# Improving Energy Performance in Canada

## Report to Parliament Under the *Energy Efficiency Act* For the Fiscal Year 2004–2005

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Her Excellency the Right Honourable Michaëlle Jean
C.C., C.M.M., C.O.M., C.D.
Governor General of Canada and Commander-in-Chief

Your Excellency,

I have the honour to present the *Report to Parliament Under the* Energy Efficiency Act for the fiscal year ending March 31, 2005, in accordance with Section 36 of the Act.

Respectfully submitted,

The Honourable John McCallum
Minister of National Revenue and
Acting Minister of Natural Resources Canada

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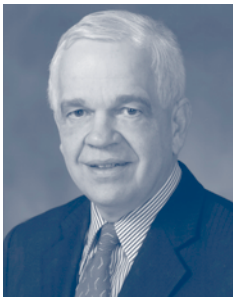
# Minister's Foreword



I am pleased to present the 12th Report to Parliament under the *Energy Efficiency Act*. This report outlines the many ways that Canada is boosting energy efficiency and increasing the use of renewable energy, as well as the key role the Government of Canada and Natural Resources Canada (NRCan) have played in achieving these results.

The past year has seen significant developments that reinforce the importance of energy efficiency. The Kyoto Protocol came into effect in February 2005 and, following that, the Government of Canada launched Project Green by releasing *Moving Forward on Climate Change: A Plan for Honouring our Kyoto Commitment*. Becoming more energy efficient is an underlying theme of our updated plan and one of the cornerstones of Canada's efforts to effectively address climate change. Recent supply disruptions caused by hurricanes in the Gulf of Mexico have also underlined the importance of using energy wisely and more efficiently.

As this report indicates, we have made progress in reducing energy use in every sector of our society, bringing economic, environmental and health benefits to Canadians. Increased energy efficiency has helped save money and fuel, bring down the greenhouse gas (GHG) emissions that contribute to climate change and improve air quality.

Here are a few examples that highlight the wide range of our successes from the fiscal year 2004-2005.

- Through the EnerGuide for Houses Retrofit Incentive program, more than 77 000 houses have been evaluated and labeled, leading to 17 000 grants totaling more than $10 million. After retrofits, home energy consumption was reduced by an average 27 percent, or 4 tonnes per year.

- The Government of Canada and the Canadian automobile industry signed a Memorandum of Understanding to reduce GHG emissions from light-duty vehicles by 5.3 megatonnes by 2010. This will be achieved through advanced technology and increased public education on energy-efficient driving techniques.

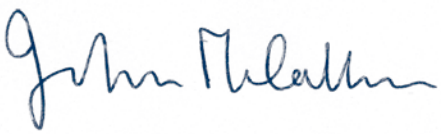
- The Government will invest an additional $920 million in the Wind Power Production Incentive over 15 years to increase the program's target to 4000 megawatts of wind-generated electricity.

- Efforts to educate and engage the public were intensified by bolstering programs such as ENERGY STAR® and EnerGuide labels and the One-Tonne Challenge, which calls on Canadians to reduce GHG emissions by 20 percent.

This is a small sample of the various programs and regulations NRCan supports to help governments, industry and individuals increase energy efficiency and reduce consumption. We are also involved in innovative research and development programs that are putting Canada at the forefront of developing clean and renewable energy technology.

Clearly, improved energy efficiency is a fundamental priority for the Government of Canada. As we search for ways to respond to climate change, I hope all Canadians will share this priority.

Through fresh perspectives, innovative approaches and creative ideas, we can strike the balance between economic prosperity and environmental well-being. We can build stronger, cleaner communities. I believe that this is our responsibility to the generations of Canadians that will follow in our footsteps.



The Honourable John McCallum
Minister of National Revenue and Acting Minister of Natural Resources Canada

# Executive Summary

Canadians spend almost $129 billion per year 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

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

Key highlights in energy use include the following:

- Between 1990 and 2003, the latest year for which figures are available, primary energy use increased by 24.0 percent.
- In 2003, secondary use accounted for 70.0 percent of primary energy use and produced 68.6 percent (502 megatonnes) of Canada's total greenhouse gas (GHG) emissions. This last figure includes emissions produced by utilities in meeting the demand for electricity.
- Without improvements in energy efficiency 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 consumes the most energy, accounting for 38.4 percent of total secondary energy use in 2003. Transportation is second (27.9 percent), followed by residential (17.2 percent), commercial/institutional (14.0 percent) and agriculture (2.5 percent).

## Promoting Energy Efficiency

For the past decade, Natural Resources Canada (NRCan) has promoted energy efficiency and the use of alternative energy as a means to reduce GHG emissions and save money. NRCan exercises a broad range of policy instruments, including leadership, information, voluntary actions, 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, as well as 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 aggregate energy intensity is sometimes used as a proxy for energy efficiency, there is a difference between the two terms. Understanding this difference is important when comparing Canada with other countries. Energy intensity is a broader measure, capturing not only energy efficiency, but also the impacts of weather variations and changes in the structure of the economy (among other aspects). While Canada has a higher aggregate intensity than most International Energy Agency (IEA) countries, it has made significant overall improvements in energy efficiency. According to a recent IEA report[1] that examined 13 countries, Canada has the fourth fastest rate of energy efficiency improvement.

[1] International Energy Agency, *Oil Crises and Climate Challenges – 30 Years of Energy Use in IEA Countries*, Paris, 2004.

## 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 far greater without improvements in energy efficiency. As reported in Chapter 1, energy efficiency improvements made between 1990 and 2003 are estimated to have reduced GHG emissions by almost 52.3 megatonnes and decreased energy expenditures by an average of $13.4 billion in 2003 alone.

Over this period, the residential sector recorded a 19.4 percent increase in energy efficiency. The figures for transportation (15.7 percent), industry (12.6 percent) and the commercial/institutional (1.1 percent) sectors demonstrate that improvements in energy efficiency are being made throughout the economy.

Through improvements in energy efficiency, Canadians can reduce the size of their energy bills and achieve important environmental goals. In 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.

In recent years, the production of energy derived from alternative sources has increased significantly. Between 1990 and 2001, the last year for which data are available, the amount of electricity generated from the sun, wind and biomass increased by 204 percent.

## Engaging Canadians

To maximize the effectiveness of its initiatives, NRCan engages a growing number of partners from the private and public sectors. Dozens of cooperative 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, highlights NRCan's efficiency and alternative energy (EAE) programs and lists their key achievements for 2004–2005. All programs are described in the corresponding sector chapter. Program entries for market transformation programs also include quantitative performance indicators in graph or table format (see below). A list of NRCan's EAE initiatives and expenditures appears in Appendix 1.

## Performance Indicators Highlighted in the Report

### Equipment

- Energy Efficiency Regulations Impact, 2010 and 2020
- Awareness Levels of ENERGY STAR® in Canada
- ENERGY STAR Qualified Appliances as a Percent of Total Category Sales in Canada, 2003

### Housing

- Annual Heating Consumption for Houses Constructed to Different Standards
- Average Energy Consumption per Household, Pre-1946 to 2001–2004 Construction
- Average Energy Consumption of New Appliances, 1990 and 2003 Models
- Number of Eligible R-2000 Housing Starts, 1990 to 2004
- National Trends in Air Leakage, Pre-1945 to 2000–2004 Construction
- Evaluations Under EnerGuide for Houses, 1998–1999 to 2004–2005
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### Buildings

- Energy Use in Commercial Buildings
- Estimated Average GHG Reductions by Type of Institution Under the Commercial Building Incentive Program, 2004
- Energy Innovators Initiative – Incentive Projects, 1998 to 2005

### Industry

- CIPEC Energy Intensity Index, 1990 to 2003
- Industrial Energy Innovators, 1995–1996 to 2004–2005

## Transportation



## Renewable Energy



## Federal House in Order

# Introduction

## Natural Resources Canada's Efficiency and Alternative Energy Program

Since the early 1990s, Natural Resources Canada (NRCan) has emphasized the promotion of energy efficiency and the use of alternative energy (i.e. alternative transportation fuels and renewable energy) as a means to reduce greenhouse gas (GHG) emissions.

## Greenhouse Gases 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. In December 1997, Canada and more than 160 other countries met in Kyoto, Japan, and agreed to targets to reduce GHG emissions. Canada's target is to reduce its GHG emissions to 6 percent below 1990 levels by the first commitment period (2008 to 2012). The Government of Canada ratified the Kyoto Protocol and notified the United Nations of its decision on December 17, 2002. With Russia's ratification on October 25, 2004, the Protocol came into force on February 16, 2005.

A complete list of NRCan's efficiency and alternative energy (EAE) initiatives in 2004–2005 is provided 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 Office of Energy Efficiency, which delivers market transformation initiatives to improve energy efficiency and the use of alternative transportation fuels
- the CANMET[1] Energy Technology Centre and the Mineral Technology Branch, which deliver EAE research and development (R&D) initiatives
- the Electricity Resources Branch, which delivers market transformation initiatives for renewable energy
- the Science Branch of the Canadian Forest Service, which undertakes R&D in the use of forest biomass for energy

In its efforts to reduce GHG emissions, NRCan emphasizes partnership and cooperation with stakeholders, such as other levels of government, the private sector and non-governmental organizations. Using 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 as well as for increasing the energy efficiency of energy production.

[1] CANMET is the Canada Centre for Mineral and Energy Technology.

## Policy Instruments

NRCan's key policy instruments are as follows:

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

Figure 1 shows how these policy tools work together to increase energy efficiency, i.e. how they help to reduce the amount of energy needed to obtain a certain level of service. R&D increases the opportunities for achieving greater levels of efficiency in a particular type of energy use. Non-R&D measures increase the take-up of existing opportunities to use energy more efficiently. Energy performance regulations eliminate less efficient products from the market.

### Regulation

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

### Financial Incentives

NRCan uses financial incentives to encourage final users of energy to employ energy efficiency and renewable energy technologies and practices. NRCan also offers financial incentives for wind energy, ethanol plants and for 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 that range from broad distribution to individual consultations with clients, to increase awareness of the environmental impact of energy use and to encourage consumers to become more energy efficient and to make greater use of alternative energy sources. Activities include publications, exhibits, advertising, toll-free lines, conferences, Web sites, workshops, training, building-design software and promotional products.

### Voluntary Initiatives

Companies and institutions work with NRCan on a voluntary basis to establish 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 important determinants of energy use. The initiatives involve industry-government agreements and, for groups of large industrial energy users, energy efficiency target setting. NRCan provides a variety of support services to assist and stimulate action by companies and institutions on energy efficiency, including developing standards and training.

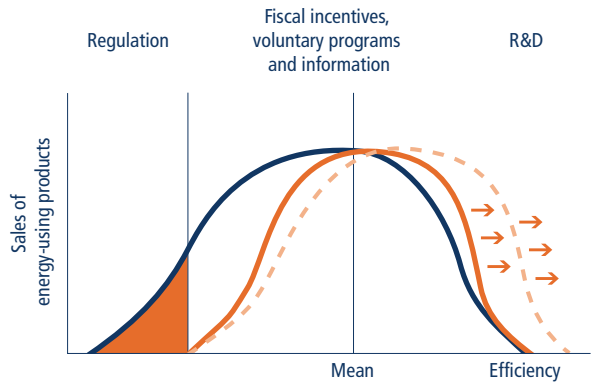
### Research and Development

NRCan's EAE initiatives support the development and dissemination of more energy-efficient equipment, processes and technologies and alternative energy technologies. R&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 in-house research in its own laboratories, by contracting out research activities to other organizations and through the federal funding initiatives listed in Chapter 9, which are the only federal interdepartmental S&T investment funds that focus on the energy sector and its economic and environmental effects.

**FIGURE 1**

Moving the Market




## Measuring Progress

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

In the past, NRCan has focused on the monitoring and tracking of 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 other government and non-government programs.

Since 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 towards a market outcome, serves as an indicator of program effectiveness. An example of a program outcome that leads to a market outcome is a householder's purchase of a more energy-efficient appliance and reduced use of electricity. Depending on the source of electricity and how the utility changes its electricity-generating methods to meet the change in demand that results from reduced electricity use, this could also lead to a decline in GHG emissions.

## In This Report

This twelfth annual Report to Parliament focuses principally on EAE initiatives that address secondary energy use. Trends in energy use and GHG emissions in Canada are discussed in Chapter 1. Chapter 2 discusses the equipment regulations under the *Energy Efficiency Act* and equipment labelling activities. Chapters 3 to 6 review individual EAE initiatives to improve energy use in housing, buildings, industry and transportation, highlighting their achievements and progress indicators. Chapter 7 deals with renewable energy sources and use. Chapter 8 describes the Government of Canada's actions to improve its own use of energy. Chapter 9 describes general programs not specific to EAE initiatives discussed in Chapters 3 to 7. The final chapter describes domestic and international cooperation in EAE. Appendix 1 contains information on NRCan's EAE expenditures. Appendix 2 contains detailed information on the data presented in this report.

# Chapter 1: 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 has favoured the development of industries that have a particularly strong energy demand.

Canadians spend almost $129 billion per year on energy to heat and cool their homes and offices and to operate their appliances, cars and industrial processes. This represents about 13 percent of the country's gross domestic product (GDP).

## Energy Use and Greenhouse Gas Emissions

There are two general types of energy use: 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 in Canada today reflects changes over several decades in energy-consuming equipment and buildings and in the behaviour of energy users. Primary energy use increased by 24.0 percent between 1990 and 2003, from 9743 petajoules to 12 081 petajoules.

Secondary energy use (8457 petajoules) accounted for 70.0 percent of primary energy use in 2003. It was responsible for 68.6 percent (502 megatonnes) of total greenhouse gas (GHG) emissions in Canada, if indirect emissions – namely, those produced by electric utilities to meet end-use electrical demand – are included.

