging from office equipment to vending machines. NRCan supports demonstration projects to validate the savings and other benefits of some of these products and to address barriers to their widespread acceptance.

Canada continues to promote ENERGY STAR guidelines in its contacts with the procurement community. It has updated an interactive cost calculator that compares energy cost savings and GHG emissions reductions associated with the purchase of ENERGY STAR qualified products. Workshops were held across Canada to make governments and institutions aware of the ENERGY STAR criteria and procurement tools.

Canada is also working with housing agencies to help them identify energy savings in their properties and to specify ENERGY STAR qualified products for replacement equipment.

Canada continues to expand the range of product types included in its ENERGY STAR agreement. Canada led the way in the development of a

technical specification for decorative light strings (also known as Christmas lights) and implemented this specification for Canada. In addition, Canada recently included fixtures, solid state lighting and external power supplies in its agreement with the Government of the United States. Finally, Canada is developing an ENERGY STAR specification for heat recovery ventilators.

NRCan developed a rating and labelling system for efficient refrigeration applications in ice and curling rinks under the name CoolSolution.⁶ An ice rink application is qualified CoolSolution if it achieves a rating higher than 50 percent. An incentive program to encourage the adoption of CoolSolution and reduce the initial payback of the first applications started in November 2006. Partnerships to accelerate the program have been successful.

CoolSolution designates innovative technologies and practices and consists of three main elements:

- heat recovery from the refrigeration system to meet all the building's heating requirements (e.g. hot air, hot water) or to export this energy for other purposes.
- adaptation to the Canadian climate by taking advantage of the naturally occurring cold temperatures. This is done by varying the temperature of the heat released into the environment according to the outdoor temperature.
- reduction of the synthetic refrigerant charges of the refrigeration system, which have a serious adverse impact on climate change. This is done by using natural refrigerants or by confining the synthetic refrigerant to the mechanical room and using environmentally friendly fluids to remove and distribute heat.

⁶ CoolSolution is an official mark of Her Majesty the Queen in the Right of Canada as represented by the Minister of Natural Resources.

ecoENERGY FOR EQUIPMENT

Objective

To exclude the least efficient energy-using equipment from the market and to influence consumers to select – and manufacturers to produce – energy-efficient products that perform above minimum standards.

Description

The ecoENERGY for Equipment program is focused on accelerating the introduction of energy-efficient products in Canada's equipment stock. The program implements minimum energy efficiency performance standards that restrict the importation and interprovincial/interterritorial shipment of the least efficient products for sale in Canada. It also carries out initiatives to increase the market share of more efficient products.

ecoENERGY for Equipment also supports labelling programs that encourage the introduction of more efficient technologies. This involves the establishment and promotion of high-efficiency performance criteria, such as ENERGY STAR, and the engagement of stakeholders to promote products that meet these criteria. As products are adopted in the marketplace, the ENERGY STAR or equivalent performance level will become the basis for new, more stringent standards.

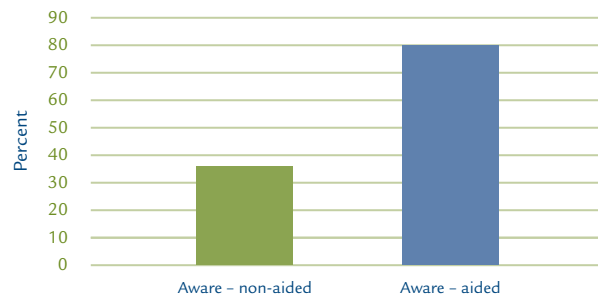
In addition, ecoENERGY for Equipment maintains a multilayered compliance and enforcement program to ensure that products meet prescribed standards and to ensure that other regulatory requirements, such as labelling, are met.

Program components include the following:

- regulations under the *Energy Efficiency Act* requiring dealers to ship only products that meet the prescribed energy efficiency standards
- the EnerGuide program, which rates and labels the energy efficiency of major household electrical appliances and heating, ventilating and air-conditioning equipment, assisting consumers in making energy-wise purchases
- the ENERGY STAR high efficiency program, which is an international initiative that identifies the most energy-efficient products in their class (see Figure 2-5)

FIGURE 2-5

ENERGY STAR Awareness Levels in Canada, 2005



Targets

Estimates indicate that by 2011, this program will result in energy savings of between 13.4 and 14.9 petajoules. At present, these energy savings convert to annual emissions reductions of between 1.4 and 1.6 Mt of GHGs and related Criteria Air Contaminants emissions.

Key 2007–2008 Achievements

- Undertook a complete analysis of options to amend the *Energy Efficiency Act* for expansion and strengthening of product regulations and provided recommendations to policy and decision-makers.
- Conducted the analysis of, and consultations necessary to pre-publish, Amendment 10 to the *Energy Efficiency Regulations*. This amendment proposes to increase the stringency of existing standards for four products; introduce standards for an additional seven products, including light bulbs; and introduce labelling requirement for a number of other lighting products.
- Conducted primary research into the standby power consumption of a myriad of products sold in Canada to provide the analytical basis for proposed standards limiting standby power consumption.
- Delivered four specialized workshops on ENERGY STAR to the procurement and institutional community.
- Maintained a comprehensive database of ENERGY STAR qualified products and information that assist utilities and other organizations across Canada in their energy efficiency programs (rebates, incentives and tax exemptions).
- Participated in a collaborative effort with the Mont-Mégantic Observatory, Hydro-Québec and Québec communities to reduce “fugitive” outdoor lighting and thereby reduce energy consumption and ensure the continued effectiveness of the Observatory.
- Coordinated the development of multi-stakeholder communities of interest with the objective of defining long-term strategic end-use objectives for lighting, space conditioning, service water use and standby power consumption. These forums will establish a framework for meeting those objectives and monitor progress toward achieving them.

For more information:

oee.nrcan.gc.ca/corporate/programs.cfm

Energy Efficiency and Alternative Transportation Fuels

Natural Resources Canada's (NRCan's) Office of Energy Efficiency (OEE) aims to strengthen and expand Canada's commitment to energy efficiency in all sectors and increase the production and use of alternative transportation fuels in Canada. The OEE is the manager of the ecoENERGY Efficiency Initiative, under the ecoENERGY suite of programs initiated on April 1, 2007. The ecoENERGY Efficiency Initiative includes the following programs:

- ecoENERGY Retrofit
- ecoENERGY for Buildings and Houses
- ecoENERGY for Industry
- ecoENERGY for Personal Vehicles
- ecoENERGY for Fleets
- ecoENERGY for Biofuels
- ecoENERGY for Equipment (see Chapter 2)

In addition to ecoENERGY, the OEE manages the Ethanol Expansion Program and the Federal Buildings Initiative.

This chapter describes the objective of each of the aforementioned programs and outlines key achievements for the 2007–2008 fiscal year.

ecoENERGY RETROFIT

Objective

To provide incentives for energy efficiency improvements in homes and in small and medium-sized organizations in the institutional, commercial and industrial sectors. The program is made up of three components:

- ecoENERGY Retrofit – Homes
- ecoENERGY Retrofit – Small and Medium Organizations
- ecoENERGY Retrofit – Existing Buildings Initiative

Targets

Estimates indicate that by 2011, ecoENERGY Retrofit as a whole will result in energy savings between 12.78 and 14.20 petajoules (PJ). At present, these energy savings convert to annual emissions reductions of between 1.0 and 1.1 megatonnes (Mt) of greenhouse gases (GHGs) and related Criteria Air Contaminants (CAC) emissions.

For more information:

ecoaction.gc.ca/retrofit

ecoENERGY RETROFIT – HOMES

Objective

To assist homeowners and owners of existing low-rise properties make smart energy retrofit decisions that will result in significant energy savings and a cleaner environment.

Description

Property owners can qualify for federal grants by improving the energy efficiency of their homes and reducing their home's impact on the environment. ecoENERGY Retrofit – Homes offers a professional evaluation by a qualified energy advisor of the energy efficiency characteristics of a house, including a diagnostic test to determine air leakage.

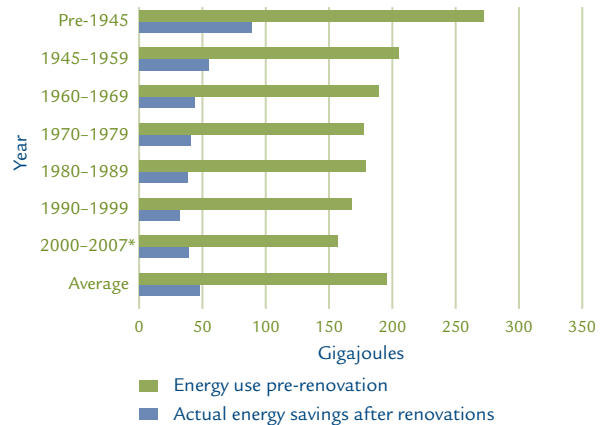
The energy advisor prepares a detailed personalized checklist of recommended upgrades for the property owner, including the EnerGuide pre-retrofit energy rating of the house. The checklist shows the recommended, most effective upgrades. The property owner chooses which upgrades to have done.

After the retrofit work is complete, the advisor performs a post-retrofit energy evaluation and assigns a new energy-rating label. After the required improvements have been made, the property owner is entitled to a grant.

It is expected that the ecoENERGY Retrofit – Homes incentives will promote smart energy use in more than 140 000 homes and will yield an average 30 percent reduction in energy use and costs. Figure 3-1 illustrates the energy use and savings gained per household before and after renovations.

FIGURE 3-1

Residential Energy Use and Energy Savings per Household, Pre-1945 to 2000–2007



*Data for 2007 are from ecoENERGY Retrofit – Homes (previous data source was EnerGuide for Houses).

Key 2007–2008 Achievements

- Over 102 000 homeowners have applied for a pre-retrofit assessment.
- Over 12 000 homeowners have completed their retrofits and have received grants.
- Established collaborative agreements with provinces, territories, utilities and other stakeholders, including British Columbia, the City of Edmonton, Saskatchewan, Manitoba, Ontario, Hydro-Québec, the Agence de l'efficacité énergétique du Québec, Gaz Métro, Gazifère, New Brunswick, Nova Scotia, Yukon and the Northwest Territories.

ecoENERGY RETROFIT – SMALL AND MEDIUM ORGANIZATIONS

Objective

To encourage Canadian businesses to make their commercial and institutional buildings and industries more energy efficient.

Description

ecoENERGY Retrofit – Small and Medium Organizations provides incentives to businesses to incorporate energy-efficient features in building improvement projects and the upgrading of industrial equipment and processes. Industrial facilities with fewer than 500 employees and commercial and institutional buildings of less than 10 000 square metres may be eligible for funds through contribution agreements with ecoENERGY Retrofit – Small and Medium Organizations.

ecoENERGY Retrofit will provide up to 25 percent of the cost of a project, to a maximum of \$50,000. Recipients of funding in this category may also qualify for funding support from utilities and/or other levels of government. To qualify, eligible organizations must submit an application detailing the energy efficiency project, including the total budget, timeframe for completion and expected results, based on a certified technical assessment of the organization's energy use.

Key 2007–2008 Achievements

- Nine information sessions were held with 435 participants.
- Ninety-six small and medium organizations had their planned retrofit projects approved for assistance.

ecoENERGY RETROFIT – EXISTING BUILDINGS INITIATIVE

Objective

To encourage commercial businesses and public institutions to become more energy efficient and reduce GHG emissions.

Description

The ecoENERGY Retrofit – Existing Buildings Initiative (EBI) was wound down during the 2007–2008 fiscal year. While active, it helped commercial organizations and public institutions explore energy efficiency options and strategies. The program provided access to tools and financial assistance to help reduce energy costs and improve competitiveness. It enrolled more than 2800 commercial, institutional, and multiunit residential organizations as members and provided over \$72 million in federal incentives.

Key 2007–2008 Achievements

- The EBI signed 95 contribution agreements for retrofit projects and 28 contribution agreements for planning activities.
- Projects that received financial incentives under the EBI are expected to result in average energy savings of approximately 20 percent.

FEDERAL BUILDINGS INITIATIVE

Objective

To assist Government of Canada organizations in implementing energy efficiency upgrades that lead to reduced energy and water use, GHG emissions and operating costs.

Description

The Federal Buildings Initiative (FBI) is an energy efficiency program targeting federal departments and agencies and Crown corporations. The FBI provides a range of products and services required by an organization in order to implement comprehensive energy efficiency improvement projects in its facilities.

The products include case studies, workshops, technical information, model procurement documents and a qualified list of private-sector energy management firms that can provide energy performance contracting services. FBI services include facilitation such as energy management technical advice, program policy advice and procurement services to assist organizations in making energy efficiency improvements.

Other levels of government, institutions and private sector firms also draw on the FBI's experience for help in designing their own energy efficiency programs. Through the FBI, thousands of federal buildings have been upgraded, saving millions of dollars and reducing the risks associated with climate change.

Key 2007–2008 Achievements

- The Canadian Forces bases in Gander, Newfoundland and Labrador, and Gagetown, New Brunswick, are proceeding with energy efficiency retrofit projects that are expected to save \$5 million in annual energy costs.
- To date, the private sector has made new and incremental investments of \$319 million in FBI projects.

- The FBI awarded energy efficiency projects that will reduce the federal government's annual utility bills by \$43 million.