This report deals with energy-related GHG emissions, which comprise carbon dioxide ($CO_2$), methane and nitrous oxide. $CO_2$ represents the majority of Canada's GHG emissions. All subsequent references in this report to $CO_2$ and GHGs include emissions that are attributable directly to secondary energy use and indirect emissions attributable to electricity generation, unless otherwise specified.

From 1990 to 2003, secondary energy use increased by 21.7 percent and related GHG emissions increased by 23.0 percent. The GHG intensity of energy changed slightly during the period as fuel switching towards less GHG-intensive fuels offset a higher GHG intensity in electricity production. The industrial sector is the largest energy user, accounting for 38.4 percent of total secondary energy use in 2003. The transportation sector is the second largest energy user at 27.9 percent, followed by the residential sector at 17.2 percent, the commercial/institutional sector at 14.0 percent and the agriculture sector at 2.5 percent.

## Energy Intensity / Energy Efficiency

Aggregate energy intensity is the ratio of energy use per unit of GDP or, alternatively, energy use per capita. Aggregate energy intensity is sometimes used as a proxy for energy efficiency because it is simple, straightforward and the data for the calculation are readily available.

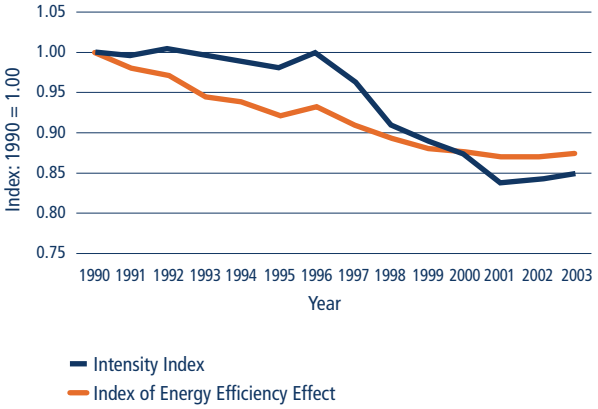
However this measure is misleading because, in addition to pure energy efficiency, intensity captures the impacts of weather variations and changes in the structure of the economy, among other things.

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 to isolate the impact of energy efficiency on changes in Canadian energy use.

Figure 1-1 compares, for Canada, an index of annual variation in energy intensity with the OEE's index of changes in energy efficiency over the period 1990 to 2003. The indexes present improvements in energy intensity and efficiency as a downward trend.

**FIGURE 1-1**

Canada: Changes in Energy Intensity and the Energy Efficiency Effect, 1990 to 2003




## International Comparisons

Canada has a higher aggregate intensity – absolute energy use per capita or per unit of GDP – than most International Energy Agency (IEA) countries, ranking second and fourth, respectively.

Meaningful comparisons of energy efficiency between countries can be difficult because very detailed energy, equipment stock, production and/or weather data for each target country are required.

However, according to a recent IEA report entitled *Oil Crises and Climate Challenges – 30 Years of Energy Use in IEA Countries*, Canada's energy efficiency improved at an average annual rate of 1 percent between 1990 and 1998, similar to the rate recorded by the United States, and the fourth fastest rate of improvement among the 13 countries included in the report (surpassed by Finland, Italy and Norway).

**TABLE 1-1**

Energy Intensities for Selected IEA Countries, 2002

| GJ* per capita | | GJ per $1,000 of GDP | |
|---|---|---|---|
| Luxembourg | 357.3 | Czech Republic | 17.9 |
| Canada | 253.9 | Hungary | 12.8 |
| United States | 226.8 | Turkey | 11.5 |
| Finland | 210.5 | Canada | 10.6 |
| Norway | 190.1 | Korea | 8.5 |
| Belgium | 166.1 | New Zealand | 8.2 |
| Sweden | 164.7 | United States | 7.1 |
| Netherlands | 155.6 | Portugal | 6.6 |
| New Zealand | 154.4 | Finland | 6.5 |
| Australia | 150.0 | Australia | 6.2 |

*Gigajoules

GDP is in 1995 US$ converted at exchange rate

## Trends in Energy Efficiency

NRCan annually publishes *Energy Efficiency Trends in Canada*, which reports on changes in energy use (and GHG emissions) and the contribution of the following key factors to these changes:

- 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.
- A higher **service level** for auxiliary equipment (e.g. computers, fax machines and photocopiers) increased energy use and emissions. This factor is only applied to commercial/institutional buildings. During the 1990s, these types of equipment were widely adopted; however, improvements in functionality increased productivity and moderated increases in energy consumption due to the use of more machines.
- **Energy efficiency** refers to how effectively energy is being used, for example, how long an appliance can be operated with a given amount of energy.

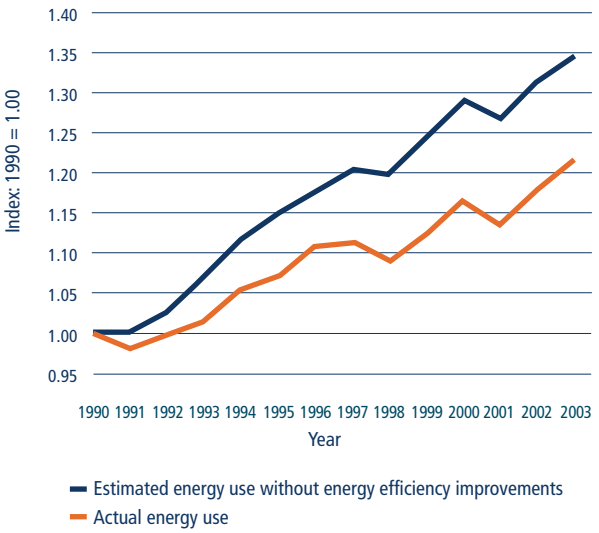
In this report, changes in energy efficiency are the net result after allowing for the changes in energy use due to changes in activity, weather, structure and service level. To the extent that other factors that affect energy use have not been captured, this measure of energy efficiency improvement might overstate or understate the "actual" change. For example, in the industrial sector, in an industry such as other manufacturing, there may have been changes in energy use due to shifts in the mix of products, but this is not captured.

Secondary energy use increased between 1990 and 2003 (from 6951 to 8457 petajoules). Without improvements in energy efficiency, increases attributable to activity, weather, structure and service level would have led to an increase in secondary energy use of 34.4 percent. However, as a result of a 12.7 percent (883 petajoules) improvement in energy efficiency, actual secondary energy use increased by 21.7 percent (8457 petajoules).

The change in energy use between 1990 and 2003, actual and without energy efficiency improvements, is shown in Figure 1-2. The difference in energy use due to energy efficiency – the estimated energy saving – represents a reduction in energy costs of $13.4 billion in 2003 and a reduction in GHG emissions of more than 52 megatonnes. Changes in energy efficiency are estimated for each of the four major end-use sectors and are presented in Chapters 3 to 6. The energy efficiency improvements were largest in the residential sector (19.4 percent), followed by the transportation sector (15.7 percent), industrial sector (12.6 percent), and commercial/institutional sector (1.1 percent).[1]

**FIGURE 1-2**

Secondary Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2003




[1] The aggregate energy-use data presented in this report are taken from Statistics Canada's *Report on Energy Supply-Demand in Canada* (RESD). Differences exist between this report and *Canada's Emissions Outlook: An Update* (CEO Update) concerning the sector allocations of RESD energy use data. The CEO Update's sector allocation is based on Environment Canada's *Trends in Canada's Greenhouse Gas Emissions 1990–1997*, whereas this report uses a definition better suited for 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 and 1997 to 2003*.

## TABLE 1-2

Explanation of Changes in Secondary Energy Use, 1990 to 2003

| | Sectors | | | | | |
|---|---|---|---|---|---|---|
| | Residential | Commercial/ Institutional | Industrial | Transportation | Total* | % Change |
| 1990 energy use (PJ) | 1289.3 | 867.0 | 2717.4 | 1877.9 | 6950.8 | |
| 2003 energy use (PJ) | 1457.6 | 1180.9 | 3245.7 | 2361.3 | 8457.3 | |
| Change in energy use (PJ) | 168.2 | 313.9 | 528.3 | 483.4 | 1506.5 | 21.7% |
| Explanatory factor (change due to) | | | | | | |
| Activity | 331.8 | 223.0 | 1209.6 | 592.0 | 2356.5 | 33.9% |
| Weather | 42.4 | 28.9 | n/a | n/a | 71.3 | 1.0% |
| Structure | 44.5 | 0.6 | -337.7 | 144.4 | -148.2 | -2.1% |
| Service level | n/a | 70.9 | n/a | n/a | 70.9 | 1.0% |
| Energy efficiency | -250.5 | -9.6 | -343.6 | -279.6 | -883.3 | -12.7% |
| Other factors | | 0.1 | | 26.6 | 39.4 | 0.6% |

*Total also includes energy use for agriculture (not shown in table)

## Trends in Renewable Energy

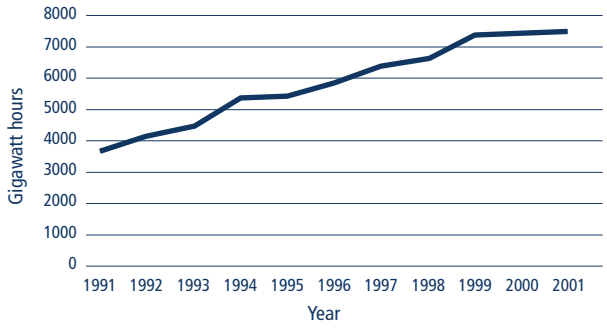
As previously noted, changes in the fuel mix employed by the Canadian economy can reduce GHG intensity. Although in the near term this can be achieved by moving from more to less GHG-intensive fuels (e.g. from coal to natural gas), over the longer term the use of renewable energy sources is expected to accelerate this trend.

Figure 1-3 shows the trend in the use in Canada of electricity generated from wind, solar and biomass, indicating a 204 percent increase over 1991–2001. Although representing only a small component of overall electricity use, the proportion of electricity generated from these renewable energy sources increased from 0.75 percent to 1.32 percent over the period, representing a 57 percent increase in its share. Most of this production was derived from biomass.

The graph does not include hydro sources, either conventional or small (less than 20 megawatts). The former accounts for about 60 percent of electricity generated in Canada; installed capacity is over 62 gigawatts. There are over 230 small hydro installations in Canada, with a total capacity of about 1500 megawatts.

## FIGURE 1-3

Electricity Production From Renewable Sources (GWh), 1991 to 2001



# Chapter 2: Equipment, Standards and Labelling

## Introduction

Among Natural Resources Canada's (NRCan's) wide range of energy efficiency initiatives are Canada's *Energy Efficiency Regulations*, standards and labelling programs.

The *Energy Efficiency Act*, which came into force in 1992, gives the Government of Canada the authority to make and enforce regulations about performance and labelling requirements for energy-using products that are imported into Canada or shipped across provincial or territorial borders.

Following extensive consultations with provincial governments, affected industries, utilities, environmental groups and others, the first *Energy Efficiency Regulations* came into effect in February 1995. The Regulations refer to national consensus performance standards developed by the Canadian Standards Association, which include testing procedures that must be used to determine a product's energy performance. Regulated products that fail to meet the minimum performance levels identified by the Regulations cannot be imported into Canada or traded interprovincially.

Through the Accelerated Standards Action Program, NRCan works with key stakeholders to improve the standards development and approval processes and accelerate the market penetration of high-efficiency residential, commercial and industrial equipment.

Regulations have now been established for more than 30 products that consume 80 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 of 1 to 200 horsepower and certain lighting products. The Regulations continue to apply to these products even if they are incorporated into a larger unit or machine that is not regulated.

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

Before adding a new product or otherwise amending the Regulations, NRCan conducts studies to analyse how the proposed change will affect the market (e.g. will it have a measurable impact on energy efficiency levels without imposing undue hardship on manufacturers). 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 Regulations, as well as on their practical application in the marketplace.

Canada's *Energy Efficiency Act* and *Energy Efficiency Regulations* support a number of labelling initiatives that aim to help consumers and commercial/industrial procurement officials identify and purchase energy-efficient equipment that will save them money and reduce greenhouse gas emissions over the life of the product.

For example, 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 consumer 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. Labels for room air conditioners indicate the model's energy efficiency ratio and provide 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 (annual fuel utilization efficiency rating for oil and gas furnaces, fireplace efficiency rating for gas fireplaces and seasonal energy efficiency ratio for central air conditioners) is published on the back page of the manufacturer's brochure and includes a bar scale that allows consumers to compare the model with others of the same size and capacity.

The EnerGuide for Industry Program uses the EnerGuide name to encourage the use of more energy-efficient off-the-shelf industrial equipment, including equipment that is prescribed under Canada's *Energy Efficiency Regulations*. This equipment includes electric motors; dry-type transformers; heating, cooling and ventilation equipment; and certain lighting products. EnerGuide for Industry offers up-to-date product databases, Web-based applications and energy-use information that enable equipment buyers to compare the energy performance of various products and select the most energy-efficient model that meets their needs.

As well, the Regulations are consistent with and build on the ENERGY STAR® initiative in Canada. 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 prescribed in the Regulations that are also part of the ENERGY STAR initiative must meet levels of energy efficiency starting at 10 percent or more than the minimum performance levels set out in the Regulations in order to qualify for the ENERGY STAR symbol. As higher-performance products penetrate the market, ultimately their efficiencies become candidate standard levels.

## Standards

As a world leader in the use of energy efficiency standards, NRCan is committed to harmonizing federal 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, minimizes the regulatory burden on manufacturers, and avoids confusion for consumers.