For more information:

oee.nrcan.gc.ca/communities-government/buildings/federal/federal-buildings-initiative.cfm

ecoENERGY FOR BUILDINGS AND HOUSES

Objective

To encourage the construction and operation of more energy-efficient buildings and houses using complementary activities, such as rating, labelling and training. This four-year program was launched April 1, 2007.

Description

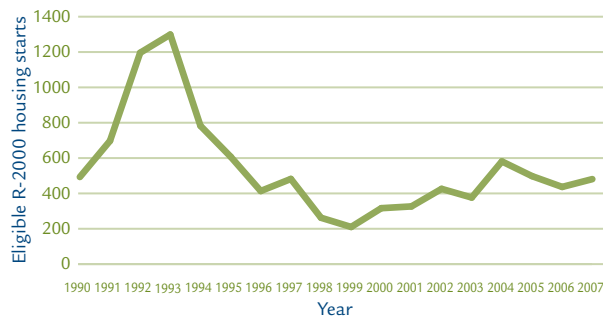
The ecoENERGY for Buildings and Houses program includes the following activities for the buildings sector:

- implementing new design tools and training, such as the Dollars to \$ense workshop, so designers, builders, owners and operators can learn about and use best practices and new technologies for energy-efficient buildings
- updating building energy ratings and promoting labelling systems for housing, including the EnerGuide Rating System, R-2000,⁷ ENERGY STAR® and Built Green™, to encourage consumers to invest in energy-efficient options (see Figure 3-2)
- engaging in ongoing dialogue and co-operation with provincial and territorial programs with a view to encouraging other levels of government to adopt more stringent building energy codes
- providing training and implementing outreach and communication strategies to increase awareness and build capacity among building owners, managers and consumers to support the adoption of sustainable energy efficiency programs.

⁷ R-2000 is an official mark of Natural Resources Canada.

- establishing and maintaining partnerships to reduce energy use and improve energy efficiency information

FIGURE 3-2
Number of Eligible R-2000 Housing Starts, 1990 to 2007



Targets

Estimates indicate that by 2011, this program will result in energy savings of between 17.09 and 18.99 PJ. At present, these energy savings convert to annual emissions reductions of 1.3 and 1.4 Mt of GHGs and related CAC emissions.

Key 2007–2008 Achievements

- Held 207 workshops and trained over 4296 professionals in energy-efficient construction systems for the housing and buildings sectors.
- Issued 108 661 housing labels for new and existing houses.
- Completed a memorandum of understanding (MOU) with the National Research Council to collaborate on the forthcoming update of the *Model National Energy Code for Buildings*.

For more information:

ecoaction.gc.ca/ecoenergy-ecoenergie/buildingshouses-batimentshabitations-eng.cfm

ecoENERGY FOR INDUSTRY

Objective

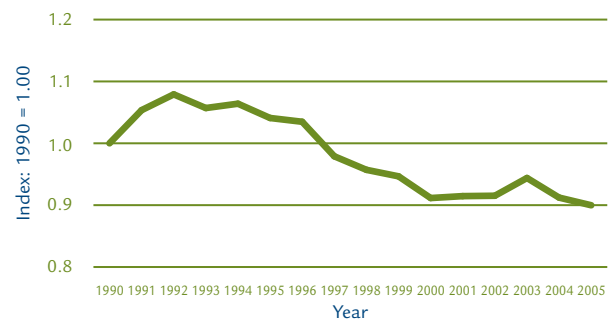
To improve industrial energy intensity and reduce energy-related industrial GHGs and air pollution.

Description

The ecoENERGY for Industry program promotes an increase in energy-saving investments across Canada's industrial sector. The program helps industry become more energy efficient by providing it with tools and services for overcoming the technical, management and financial barriers to project implementation.

ecoENERGY for Industry is an industry-government partnership delivered through the Canadian Industry Program for Energy Conservation (CIPEC). CIPEC is committed to promoting and encouraging energy efficiency improvements and reductions in GHG emissions through voluntary action across Canada's industrial subsectors. The estimated CIPEC energy intensity index is shown in Figure 3-3.

FIGURE 3-3
CIPEC Energy Intensity Index, 1990 to 2005



Program components include the following:

- the Dollars to \$ense energy management workshops, which teach industry members how to improve operational efficiency, create a better work environment and reduce GHG emissions (see Figure 3-4)

- the ecoENERGY Assessment Incentive for Industry, which offers a financial incentive to help industrial companies conduct state-of-the-art process integration and computational fluid dynamics studies that identify opportunities for increasing energy efficiency and improving production processes
- the CIPEC Leaders network, which demonstrates the industrial sector's commitment to reducing energy use, gives members recognition, networking opportunities for best-practice sharing and eligibility for financial incentives

- Welcomed 156 new members to the CIPEC Leaders network, which has over 1600 members, and held 59 network meetings.

For more information:

ecoaction.gc.ca/ecoenergy-ecoenergie/industry-industrie-eng.cfm

ecoENERGY FOR PERSONAL VEHICLES

Objective

To encourage and support improvements in energy efficiency by encouraging Canadians to buy, drive and maintain their vehicles with fuel efficiency in mind.

Description

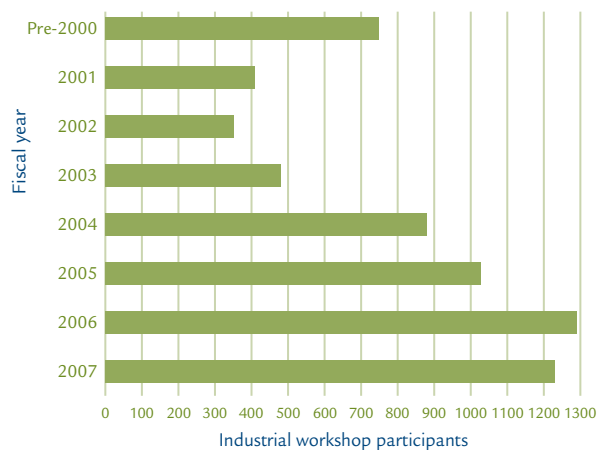
The ecoENERGY for Personal Vehicles program raises awareness of the impact of vehicle choice and use on fuel efficiency and the environment. It does so through the following:

- decision-making information and tools, such as the *Fuel Consumption Guide*, labels and vehicle awards
- “Eco” driver education and training
- idle-free and tire inflation campaigns
- collaborative ventures with community groups and industry stakeholders

ecoENERGY for Personal Vehicles also facilitates work with the vehicle industry to implement and monitor the voluntary MOU between the Government of Canada and the auto industry to reduce automobile GHG emissions. Program components include the following:

- the EnerGuide labelling system, which places fuel consumption labels on all new light-duty vehicles sold in Canada (see Figure 3-5)

FIGURE 3-4
Industrial Dollars to \$ense Participants, pre-2000 to 2007



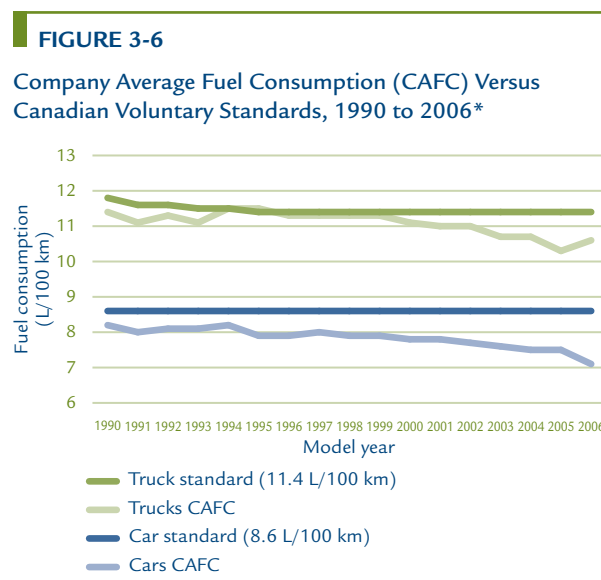
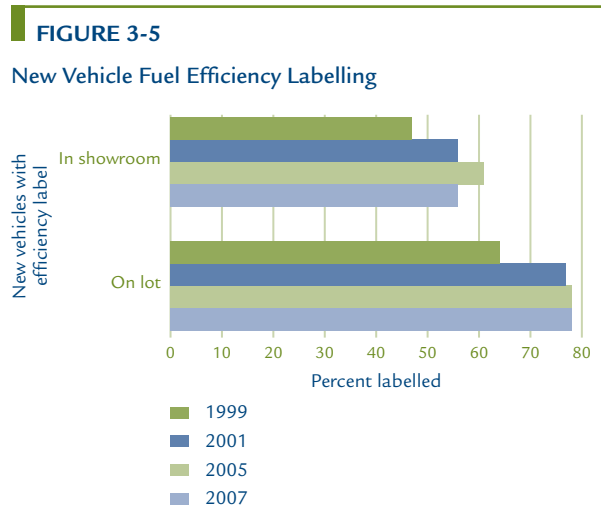
Targets

Estimates indicate that by 2011, this program will result in energy savings of between 4 and 17 PJ. At present, these energy savings convert to annual emissions reductions of between 0.4 and 1.7 Mt of GHGs and related CAC emissions.

Key 2007–2008 Achievements

- Delivered Dollars to \$ense energy management workshops for 1290 industrial participants.
- Initiated six studies on process integration, computational fluid dynamics, combustion and energy performance contracting.

- the 2005 MOU between the Government of Canada and the Canadian auto industry, which provides a framework for auto makers to produce more fuel-efficient and lower-GHG-emission vehicles by 2010 (see Figure 3-6)
- the annual ecoENERGY for Vehicles Awards, which recognize, and identify for consumers, the most fuel-efficient light-duty vehicles in their classes sold in Canada
- the Auto\$mart driver education series, which teaches drivers how to drive safely, save money and protect the environment by using fuel-efficient driving techniques
- idle-free and tire maintenance campaigns, which, through the use of educational materials and outreach activities, encourage drivers to embrace fuel-efficient practices



* 2002–2006 data are estimates.

Targets

Estimates indicate that by 2011, this program will result in energy savings of between 50.5 and 75.2 PJ. At present, these energy savings convert to annual emissions reductions of between 4.8 and 5.4 Mt of GHGs and related CAC emissions.

Key 2007–2008 Achievements

- Distributed over 350 000 copies of the *Fuel Consumption Guide*, including 186 000 to 3386 new car dealerships and 53 000 to Canadian Automobile Association offices.
- Trained 350 000 drivers in fuel-efficient driving practices.
- Reached over 5 million Canadians through exhibits and other marketing activities.

For more information:

vehicles.gc.ca

ecoENERGY FOR FLEETS

Objective

To achieve reductions in fuel use and related costs, air contaminants and GHG emissions through a wide range of measures targeting operators and managers of Canada's commercial and institutional road vehicle fleets.

Description

The ecoENERGY for Fleets program promotes the adoption of existing and emerging new technologies, such as energy-efficient vehicle components and hybrid technologies, and best practices, such as fuel management techniques, in the commercial/institutional road transportation sector.

ecoENERGY for Fleets is aimed at the commercial/institutional fleet transportation sector and provides information, workshops, technical demonstrations and training programs on fuel-efficient practices for fleet vehicles. Program components include the following:

- the “Idle-Free Quiet Zone” campaign, which uses educational materials and incentives to encourage truck drivers to turn off their vehicles at truck stops
- Fuel Management 101 workshops, which assist fleet managers with the preparation, implementation and monitoring of a fuel management plan
- SmartDriver training programs, which offer knowledge sharing and on-the-road instruction to drivers of various types of fleets for the purpose of reducing fuel consumption

Targets

Estimates indicate that by 2011, this program will result in energy savings of between 6.87 and 10.84 PJ. At present, these energy savings convert to annual emissions reductions of between 0.5 and 0.7 Mt of GHGs and related CAC emissions.

Key 2007–2008 Achievements

- Registered 62 truck stops across Canada under the “Idle-Free Quiet Zone” campaign.
- Developed new bilingual materials for Fuel Management 101 workshops and conducted four workshops.
- Trained 423 school bus drivers under the SmartDriver for School Bus program.

For more information:

fleetsmart.gc.ca

ECOENERGY FOR BIOFUELS

Objective

To encourage the development of a competitive domestic industry for the production of renewable alternatives to gasoline and diesel in Canada.

Description

ecoENERGY for Biofuels will invest up to \$1.5 billion over nine years to support the production of renewable alternatives to gasoline and diesel in Canada. Announced in 2007, the initiative will make investment in production facilities more attractive by partially offsetting the risks associated with fluctuating feedstock and fuel prices. The program will provide an operating incentive to producers of renewable alternatives to gasoline, such as ethanol, and renewable alternatives to diesel, such as biodiesel, in cases where they have signed a contribution agreement with NRCan and where industry needs support to remain profitable.

ecoENERGY for Biofuels is a key component of Canada's renewable fuels strategy, which aims to

- reduce the GHG emissions resulting from fuel use
- encourage greater production of biofuels
- accelerate the commercialization of new biofuel technologies
- provide new market opportunities for agricultural producers and rural communities

Key 2007–2008 Achievements

- Program received required approvals.
- Consultations were conducted with biofuels industry stakeholders on program design to ensure program effectiveness.
- Program roll-out was completed, including Web materials, application form and contribution agreement template.

For more information:

ecoaction.gc.ca/biofuels

ETHANOL EXPANSION PROGRAM

Objective

To expand fuel ethanol production and use in Canada and reduce transportation GHG emissions.

Description

The Ethanol Expansion Program (EEP) was a \$100-million program, co-managed by NRCan and Agriculture and Agri-Food Canada, for which funding ended March 31, 2007. The program provided contributions, with repayment terms, toward the construction costs of new ethanol production facilities or the expansion of existing ones. The intermediate outcomes of the EEP are expanded ethanol production, increased consumer adoption of ethanol and more markets for ethanol fuels in Canada. Nine ethanol plant projects were allocated contributions under the EEP. The longer-term outcome is a reduction in GHG emissions from the transportation sector as ethanol replaces conventional fuels.

Key 2007–2008 Achievements

- Four new ethanol plants started production, adding approximately 313 million litres of ethanol to Canada's annual ethanol production capacity and bringing the total annual capacity to 871 million litres per year.
- Construction started on two other ethanol plants, which will add another 350 million litres per year in 2008.
- These six plants, which were allocated a total of \$63.7 million under the EEP, will reduce GHGs on a full life-cycle basis by an estimated 0.9 Mt a year.

For more information:

vehiclefuels.gc.ca

Energy Science and Technology

INTRODUCTION

Natural Resources Canada (NRCan) invests in the research, development and demonstration (R,D&D) of new and emerging energy science and technology (S&T) that produces economic, social and environmental benefits for Canadians. NRCan's Office of Energy Research and Development (OERD) and CanmetENERGY lead the federal government's energy S&T operations.

The OERD oversees the management of the Program of Energy Research and Development (PERD) and Technology and Innovation Research and Development (T&I R&D). These programs allocated over \$84 million in 2007–2008 to help find new, long-term, cleaner and more efficient solutions to reducing environmental emissions by developing and disseminating new knowledge and new technologies through R,D&D initiatives. The OERD is also implementing the \$230-million ecoENERGY Technology Initiative announced in mid-2007. About 75 percent of the programs and activities allocated funding by the OERD are managed and carried out by the Department (including CanmetENERGY).

CanmetENERGY generates and provides knowledge and technologies to advance the development and use of innovative solutions contributing to the well-being of Canadians and to progress toward meeting Canada's economic, social and environmental policy objectives. It works with industry, academia, utilities, associations, nongovernmental organizations and other governments to develop and demonstrate energy-efficient, alternative and renewable energy technologies and processes. It undertakes projects and activities in the following areas of expertise:

- clean energy systems for buildings and communities
- clean electric power generation
- clean energy systems for industry
- clean transportation energy
- environmentally sustainable oil and gas development
- bioenergy

This chapter describes in detail the programs, activities and 2007–2008 key achievements of the OERD, CanmetENERGY and other partners in energy S&T.

PROGRAM OF ENERGY RESEARCH AND DEVELOPMENT

Objective

To fund research and development (R&D) designed to ensure a sustainable energy future for Canada in the best interests of our economy and our environment.

Description

PERD's budget for 2007–2008 was approximately \$56.6 million. NRCan allocated \$42.6 million to energy R&D programs managed and carried out in the Department, more than 50 percent of which contributed to improved energy efficiency and the integration of renewable energy sources in Canada. The remaining \$13 million was allocated to 12 federal departments and agencies that are PERD partners.

Efficiencies are sought in energy production, distribution and end-use. Production encompasses fossil fuels and alternative sources, including biomass. Examples of funded projects are outlined in the remainder of this chapter.

During 2007–2008, based on recommendations of an advisory panel and as mandated in the 2005 Budget, the management of energy S&T delivery was reorganized into a streamlined set of portfolios encompassing the whole innovation chain, from basic research to applied research, pilot plants and demonstrations, thereby ensuring faster market access to technologies developed with federal funds.

For more information:

nrcan.gc.ca/eneene/science/perdprde-eng.php

TECHNOLOGY AND INNOVATION RESEARCH AND DEVELOPMENT

Objective

To advance promising greenhouse gas (GHG) reduction technologies through R&D, promote demonstration and early adoption initiatives to achieve long-term GHG reductions, and strengthen Canada's technology capacity.

Implemented in 2003 with \$115 million in federal funding over five years, T&I R&D is based on long-term strategic planning that takes into account expected energy futures and visions to 2025. R&D is conducted in the strategic areas of advanced end-use efficiency technologies in buildings, transportation, industry, decentralized energy production (including renewables), biotechnology, the hydrogen economy, and cleaner fossil fuels (e.g. searching for efficiencies in bitumen and heavy oil, unconventional gas supply, and clean coal and carbon capture). An expenditure review reduced funding to \$109 million.

The T&I R&D budget for 2007–2008 was \$28 million. NRCan allocated \$20.7 million to energy R&D programs managed and carried out in the department. Key NRCan R&D achievements contributing to improved energy efficiency in Canada are included in the programs described in this chapter. The remaining \$7.3 million was allocated to seven federal departments that are T&I R&D partners.

A result achieved through investment in renewable energy over many years (through PERD and T&I R&D funding) prompted Iogen Corporation, an Ottawa producer of industrial enzymes, to build the first commercial plant in Canada to convert waste biomass like straw into cellulosic ethanol fuel. Using waste biomass feedstocks has the potential for life-cycle GHG emissions reductions of 80 percent compared with gasoline, and biomass feedstocks offer the added advantage of costing less than grain. NRCan estimates that ethanol produced with Iogen's technology could generate GHG reductions about twice as large as the amounts achievable with conventional grain-based ethanol.

ecoENERGY TECHNOLOGY INITIATIVE

The ecoENERGY Technology Initiative is a \$230-million federal government investment in S&T to accelerate the development and market readiness of clean energy technology solutions. The Initiative is a component of ecoACTION, the suite of government actions targeting clean air and GHG emissions reductions. It will help in the search for long-term solutions to reduce and eliminate air pollutants from energy production and use. The Initiative aims at eight high-priority technology areas, is based on extensive consultation with stakeholder groups and promotes public-private collaboration.

Energy Technology Priority Areas

The Initiative is directed toward increasing clean energy supplies, reducing energy waste and reducing pollution from conventional energy. In this context, its eight priority technology areas are as follows:

- cleaner fossil fuels – focusing on the environmental aspects of oil sands development
- clean coal and carbon capture and storage
- distributed electricity generation from renewable energy and other clean energy sources
- next-generation nuclear energy technologies
- bio-based energy systems
- low-emissions industrial systems
- clean transportation systems
- built environment – focusing on the integration of renewable energy technologies in buildings and community systems

NRCan identified these priorities by consulting stakeholders, including the National Advisory Panel on Sustainable Energy Science and Technology, the Energy Technology Working Group of the Council of Energy Ministers, the National Round Table on the Environment and the Economy, and the Canadian Academy of Engineering.

The ecoENERGY Technology Initiative focuses heavily on private-public collaborative arrangements. The Initiative will be delivered primarily through the following:

- responses to NRCan calls for competitive, theme-based project proposals from the national energy S&T community
- federal laboratories, to continue and establish clean energy research in the eight priority areas of the Initiative

CLEAN ENERGY SYSTEMS FOR BUILDINGS AND COMMUNITIES

Objectives

To develop, demonstrate and promote – in domestic and foreign markets – technologies, practical decision-making tools, processes, codes, standards and best practices that help communities select more efficient and cost-effective energy, waste and water technologies and design solutions to support a sustainable energy future based on reduced energy consumption and GHG emissions.

Description

CanmetENERGY plays a leadership role in the R,D&D of energy-efficient and renewable energy technologies for houses, buildings and communities by

- fostering the commercialization of new technologies
- identifying and developing opportunities for integration of technologies
- developing infrastructure to support innovation, such as codes, policies and standards
- developing linkages between utilities, industry and academia
- supporting training and education
- disseminating results and findings
- facilitating the export of Canadian technologies to international markets
- engaging in international co-operation

Specific work includes the development of design, modelling and analysis tools and integrated design approaches, such as building energy simulation software making it possible to achieve greater energy efficiency to be implemented at minimal incremental costs. CanmetENERGY develops, distributes and supports building energy simulation software for the Canadian construction industry and Government of Canada ecoACTION programs.

CanmetENERGY is active in the R,D&D of energy-efficient heating, ventilation, air-conditioning and refrigeration technologies, including standards, efficiency labelling, heat recovery systems, integration of technologies and adaptation to the Canadian context. CanmetENERGY assists in increasing the use of solar thermal and solar photovoltaic energy technologies in Canada by developing technologies, standards, policies and programs to create a Canadian-based, globally competitive solar industry. Other work includes community energy systems, daylighting, intelligent building controls and recommissioning of buildings.

CanmetENERGY's partnerships with industry help to build advanced residential and commercial buildings that incorporate a wide array of innovative technologies and consume significantly less energy than their conventional counterparts. Under cost-sharing arrangements to accelerate the development and commercialization of a new generation of advanced and energy-efficient technologies, CanmetENERGY is helping the Canadian residential and commercial building industry produce some of the most environmentally advanced structures on the planet.

Key 2007–2008 Achievements

- CanmetENERGY is helping to update the *Model National Energy Code for Buildings*, the revised version of which will be released in 2012. In 2007–2008, the Standing Committee on Energy Efficiency in Buildings was formed, as were five task groups. CanmetENERGY is a member of the Task Group on Building Envelope and the Task Group on Building Energy Performance Compliance. A scoping exercise for each task group was undertaken, and funding has been put in place.

- CanmetENERGY increased the number of users of the RETScreen^{®8} Clean Energy Project Analysis Software to more than 147 000 people in 222 countries, adding an average of 1000 new users every week. More than 160 colleges and universities worldwide are now using RETScreen for education. As well, CanmetENERGY launched a major new version of the RETScreen software, including a suite of new models to evaluate energy efficiency measures for residential, commercial and institutional buildings; communities; and industrial facilities and processes.
- CanmetENERGY facilitated the successful technology transfer and demonstration of a combined photovoltaic and solar thermal hybrid technology with the Solar Buildings Research Network, headquartered at Concordia University. The Network developed and implemented a strategy to effectively transfer this knowledge to architects, manufacturers, home builders and utilities.
- CanmetENERGY and Doug Tarry Homes Ltd. piloted the Solar Ready homes project, which required the builder to incorporate defined criteria into its construction designs and practices in order to accommodate solar hot-water technology.
- CanmetENERGY is facilitating the integrated design process, a new approach to designing, to enable a new laboratory to relocate NRCan employees to McMaster University in Hamilton, Ontario. The objective is to achieve the highest levels of energy efficiency, reduce energy bills and minimize the use of program funding for building operations.
- CanmetENERGY continues to see the benefits of its work with industry leaders in heating refrigeration systems. CIMCO Refrigeration developed its ECO CHILL[®] system with NRCan technical support and expertise and has been selected to provide all refrigeration systems where heating and refrigeration are required at the Vancouver Olympic games.

⁸ RETScreen is a registered trademark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

- Ice Kube Systems Ltd. (IKS) has signed an agreement to demonstrate the application of IKS modular refrigeration/heat-pump units integrated with underground thermal energy storage for district energy. This integrated system will supply 240 tonnes of refrigeration to a multi-pad indoor arena and ensure the recovery and re-use of almost 100 percent of the heat rejected by the refrigeration process.
- CanmetENERGY developed a Canadian Advanced Recommissioning (RCx) course and delivered two workshops in collaboration with NRCan's Office of Energy Efficiency, BC Hydro and Union Gas Limited. The RCx course is part of CanmetENERGY's commitment to develop RCx training programs, guidelines and tools to help create awareness and promote best practices that reduce energy consumption and improve the performance of building systems.
- CanmetENERGY developed the Sustainable Urban Neighbourhood (SUN) process, which was piloted during the design of the mixed-use Emerald Hills Urban Village in Strathcona County, Alberta. SUN offers an approach for translating broader concepts of sustainable development and living, including energy efficiency, alternative energy and reduced water use, into applications at the neighbourhood level.
- CanmetENERGY develops and supports building simulation software for the Canadian housing industry. Last year, its HOT2000⁹ software was used to run simulations for energy efficiency upgrades on 106 701 Canadian houses, bringing the total to date to 386 307.

For more information:

canmetenergy.nrcan.gc.ca/eng/buildings_communities.html

⁹ HOT2000 is an official mark of Natural Resources Canada.

CLEAN ELECTRIC POWER GENERATION

Objective

To develop and apply technologies for renewable electricity production and for cleaner power generation from fossil fuels, with the goal of increasing efficiency and achieving the reduction and, ultimately, the elimination of emissions of acid rain precursors, GHGs, particulates and identified priority substances, such as mercury, trace elements and organic compounds.

Description

CanmetENERGY's work on clean electric power generation focuses on improving the economics and efficiency of renewable energy technologies, including wind energy, solar power, small and low-head hydro, marine energy and energy storage. CanmetENERGY's R&D supports the growth of the renewable energy industry in Canada by

- fostering the development of new technologies
- identifying and developing opportunities for the integration of renewables
- developing infrastructure to support innovation, such as codes, policies and standards
- developing linkages between utilities, industry and academia
- conducting resource assessments

CanmetENERGY also focuses on improving the performance of, and reducing emissions from, existing fossil fuel power plants. Moreover, it focuses on developing new advanced cycles for the conversion of fossil fuels to electricity with complete or near-complete capture and elimination of CO₂ and other emissions. Additional research includes work on issues associated with the transport and storage of CO₂. Through advanced tools and technologies, CanmetENERGY assists major industrial energy consumers in reducing the energy intensity of their operations and in reducing GHG emissions and emissions of other air pollutants, while enhancing competitiveness and profitability.