For instance, the performance requirements in Canada's *Energy Efficiency Regulations* are similar to those in several Canadian provinces that regulate energy-using equipment manufactured and sold within their borders. Although NRCan works closely with these provinces to ensure maximum harmonization of standards, in some cases provincial regulations may differ from the federal requirements or may apply to other types of energy-using equipment.

Due to the highly integrated North American market, Canada's energy performance requirements for many products are also similar to those regulated in the United States. As well, Canada's EnerGuide labelling requirements are coordinated with the U.S. EnergyGuide labelling program. Harmonization work is also undertaken through the North American Energy Working Group, which involves Canada, the United States and Mexico.

The Asia-Pacific Economic Cooperation (APEC) organization is another important forum for regional cooperation on harmonization issues. Trade and investment liberalization and facilitation are high on the agenda of the APEC Energy Working Group (EWG). Among other initiatives, the EWG has been endeavouring to harmonize energy efficiency test methods and conformity assessment regimes of Asia-Pacific economies that use energy efficiency standards and labels as part of their environmental or energy programs.

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

## Compliance and Enforcement

The *Energy Efficiency 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 a range of enforcement measures, when necessary.

NRCan emphasizes self-monitoring, reporting, voluntary compliance and collaboration. However, the *Energy Efficiency Act* prescribes enforcement measures that can be used if dealers violate the law. Enforcement

activities include preventing products that do not meet the prescribed energy efficiency standard from entering Canada; preventing the sale or lease of non-compliant products in Canada; and fines. Violators can also be fined under the Canada Border Services Agency's (CBSA's) Administrative Monetary Penalty System 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 originating from two sources: energy efficiency reports and the import documents. Section 5 of the *Energy Efficiency Act* requires that dealers provide energy efficiency reports when they first market a new product model. They provide NRCan with such information as the energy performance of each particular model, the name of the testing agency, the size category and other facts, as described in Schedule IV of the Regulations.

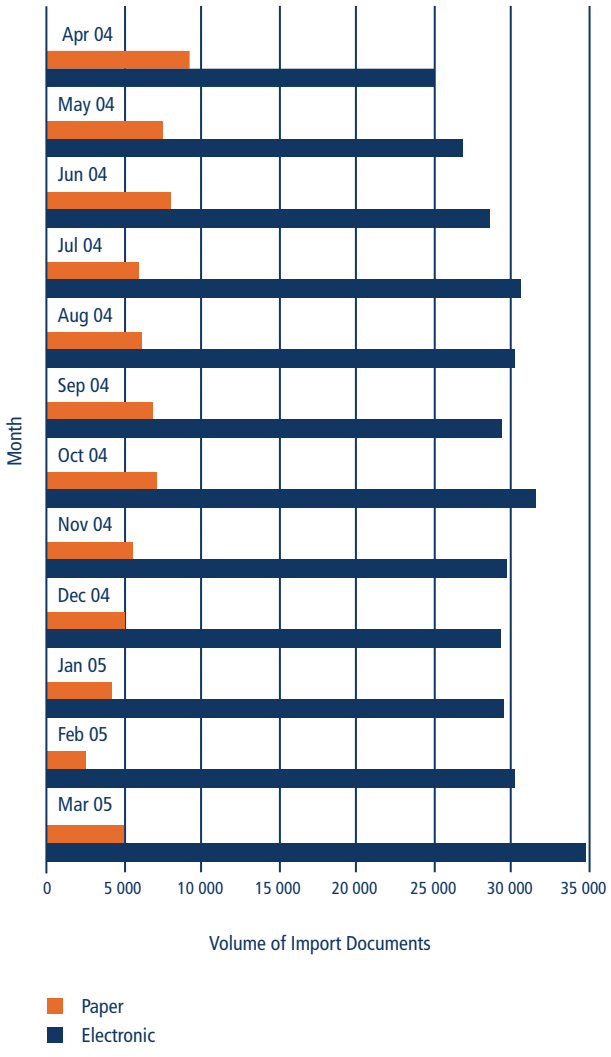
The Regulations require that when importing a regulated product to Canada, dealers must provide, on customs documents for CBSA officers, specific product information (type of product, brand name, model number, name and address of dealer and purpose of import) on all shipments. Customs documents contain much less information than the energy efficiency report, but there is enough to allow NRCan to verify that there is a matching energy efficiency report. NRCan is then in a position to verify that all products that enter Canada meet the required energy performance levels and to take action when necessary.

## Key 2004–2005 Achievements

- NRCan processed over 388 000 records (records from April 1, 2004, to February 28, 2005) relating to the importation of regulated energy-using products to Canada in 2004–2005. The graph below illustrates the volume of import documents received in paper and electronically per month over the 2004–2005 fiscal year.
- Over 127 000 new or revised model numbers were submitted to NRCan for entry into NRCan's equipment database (records from April 1, 2004, to March 21, 2005) from energy efficiency reports received from dealers.
- The processes for submitting the required energy efficiency reports were improved, thereby making it easier to update and process greater amounts of data in the database. This will have a positive effect on the system's monitoring capabilities.
- New reporting forms were developed for energy-using products added to the Regulations.
- Fact sheets and electronic bulletins were distributed to dealer, manufacturer and importer communities about new regulations on exit signs, chillers and dry-type transformers and the coming into force of Amendment 8 to the Regulations. Other communications included notices to stakeholders reminding them of the requirements of the Regulations. Instances of non-compliance were handled on a case-by-case basis in accordance with the Compliance Policy.

**FIGURE 2-1**

Monthly Import Volumes



## Regulatory Impact to Date per 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.*

As a result of Canada's minimum energy performance standards, it is estimated that an aggregate annual emissions reduction of 25.6 megatonnes will be achieved by 2010. This is equivalent to taking 4 million cars off the road. The net benefit to consumers from just the latest amendment that prescribes new standards for clothes washers, water heaters, chillers and exit signs is estimated to be $47 million by 2010. These benefits will continue to grow throughout the lifetime of the machines, which in some cases is 25 years.

**TABLE 2-1**

*Energy Efficiency Regulations* Impact (Aggregate Annual Savings)

| *Products (Amendment in brackets)* | *Energy Savings (PJ)* | | $CO_2$ *Reductions (Mt)* | |
|---|---|---|---|---|
| | *2010* | *2020* | *2010* | *2020* |
| Residential appliances | 117.20 | 133.84 | 13.26 | 15.60 |
| Lamps (fluorescent/incandescent) | 11.60 | 13.40 | 7.55 | 9.80 |
| Motors | 16.30 | 17.70 | 2.03 | 2.14 |
| Commercial HVAC | 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 hot water, exit signs, chillers (8) | 16.20 | 42.67 | 1.29 | 3.61 |
| A/C, commercial refrigeration (draft 9) | 1.57 | 5.35 | 0.16 | 0.53 |
| **Total** | **178.15** | **240.86** | **25.60** | **34.29** |

*Values different from RIAS due to emission factor change (using 99.3)

## Labelling and Promotion

Since 1978, the EnerGuide label has enabled Canadians to compare the energy consumption of an appliance with that of another. In 1995, placing an EnerGuide label on major electrical household appliances and room air conditioners became mandatory, with the introduction of the *Energy Efficiency Regulations*. Placing a label on a product before the first retail sale shows consumers how much energy a product uses, enabling them to consider the most energy-efficient purchase.

A voluntary EnerGuide rating for gas furnaces, central air conditioners and heat pumps was introduced in 1997. Since these products are typically purchased from a product brochure or catalogue, placing a label on the product would not be useful. Manufacturers are encouraged to print an EnerGuide rating in product brochures or catalogues, so consumers can compare the efficiency of the product when they are in the buying process. To date, manufacturers representing 85 percent of the products in the marketplace participate in the EnerGuide rating program and publish the ratings in their brochures.

In 2001, EnerGuide ratings for oil furnaces were introduced. In the fall of 2003, coincident with the requirement in Canada's *Energy Efficiency Regulations* to test, verify and report on fireplace efficiency, manufacturers were asked to integrate EnerGuide Fireplace Efficiency ratings in their brochures.

**FIGURE 2-2**

EnerGuide Label

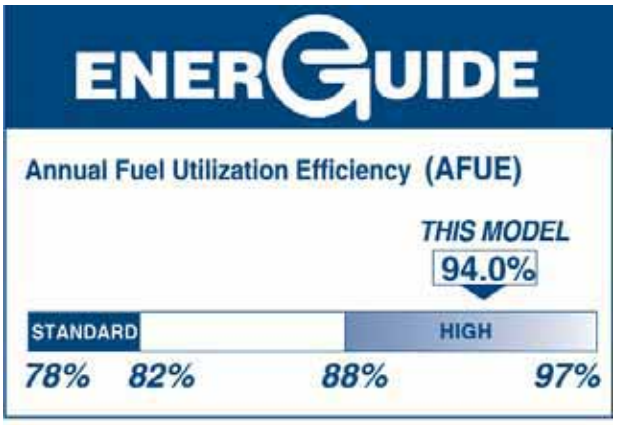
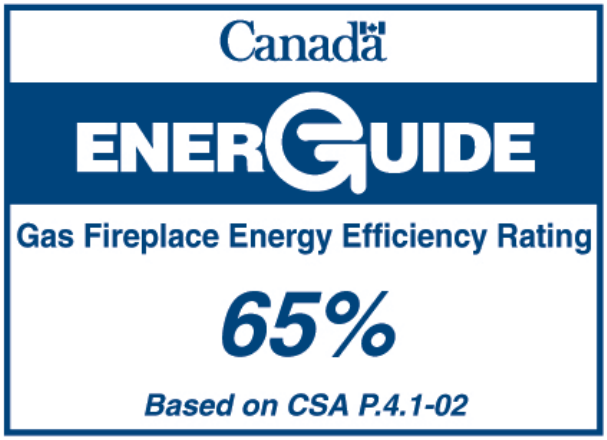



**FIGURE 2-3**

EnerGuide Label



EnerGuide directories with energy ratings for major appliances and room air conditioners are published each year and distributed to consumers, retailers and appliances sales people. In fulfilling requests for information, electric utilities and provincial governments also distribute the directories. On-line directories for all appliances and heating and cooling equipment are available and updated monthly.

Regularly conducted surveys indicate that over 50 percent of Canadians are aware of the EnerGuide label.

**FIGURE 2-4**

EnerGuide Label

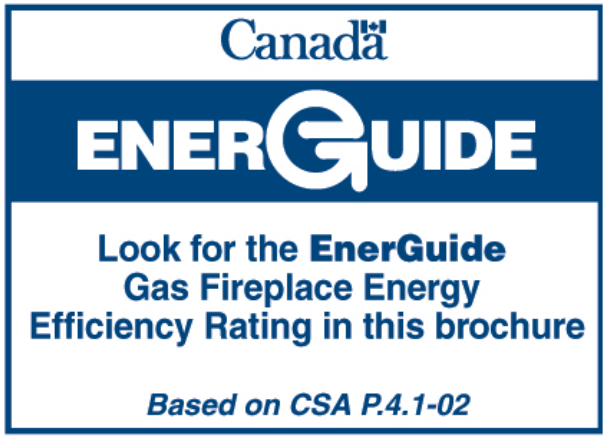



**FIGURE 2-5**

ENERGY STAR® Label


Responding to a desire by Canadians to have a labelling system designed to identify the best performers, Canada officially introduced, in 2001, ENERGY STAR, the international symbol for energy efficiency. An agreement was signed with the U.S. Environmental Protection Agency and the U.S. Department of Energy. The Office of Energy Efficiency is the official custodian of the program for Canada. Canada became the fifth country to join the ENERGY STAR program with Australia, New Zealand, Japan and Taiwan. The European Union has adopted ENERGY STAR for office equipment.

ENERGY STAR establishes high efficiency criteria and levels for select products for the residential and commercial sectors. Product categories are selected for the technical potential for high efficiency. This is a voluntary program. However, organizations must demonstrate that products meet the admissibility criteria and high performance levels endorsed by ENERGY STAR. For appliances and heating and cooling products, the criteria are based on the same test standards as those required under the *Energy Efficiency Regulations* and are used to qualify products for the ENERGY STAR symbol.

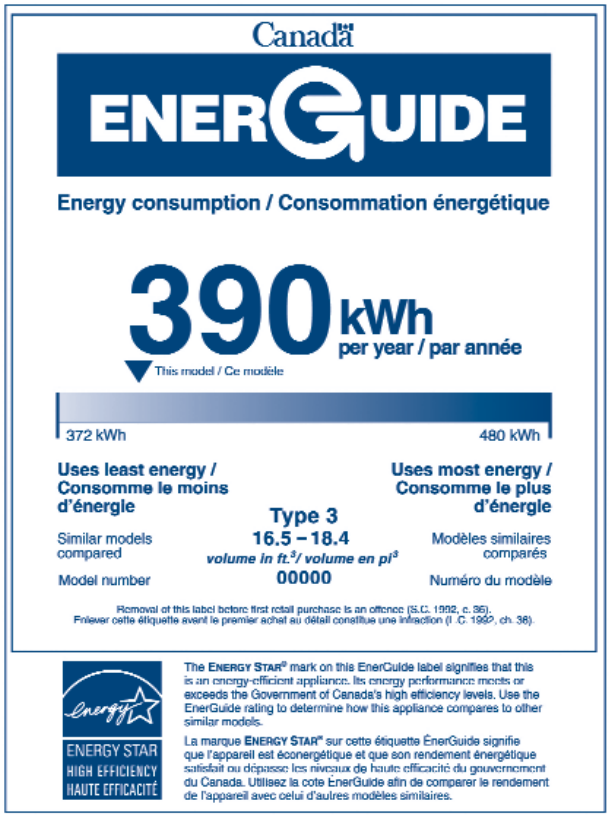
Canada promotes specific product categories where levels and criteria can be harmonized with those of the United States, including the following:

- Major appliances
- Heating, cooling and ventilation
- Consumer electronics
- Office equipment
- Windows and doors (Canadian levels)
- Some lighting (not fixtures)
- Some commercial equipment

Canada has also integrated ENERGY STAR with the EnerGuide label for 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. ENERGY STAR also combines with EnerGuide ratings for gas furnaces, central air and air-to-air heat pumps.