CanmetENERGY's work on emerging technologies in clean power includes new forms of power generation, such as wind, small hydro, natural gas combined-cycle plants and advanced fluidized bed combustion. Significant R&D also focuses on CO₂-neutral combustion systems, CO₂ sequestration, CO₂ injection for enhanced oil recovery, advanced power generation cycles, clean coal technologies and distributed energy resources. CanmetENERGY also conducts leading-edge work in the burgeoning priority area of decentralized energy resources, where renewable energy sources are becoming more localized and integrated into the main grid.

CanmetENERGY addresses the technical, institutional and regulatory barriers to clean power by promoting grid integration, developing standards, generating knowledge and transferring important information to Canadian decision-makers. CanmetENERGY provides stakeholders with the necessary information to make informed decisions, coordinates various research projects, participates in international committees that establish standards and codes, develops and hosts workshops and conferences, develops publications and produces training tools. CanmetENERGY capitalizes on its sector expertise by carrying out projects in collaboration with key research consortia, including industry, universities, research groups, public services and other departments and governments.

Key 2007–2008 Achievements

- Advanced distributed generation models generated with the CYMDIST software were released, along with case studies. These models and case studies form the basis of tutorial material for utility engineers to improve their knowledge of renewable and distributed generation applications.
- Working with Electric Utility Consultants, Inc. (now called EUCI) and Canadian stakeholders, CanmetENERGY organized a national conference to discuss strategic and tactical issues in implementing a “smart grid” network in Canada. The smart grid serves an important role in facilitating energy efficiency programs and integrating renewable and distributed energy resources.

- CanmetENERGY was instrumental in establishing the International Electrotechnical Commission (IEC) Technical Committee 114 on Marine Energy. CanmetENERGY is chairing this 15-member committee, which will develop international standards. At the same time, CanmetENERGY, working with the Standards Council of Canada, established a mirror committee that will advise on the IEC standards development process to ensure that international standards reflect the development needs of a rapidly growing marine energy industry in Canada.
- Working with Agriculture and Agri-Food Canada and more than 20 agricultural and energy organizations across Canada, CanmetENERGY launched the Integration of Renewable Energy on Farms Web site. The site is a repository of technical information and online tools for analysing the potential for integrating renewable energy sources into individual farms. CanmetENERGY's expertise was used to develop, screen, validate and consolidate the best information available.
- After carrying out preliminary laboratory studies, CanmetENERGY installed an advanced 6-kilowatt (kW) micro-cogeneration system, coupled to a three-borehole heat storage system and heat pumps, at the Canadian Centre for Housing Technology (CCHT). The system demonstrated the capacity to supply all the heat and electrical energy required by CCHT and to return electrical energy to the grid at nearly three times the overall efficiency of a central power plant.

For more information:

canmetenergy.nrcan.gc.ca/eng/clean_fossils_fuels.html

CLEAN ENERGY SYSTEMS FOR INDUSTRY

Objective

To identify, encourage and support the development and application of leading-edge, energy-efficient and environmentally responsible processes, practices, products, systems and equipment in Canadian industry to improve its energy efficiency, productivity, competitiveness and profitability, while reducing GHG emissions and other environmental impacts.

Description

CanmetENERGY works with industry to co-manage and share the costs of development and commercialization of a range of technologies, including process integration, learning-based expert systems, combustion systems and controls, manufacturing processes, and environmentally friendly and energy-efficient processes for energy-intensive industries. CanmetENERGY's R&D in the industry sector focuses on plant-wide industrial process analysis techniques and advanced process control systems that identify and correct inefficiencies in plant operation and design while taking into account energy, economic and environmental aspects.

CanmetENERGY's R&D also includes the development and testing of semi-pilot-scale plants, pilot plants, prototypes and full-scale field trials. This research evaluates operating performance, energy efficiency and environmental impacts and emerging concepts in chemical and energy conversion, including hydrogen production from hydrocarbon and renewable sources. In addition, CanmetENERGY disseminates technical information to encourage adoption of these techniques and practices in targeted energy-intensive sectors of Canadian industry.

CanmetENERGY clients are from a variety of industries, including pulp and paper, gas, oil upgrading and refining, petrochemicals, engine manufacturing, steel, chemicals, food and drink, solid wood, waste oil recycling and rendering, and specialty ceramic manufacturing. Its other clients are gas and electric utilities, equipment manufacturers and other governments.

Key 2007–2008 Achievements

- CanmetENERGY scientists and research engineers recently completed an important case study of Tembec Inc.'s Skookumchuck pulp mill in southeastern British Columbia. The study points the way to significant reductions in freshwater demands, effluent levels and energy consumption. Although the Skookumchuck mill is already one of the most water- and energy-efficient mills in Canada, the team found room for reductions of up to 20 percent in freshwater demand and the potential to increase the mill's power generation for export by approximately 4 megawatts. CanmetENERGY is developing software tools to capture the team's findings so water-intensive processes can be optimized throughout the pulp and paper industry.
- In co-operation with CANMET Mining and Mineral Sciences Laboratories (MMSL), the CANMET-MMSL Experimental Mine in Val-d'Or, Quebec, and Mining Technologies International Inc., CanmetENERGY is developing an energy-efficient diesel/electric hybrid scoop tram for mining operations. A prototype has been built and will undergo field testing shortly. The projected potential benefits over 10 years include more than 170 000 barrels of oil equivalent (BOE) in energy savings and almost 60 kilotonnes (kt) of CO₂ emissions reduction. Another environmental benefit is lower emissions of particulate matter through the displacement of small diesel engine use.
- In co-operation with the Natural Sciences and Engineering Research Council of Canada (NSERC), Hydro-Québec, Rio Tinto Alcan and the Université de Sherbrooke, CanmetENERGY launched the NSERC Chair in Industrial Energy Efficiency. The projects and prototypes that are developed will be relevant to many areas of activity and primarily target industrial applications.

- CanmetENERGY is working with Hatch of Mississauga, Ontario, to develop a continuous reduced iron and steelmaking process that improves energy efficiency, reduces costs and enhances competitiveness. The process could save over 60 terajoules (TJ), or 10 000 BOE, per year and lower emissions by 50 kt per installation.
- With CanmetENERGY support, Murox of Boucherville, Quebec, is developing an energy-efficient wall for the commercial, industrial and institutional construction markets. Once commercialized, the projected potential impacts of the wall over 10 years will be energy savings of 685 TJ (112 000 BOE) and CO₂ emissions reductions of 48 kt.
- CanmetENERGY is working with EMPCO (Canada) Ltd. of Whitby, Ontario, on a new slag door for electric arc furnace steelmaking applications. Making the door airtight will ensure that less air infiltrates the furnace chamber, yielding a more energy-efficient process. Over the next 10 years, energy savings could amount to over 3.4 PJ (550 000 BOE), and CO₂ emissions could be reduced by 2 megatonnes.
- CanmetENERGY is working with Airex Industries of Montréal to develop equipment for the recovery and use of waste heat. Adopters of this technology could save 5 PJ (865 000 BOE) and reduce CO₂ emissions by 260 kt.

For more information:

canmetenergy.nrcan.gc.ca/eng/industrial_processes.html

ENVIRONMENTALLY SUSTAINABLE OIL AND GAS DEVELOPMENT

Objective

To provide S&T for the continued, secure supply of affordable and cleaner fossil fuels, with little or no adverse environmental impact on GHG and Criteria Air Contaminants (CAC) emissions, and thereby help resolve oil sands environmental (including water) issues and clean air issues for the upstream oil and gas industry.

Description

CanmetENERGY conducts fundamental and applied research to develop knowledge and implement leading-edge technologies for the oil sands sector. Knowledge gained is used to inform energy policy development and industry decisions that will improve the quality of life for Canadians.

CanmetENERGY fosters innovation in oil sands and heavy oil technology through activities ranging from fundamental science to commercial-scale technical support. CanmetENERGY's strength lies in its staff's fundamental understanding of the chemistry, physics and engineering of oil sands and heavy oil processes, coupled with sophisticated analytical instrumentation and pilot-scale units providing proof of concept for technologies.

S&T is one tool used by NRCan to make significant progress toward meeting its water and tailings, GHG and other air emissions challenges in the oil and gas sector. Major improvements need to be made in the entire process chain of oil sands and heavy oil development, from the initial extraction to the production of petroleum products. CanmetENERGY's international client base and partnerships with provincial and territorial governments, industry and academia ensure that the best available technologies in the world can be modified and applied to the resource. Its partnerships also ensure there are synergies and fast-track deployment of new technologies, innovations and knowledge dissemination.

Key 2007–2008 Achievements

- CanmetENERGY worked on fundamental clay-water chemistry interactions. This is important for defining the consolidated tailings (CT) “recipe.” From this fundamental work, a variety of CT chemicals were evaluated, including CO₂. A major project was undertaken on a key requirement for commercialization – the direct sequestration of CO₂ from surface-mined oil sands. The project has identified additional alternative chemicals for the dry stackable tailings activity.
- CanmetENERGY conducted research to gain an understanding of the impact of bitumen chemistry on extraction processes (through interactions with clays). Some of the work involved collaboration with Environment Canada and led to several publications. As a result of the fundamental knowledge acquired concerning the importance of bitumen chemistry in extraction processes, a small project with Titanium Corporation Inc. was launched. In this project, bitumen and naphtha would be removed from the valuable mineral component in froth treatment tailings. This prompted the Government of Alberta to contribute \$3.5 million for investigating and commercializing some bitumen and naphtha removal technologies.
- Suncor Energy Inc.’s water chemistry model underwent significant reworking to incorporate it in the company’s new mine plans. CanmetENERGY also completed a study on the fate of naphthenic acids in oil sands related systems. Initial results indicated that clean clays do not provide a sink as hypothesized but organics do provide a sink.
- A comprehensive client-funded project was just completed using CanmetENERGY’s pilot plants, distillation unit, coker, hydrotreater and advanced cracking evaluation unit. CanmetENERGY worked with British Petroleum to simulate the optimal processing scheme for upgrading and refining Canadian bitumen. Their aim was to produce clean transportation fuels, while minimizing energy consumption

during the process and removing sulphur to meet stringent ultra-low sulphur contents in fuels. Such conversions by industry are necessary to meet the proposed increases in bitumen production from Alberta.

- The CANMET Hydrocracking Process is designed to process highly aromatic feeds such as bitumen, resulting in 100 percent conversion of the feed with no waste by-products. It was developed in co-operation with Petro-Canada, which built and operated a 5000-barrels-per-day demonstration facility in Montréal. CanmetENERGY scientists are also working with Universal Oil Products (UOP) to provide pilot-plant testing, consultation and analysis of historical and new data. This resulted in UOP signing a licensing agreement and a \$1.4-million contract with NRCAN for pilot-plant support while UOP builds its own pilot plant.

For more information:

canmetenergy.nrcan.gc.ca/eng/oil_sands.html

CLEAN TRANSPORTATION ENERGY

Objective

To develop and deploy, in partnership with industry, academia and the provinces and territories, leading-edge hydrogen, fuel cell and transportation technologies that reduce GHG emissions and minimize urban air pollution.

Description

CanmetENERGY works with stakeholders in the domestic and international hydrogen and transportation technology industries. These industries include original equipment manufacturers, industry associations, fleet managers, transit authorities, utilities, provincial and territorial governments, research organizations, universities, other federal departments, the U.S. Department of Energy and the International Energy Agency. Together they develop and deploy innovative cleaner transportation technologies and alternative fuels.

R&D partnerships advance the development and deployment of innovative technologies, standards and infrastructure development, propulsion systems, engine controls, and energy and fuel storage systems. CanmetENERGY has worked with Canadian industry for more than 20 years to establish Canada as a world leader in fuel cell and hydrogen-refuelling technologies. It has supported student vehicle challenges since the 1980s. These challenges bring university and college students from across North America and automotive manufacturers together for the purpose of modifying existing vehicles so they can run on a variety of alternative fuels. CanmetENERGY supports the development of alternative transportation fuel technologies, such as those for natural gas, biodiesel and ethanol vehicles, to strengthen a Canadian industry that is now exporting commercial products.

CanmetENERGY managed the Canadian Transportation Fuel Cell Alliance, a private- and public-sector initiative aimed at developing the infrastructure needed to deploy hydrogen-fuelled vehicles. It also evaluated options for the production and delivery of hydrogen for light-, medium- and heavy-duty vehicles and monitored the resulting GHG reductions. Moreover, it developed training, certification and safety standards in support of hydrogen and fuel cell technologies. Fiscal 2007–2008 was the final year of the program.

Key 2007–2008 Achievements

Research and Development

- Optimized the material composition and fabrication process for hydrogen storage for use in micro fuel cell applications. An early application for this technology may be to replace batteries in cell phones with hydrogen fuel cells that can recharge in five minutes and run twice as long as a standard cell phone.
- Developed a high-density compact rechargeable battery system for electric vehicles that shortens charge time, increases vehicle range and improves safety. This 0.5-kWh lithium-ion battery module will serve as the building block for plug-in hybrid electric vehicles.

- Completed the modelling, detailing and optimization of a gasification process for large-scale hydrogen production for potential use in Canada's oil sands. This process is based on the iron-to-iron oxide cycle and provides for sequestration of a separate CO₂ stream.

Demonstration

- Established a hydrogen-fuelling station in Prince Edward Island, which is fuelling two Ford hydrogen internal combustion engine shuttle buses. The hydrogen is produced from wind power at North Cape and demonstrates the utilization of renewable energy in the transportation sector.
- Four stationary fuelling stations and one mobile fuelling station are operating in British Columbia as part of the Hydrogen Highway™. The five Ford Focus fuel-cell cars successfully completed their third year of on-road testing and evaluation in the Vancouver and Victoria areas, accumulating 186 000 kilometres of use.
- A hydrogen-fuelled airport tugger is being operated by Air Canada in a demonstration project underway at Vancouver International Airport.
- Commissioned a self-serve, fast-fill hydrogen-fuelling station using waste hydrogen in North Vancouver. The project serves to increase Canadian capacity for capturing and purifying industrial waste hydrogen. Canada is the world's largest hydrogen producer per capita, and waste hydrogen has significant potential to become an important Canadian resource.

For more information:

canmetenergy.nrcan.gc.ca/eng/transportation.html

SUSTAINABLE BIOENERGY

Objective

To assist Canadian industry in the R,D&D of bioenergy technologies, thereby increasing the production and use of bioenergy, which generates environmental and economic benefits.

Description

CanmetENERGY supports the R,D&D of bioenergy technology through cost-shared agreements, promotes bioenergy as a renewable and sustainable energy source, advocates the need for proper policies and programs relating to bioenergy, and raises the public's and policy makers' awareness of the benefits of bioenergy.

CanmetENERGY's biomass energy conversion technology expertise covers the following main processes:

- combustion – converting forestry, agricultural and municipal residues into heat and power under environmentally sound conditions
- gasification – converting forestry, agricultural and municipal residues into syngas
- pyrolysis – converting forestry and agricultural residues into bio-oils and value-added products
- fermentation – converting the starch and cellulose components in biomass into bio-ethanol
- transesterification – converting a variety of new and used vegetable oils, tallow and yellow grease into bio-diesel
- anaerobic digestion – converting manures and food-processing and municipal wastes into methane-rich biogas

Activities focus on improving the reliability and lowering the cost of technologies, disseminating information on technology feasibility and economics to potential users, and helping industry demonstrate its products in domestic and foreign markets.

Initiatives include R,D&D, technical and socio-economic studies, end-use demonstrations and testing, feasibility studies, process analysis, verification, testing and improvement, standards development, emissions reductions, modelling, conference and workshop

support, information dissemination, International Energy Agency collaboration and committees, stakeholder education, and standards development.

CanmetENERGY plays a leadership role in the Canadian Biomass Innovation Network, a multi-departmental working group formed to direct federal R&D on bioenergy and bioproducts. Clients include the agricultural and forestry sectors (biomass producers and bioenergy consumers), municipalities and industrial partners. (For more information, see “Canadian Biomass Innovation Network,” in the next section.)

Key 2007–2008 Achievements

- With CanmetENERGY support, Powerbase Energy Systems Inc. recently built 3175-kW combined heat and power containerized units to be demonstrated on working farms in eastern Ontario. These units are fully automated. They include biogas and anaerobic digester management controls, heat exchangers for farm heat supply, the electronic controls needed to sell electricity to the grid, and safety equipment.
- CanmetENERGY provided R,D&D support and laboratory expertise to Enerkem Inc. for the development of a thermochemical process producing cellulose-based ethanol. The process involves the gasification of biomass to syngas and the subsequent catalytic conversion of syngas to methanol and, finally, to ethanol. The company has taken the technology from lab scale to pilot scale at its Sherbrooke, Quebec, facility. Now it is building a large-scale demonstration unit in nearby Westbury, Quebec.
- CanmetENERGY worked with Vaperma Inc., an advanced gas separation company, to develop the Siftek™ membrane. The membrane can separate ethanol-water mixtures over a wide range of water concentrations, ultimately producing fuel-grade ethanol. Vaperma is working on a second-generation membrane that could be used for cellulosic ethanol.
- CanmetENERGY's support of R,D&D activities with Nexterra Energy Corp. contributed to recent successes. The first was the sale of a multi-million-dollar biomass gasification system to Dockside

Green Power Limited. Another success was the strategic alliance formed with Johnson Controls, Inc., a global leader in facility management and control. Nexterra's biomass gasification solutions were offered to Johnson Controls customers in such sectors as higher education, health care, government facilities and industrial operations. Nexterra recently won the prestigious GLOBE Award for Technology Innovation and Application for outstanding achievement in environmental stewardship.

For more information:

canmetenergy.nrcan.gc.ca/eng/bioenergy.html

CANADIAN BIOMASS INNOVATION NETWORK

Objective

To develop sustainable and cost-effective technologies in bioenergy, biofuels, bioproducts and industrial bioprocesses for market acceptance while utilizing biomass resources in a sustainable and responsible way.

Description

The Canadian Biomass Innovation Network (CBIN) supports strategic R&D in bioenergy, biofuels, bioproducts and industrial bioprocesses to reduce fossil fuel energy consumption, directly or indirectly reduce GHG and CAC emissions, diversify the energy supply and seed the development of Canada's bio-based economy.

CBIN is a horizontal program developed and managed by five departments: Agriculture and Agri-Food Canada, Environment Canada, Industry Canada, the National Research Council and NRCan. CBIN coordinates and manages two federal government bio-based R&D initiatives:

- the PERD Bio-Based Energy Systems and Technologies program (\$3.3 million in 2007–2008)
- the biotechnology R&D component of the Technology and Innovation Initiative (\$5.8 million in 2007–2008)

Key 2007–2008 Achievements

- Developed an environmental assessment framework with environmental criteria validated under Canadian conditions for the placement of cellulosic bioethanol facilities. The data generated were considered critical to developing key elements of the architecture for the Renewable Fuels Strategy and subsequent research strategy. The data were used by Agriculture and Agri-Food Canada's ecoAgriculture Biofuels Capital Initiative, U.S. federal government agencies, four provinces (British Columbia, Alberta, Saskatchewan, Ontario) and 33 U.S. states for assisting in the optimal location of biofuels production and conversion facilities.
- Created a comprehensive inventory of sustainable sources of woody and crop residue biomass that is incorporated in the Biomass Inventory Mapping and Analysis Tool (BIMAT). The inventory identifies, at source, herbaceous and woody biomass feedstock availability, preliminary estimates of costs to recover and the type or characterization of feedstock and then represents the information as a map. BIMAT development has generated substantial interest in Canada, Europe and the United States. Demonstrations of the BIMAT are in the planning stage.
- Evaluated the replacement of natural gas with biomass-derived fuels for kiln-heating and power boiler applications to reduce energy requirements and GHG emissions. The use of biomass-derived fuels in lime kilns would introduce pulp and paper mills to conversion technologies, such as gasification and pyrolysis. This use would facilitate the conversion of biomass into value-added bioproducts, including ethanol, biodiesel and speciality chemicals, and set the stage for conversion of pulp mills into bio-refineries. Preliminary results indicate a potential for replacing more than 50 percent of natural gas with syngas, with minimal effects to regular lime kiln operations.

For more information:

cbin.gc.ca

Renewable Energy

RENEWABLE ENERGY USE

In 2006, renewable sources accounted for approximately 61 percent of Canadian installed electricity capacity (see Table 5-1). Most of the renewable energy used in Canada comes from either hydroelectricity or thermal energy from biomass, such as wood-waste sources (see Table 5-2).

TABLE 5-1

Electricity Generation Capacity From Renewable Sources (includes hydroelectricity)

Year	Renewable electricity generation capacity (megawatts)	Total capacity (percent)
1990	59 557	58
1991	61 116	58
1992	62 895	58
1993	63 114	56
1994	63 175	56
1995	66 542	57
1996	67 101	59
1997	68 202	61
1998	68 340	62
1999	68 614	62
2000	69 031	62
2001	68 845	61
2002	71 032	62
2003	72 275	62
2004	72 947	60
2005	74 368	61
2006	75 812	61

Source: Statistics Canada, *Electric Power Generating Stations* (Cat. No. 57-206-XIB).

TABLE 5-2

Renewable Energy Markets and Technologies Used in Canada

<i>Electricity</i>	<i>Thermal Energy</i>
Hydroelectricity	Biomass (e.g. roundwood, pellets, wood chips)
Tidal	Ground-source heat pumps (e.g. earth energy)
Biomass (e.g. wood waste)	Solar air-heating systems
Biogas (e.g. methane from landfill sites)	Solar hot water systems
Wind	
Photovoltaic systems	
<i>Mechanical Power</i>	<i>Transportation</i>
Wind water pumps	Biodiesel
	Ethanol from biomass

Hydroelectricity

Hydroelectricity is a renewable form of electricity generated from a system or technology that uses a mechanical method to capture and convert the potential energy of water.

Hydro is the main source of electricity in Canada, accounting for approximately 60 percent of the electricity generated in 2005. Canada's hydro supply is dominated by large-scale projects that were developed by electric utilities. Of the 72 661 megawatts (MW) of installed hydro capacity, 3421 MW come from small hydro sites (capacity less than 50 MW), equal to about 2.8 percent of Canada's total installed electricity capacity. Significant potential remains for additional hydroelectric development in most provinces and territories.

Biomass

Bioenergy is a renewable source of energy derived from the conversion of matter from living organisms or metabolic by-products. Canada has an abundant supply of many types of biomass, which is important for the production of energy, biofuels, materials and chemicals. The two largest sources of biomass supply in Canada are forestry and agricultural operations.

Biomass supply typically takes the following forms:

- forestry – mill or pulp-and-paper residues, black liquor from the pulping process, forest residue, forest management thinnings and short rotation crops
- agriculture – agricultural crops, crop residue, processing residues, algae and aquatic biomass
- other organic waste – animal waste, such as manure from feed lots, municipal solid waste and industrial wastes

Approximately 4.6 percent of Canada's energy supply comes from bioenergy. This amount of renewable bioenergy ranks second to hydro power (which generates 11.5 percent of Canada's energy). Most of the bioenergy produced is in the form of industrial process heat, electricity and residential space heating.

The pulp and paper industry is Canada's major producer and user of bioenergy. Heat and electricity produced by industry, electricity generated by independent power producers, and residential wood heat are considered commonplace in Canada's energy mix. For example, approximately 3 million Canadian households use wood for home heating. Roundwood is typically used but alternatives include wood chips and pellets. Wood for home heating is usually burned in stand-alone wood stoves, wood furnaces with hot water or forced-air systems, fireplaces with advanced combustion inserts, high-efficiency fireplaces or high-thermal-mass masonry heaters.

Biogas and landfill gas (methane-rich gases that are derived from manure, animal processing wastes, other agricultural residues and municipal waste) for energy production is just emerging. The gases contributed just over 111 MW of power in 2006.

Biomass also shows potential as a feedstock for liquid fuels. Approximately 200 million litres of fuel ethanol are produced annually in Canada from cereal grain and corn. Biodiesel is also produced in small quantities, but production is increasing. Canada has potential to increase its bioenergy production in a sustainable manner.

Earth Energy

As a result of the sun heating the surface of the planet, and because of the insulating qualities of the earth itself, the temperature 1 or 2 metres below the surface remains fairly constant – between 5°C and 10°C. This temperature is warmer than that of the air during the winter and cooler than that of the air in the summer. A ground-source heat pump takes advantage of this temperature difference by using the earth or groundwater as a source of heat in the winter and as a “sink” for heat removed from indoor air in the summer. For this reason, a ground-source heat pump is known as an earth energy system (EES).

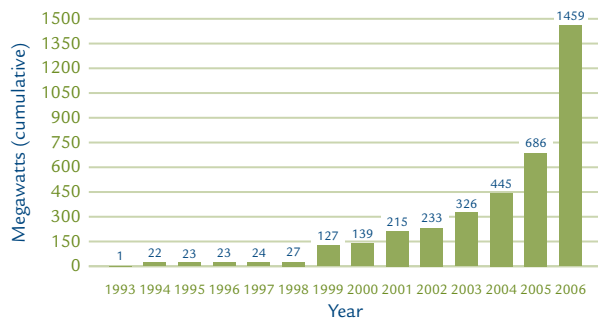
During winter, EES installations remove heat from the earth using a liquid, typically an antifreeze solution or water that circulates within an underground loop. The EES then upgrades the heat with a conventional heat pump and transfers it to indoor space or the water-heating system. During summer, the system reverses this process to operate as an air conditioner. EES installations supply less than 1 percent of the market for space and water heating and cooling in Canada.

Wind Energy

Wind turbines convert the kinetic energy of wind into electrical or mechanical energy. Canada's land mass and coastal waters combine to provide a wind resource with potential estimated at more than 100 000 MW. As of December 2006, a total of 1459 MW of wind power was installed in Canada. This amount makes Canada the thirteenth country that has reached the 1000-MW milestone and the country with the twelfth-largest installed wind energy capacity. For Canadian wind power, 2006 was a record year, with a 113 percent increase over the 2005 level (1459 MW compared with 686 MW). Recent policy developments have spurred record growth in the Canadian wind generation industry (see Figure 5-1). Wind energy currently accounts for approximately 0.6 percent of Canada's total electricity generation, up from 0.4 percent in 2005.

FIGURE 5-1

Canadian Wind Power Capacity, 1993 to 2006



Source: Canadian Wind Energy Association

Wind energy also provides mechanical power. Several thousand wind-powered water pumps are used throughout Canada, mostly in the Prairie provinces. As well, Canadians use small, residential-sized wind turbines to power cottages and remote houses.