## FIGURE 2-6

EnerGuide/ENERGY STAR Label




Having established industry-accepted norms for high efficiency, ENERGY STAR has become the criterion to meet for incentive and rebate programs.

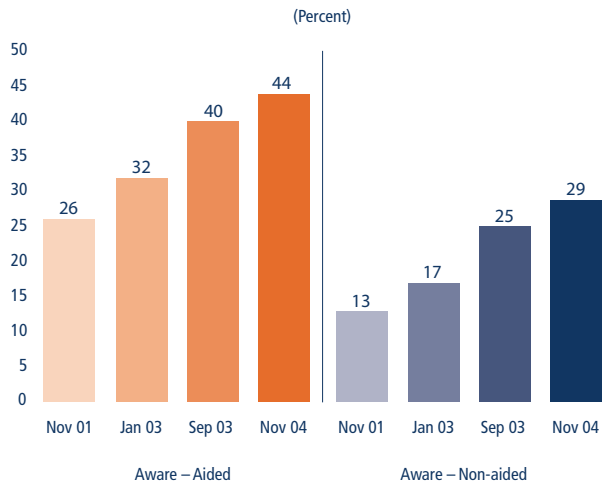
As part of the *Government of Canada Action Plan 2000 on Climate Change,* pilot projects have been implemented in partnership with seven Canadian gas utilities and a non-government organization to promote the purchase of ENERGY STAR qualified gas furnaces and boilers. From 2001 to 2005, 57 365 rebates for high-efficiency furnaces and boilers have been provided to Canadians. The partners' contribution amounted to $12 million; Canada's, $8 million. With NRCan participation, some utilities doubled the number of rebate and/or loan recipients compared to their previous programs. The participating organizations also coordinated the delivery of coupons by manufacturers, to complement the incentive. These incentives were designed to address three major barriers to higher efficiency: awareness, accessibility to high-efficiency products and acceptance.

ENERGY STAR was also used as the basis for sales tax rebates in Ontario and Saskatchewan for the purchase of qualifying appliances (refrigerators, dishwashers, clothes washers and freezers). Organizations across Canada have used ENERGY STAR as a campaign driver to promote replacement with, or purchase of, higher efficiency products.

Surveys on the awareness of ENERGY STAR have shown an increase in awareness and understanding of the symbol since 2001. Recognition of ENERGY STAR has evolved from seeing the symbol on computer equipment, to more often seeing it on major appliances.

## FIGURE 2-7

Awareness Levels of ENERGY STAR in Canada




As a result of continued efforts to promote ENERGY STAR qualified appliances, industry figures show an increase in market penetration.

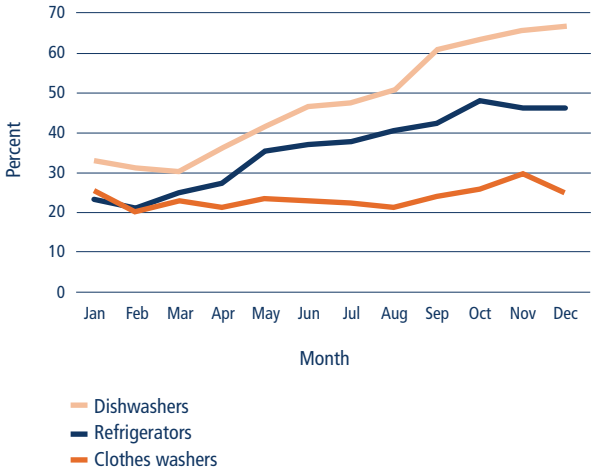
ENERGY STAR is also well known in the commercial sector, with criteria for products ranging from office equipment to traffic signals. NRCan supports demonstration projects to validate the savings and other benefits of some of these products and address barriers to their widespread acceptance. One example would be support for the installation and monitoring of LED traffic signals in Winnipeg to confirm their excellent performance in cold-weather climates.

Canada has introduced ENERGY STAR guidelines for procurement officials. It has developed an interactive cost calculator that compares energy cost savings and GHG emissions reductions associated with the purchase of ENERGY STAR qualified products. A series of workshops were launched across Canada to make governments, institutions and city officials aware of the ENERGY STAR criteria and procurement tools. ENERGY STAR will also be featured prominently in the new federal green procurement policy.

Canada continues to expand the type of products included in its ENERGY STAR agreement. As an example, Canada has recently included vending machines, commercial refrigeration, compact fluorescent lamps and commercial clothes washers in its exchange of letters with the United States government.

**FIGURE 2-8**

ENERGY STAR Qualified Appliances as a Percent of Total Category Sales in Canada in 2003



# Chapter 3: Housing

## 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, heating water, and operating appliances, electronic equipment and lights. This sector accounts for 17.2 percent (1458 petajoules) of secondary energy use and 15.9 percent (80 megatonnes) of greenhouse gas (GHG) emissions.

Most dwellings in Canada are single detached houses, followed by apartments, single attached dwellings and mobile homes (see Figure 3-1). Because single detached and attached houses predominate, most Natural Resources Canada (NRCan) residential building programs focus on these types of dwellings.

Space and water heating make up 81.3 percent of residential energy use, followed by the shares devoted to operating appliances, lighting and space cooling (see Figure 3-2).

Between 1990 and 2003, residential energy use increased by 13.0 percent, or 168 petajoules (from 1289 to 1458 petajoules). From 1990 to 2003, GHG emissions from the residential sector increased by 14.8 percent. GHG intensity changed little because fuel switching towards less GHG-intensive fuels offset an increase in the GHG intensity of electricity production over the period.

Four main factors tended to influence residential energy use – activity, weather, structure and energy efficiency:

- activity – the increase in the number of households and the size of dwellings (the principal measures of residential activity) increased energy use by 25.7 percent (332 petajoules).
- weather – a colder winter and a warmer summer in 2003 compared with 1990 led to an increase in space-conditioning requirements. This increased energy use by 3.3 percent (42 petajoules).
- structure – the percentage shares of energy end-uses changed over the period such that they increased energy use by 3.5 percent (45 petajoules).
- energy efficiency – improvements in energy efficiency decreased energy use by 19.4 percent (251 petajoules).

**FIGURE 3-1**

Canadian Households by Type of Dwelling, 2003

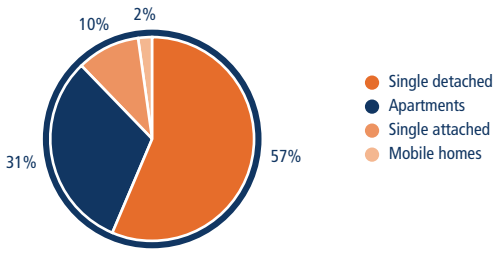
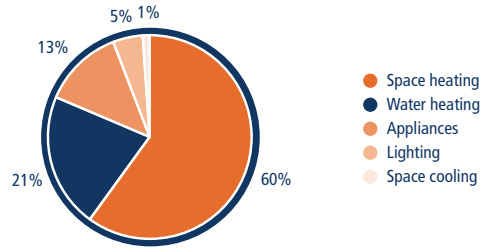



**FIGURE 3-2**

Residential Energy Use by Purpose, 2003




Growth in residential energy use was driven in large part by growth in activity. This increase was partially offset by significant improvements in energy efficiency. Structural changes had a minor impact on residential energy use.

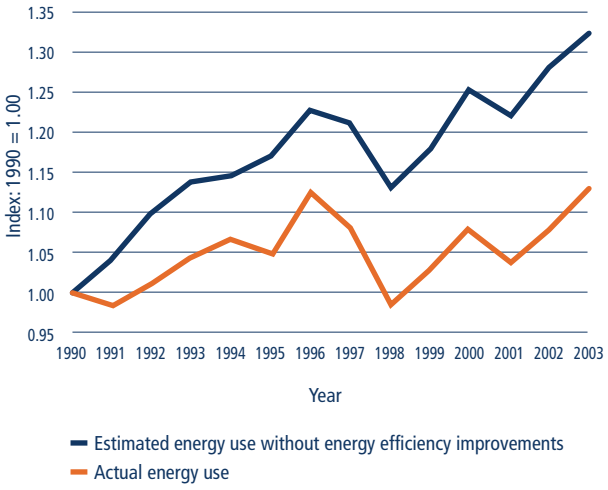
The change in overall residential energy use from the years 1990 to 2003, as well as the estimated energy savings due to energy efficiency, is shown in Figure 3-3. Figures 3-4 and 3-5 show how energy consumption differs for houses built to different standards and in different periods, reflecting improvements in building construction. Figure 3-6 shows how average energy consumption of new appliances has improved by comparing 1990 and 2003 models.

NRCan delivers initiatives to increase energy efficiency in the following residential sub-sectors:

- new houses
- existing houses
- residential equipment (refer to Chapter 2)

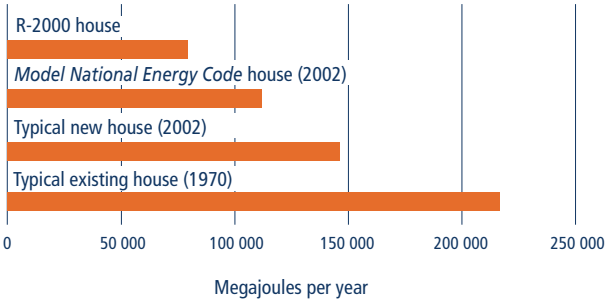
## FIGURE 3-3

Residential Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2003




## FIGURE 3-4

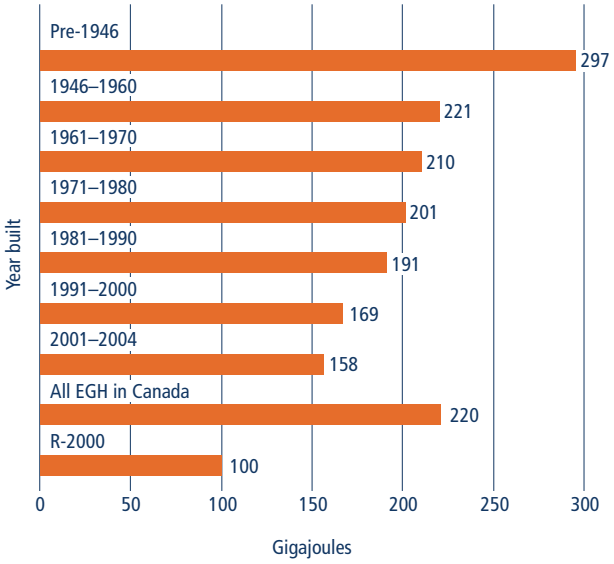
Annual Heating Consumption for Houses* Constructed to Different Standards




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

## FIGURE 3-5

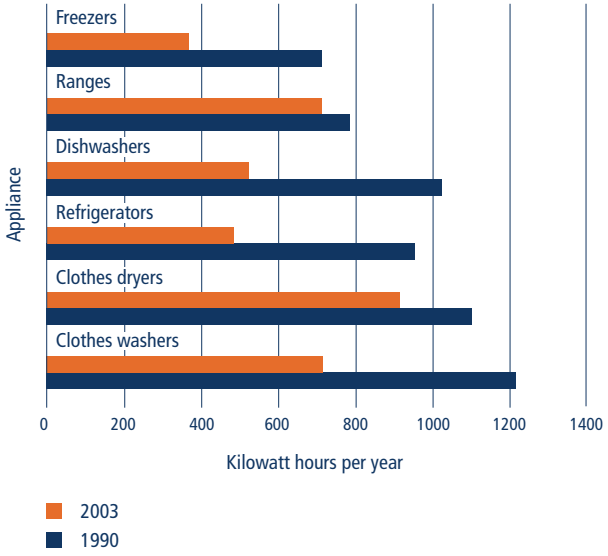
Average Energy Consumption per Household*, Pre-1946 to 2001–2004 Construction




* From R-2000 and EnerGuide for Houses programs

## FIGURE 3-6

Average Energy Consumption of New Appliances, 1990 and 2003 Models



## New Houses: R-2000 Standard and EnerGuide for (New) Houses

**Objective: To increase market adoption of energy-efficient new houses by promoting changes in construction practices and by labelling houses for energy performance.**

The R-2000 Standard is a voluntary technical performance standard that encourages Canadian builders to build, and Canadian consumers to purchase, houses that are more energy efficient and environmentally responsible than is required by current Canadian building codes. NRCan trains and licenses R-2000 homebuilders and other professionals in R-2000 Standard construction techniques and practices, and provides third-party quality assurance by testing and certifying R-2000 homes.

EnerGuide for (New) Houses is an energy-performance rating and labelling scheme designed to encourage the industry to build, and consumers to purchase, more energy-efficient houses. The EnerGuide for Houses (EGH) scheme is based on the R-2000 Standard and training, and it targets large-volume, mass-market builders.