Solar Energy

Three main technologies use energy from the sun:

- passive solar technologies – buildings are designed and located to maximize their reception of solar energy
- active solar thermal systems – solar radiation is converted into thermal energy for heating air or water in residential, commercial and industrial applications
- solar electric (photovoltaic [PV]) systems – solar radiation is used to produce electricity

The Canadian active solar thermal installed capacity in 2005 was 419 000 square metres (m²), or 290 MW_{thermal}. The domestic market increase has averaged 17 percent annually since 1998. In 2005, the solar thermal collector market in Canada was 61 500 m², compared with 53 600 m² in 2004.

The Canadian total PV installed capacity in 2006 was 20.5 MW, with a sustained domestic market growth that has averaged 22 percent annually since 1992. In 2006, the PV module market in Canada was 3.75 MW, compared with 3.68 MW in 2005.

Natural Resources Canada carries out two initiatives to increase the use of small-scale renewable energy in Canada: ecoENERGY for Renewable Power and ecoENERGY for Renewable Heat. They are outlined below.

ecoENERGY FOR RENEWABLE POWER

Objective

To encourage the production of 14.3 terawatt hours (TWh) of electricity from low-impact renewable energy sources (about 4000 MW of new capacity), such as wind, hydro, biomass, solar PV and ocean energy, between April 1, 2007, and March 31, 2011.

Description

The ecoENERGY for Renewable Power program provides an incentive of one cent per kilowatt hour to an eligible low-impact renewable energy project for up to 10 years. Eligible recipients include businesses, institutions/organizations, independent power producers, public and private utilities, and co-operatives that install qualifying renewable power systems. Qualifying projects must have a total rated capacity of 1 MW or greater.

Targets

By 2011, the program will have contributed to the annual generation of 14.3 TWh of electricity or about 4000 MW of capacity, depending on the mix of energy sources supported under the program. At present, these energy savings convert to annual emissions reductions of between 6 and 6.7 megatonnes of GHGs and related Criteria Air Contaminants (CAC) emissions.

Key 2007–2008 Achievements

- Program was launched April 1, 2007.
- 171 projects were registered, representing more than 11 000 MW of capacity.
- 12 contribution agreements were signed with proponents, representing about \$305 million in federal funding over 10 years and 948 MW of new renewable power capacity.

For more information:

ecoaction.gc.ca/ecorp

ecoENERGY FOR RENEWABLE HEAT

Objective

To increase the use of renewable energy technologies, develop thermal energy industry capacity and contribute to the reduction of harmful emissions.

Description

The ecoENERGY for Renewable Heat program supports renewable thermal technologies used for space heating and cooling and water heating, through a mix of deployment incentives, residential pilot projects and industry capacity-development funding:

- deployment incentive – providing a financial contribution to encourage the deployment of solar thermal units in the industrial, commercial and institutional sectors
- residential pilot projects – providing financial contributions to test, through collaborative ventures, various approaches to the delivery of solar water-heating projects to encourage the deployment of solar water-heating units in the residential sector
- industry capacity-development – providing financial contributions to develop technology standards, certification procedures for solar thermal technologies, human resources skills and tools for renewable thermal technologies and to provide public information on renewable thermal energy technologies

Targets

It is estimated that, by 2011, this program will result in energy savings of 0.35 petajoules. At present, these energy savings convert to annual emissions reductions of about 20 kilotonnes of GHGs and related CAC emissions.

The emissions reduction expectations are derived from assumptions regarding the displacement of fossil fuel energy used for space heating and water heating in Canada's building and housing stock, based on current energy consumption profiles. Actual emissions reductions achieved will depend on project parameters, such as the efficiency of the heating equipment in use, the type of fuel displaced, the solar thermal unit output and the thermal loads being applied to the solar units deployed.

Key 2007–2008 Achievements

- Received 369 funding applications from industrial, commercial and institutional sectors to install solar air and solar hot-water systems and signed over 200 contribution agreements with successful applicants, representing about \$6 million in federal funding.

- Developed a pilot project that will provide incentives that will result in the installation, by utilities, developers and buyers' groups, of 8000 solar water-heating systems in Canadian homes over the three remaining years of the program. It will also set the stage for the transformation of the Canadian water-heating market.
- Established a partnership with two provincial governments and renewable energy industry associations.

For more information:

ecoaction.gc.ca/heat

Co-operation

INTRODUCTION

This chapter describes Natural Resources Canada's (NRCan's) co-operation with provincial and territorial governments and internationally on efficiency and alternative energy (EAE) during the reporting period. Examples of program co-operation on specific EAE initiatives are in the "Key Achievements" sections in earlier chapters.

Municipal governments and agencies participate in NRCan's EAE measures as clients (for training workshops, as recipients of financial incentives, etc.) and as partners (e.g. in anti-idling projects). At the same time, NRCan participates in ventures led by municipal organizations, such as the Green Municipal Fund (see accompanying textbox), and by provincially and territorially regulated electricity utilities and provincially regulated natural gas utilities.

Several institutions in Canada address energy efficiency issues in broad terms, including the three data and analysis centres established by NRCan, the host universities and other partners. These centres are also sponsored by other federal departments, provincial government agencies, and various associations and energy supply utilities. Their main objectives are to facilitate access to data on energy use in the industry, transportation and building sectors; monitor the quality of data; and investigate methods of improving data collection and analysis.

There are two national consultative bodies in the area of energy efficiency: the Assistant Deputy Minister Steering Committee on Energy Efficiency (ASCEE), established under the Council of Energy Ministers; and the Office of Energy Efficiency's (OEE's) National Advisory Council on Energy Efficiency (NACEE).

Green Municipal Fund

The Government of Canada endowed the Federation of Canadian Municipalities (FCM), a non-profit organization, with \$550 million to establish the Green Municipal Fund (GMF) for the purpose of providing a long-term, sustainable source of funding for municipal governments and their partners. The GMF invests in plans, studies and projects that offer the best examples of municipal leadership in sustainable development and that can be replicated in other Canadian communities.

Under the GMF agreement, the Government of Canada (represented by NRCan and Environment Canada) participates in governance of this revolving fund, along with representatives from the public and private sectors, including municipal officials and technical experts, through a peer review committee and an advisory council. The FCM board of directors approves projects in light of the council's recommendations.

As of March 31, 2008, the GMF had approved over \$375 million for 690 plans, studies and projects with a total project value of \$2.2 billion.

ASSISTANT DEPUTY MINISTER STEERING COMMITTEE ON ENERGY EFFICIENCY

In 2004, federal, provincial and territorial energy ministers established the ASCEE and tasked it with establishing a coordinated, complementary agenda for energy efficiency in the built environment, industry and transportation sectors. The ASCEE held seven meetings in 2007–2008, with members representing the federal, provincial and territorial governments.

There are three working groups under the auspices of the ASCEE. In 2007, these groups contributed to the development of the Council of Energy Ministers' document *Moving Forward on Energy Efficiency in Canada: A Foundation for Action*.

- Formed in 2003, the Demand Side Management Working Group (DSMWG) has members representing NRCan, industry and all provinces and territories. The DSMWG has initiated studies on such subjects as demand side management potential in Canada, best practices in performance measurement, and reporting and regulatory frameworks.
- The ASCEE sponsored the formation of the Transportation Working Group on Energy Efficiency (TWGEE) in 2005. Its mandate is to assess the status and enhance the alignment of transportation energy efficiency activities across federal, provincial and territorial jurisdictions and to investigate opportunities for further collaboration and new initiatives. The TWGEE comprises government officials from federal and provincial energy and transportation departments and ministries.
- The Industry Working Group on Energy Efficiency was formed in 2006. It promotes information exchange among industrial energy end-users and authorities, agencies, utilities and jurisdictions involved in the design, development and delivery of industrial energy efficiency programming in Canada.

NATIONAL ADVISORY COUNCIL ON ENERGY EFFICIENCY

NACEE was created in April 1998 to assist the OEE as an innovative government organization by

- assessing and advising on the OEE's strategic approach to meeting federal policy objectives
- advising the OEE on its performance and business planning and reporting on progress
- considering issues related to accelerating growth in energy efficiency in the Canadian economy

NACEE membership is drawn from across Canada. It includes representatives from various levels of government, academia, economic sectors, energy utilities and advocacy groups. NACEE met three times during 2007–2008.

FEDERAL-PROVINCIAL AND FEDERAL- TERRITORIAL CO-OPERATION

Interest continues to grow in energy efficiency as a means of maximizing services based on the existing energy supply capacity in the country. In addition to general co-operation on energy efficiency, provincial and territorial governments helped to deliver tools, or employed tools provided by federal EAE programs, to reduce energy costs, address climate change, increase competitiveness, improve air quality and create economic opportunities. Coordination between the federal and provincial/territorial levels avoids duplication and ensures efficient program delivery.

All provinces and territories engage in energy efficiency activities and/or deliver energy efficiency programs in their jurisdictions. In some provinces and territories, specific organizations are mandated to promote energy efficiency. For example, one of the objectives of Alberta's Climate Change Central is to focus on information and action on energy efficiency and conservation in the province. The Office of the Fire Commissioner of Manitoba is

engaging stockholders in a review of the Energy Code Advisory Committee recommendations, the introduction of water efficiency in the plumbing code and the identification of barriers in the *Manitoba Building Code* to energy and water efficiency in buildings. The Ontario Power Authority's Conservation Bureau provides leadership in planning and coordinating measures for electricity conservation and load management. The Canada-Yukon Energy Solutions Centre is a service and program delivery agency for federal and Yukon government programs on energy efficiency and green power.

Recently, there has been a greater focus on energy efficiency in the Maritime provinces, as evidenced by the creation of three agencies: Efficiency NB, Conserve Nova Scotia and Prince Edward Island's (P.E.I.'s) Office of Energy Efficiency. Efficiency NB's mandate is to promote efficient energy use, help control energy expenses and lessen the impact of energy use on the environment, while P.E.I.'s Office of Energy Efficiency provides advice and programs to promote sustainable energy use. Other regional organizations of note are the Arctic Energy Alliance in the Northwest Territories, the Nunavut Energy Centre and the Agence de l'efficacité énergétique du Québec.

Use of Federal EAE Program Tools by Utilities, Provinces and Territories

Provincial and territorial governments and utilities use federal EAE program tools to complement their own energy efficiency programs. Here are some examples:

- Homeowners in Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, British Columbia, Yukon and the Northwest Territories can access both provincial/territorial and federal home retrofit programs through a single energy evaluation offered under ecoENERGY Retrofit – Homes. The ecoENERGY evaluation and its criteria are also used by these jurisdictions to determine eligibility for incentives.
- Canadians in most provinces and territories can benefit from rebates and sales tax exemptions on selected ENERGY STAR® products. The ENERGY STAR program is administered by the OEE and is used by a number of provinces and utilities as a qualifying criterion.
- NRCan's R-2000 Standard is used by utilities in Saskatchewan, Manitoba and Newfoundland and Labrador as a qualifying criterion for incentives and rebates designed to encourage the construction of energy-efficient new homes.
- Most of the provincial and territorial bodies responsible for driver education use the Auto\$mart Driver Education Kit, developed by the OEE, to educate young drivers on fuel efficiency. For example, Manitoba Public Insurance has recently incorporated an Auto\$mart component into its curriculum, and many provinces display the OEE's publications in their licensing bureaus.

The Building Energy Codes Collaborative

The Building Energy Codes Collaborative (BECC) is a provincial-territorial-federal committee supported by the Council of Energy Ministers, ASCEE and NRCan. BECC is made up of representatives from provincial/territorial code and energy ministries, departments and agencies; NRCan; and the Canadian Codes Centre. The objectives of the BECC are as follows:

- provide a forum for provinces, territories and the federal government to support the update, regulatory adoption and implementation of the *Model National Energy Code for Buildings* (MNECB) by responsible authorities
- work in co-operation with the provinces and territories and the Canadian Commission on Building and Fire Codes toward a national consensus on establishing energy efficiency in the code process
- explore other regulatory and/or program instruments for increasing energy efficiency in new housing, including updating the MNECB
- seek support from the federal government and the energy and building code ministries in the provinces and territories and engage their representatives in the process

NRCan and BECC prepared a business plan for updating the MNECB and presented it to the Canadian Commission on Building and Fire Codes. Commission members unanimously approved the following motion at its annual meeting in Calgary in February 2007: “. . . that the updating of the MNECB as a progeny document based on the BECC Business Plan be approved.”

NRCan then prepared and signed a memorandum of understanding with the National Research Council (NRC). NRCan is contributing up to \$5 million over four years to support the technical development of the new code and is providing technical expertise to the NRC team tasked with

developing national codes. The NRC launched the project, and the Standing Committee on Energy Efficiency in Buildings held its first meeting on updating the code in Ottawa in December 2007.

The updated MNECB will be published by 2011 in an objective-based format. It will complement objective-based model national construction codes published in 2005.

Co-operation Agreements

NRCan’s memorandum of agreement (MOA) on EAE with the Agence de l’efficacité énergétique du Québec provides for the consultation and sharing of information between the two governments, the coordination of EAE activities in Quebec and the creation of opportunities for joint projects. Further, the management committee established under the MOA reviews policy and program developments, progress on joint program initiatives and areas for further co-operation. NRCan is working with the Agence de l’efficacité énergétique to deliver services under the ecoENERGY programs.

The MOA played a role in facilitating three activities in particular:

- management of the licensing agreement for local delivery of ecoENERGY Retrofit – Homes
- NRCan’s Buildings Division’s continued processing of payments for the former EnerGuide for Existing Buildings and Commercial Building Incentive programs under a letter of co-operation (LOC) with the Agence de l’efficacité énergétique that covers 2007–2008 and 2008–2009. Though the two programs are closed, payments, which can be made only when the client proves to NRCan that work has been completed, are still being processed.
- management of an agreement on the Programme d’intervention en réfrigération dans les arénas du Québec, under which NRCan has provided technical support for the implementation of innovative refrigeration systems in Quebec ice rinks

NRCan's LOC on energy efficiency and renewable energy with the Government of Yukon facilitates information sharing and the creation of opportunities for joint projects in Yukon. These projects include the Canada-Yukon Energy Solutions Centre in Whitehorse. The Centre provides access to technical services and programs for the Yukon population and undertakes outreach and public education activities.

NRCan works co-operatively with the Office of the Fire Commissioner of Manitoba, a special operating agency of Manitoba Labour and Immigration, to engage Manitoba stakeholders in a review of the Energy Code Advisory Committee recommendations. Manitoba is also consulting stakeholders on introducing water efficiency in the plumbing code and identifying barriers in the *Manitoba Building Code* to energy and water efficiency in buildings. The result will be a stakeholder consultation report provided to Manitoba's Minister of Labour and Immigration and Minister of Science, Technology, Energy and Mines.

The Government of Canada contributes to the Arctic Energy Alliance as a means of promoting energy efficiency and renewable energy in the Northwest Territories and providing opportunities for EAE projects. The Alliance is also the R-2000 delivery agent in the Northwest Territories. Through the contribution agreement with the Qulliq Energy Corporation, the Government of Canada contributes to the Nunavut Energy Centre, which promotes energy efficiency and renewable energy in Nunavut.

NRCan works with Ontario's Ministry of Small Business and Entrepreneurship, the Independent Electricity System Operator and local distribution companies to provide energy management training to individual companies across Ontario through Dollars to \$ense workshops.

The Government of Canada promotes energy efficiency and renewable energy in Alberta by working with Climate Change Central, a non-profit corporation funded by a number of stakeholders, including the Government of Alberta.

Sustainable Development Technology Canada – NextGen Biofuels Fund™

The NextGen Biofuels Fund™ is a \$500-million program scheduled to run from 2008 to 2017. Responsibility for the program is held jointly by NRCan and Environment Canada. The fund is managed under the auspices of Sustainable Development Technology Canada (SDTC.)

The NextGen Biofuels Fund™ aims to facilitate the establishment of first-of-a-kind, large, demonstration-scale facilities for the production of next-generation biofuels and co-products in Canada; improve the sustainable development impacts arising from the production and use of biofuels; and encourage retention and growth of technology expertise and innovation capacity for the production of next-generation biofuels.

Next-generation renewable fuels are derived from non-traditional renewable feedstocks – such as forest biomass, fast-growing grasses and agricultural residues – and are produced with non-conventional conversion technologies. An eligible project must use feedstocks that are or could be representative of Canadian biomass, and the technology must have been demonstrated at the pre-commercial pilot scale. SDTC will support up to 40 percent of eligible project costs.

INTERNATIONAL CO-OPERATION

NRCan co-operates with several international organizations and foreign governments in EAE program areas. Canada benefits from this co-operation by

- learning about improved ways of designing and delivering EAE programs to meet policy objectives
- working with others on the harmonization of energy efficiency tests and performance standards to reduce barriers to trade in energy-using products

International Energy Agency

The International Energy Agency (IEA), based in Paris, France, is an autonomous agency of the Organisation for Economic Co-operation and Development. The IEA runs a comprehensive program of energy co-operation among its 26 member countries, including Canada. IEA member governments have committed to sharing energy information, coordinating energy policies and co-operating on the development of rational energy programs incorporating energy security, economic development and environmental protection. The IEA and its governing board are assisted in their work by several standing groups and special committees, which bring together energy specialists from member countries.

The Standing Group on Long-Term Co-operation (SLT) is the key committee on the policy side. The Group analyses policies to promote conservation and the efficient use of energy, the increased use of alternatives to oil, and other measures to increase long-term energy security while protecting the environment. The SLT monitors energy developments in member countries and makes recommendations on energy policy through a regular series of individual country reviews. The SLT's Energy Efficiency Working Party (EEWP) provides advice on and direction to the IEA's work on specific energy efficiency issues. The OEE represents Canada on the EEWP.

Canada's international energy research and development (R&D) objectives are mainly advanced through the IEA's working parties, implementing agreements and the Committee for Energy Research and Technology, chaired by NRCan. Canada participates in 32 of the IEA's 40 implementing agreements on R&D collaboration programs. NRCan spent \$752,000 on IEA implementing agreements in 2007–2008, in addition to personnel and travel expenditures. In many programs, this work has helped to accelerate technology development in Canada, generating benefits that far outweigh the direct costs of collaboration.

Canada also co-operates with research centres in member countries on several R&D and technology agreements and programs. NRCan facilitates R&D and commercial business ventures abroad by Canadian firms by undertaking a wide variety of activities. These activities include participating in various IEA tasks and supporting technical and trade-oriented workshops and conferences.

Group of Eight

Member states of the Group of Eight (G8) are Canada, France, Germany, Italy, Japan, Russia, the United Kingdom, the United States and the European Union. The G8 Summit in 2005 established the Gleneagles Plan of Action, which includes a number of actions in the area of EAE. While NRCan's participation in the IEA and international mechanisms for standards harmonization respond to many of the listed activities, others are implemented through NRCan's EAE programs.

At the G8 summit in 2007 in Heiligendamm, Germany, the leaders of the G8 countries and Brazil, China, India, Mexico and South Africa agreed to initiate a topic-driven dialogue under the "Heiligendamm Process." The Process has four pillars, and working groups have been formed around each one. Energy, with a special focus on energy efficiency, is one of the pillars. The Energy Working Group will explore the common ground

available for building international support for new ideas and approaches for increasing energy efficiency. It will focus on energy security, development of a sustainable buildings network, energy efficiency in power generation (particularly in existing power plants), and alternative sources of energy and renewable energy. Canada, represented by the OEE, is co-chair with India. The Working Group held its first meeting in March 2008.

Asia-Pacific Economic Cooperation

At the 2007 Asia-Pacific Economic Cooperation (APEC) Economic Leaders' Meeting, leaders highlighted the importance of improving energy efficiency in the Sydney APEC Leaders' Declaration on Climate Change, Energy Security and Clean Development. The declaration endorsed an APEC-wide regional aspirational goal of a reduction in energy intensity of at least 25 percent by 2030 (with 2005 as the base year).

The OEE is a member of the APEC Expert Group on Energy Efficiency and Conservation (EGEE&C), which reports to APEC's Energy Working Group. One of the tasks of the EGEE&C is updating and maintaining the APEC Energy Standards Information System (ESIS). ESIS provides public, up-to-date information on appliance and equipment energy standards and regulations. It also provides links to experts and information related to standards and regulations used by APEC and other economies. NRCan contributes regularly to the database by providing updated information on Canadian equipment standards and labelling and new initiatives, such as the phase-out of incandescent lamps.

United Nations

RETScreen® International is managed under the leadership of NRCan's CanmetENERGY Varennes (QC) Research Centre. RETScreen is managed through cost- and task-shared collaborative ventures with other governments and multilateral organizations, and with technical support from more than 250 experts representing industry, government and academia. Key partners are NASA's Langley Research Center and the Renewable Energy and Energy Efficiency Partnership. Other key international partners include the Energy Branch of the United Nations Environment Programme (UNEP) and the UNEP Solar and Wind Energy Resource Assessment, which is sponsored by the Global Environment Facility.

Mexico

NRCan signed a memorandum of understanding (MOU) on EAE co-operation with the Mexican Energy Secretariat in June 1996. Its objective is to contribute to the EAE objectives of Canada and Mexico by improving the design and delivery of EAE programs and by fostering trade, investment, technical and other exchanges related to energy-efficient products, energy management services, and alternative energy goods and services. Under the MOU, officials of Mexico's National Commission for Energy Savings (CONAE) participated in an industrial energy efficiency conference held in May 2005 in Ottawa. In March 2006, NRCan organized an energy efficiency workshop in Puebla, Mexico, in co-operation with CONAE.

Established in 2004, the Canada-Mexico Partnership (CMP) is designed to serve as a mechanism for identifying policies for facilitating co-operation, enhancing investment and creating opportunities for Canadian entrepreneurs to take part in projects that contribute to the socio-economic development of Mexican society. Sustainable housing has been identified as a priority theme under the CMP. Canada Mortgage and Housing Corporation (CMHC) has been charged

with chairing a working group on sustainable housing technologies under the CMP within the framework of a letter of intent (LOI) with CONAVI, the Mexico National Housing Agency. The LOI establishes the scope of the working group activities. NRCan participates as a member of this working group through the CANMET Energy Technology Centre.

In 2006, under the CMP, NRCan and CMHC facilitated meetings between Mexican builder-developers and Canadian photovoltaic (PV) and solar domestic hot water companies. In 2007, five PV units were installed in a residential development in Mexicali, Mexico, using a system designed by ICP, a Montréal company. The project will be used as a case study to provide the builder, state and utility with field data to assess the value of developing a business case for an incentive-based PV program for residential grid-connected PV energy supply in the region. In 2006, Mexican stakeholders also expressed interest in Canadian approaches to sustainable neighbourhood-scale projects, including standards for sustainable projects, decision-making tools and access to Canadian case studies. A workshop to facilitate this information exchange was conducted in Tijuana, Mexico, in 2007.

Innovative financing for renewable energy and energy-efficient projects is an ongoing theme under the CMP working group. Mexico is launching a “green mortgage” instrument, and government and industry stakeholders have expressed interest in learning more about financing instruments for renewable energy and energy efficiency features in housing. This theme remains an area of mutual interest.

United States

In September 2005, NRCan’s OEE signed an MOU with the U.S. Environmental Protection Agency to share in the common goal of achieving greater energy efficiency and reducing carbon dioxide, particulate matter and oxides of nitrogen emissions through the work of their respective programs: ecoENERGY for Fleets (FleetSmart) and the SmartWay Transport Partnership. These two programs use a voluntary approach with the on-road freight sector to increase energy efficiency through training, education and reporting initiatives. They are working together to harmonize program efforts in Canada and the United States.

North America

In July 2007, energy ministers of Canada, the United States and Mexico signed a co-operation agreement on energy science and technology. The trilateral agreement provides a legal framework for R&D co-operation on new technologies in such areas as bioenergy, clean coal, carbon capture and storage, fuel cells, and electricity networks. This new agreement supersedes a previous U.S.–Canada MOU on energy R&D.

NRCan continues to participate with the United States and Mexico in the Energy Efficiency Experts Group of the North American Energy Working Group (NAEWG) to promote the harmonization of energy efficiency standards and co-operation on energy efficiency labelling programs. In 2007–2008, work under NAEWG primarily involved coordinating the energy sector commitment to the North American Security and Prosperity Initiative. In addition to ongoing standards and program collaboration, NAEWG initiatives were implemented to develop a North American approach to vehicle fuel efficiency and standby loss by electricity-using products. A workshop on energy efficiency was held in Mexico City on October 1–2, 2007, to promote trilateral collaboration on transportation.

Natural Resource Canada's Efficiency and Alternative Energy Initiatives and Expenditures, 2007–2008

(millions of dollars)

Energy Efficiency and Alternative Transportation Fuels¹	\$74.9
ecoENERGY for Equipment	
ecoENERGY Retrofit – Homes	
ecoENERGY Retrofit – Small and Medium Organizations	
ecoENERGY Retrofit – Existing Buildings Initiative	
Federal Buildings Initiative	
ecoENERGY for Buildings and Houses	
ecoENERGY for Industry	
ecoENERGY for Personal Vehicles	
ecoENERGY for Fleets	
ecoENERGY for Biofuels	
Ethanol Expansion Program	
National Energy Use Database	

¹ The Energy Efficiency and Alternative Transportation Fuels total does not include the Sustainable Development Technology Canada – NextGen Biofuels Fund™. For details on this Fund, refer to the text box on page 61.

(millions of dollars)

Energy Efficiency – Energy Science and Technology²	\$98.9
Clean Energy Systems for Buildings and Communities	
Clean Electric Power Generation	
Clean Energy Systems for Industry	
Environmentally Sustainable Oil and Gas Development	
Clean Transportation Energy	
Sustainable Bioenergy	
Canadian Biomass Innovation Network	
Alternative Energy – Renewable Energy Sources	\$54.3
ecoENERGY for Renewable Heat	
ecoENERGY for Renewable Power	
Wind Power Production Incentive ³	
Initiative to Purchase Electricity From Emerging Renewable Energy Sources ⁴	
Total	\$228.1

² Totals allocated for the Program of Energy Research and Development, Climate Change Technology and Innovation Research and Development, and ecoENERGY Technology Initiative in Chapter 4 are reflected in the relevant program entries.

³ The Wind Power Production Incentive is fully committed, but incentives will be paid out to recipients until 2016–2017.

⁴ The Initiative to Purchase Electricity From Emerging Renewable Sources is fully committed, but incentives will be paid out until 2011–2012.