Key 2004–2005 Achievements

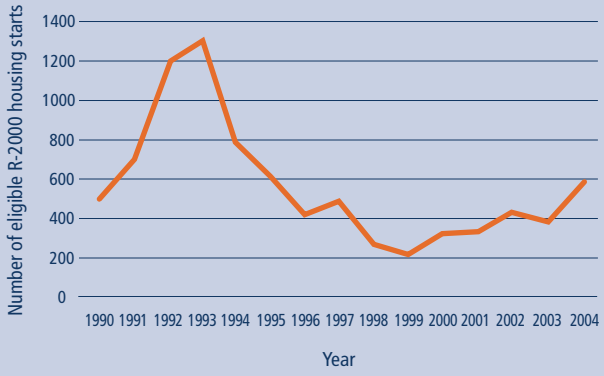
- Over 2200 industry professionals received training in energy-efficient construction techniques and the sizing and installation of high-efficiency heating and ventilation systems.
- EnerGuide for New Houses rating scheme was launched; over 40 of Canada's largest tract builders are participating.
- Building Canada teams from western, central and eastern Canada are now involved in recruiting and training key, very large-volume builders to construct and EGH-label energy-efficient houses.

*For more information:*
oee.nrcan.gc.ca/r-2000/english

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

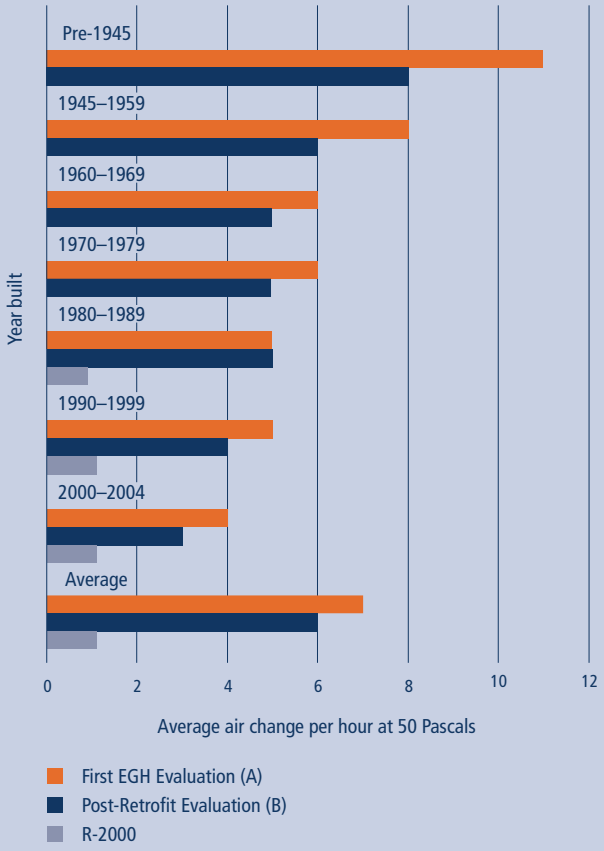
### FIGURE 3-7

Number of Eligible R-2000 Housing Starts, 1990 to 2004




### FIGURE 3-8

National Trends in Air Leakage, Pre-1945 to 2000–2004 Construction



## New Houses: Housing Energy Technology Program

**Objective: To accelerate the development and market adoption of energy-efficient housing technologies.**

Working in partnership with associations, government and industry, the CANMET Energy Technology Centre (CETC) manages this program to develop and deploy highly specialized solutions that help reduce, in a cost-effective manner, the energy consumption and GHG emissions of Canadian houses. Progress to date includes the identification, accelerated development and broader deployment of a number of promising technologies, such as advanced integrated mechanical systems (now trademarked ēKOCOMFORT™) and electronically commutated motors.

In whole house design, the development and technical support of the R-2000 Standard has led to extensive technology development and deployment throughout the housing sector. Through its associated Building Energy Simulation Program, CETC's software tools are widely used to assess the energy use in a home. CETC also develops more energy-efficient frames for windows and is a lead managing agency for the Canadian Centre for Housing Technology (CCHT), an advanced testing facility for assessing whole-house impacts of emerging technologies.

Key 2004–2005 Achievements

- Field trials with five manufacturing groups of the ēKOCOMFORT system were completed. These involved oil and gas installations in new and retrofit units in southern Ontario and Nova Scotia. First generation products proved to be robust and carry out expected functions in the field. The results also indicated significant electrical savings. These results are now being used by manufacturers that are developing second generation products.
- Three residential Combined Heat and Power (CHP) technologies have been installed at the CCHT in the last year. These include the first Canadian installation of a residential fuel cell; the installation of three residential-scale solar photovoltaic systems; and both the installation and testing of a Stirling Engine.
- Completed an assessment of energy-efficient ventilation strategies that improve indoor air quality. Results showed that running your furnace fan at frequent and regular intervals does improve the indoor air quality of a home by ensuring sufficient fresh air in all spaces throughout the house at appropriate times. This was shown to be a less costly alternative to running the fan continuously.

*For more information:*
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_bg_e.html

ēKOCOMFORT is a Trademark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

## New Houses: Super E™ House Program

**Objective: To build capacity for exporting energy-efficient, durable and environmentally friendly Canadian housing technology to foreign markets.**

The Super E™ House Program is a strategic housing export initiative delivered by NRCan as part of the Team Canada export strategy. The program adapts internationally leading Canadian energy efficiency standards to foreign markets and identifies appropriate technologies for them to create unique market opportunities for Canadian housing technology companies. Launched in 1998, the Super E House Program has facilitated partnerships between Canadian builders and their foreign counterparts to increase market penetration of Canadian energy-efficient technologies internationally.

The Canada Mortgage and Housing Corporation (CMHC), the Canadian Forest Service (CFS) and CETC financially support the Super E U.K. program. The Super E Japanese program is financially supported by CETC with in-kind support from CMHC. In both cases, there is strong support from the Department of Foreign Affairs and International Trade (now divided into Foreign Affairs Canada and International Trade Canada). Industry members also contribute to the success of the program through in-kind and financial contributions (member fees).

The Super E House Program is attracting demand and generating real economic benefits back to Canada in the form of at least $30 million for Canada to date. There are 65 Canadian and international companies involved in the program and over 550 houses have been built or contracted in Japan and the U.K.

Key 2004–2005 Achievements

- Launched a new partnership with CMHC to incorporate seniors and flex housing elements into the Super E program in Japan. There is a documented demand for energy-efficient, healthy and comfortable facilities for the growing population of seniors in Japan.
- A five-year contract was signed under the Super E program in the U.K. for 1400 Super E units commencing in January 2005. This represents $100 million in value.
- Official opening of a Super E demonstration house in Beijing, China, was held in March 2005, one of two projects currently active in China. The project was built in partnership with the Council of Forest Industries and the Chinese Academy of Forests. The home will be monitored for energy performance and wood moisture content, and the results will help guide future energy and building code regulatory policy in China for low-rise wood-frame housing.

*For more information:*
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_bg_e.html

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

## Existing Houses: EnerGuide for Houses and Retrofit Incentives

**Objective: To encourage Canadians to improve the energy efficiency of their homes.**

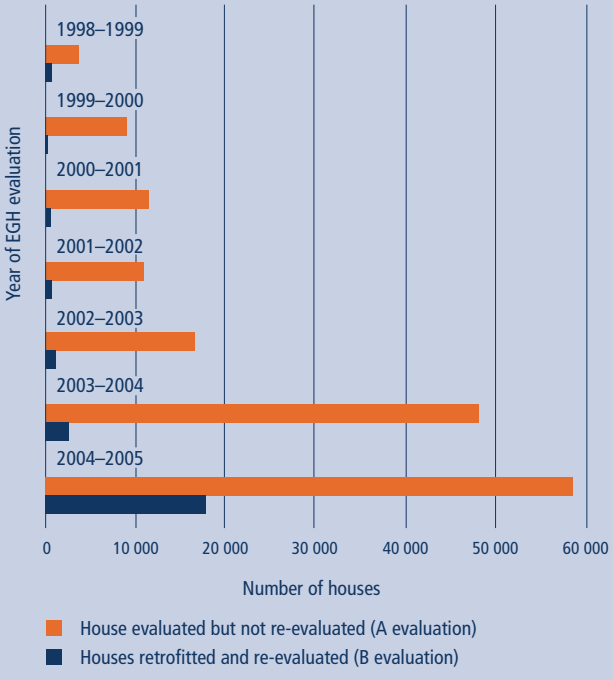
EnerGuide for Houses (EGH) provides Canadian homeowners with personalized expert advice on how to best improve the energy performance of their houses, especially when undertaking renovation and maintenance projects. Under EGH, a retrofit incentive was officially launched in October 2003. Homeowners can now qualify for a non-taxable grant, which represents about 10 to 20 percent of their expenditures, when they retrofit their homes. The grant is based on the differential improvement in the house's energy rating, as measured by a pre- and post-renovation EGH energy evaluation.

Key 2004–2005 Achievements

- Over 77 000 houses evaluated and labelled.
- Issued over 17 000 grants, totalling over $10 million.
- Reduced energy consumption by an average 27 percent in post-retrofit homes; grant recipients reduced carbon dioxide by an average of 4 tonnes per year, per house.

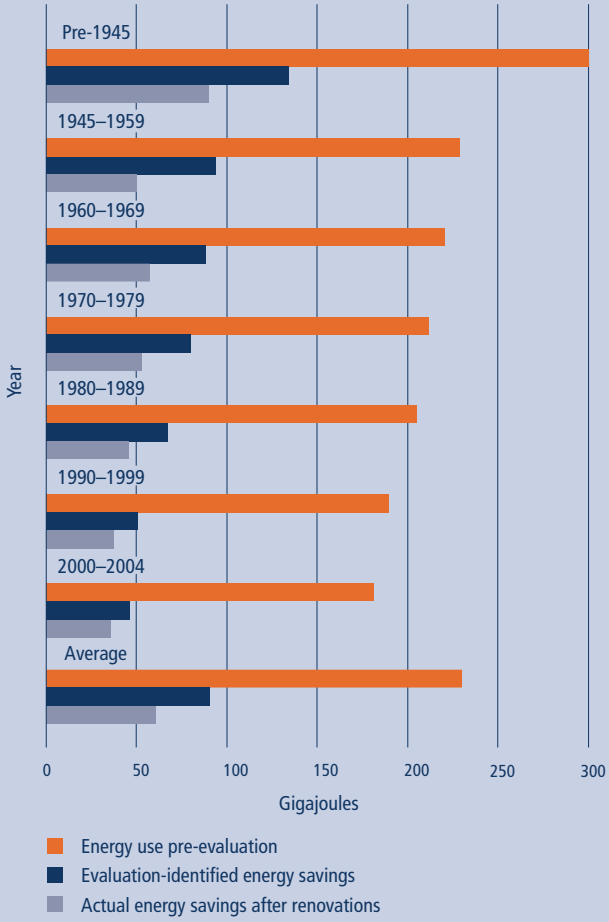
### FIGURE 3-9

Evaluations Under EnerGuide for Houses, 1998–1999 to 2004–2005




### FIGURE 3-10

Residential Energy Use and Energy Savings per Household, Pre-1945 to 2000–2004




*For more information:*
energuideforhouses.gc.ca

# Chapter 4: Buildings

## 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, space cooling, lighting, motive power for services such as pumping and ventilation in buildings, and street lighting.

In 2003, the total commercial/institutional sector accounted for 14.0 percent (1181 petajoules) of secondary energy use and 13.8 percent (69.3 megatonnes) of greenhouse gas (GHG) emissions.

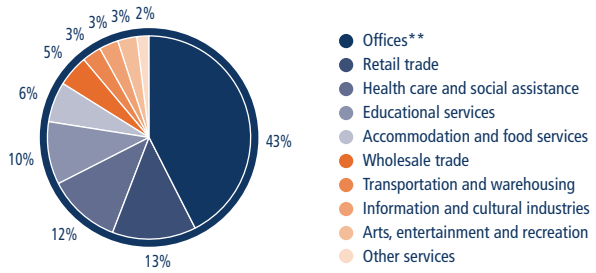
To highlight energy use in commercial/institutional activities, the following analysis excludes energy use for street lighting. The commercial/institutional sector comprises many activity types (see Figure 4-1). Retail trade and offices account for more than half of commercial/institutional sector energy demand. Health care and social assistance, accommodation and food services, and educational services account for another 28 percent of that demand. Natural Resources Canada's (NRCan's) initiatives address all of these major energy-using activity types.

Energy is used for six purposes in commercial/institutional activities. The largest of these is space heating, which accounts for more than half of energy use in this sector (see Figure 4-2). Each of the remaining five uses of energy accounts for between 6 and 13 percent of energy demand in this sector.

Between 1990 and 2003, commercial/institutional energy use, excluding street lighting, increased by 36.6 percent, or 314 petajoules (from 858 to 1172 petajoules). However, GHG emissions from the sector rose by 45.2 percent in the same period. Emissions increased more quickly than energy use due to the increased use of energy sources with a higher GHG content.

**FIGURE 4-1**

Commercial/Institutional Energy Use by Activity Type*, 2003

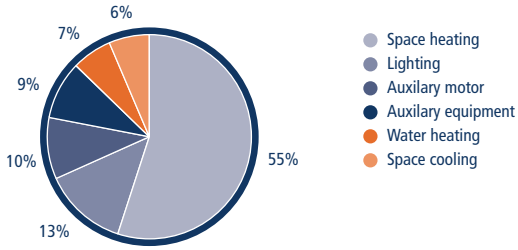



* Excludes street lighting

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

**FIGURE 4-2**

Commercial/Institutional Energy Use by Purpose*, 2003




* Excludes street lighting

During 1990–2003, a steady increase in activity largely contributed to increased energy use. To a lesser degree, the service level for auxiliary equipment, structure (the mix of building types) and weather also each played a role. However, energy efficiency slowed this rate of increase. Specifically, the energy use changes attributed to each of these factors are

- activity – a 25 percent increase in floor space resulted in a 223-petajoule increase in energy use
- weather – fluctuations in weather resulted in a 3.4 percent increase in energy use (29 petajoules)
- structure – a shift in activity resulted in a 0.1 percent increase in energy use (1 petajoule)
- service level – a higher service level for end-users resulted in an 8.3 percent increase in energy use (71 petajoules)
- energy efficiency – a 1.1 percent improvement in energy efficiency resulted in a decrease of 10 petajoules

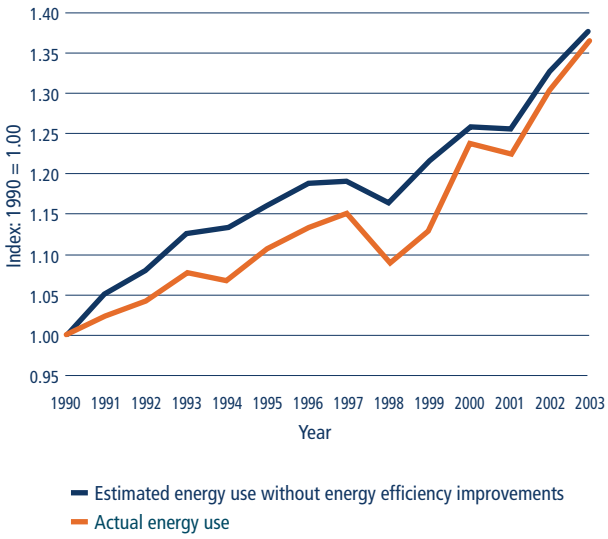
Without improvements in energy efficiency, increases attributable to activity, weather, structure and service level would have led to an increase in commercial/institutional energy use of 37.7 percent (323 petajoules). However, as a result of a 1.1 percent improvement in energy efficiency, actual energy use increased by 36.6 percent. This change in energy use during 1990–2003, as well as the estimated energy savings due to energy efficiency, is shown in Figure 4-3. Figure 4-4 shows how energy use in commercial buildings compares to certain standards.

NRCan delivers initiatives to increase energy efficiency in the following sub-sectors of the commercial/institutional sector:

- new buildings
- existing buildings
- equipment (refer also to Chapter 2)
- community energy systems

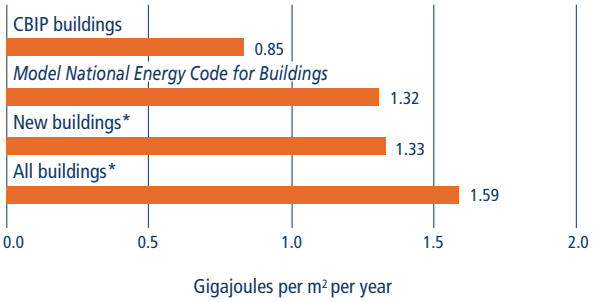
## FIGURE 4-3

Commercial/Institutional Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2003




## FIGURE 4-4

Energy Use in Commercial Buildings




* Source: Commercial and Institutional Building Energy Use Survey (CIBEUS), 2000. Estimates relate only to the surveyed area of populations over 175 000, and in Atlantic Canada to populations over 50 000.

## New Buildings: Commercial Building Incentive Program

**Objective: To improve the energy efficiency of new commercial, institutional and multi-unit residential buildings.**

The Commercial Building Incentive Program (CBIP) provides financial incentives to builders and developers who incorporate energy-efficient features into the design and construction of new commercial, institutional and multi-unit residential buildings. To qualify for the incentive, buildings must be at least 25 percent more energy efficient than similar buildings constructed to the *Model National Energy Code for Buildings* (MNECB). However, results indicate that CBIP buildings are on average 35 percent better than similar buildings constructed to the MNECB. The program is delivered by the Government of Canada and co-marketed by a number of provincial/territorial utilities, provincial/territorial energy efficiency and climate change agencies, and building professional organizations.

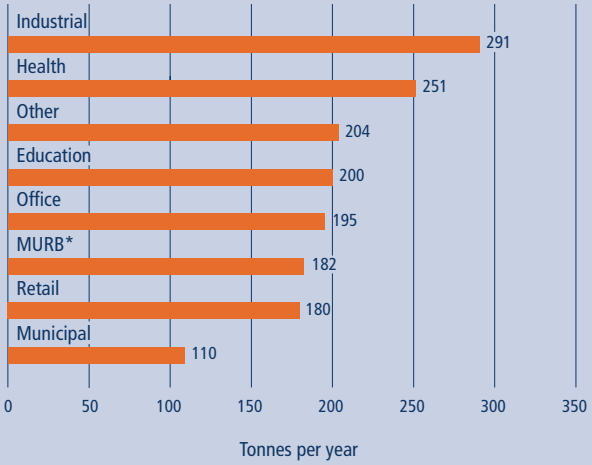
Key 2004–2005 Achievements

- Incentives given to 165 projects during 2004–2005, representing 32 percent of the 519 projects incented since the launch of the program in 1998.
- Through its partnership with the Canada Green Building Council (CaGBC), the CBIP criteria of 25 percent better than the MNECB was adopted as a prerequisite for the LEED (Leadership in Energy and Environmental Design) Green Building Rating System.
- The Retail Food sector, which accounts for about 30 percent of new construction activity in Canada, became fully engaged in the program, with 42 newly constructed supermarkets achieving the CBIP criteria in 2004–2005.

*For more information:*
oee.nrcan.gc.ca/newbuildings

**FIGURE 4-5**

Estimated Average GHG Reductions by Type of Institution Under CBIP, 2004




*Multi-unit residential building

## New Buildings: Industrial Building Incentive Program

**Objective: To improve the energy efficiency of new industrial buildings.**

The Industrial Building Incentive Program (IBIP), a demonstration program, extends the precepts of CBIP to the industrial sector. IBIP offers an incentive to companies building new energy-efficient industrial facilities to offset additional design costs inherent in the initial attempts at energy-efficient designs and building/process integration. The design is assessed against a reference generated from the MNECB.

Key 2004–2005 Achievements

- Five contribution agreements were signed, bringing the number of projects supported since the launch of the program in 2002 to 20.
- Three case studies were prepared.
- The *IBIP Technical Guide* was updated.

*For more information:*
oee.nrcan.gc.ca/newbuildings

## New Buildings: Green Buildings Program

**Objective: To reduce energy use, resource consumption and emissions from commercial buildings through design, construction and retrofitting while increasing cost-effectiveness.**

The program plays a significant role in establishing goals for energy efficiency and sustainability in commercial buildings through a variety of key activities. Through CETC's C-2000 Program for Advanced Commercial Buildings – which was a small demonstration program for high-performance buildings – CETC worked with industry to demonstrate buildings that reduce energy consumption by 50 percent and water consumption by 40 percent. The program continues to provide the necessary tools, guidelines and techniques through its integrated design process (IDP) for industry and associations to use to produce optimized, energy-efficient green buildings and green building programs.

The program also provides ongoing support to NRCan programs such as CBIP by developing guidelines, providing technical support and developing downloadable simulation software tools that perform accurate building analysis, assist in design and measure compliance with these incentive programs.

NRCan launched the Green Building Challenge (GBC) in 1996 (now managed by a third party) and established Sustainable Building conferences to showcase the results and best practices of the competing energy-efficient buildings. GBC brings together more than 20 countries focused on the development and testing of an internationally accepted system for assessing the environmental performance of buildings. The NRCan-developed electronic GBTool™ is used in the assessments.

Key 2004–2005 Achievements

- Recently, the new $7.5-million, 50 000-square-foot Canadian headquarters for Smith Carter Architects and Engineers Incorporated officially opened in Winnipeg, having been designed with assistance from CETC's C-2000 experts. It is being hailed as the most energy-efficient, environmentally friendly office in Manitoba and one of the greenest in Canada.

- CETC supported the development of LEED Canada – an industry-driven assessment system for green buildings – by helping with the development of criteria for its rating system and participating in the committee that helped form CaGBC, the organization responsible for LEED Canada.
- CETC assisted in development of the new version of its GBTool™, which was used by international teams to assess submissions for the 2005 World Sustainable Building Conference held in Tokyo in September 2005.

*For more information:*
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_bg_e.html

GBTool is a Trademark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

## Existing Buildings: Energy Innovators Initiative

**Objective: To encourage commercial businesses and public institutions to become more energy efficient and reduce their GHG emissions that contribute to climate change.**

The Energy Innovators Initiative (EII) helps commercial organizations and public institutions explore energy efficiency options and strategies, offering them access to tools and financial assistance to help reduce energy costs and improve competitiveness. Members join the EII by sending a letter to the Minister of Natural Resources from senior management stating their commitment to energy efficiency. Currently, over 2000 commercial, institutional and multi-unit residential organizations across Canada are Energy Innovators.

After joining the EII, members can apply for Energy Retrofit Assistance (ERA) funding for retrofit planning activities and retrofit implementation projects in existing commercial/institutional buildings.

Key 2004–2005 Achievements
- EII program membership surpassed 2000 Canadian organizations.
- Twenty-one formal partnerships were established through contribution agreements with member-based associations.
- Since 1998, approved energy retrofit projects have involved over 4800 member buildings.

**TABLE 4-1**

Energy Innovators Initiative – Incentive Projects, 1998 to 2005 (Millions of dollars)

| | |
|---|---|
| Federal incentive | 52.3 |
| Client investment | 888.1 |
| Annual energy cost savings | 122.8 |

*For more information:*
oee.nrcan.gc.ca/eii

## Equipment: Refrigeration Action Program for Buildings

**Objective: To support the development and the adoption of innovative refrigeration technologies that reduce energy consumption, synthetic refrigerant use and GHG emissions in commercial and institutional buildings.**

The Refrigeration Action Program for Buildings (RAPB) was launched in 2003 under the *Climate Change Plan for Canada* and focuses on the deployment of innovative refrigeration technologies integrated with a building's heating, ventilating and air-conditioning (HVAC) systems, in order to drastically reduce refrigerant losses, allow the recovery and upgrade of the heat rejected by the refrigeration system, and adapt the system's operation to the Canadian climate. To meet its objective, the RAPB performs capacity building, demonstration, information and training activities in partnership with key stakeholders, for Canadian supermarkets, ice rinks and curling rinks. The RAPB also undertakes research and development activities on refrigeration technological solutions.

Key 2004–2005 Achievements

- Launched and are successfully operating a demonstration project of innovative integrated HVAC and refrigeration technologies at the Loblaws Inc. supermarket in Repentigny, Quebec. CETC–Varennes provided technical support for the design and installation phases of the project and carries out performance analysis of the system implemented.
- Commenced three demonstration projects of an innovative integrated HVAC and refrigeration system for ice rinks, manufactured by the Canadian company CIMCO Refrigeration (a Division of Toromont Industries Ltd). The projects are in Fort Saskatchewan, Alberta; Pilot Mound, Manitoba; and La Pêche, Quebec. CETC–Varennes will provide technical support and carry out performance analysis of the implemented systems.
- As part of the deployment program, training sessions and workshops have been launched across Canada to create awareness of and build capacity on innovative refrigeration technologies and practices.

*For more information:*
cetc-varennes.nrcan.gc.ca/en/ref.html

## Equipment: Buildings Program – Intelligent Buildings

**Objective: To develop and promote the adoption of intelligent building technologies and innovative building operation practices that reduce energy consumption and GHG emissions.**

The program focuses on intelligent building technologies and practices, such as re-commissioning, that reduce a building's energy consumption while ensuring the occupants' comfort and preserving indoor air quality. To meet its objectives, the program develops, demonstrates and deploys, in partnership with key stakeholders, intelligent buildings technologies in Canadian commercial/institutional buildings.

Key 2004–2005 Achievements

- Organized, at CETC–Varennes, RECOM 2004 – a workshop to increase awareness about the impacts of the optimization of building operation. The workshop attracted more than 50 people from the public, private and academic sectors.
- Signed a Memorandum of Understanding between CETC–Varennes and Public Works and Government Services Canada for optimizing the operation of eight federal buildings across Canada using the software tool DABO, the Diagnostic Agent for Building Operators, developed by CETC–Varennes.

*For more information:*
cetc-varennes.nrcan.gc.ca/en/b_b/bi_ib.html

## Equipment: Building Energy Simulation Program

**Objective: To contribute to the improvement of design, performance, cost-effectiveness, integration and deployment of energy-efficient building technologies and techniques, through simulation modelling and applications-driven implementation tools for the market.**

Through this program, the Simulation Team develops, distributes and supports building simulation software for the Canadian housing and building industry. These software tools are used by architects and engineers to optimize the energy performance of individual technologies and whole building designs, as well as to demonstrate compliance with such programs as the R-2000 Standard, EnerGuide for Houses and (New) Houses, CBIP, the *Model National Energy Code for Buildings* and the *Model National Energy Code for Houses*. The team is involved in all aspects of the software development process, from design and programming to distribution, maintenance, and user training and support.

The Simulation Team developed the next generation residential energy analysis software, HOT3000™, a more advanced version of HOT2000™, with a more comprehensive and expandable simulation engine (based on the ESP-r program). HOT3000 is capable of expanding to meet the complexities of the energy-saving technologies and strategies entering the market and emerging in industry research and development. The ESP-r program was created by the University of Strathclyde in Scotland and modified by CETC to meet Canadian simulation needs. The University of Strathclyde remains a collaborator on several simulation software development projects.

Key 2004–2005 Achievements

- Developed $H_2$ Cogen, a software program to help analyse the feasibility of wind-generated hydrogen-based building cogeneration systems. This system is based on the idea that excess electricity generated by a wind farm is converted into hydrogen at the building site, stored and then converted back to electricity when the building needs cannot be met directly by the wind farm.
- Continued to take a leading role in developing and validating methods for modelling cogeneration systems, by chairing a research annex for the International Energy Agency. This work included the development of a Stirling Engine model within a whole-building simulation program as well as an advanced version of a solid-oxide fuel cell model. These are important advancements in the analysis and study of distributed generation systems for buildings. Further validations of these new models will continue into the next year.
- Using CETC software, 200 000 houses and over 500 commercial buildings have been simulated for improved energy efficiency to date. Since the announcement of the EnerGuide for Houses retrofit incentive, on average, CETC software is being used 275 times per day.