Data Presented in the Report

The aggregate energy use data presented in this report are taken from Statistics Canada's *Report on Energy Supply–demand in Canada* (RES-D). Differences exist between this report and *Canada's Emissions Outlook: An Update* (CEO Update) concerning the sector allocations of RES-D energy-use data. The CEO Update's sector allocation is based on Environment Canada's *Trends in Canada's Greenhouse Gas Emissions 1990–1997*. This report, however, uses a definition better suited for the purpose of energy end-use analysis. Some modifications to the original Statistics Canada data were required and are documented in Appendix A of Natural Resources Canada's *Energy Use Data Handbook, 1990 to 2005*.

FIGURE 1-1: Secondary Energy Use by Sector, 2005

Sector	Industrial	Transportation	Residential	Commercial/ Institutional	Agriculture	Total
Energy use (PJ)	3209	2502	1402	1153	209	8475
Percentage	0.379	0.295	0.165	0.136	0.025	1.000

FIGURE 1-2: GHG Emissions From Secondary Energy Use by Sector, 2005

Sector	Transportation	Industrial	Residential	Commercial/ Institutional	Agriculture	Total
GHG emissions (Mt)	177.5	164	73.8	65.3	14.4	495
Percentage	0.36	0.33	0.15	0.13	0.03	1.00

FIGURE 1-3: Energy Intensity and the Energy Efficiency Effect, 1990 to 2005

Index: 1990 = 1.00	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Energy intensity index	1.00	1.00	1.00	1.00	0.99	0.98	1.00	0.97	0.91	0.89	0.87	0.84	0.85	0.85	0.84	0.81
Index of energy efficiency effect	1.00	0.98	0.97	0.96	0.96	0.92	0.93	0.91	0.89	0.87	0.87	0.86	0.87	0.88	0.86	0.84

FIGURE 1-4: Secondary Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005

Index: 1990 = 1.00	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Estimated secondary energy use without energy efficiency improvements	1.00	1.00	1.03	1.05	1.09	1.15	1.17	1.20	1.20	1.25	1.29	1.27	1.31	1.33	1.36	1.38
Actual energy use	1.00	0.98	1.00	1.01	1.05	1.07	1.11	1.11	1.09	1.12	1.17	1.14	1.18	1.22	1.23	1.22

FIGURE 1-5: Canadian Households by Type of Dwelling, 2005

Dwelling type	Number of households	Percentage
Single detached homes	7 083 709	56
Single attached homes	1 320 470	10
Apartments	3 936 757	31
Mobile homes	245 834	2
Total	12 586 770	100

FIGURE 1-6: Residential Energy Use by End-Use, 2005

Activity	Energy use (PJ)	Percentage
Space heating	846.1	60
Water heating	248.2	18
Appliances	203.0	14
Lighting	68.4	5
Space cooling	36.5	3
Total	1402.2	100

FIGURE 1-7: Number of Households, Average Floor Space by Household and Energy Intensity Indexes, 1990 to 2005

Index: 1990 = 1.00	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Number of households	1.00	1.03	1.05	1.07	1.08	1.10	1.12	1.13	1.15	1.17	1.19	1.20	1.22	1.23	1.25	1.27
Average floor space by household	1.00	1.01	1.01	1.02	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
Energy intensity (GJ/household)	1.00	0.96	0.97	0.98	0.98	0.95	1.01	0.96	0.86	0.88	0.91	0.86	0.89	0.91	0.88	0.86

FIGURE 1-8: Residential Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005

Index: 1990 = 1.00	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Estimated energy use without energy efficiency improvements	1.00	1.04	1.10	1.14	1.14	1.17	1.22	1.21	1.14	1.18	1.25	1.22	1.28	1.32	1.32	1.34
Actual energy use	1.00	0.98	1.01	1.04	1.07	1.05	1.12	1.08	0.99	1.03	1.08	1.04	1.08	1.12	1.10	1.09

FIGURE 1-9: Annual Heating Consumption for Houses* Constructed to Different Standards

House type	Annual heating consumption (GJ)
R-2000 house	78.75
Model National Energy Code house (2002)	112.10
Typical new house (2002)	146.27
Typical existing house (1970)	216.81

* 198-m² one-storey, single detached house heated with natural gas, Ottawa, Ontario

FIGURE 1-10: Average Energy Consumption of New Electric Appliances, 1990 and 2005 Models

Appliance	1990 (KWh/yr)	2005 (KWh/yr)
Freezers	714	386
Electric ranges	772	573
Refrigerators	956	469
Dishwashers	841	324
Clothes dryers	1103	904
Clothes washers	1218	444

FIGURE 1-11: Commercial/Institutional Energy Use by Activity Type*, 2005

Activity type	Energy use (PJ)	Percentage
Offices**	399.5	35
Retail trade	192.1	17
Educational services	158.9	14
Health care and social assistance	105.3	9
Accommodation and food services	86.3	7
Wholesale trade	64.1	6
Transportation and warehousing	54.0	5
Arts, entertainment and recreation	36.3	3
Information and cultural industries	27.6	2
Other services	21.1	2
Total	1145.2	100

* Excludes street lighting

** "Offices" includes activities related to finance and insurance; real estate and rental and leasing; professional, scientific and technical services; and public administration.

FIGURE 1-12: Commercial/Institutional Energy Use by Purpose, 2005

End use	Energy use (PJ)	Percent
Space heating	585.3	51
Auxiliary equipment	165.6	14
Lighting	108.0	9
Space cooling	99.6	9
Water heating	98.6	9
Auxiliary motors	88.1	8
Street lighting	7.9	1
Total	1153.0	1.00

FIGURE 1-13: Commercial/Institutional Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005

Index: 1990 = 1.00	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Estimated energy use without energy efficiency improvements	1.00	1.05	1.08	1.13	1.14	1.16	1.20	1.20	1.17	1.22	1.26	1.26	1.34	1.36	1.36	1.42
Actual energy use	1.00	1.03	1.04	1.08	1.07	1.11	1.13	1.15	1.09	1.13	1.24	1.22	1.31	1.35	1.35	1.33

FIGURE 1-14: Industrial Energy Use by Subsector – Including Electricity-Related Emissions*, 2005

Subsector	Industrial Energy Use (%)	Energy use (PJ)
Pulp and paper	26	823.7
Mining	20	647.8
Other manufacturing**	17	539.6
Petroleum refining	11	360.6
Smelting and refining	8	264.7
Iron and steel	7	236.9
Chemicals	6	186.6
Other industries***	3	80.6
Cement	2	69.0
Total	100	3209.4

* The above subsectors reflect the current definitions in the Report on Energy Supply-demand in Canada.

** "Other manufacturing" comprises more than 20 manufacturing industries.

*** "Other industries" includes construction and forestry.

FIGURE 1-15: Cost of Energy to Manufacturing Industries as a Percentage of Total Production Cost, 2005

Industry	Energy cost (%) of total production cost
Transportation equipment and manufacturing	0.86
Petroleum refining	2.47
Chemicals	12.79
Iron and steel	12.99
Pulp and paper	15.04
Aluminum	16.78
Cement	37.07

FIGURE 1-16: Industrial Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005

Index: 1990 = 1.00	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Estimated energy use without energy efficiency improvements	1.00	1.14	1.14	1.18	1.19	1.24	1.28	1.24	1.28	1.29	1.31	1.31
Actual energy use	1.00	1.08	1.11	1.10	1.08	1.11	1.15	1.10	1.16	1.20	1.20	1.18

FIGURE 1-17: Transportation Energy Use by Mode, 2005

	Energy use (PJ)	Percentage
Passenger light vehicle	1070.4	
Passenger aviation	251.5	
Passenger bus	51.8	
Passenger rail	2.5	
Passenger total	1376.1	55.0
Freight aviation	7.9	
Freight truck	833.0	
Freight marine	111.2	
Freight rail	76.4	
Freight total	1028.3	41.1
Off-road total	97.4	3.9
Total transportation energy use	250.8	100.0

FIGURE 1-18: Market Shares of New Passenger Car and Light Truck Sales, 1990 to 2005

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Passenger car	74.7	75.2	72.7	69.7	67.2	65.1	62.8	59.7	59.1	60.9	63.0	63.4	62.7	62.1	61.58	61.59
Passenger light truck	25.3	24.8	27.3	30.3	32.8	34.9	37.2	40.3	40.9	39.1	37.0	36.6	37.3	37.9	38.42	38.41

FIGURE 1-19: Transportation Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2005

Index: 1990 = 1.00	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Estimated energy use without energy efficiency improvements	1.00	0.98	1.01	1.05	1.12	1.15	1.18	1.23	1.27	1.32	1.34	1.36	1.38	1.41	1.48	1.52
Actual energy use	1.00	0.96	0.99	1.00	1.05	1.07	1.09	1.13	1.17	1.20	1.22	1.21	1.23	1.26	1.31	1.33

FIGURE 1-20: Average Activity per Truck, 1990 to 2005 (tonne kilometres/truck)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Medium-and heavy-duty truck vehicle activity	105 742	98 658	103 459	117 687	133 653	142 910	141 219	163 975	162 926	175 266	178 269	198 998	197 396	202 326	219 262	236 677

FIGURE 1-21: Trucking Energy Intensity, 1990 to 2005 (megajoules/tonne kilometres)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Medium-and heavy-duty truck energy intensity	3.71	3.81	3.79	3.62	3.44	3.46	3.41	3.33	3.16	2.99	3.02	2.83	2.80	2.92	2.86	2.72

FIGURE 1-22: Shares of On-Road Transportation Fuel, 2005

Fuel type	Energy use (petajoules)	Percentage
Electricity	3.5	0.18
Natural gas	1.9	0.10
Motor gasoline	1280.1	65.18
Diesel	659.2	33.56
Liquefied petroleum gas	10.3	0.52
Renewable fuels	9.1	0.46
Total	1964.1	100.00

FIGURE 2-1: Volume of Monthly Import Documents

Month	Paper	Electronic
Apr. 07	2 677	54 217
May 07	2 639	62 432
Jun. 07	2 480	66 194
Jul. 07	1 959	62 462
Aug. 07	2 436	68 386
Sep. 07	1 570	68 537
Oct. 07	864	85 151
Nov. 07	253	86 365
Dec. 07	100	83 720
Jan. 08	175	95 602
Feb. 08	152	93 899
Mar. 08	36	100 135
Total	15 341	927 100

FIGURE 2-4: ENERGY STAR Qualified Appliances as a Percentage of Total Category Sales in Canada, 1999 to 2005

Appliance	Model Year						
	1999	2000	2001	2002	2003	2004	2005
Dishwashers	0.56	1.57	9.66	29.77	56.5	80.95	90.8
Refrigerators	11.4	22.26	40.68	34.16	37.6
Washers	1.93	2.24	9.24	22.07	30.55	36.16	45.9

FIGURE 2-5: ENERGY STAR Awareness Levels in Canada, 2005

	Percent
Aware – non-aided	36
Aware – aided	80

FIGURE 3-1: Residential Energy Use and Energy Savings per Household, Pre-1945 to 2000–2007

	Pre-1945	1945–1959	1960–1969	1970–1979	1980–1989	1990–1999	2000–2007*	Average
Energy use pre-renovation (GJ)	272	205	189	177	179	168	157	195
Actual energy savings after renovations (GJ)	89	55	44	41	38	32	39	48

* Data for 2007 are from ecoENERGY Retrofit – Homes (previous data source was EnerGuide for Houses).

FIGURE 3-2: Number of Eligible R-2000 Housing Starts, 1990 to 2007

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Number of R-2000 houses	495	699	1196	1299	784	610	416	484	265	213	319	329	428	379	583	500	439	483

FIGURE 3-3: CIPEC Energy Intensity Index, 1990 to 2005

Index: 1990 = 1.00	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Energy intensity index	1.00	1.05	1.08	1.06	1.06	1.04	1.03	0.98	0.96	0.95	0.91	0.91	0.92	0.94	0.91	0.90

FIGURE 3-4: Industrial Dollars to \$ense Participants, pre-2000 to 2007

Fiscal year	Pre-2000	2001	2002	2003	2004	2005	2006	2007
Number of industrial workshop participants	748	408	353	481	880	1027	1290	1230

FIGURE 3-5: New Vehicle Fuel Efficiency Labelling

Year	On lot	In showroom
1999	64	47
2001	77	56
2005	78	61
2007	78	56

FIGURE 3-6: Company Average Fuel Consumption (CAFC) Versus Canadian Voluntary Standards, 1990 to 2006*

Model year	Truck standard (11.4 L/100 km)	Trucks CAFC	Car standard (8.6 L/100 km)	Cars CAFC
1990	11.8	11.4	8.6	8.2
1991	11.6	11.1	8.6	8.0
1992	11.6	11.3	8.6	8.1
1993	11.5	11.1	8.6	8.1
1994	11.5	11.5	8.6	8.2
1995	11.4	11.5	8.6	7.9
1996	11.4	11.3	8.6	7.9
1997	11.4	11.3	8.6	8.0
1998	11.4	11.3	8.6	7.9
1999	11.4	11.3	8.6	7.9
2000	11.4	11.1	8.6	7.4
2001	11.4	11.0	8.6	7.8
2002	11.4	11.0	8.6	7.7
2003	11.4	10.7	8.6	7.6
2004	11.4	10.6	8.6	7.5
2005	11.4	10.6	8.6	7.4
2006	11.4	10.2	8.6	7.0

*2002–2006 data are estimates.

FIGURE 5-1: Canadian Wind Power Capacity, 1993 to 2006

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Wind power capacity (MW)	1	22	23	23	24	27	127	139	215	233	326	445	686	1459

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