*For more information:*
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_bg_e.html

HOT2000 is an official mark of Natural Resources Canada.

HOT3000 is a Trademark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

## Community Energy Systems: Community Energy Systems Program

**Objective: To increase the sustainability of Canadian communities by addressing their energy needs.**

This program works in partnership with Canadian communities and businesses to address energy needs through a holistic approach to energy efficiency, renewable energy and community energy planning. NRCan has supported many district energy projects (some of which are based on renewable energy such as using waste energy from the local power plants) in Ontario, Prince Edward Island, Northwest Territories, Nunavut and Yukon. NRCan continues to help communities to develop Sustainable Community Energy Plans, using tools that are designed to reduce energy demand, emphasize conservation and promote reliance on local renewable energy sources.

Key 2004–2005 Achievements

- Continued the community energy training program and held workshops in New Brunswick, Nova Scotia and Prince Edward Island.
- Provides the planning methodology which enables municipalities to develop a long-term growth strategy while minimizing energy consumption and maximizing renewable energy. This is now being used by municipalities across the country.
- Completed the laboratory testing of a jet ejector to provide cooling using microturbine exhaust. Experiments with super-charging of microturbines has resulted in increased electrical output.

*For more information:*
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_ces_e.html

# Chapter 5: Industry

## Energy Use and Greenhouse Gas Emissions

The industrial sector includes all manufacturing industries, all mining activities, forestry and construction; however, it excludes electricity generation. This sector uses energy in industrial processes as a source of motive power to produce heat or to generate steam. Overall, industrial energy demand accounts for 38.4 percent (3246 petajoules) of secondary energy use and 33.7 percent (169 megatonnes) of greenhouse gas (GHG) emissions (including electricity-related emissions).

Within the industrial sector, energy is consumed primarily in pulp and paper, mining, petroleum refining, and smelting and refining industries. Pulp and paper alone accounted for about 26.2 percent of total industrial energy demand in 2003 (see Figure 5-1).

In most industries, energy purchases account for only a small proportion of total expenditures. However, for some relatively energy-intensive industries – cement, chemicals, and pulp and paper – this share is higher than 13 percent (see Figure 5-2). For cement, in particular, the share is as high as 38 percent.

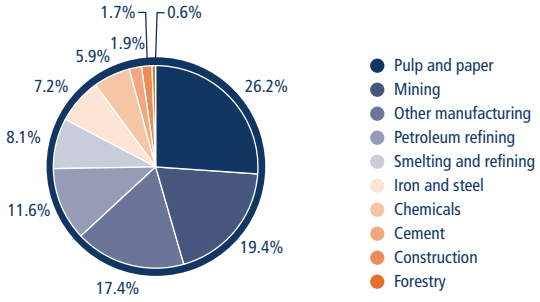
Actual industrial energy use increased by 19.4 percent (528 petajoules) between 1990 and 2003. This increase was driven by a 44.5 percent increase in industrial activity, measured as a combination of physical units of production, gross output and gross domestic product (GDP). However, some of this increase in energy use that would have resulted from the increase in activity was offset by improvements in energy efficiency and structural change – the shift to less energy-intensive industries (such as electrical and electronics).

Three main factors influenced energy use:

- activity – increases in physical units of production, gross output and GDP contributed to a 44.5 percent increase in industrial activity resulting in a 1210-petajoule increase in energy use.
- structure – the change in the mix of activity toward less energy-intensive industries resulted in a 338-petajoule decrease in energy use.
- energy efficiency – due to a 12.6 percent improvement in energy efficiency, the industrial sector avoided 344 petajoules of energy use between 1990 and 2003.

### FIGURE 5-1

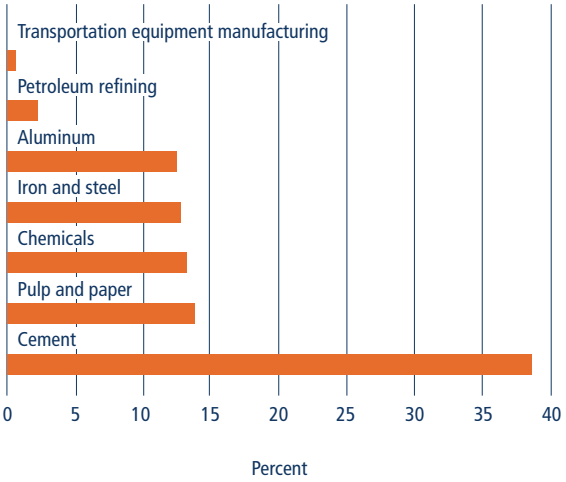
Industrial Energy Use by Sub-Sector*, 2003




* Note: The above sub-sectors reflect the current definitions in the *Quarterly Report on Energy Supply-Demand in Canada*. "Other manufacturing" comprises more than 20 manufacturing industries.

### FIGURE 5-2

Cost of Energy to Manufacturing Industries as a Percentage of Total Production Cost, 2003



The change in energy use between 1990 and 2003 and the estimated energy savings due to energy efficiency are shown in Figure 5-3.

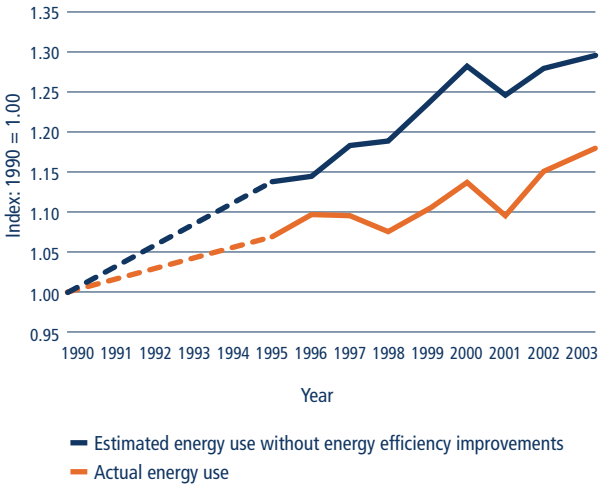
Between 1990 and 2003, industrial GHG emissions including electricity-related emissions increased by 19.2 percent. Excluding electricity-related emissions, industrial GHG emissions increased by 10.6 percent over the same period. Most of this increase in direct GHGs occurred in the upstream mining industry, since the mining (excluding upstream), manufacturing and construction industries realized a 4.4 percent decrease in GHG emissions.

Natural Resources Canada (NRCan) delivers initiatives to increase energy efficiency in the following components of the industrial sector:

- industrial processes and technologies
- equipment (refer to Chapter 2)
- buildings (refer to Chapter 4)

**FIGURE 5-3**

Industrial Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2003



## Industrial Processes and Technologies: Industrial Energy Efficiency

(Canadian Industry Program for Energy Conservation [CIPEC] and Industrial Energy Innovators [IEI])

**Objective: To help Canadian industry use energy efficiency investments to improve competitiveness and to contribute to Canada's climate change goals.**

CIPEC is a unique industry-government partnership committed to promoting and encouraging energy efficiency improvements and reductions in GHG emissions through voluntary action across Canada's industrial sectors. CIPEC comprises 26 sector task forces that involve 48 trade associations.

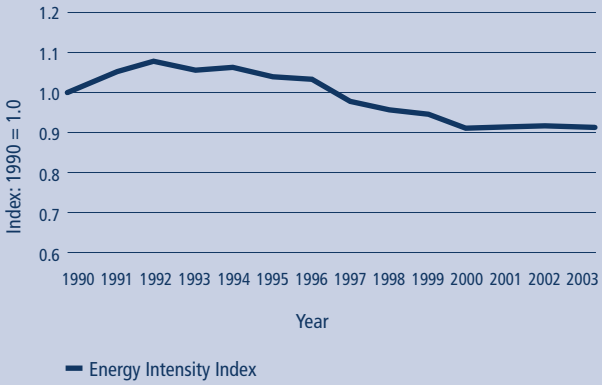
CIPEC, a sector-level program, and IEI, a company-level program, both address barriers to planning, implementing, tracking and reporting energy efficiency projects in industry. Key elements include the establishment and tracking of energy efficiency improvement targets and plans, and the development of products and services that overcome barriers to continued energy efficiency improvements. NRCan provides support via employee awareness kits and events, best-practices guides, technical and planning information, energy audits of varying sophistication, benchmarking and workshops on energy management. Information on industrial cogeneration and on determining the technical eligibilty of energy efficiency projects for the Class 43.1 Accelerated Capital Cost Allowance tax write-off is also available.

CIPEC targets all of industry, including mining, manufacturing and construction as well as upstream oil and gas and electricity generation. In 2003, CIPEC industries contributed $288.6 billion ($97 GDP) to the Canadian economy. This represents 28 percent of Canada's total GDP ($288,618 / $1,015,974). Of this amount, about 83 percent came from the Manufacturing, Mining and Construction components of CIPEC, and 17 percent came from CIPEC Energy Producers.

Between 1990 and 2003, CIPEC industries improved their energy intensity by 8.7 percent. Had energy intensity remained constant and not declined by 0.7 percent per year, GHG emissions would have been 27.8 megatonnes higher.

**FIGURE 5-4**

CIPEC Energy Intensity Index, 1990 to 2003



The Manufacturing, Mining and Construction components of CIPEC improved their energy intensity by an average of 1.8 percent per year, or 21.4 percent, since 1990. Although CIPEC Energy Producers' energy intensity has increased by 13.4 percent since 1990, their energy intensity has decreased by 1.4 percent since 2001.

CIPEC Industries avoided approximately $3.4 billion in energy costs in 2003, owing to effective energy management.

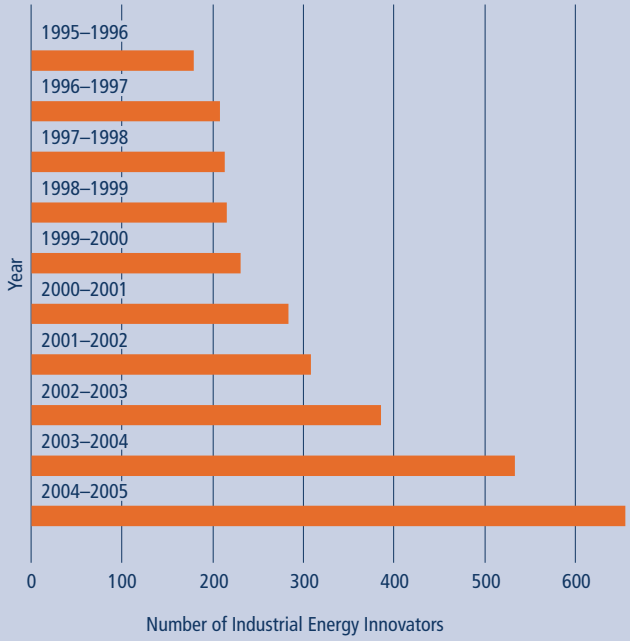
Key 2004–2005 Achievements

- Recruited 124 new Industrial Energy Innovators (see Figure 5-5).
- Initiated 137 Industrial Energy Audits.
- Had 1000 industrial participants in Dollars to $ense workshops, almost double the participation in 2003–2004.

*For more information:*
oee.nrcan.gc.ca/cipec/ieep

**FIGURE 5-5**

Industrial Energy Innovators, 1995–1996 to 2004–2005



## Industrial Processes and Technologies: Cleaner Fossil Fuel Power Generation

**Objective: To design, develop and deploy technologies for power generation from fossil fuels with increased efficiency and reduction and ultimately elimination of emissions of acid rain precursors, GHGs, particulates and identified priority substances – mercury, trace elements and organic compounds.**

Research focuses on improving performance and reducing emissions for existing fossil fuel power plants and on developing new advanced cycles for conversion of fossil fuels to electricity with complete or near complete capture and elimination of carbon dioxide ($CO_2$) and other emissions. Additional research undertaken includes issues associated with the transport and storage of $CO_2$.

Key 2004–2005 Achievements

- Developed Canadian technology roadmaps that identify technologies that will be needed for the clean and efficient use of coal with $CO_2$ capture and storage. Published *$CO_2$ Capture and Storage Roadmap* and *Canadian Clean Coal Technology Roadmap*.
- Commissioned a new pressurized gasifier research pilot plant as part of an advanced clean coal research program. The unit, the only one of its type in North America, will act as an economical test bed for Canadian utilities interested in advanced technology development, hydrogen production and $CO_2$ capture. Gasification provides high electricity generation efficiency; allows $CO_2$ capture at low cost and low energy penalty; permits economical, highly efficient removal of sulphur oxide, nitrogen oxide and mercury; and will provide energy security through clean use of Canada's indigenous coal reserves.
- Successfully demonstrated a new measurement and characterization methodology for $PM_{2.5}$ fine particulate matter emissions. Application of Canada-wide standards to large industrial sources in 2010 will require reliable measurement methods. Developed a novel source dilution sampling and fine particulate matter (PM) measurement system for fossil fuel combustion units to provide ambient-compatible data on $PM_{2.5}$ emissions as defined by the Canadian and U.S. Ambient Air Standards. The research team received a Departmental Merit Award for this work.

*For more information:*
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_act_e.html

## Industrial Processes and Technologies: Processing and Environmental Catalysis Program

**Objective: To solve industrial process problems and undertake research in areas with high potential for significant environmental and economic benefits.**

The program's facilities, including semi-pilot-scale plants, are used for process testing and the evaluation of novel concepts in chemical and energy conversion, including hydrogen production from hydrocarbon and renewable sources. Clients include oil and gas companies, petrochemical companies, engine manufacturers, waste oil recyclers and renderers, and specialty ceramic manufacturers.

Key 2004–2005 Achievements

- Developed technology for the production of low-sulphur, high-cetane blending stock from waste restaurant grease and vegetable oils. A royalty-bearing licence agreement for Cetaner technology was signed with North Texas BioEnergy Ltd.
- Developed a catalytic process for producing ethanol from acetic acid. Catalyst testing was done for Woodland Chemicals, a technology development company that has proprietary technology for producing fuel ethanol from biomass residues.
- Developed a direct carbon fuel cell to convert carbon-rich solids to electricity. A 10-watt unit was designed, and a cold flow model was built and tested. A collaborative research agreement is being negotiated with a fuel cell manufacturer in order to facilitate the fuel cell's development.

*For more information:*
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_pec_e.html

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## Industrial Processes and Technologies: Industrial System Optimization Program

**Objective: To support the development and adoption of innovative energy-efficient design practices in Canadian industry to improve its energy efficiency and productivity, while decreasing GHG emissions and other environmental impacts.**

The program focuses on plant-wide industrial process analysis techniques, such as Process Integration (PI) and advanced process control systems, to identify and correct inefficiencies in plant operation and design taking into account energy, economy and environmental aspects. It seeks to meet its objective by performing leveraged research and development through national and international collaboration. Furthermore, the program disseminates technical information that will encourage the adoption of these practices in targeted energy-intensive sectors of Canadian industry including pulp and paper, oil upgrading and refining, petrochemicals, steel, chemicals, food and drink, and solid wood.

Key 2004–2005 Achievements

- Conducted a successful program to demonstrate the benefits of PI for medium-sized processes in small- and medium-sized enterprises: four plant-wide energy analyses completed in the food and drink and textile industries. Together, these studies allowed the participating companies to identify cost-effective energy- and water-savings projects that can lead to savings of $3 million per year, with an average pay back period of less than two years and $CO_2$ emission reductions of 14 000 tonnes per year (energy efficiency improvements of 20 to 35 percent).
- Completed an opportunity analysis and technology assessment of sludge upgrading systems for energy production as a viable alternative to land filling in the Canadian pulp and paper mills. The work was coordinated by an advisory committee formed by specialists from major pulp and paper companies, research centres and federal departments. This technological-economic assessment will help industry select the most cost-effective and environmental friendly solutions to reduce the adverse effect of pulp and paper sludge disposal.

*For more information:*
cetc-varennes.nrcan.gc.ca/en/indus.html

## Industrial Processes and Technologies: Industry Energy Research and Development (IERD) Program

**Objective: To encourage and support the development and application of leading-edge, energy-efficient and environmentally responsible processes, products, systems and equipment in industry.**

Financial support is provided for commercially confidential applied research and development (R&D) activities, which is repayable if the project is commercially successful. Program clients from all industrial sectors range from small- and medium-sized companies to multinational corporations.

Key 2004–2005 Achievements

- Assist Synodon Inc. of Edmonton in developing realSens™ technology for high-speed aircraft to accurately sense natural gas leaks in pipelines. Currently, five million kilometres of pipelines are regularly tested by inspectors with hand-held sensors. By enabling aircraft to remotely pinpoint minute leaks of natural gas, realSens™ will reduce inspection costs, increase safety and reliability, and control fugitive emissions of natural gas – a waste of energy and a potent greenhouse gas.
- With the financial support of IERD, Marine Exhaust Solutions Inc. of Prince Edward Island is demonstrating the EcoSilencer™, a marine engine exhaust gas scrubber. It removes significant amounts of sulphur dioxide and particulate matter, as well as reduces the noise level from the exhaust, and meets anticipated European Union marine emissions regulations. The unit is amenable to heat recovery for on-board use, thereby reducing energy use and GHG emissions by as much as 10 percent.
- Turbocor Inc. of Montréal is developing a new compressor and refrigeration rack for supermarket counter refrigeration. This refrigerator is designed to reduce energy consumption by 30 percent. Projections show that the energy savings generated worldwide by this technology could attain 28 petajoules per year and associated GHG emission reduction of over 1 million tonnes per year by 2015.

*For more information:*
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/factsheet_industry_energy_research_and_development_program_e.html

## Industrial Processes and Technologies: Emerging Technologies Program (ETP)

**Objective: To support the identification and demonstration of new and emerging energy-efficient technologies.**

Projects are co-managed and cost-shared with industry and other stakeholders, such as gas and electric utilities, other governments and equipment manufacturers. Financial support is provided for the development and testing of pilot plants, prototypes and full-scale field trials to evaluate operating performance, energy efficiency and environmental impacts. NRCan's financial support is repayable from any cost savings or revenues realized from a project.

Key 2004–2005 Achievements

- With the financial support of the ETP, Cambior Inc.'s Niobec Mine of Saint-Honoré-de-Chicoutimi, Quebec, and Hydro-Québec are designing and demonstrating a high-efficiency electrical-induction ore-concentrate dryer to replace the current oil-fired dryer. This will reduce energy consumption and GHG emissions.
- The ETP contributed to in-plant testing of a ceramic heat recovery unit in the flue of a zinc oxide furnace by G.H. Chemicals Ltd. of Saint-Hyacinthe, Quebec, and the Natural Gas Technology Centre, Boucherville, Quebec. The resulting 20 percent energy savings has justified installation of the heat recovery unit on four more furnaces with plans for installation on all 20 furnaces at the G.H. Chemicals' plant.
- Westport Innovations Inc. of Vancouver, British Columbia, has completed an ETP-sponsored one-year field trial of its high-efficiency, direct-injection natural gas engine for stationary power generation, at a water/wastewater treatment facility in Grande Prairie, Alberta. GHG emissions were reduced by 26 percent compared with the Alberta electrical grid and 21 percent compared with a diesel generator.

*For more information:*
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/funding_programs_etp_e.html

## Industrial Processes and Technologies: Industrial Energy Innovation

**Objective: To assist major industrial energy consumers to reduce the energy intensity of their operations and to reduce GHG emissions, by-product emissions of $CO_2$ and other GHGs.**

Industrial combustion processes are the major sources of industrial GHG emissions. Because they operate at low thermal efficiencies of 30 to 50 percent, there are major opportunities to improve industrial energy efficiency and productivity while significantly reducing GHG emissions.

CETC's work in this area includes changing the interaction of the combustion system with the process with advanced tools and technologies. As well, together with the Large Final Emitters Group and the Office of Energy Efficiency, CETC held technical workshops with major industry sectors (steel, mining, smelting and refining, cement, lime, and pulp and paper) and with CIPEC, industrial associations and individual companies to help define and map partnerships for a generic industrial combustion R&D program and applications to take advantage of these opportunities, with potential energy and GHG reductions of 10 to 40 percent. In addition, it is engaged in developing generic tools and technologies that cross industry sectors, fuels and furnaces.

Key 2004–2005 Achievements

- Application of state-of-the-art burner technologies to industrial processes. High Temperature Air Combustion (HTAC) technology has the potential to reduce natural gas use by as much as 50 percent in steel heating processes and maintain ultra-low nitrogen oxide emissions. This will reduce GHG emissions. The Industrial Energy Innovation program has been active in this area, presenting eight workshops to steel companies and developing project descriptions for two research consortia for HTAC technology development. As well, it received four written expressions of interest in these consortia, prepared a business plan to include the consortia and the installation of a Pilot-Scale Research Industrial Furnace at CETC–Ottawa, and prepared reports on the cost benefit analysis of the HTAC technology in steel furnaces.
- Jointly with Large Final Emitters, conducted one- to two-day workshops at CETC–Ottawa with each major industrial energy-intensive sector – steel, mining and smelting, refining, cement, lime, pulp and paper – to develop technical roadmaps to define and achieve industry R&D needs and goals.
- Developed and tested a software tool, EFFECC (Efficiency Evaluation and Combustion Calculation Tool), that can be installed on any computer and easily used by engineers or consultants doing combustion energy evaluations. This software promptly identifies efficiency opportunities, as well as major heat losses that can cause excessive GHG emissions due to incomplete combustion, heat transfer and exhaust of combustion products.

*For more information:*
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_e.html

## Industrial Processes and Technologies: Minerals and Metals Program

**Objective: To reduce GHG emissions from Canada's minerals and metals sector by enhancing mineral and metal recycling processes and practices, by encouraging replacement of cement in concrete by supplementary cementing materials (SCMs), and by assessing alternate production processes.**

The Minerals and Metals Program is a component of the *Government of Canada Action Plan 2000 on Climate Change* managed by CANMET Mineral Technology Branch. It has a GHG emissions reduction target of 1.65 million tonnes of $CO_2$ equivalent per year, by 2010. It consists of 1) the Enhanced Recycling program that aims to increase Canada's potential to recycle all materials by developing new approaches and improving upon existing recycling infrastructure, practices and policies; and 2) the Enhanced Emission Reductions for Minerals and Metals program, which supports activities that will increase the use of SCMs in concrete to replace portland cement (thereby reducing the GHG emissions of concrete production) and which examines processes where improved understanding can lead to new emission-reduction opportunities in the minerals and metals industry sector.

Key 2004–2005 Achievements

- The Enhanced Recycling program raised awareness of many important issues among a broad group of stakeholders across Canada, especially at the municipal and regional level, through participation in various communications opportunities. Other activities included completion of a project to characterize construction and demolition wastes, and significant progress on a pilot project to examine the feasibility of adding scrap metal to a residential blue box collection program.
- CANMET's Materials Technology Laboratory completed the development of a user-friendly tool for contractors wanting to use SCMs in their construction projects.
- In partnership with stakeholders, several projects were undertaken to demonstrate the viability of and resolve technical issues associated with SCM use in different applications.

*For more information:*

recycle.nrcan.gc.ca/default_e.htm

nrcan.gc.ca/mms/canmet-mtb/mtl/research/concrete_e.htm

## Industrial Processes and Technologies: Mine Ventilation

**Objective: To reduce energy consumption and GHG emissions associated with mine ventilation through infrastructure automation (to support demand-based delivery systems), ventilation network optimization and management, and less air-volume demanding technology.**

Mine ventilation systems that were traditionally designed to operate at maximum flow (peak production 24 hours a day, 7 days a week) are being adjusted to match actual production needs. Ventilation is required in underground mines to maintain a safe working environment by diluting and removing harmful pollutants (dusts and gases) and providing a thermally suitable working climate. Providing sufficient and suitable ventilation can account for 40 percent of the energy consumed underground by a mining operation. Energy savings at less than peak demand range from linear for the heating/cooling systems through to a cubic relationship for the primary fan system. However, optimizing energy use is not straightforward, as it depends on the specific consumption profile (i.e. electricity versus heating fuels and primary versus secondary delivery systems) for each mine and requires evaluation on a case-by-case basis.

Key 2004–2005 Achievements

- In order to assess potential cost, energy requirements and GHG-reduction strategies, CANMET – Mining and Mineral Science Laboratories investigated process-based modelling of ventilation needs as a function of the life of the mine. This will enable mine management to select the level of ventilation that is appropriate to support production and to dilute contamination, on an on-demand basis. The models are expected to be available by 2006.
- The case study for the implementation of ventilation on demand at an Inco mine continues. The first phase monitored activity and revealed that some ventilation infrastructure operates needlessly for long periods of time. Logging of energy demands associated with ventilation as a function of production cycles is ongoing. In the next phase, modelling will enable Inco to evaluate, through a business case, the ventilation control options that can result in providing air as it is needed.

*For more information:*
nrcan.gc.ca/mms/canmet-mtb/mmsl-lmsm/mines/air/air-e.htm

# Chapter 6: Transportation

## Energy Use and Greenhouse Gas Emissions

The transportation sector consists of three sub-sectors: passenger, freight and off-road. Passenger and freight transportation accounted for 56.0 percent and 40.1 percent, respectively, of transportation energy use, with off-road representing only 3.9 percent in 2003. The passenger sub-sector is composed of three modes: road, rail and air. The freight sub-sector, as defined by Natural Resources Canada (NRCan), is composed of road, rail, air and marine. Road transport uses the most energy, accounting for 79.0 percent of total transportation energy use in 2003. Of this amount, 59.4 percent was passenger energy use and 40.6 percent was freight energy use (see Figure 6-1).

All NRCan transportation energy-use programs focus on the energy used in road transportation. Total transportation energy use increased by 25.7 percent (483 petajoules) over 1990 to 2003 (see Figure 6-2). Passenger transportation energy use increased by 15.1 percent (173 petajoules), while freight transportation energy use increased by 40.1 percent (271 petajoules).

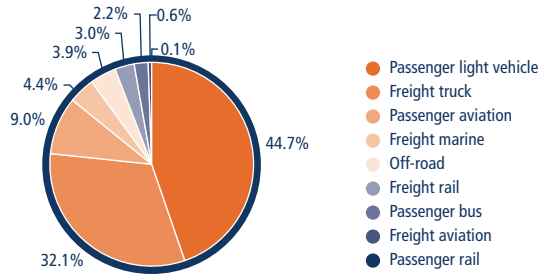
Three main factors influenced energy use:

- activity – due to increases in population and economic activity, there was greater transportation activity (measured as passenger-kilometres for passenger transportation and tonne-kilometres for freight transportation). This increased transportation energy use by 33.2 percent (592 petajoules). The freight and passenger segments contributed to this increase by 51.1 percent and 48.9 percent, respectively.
- structure – shifts between modes of transport within both the freight and passenger segments resulted in an increase of 8.1 percent in transportation energy use (144 petajoules). The effects of mode shifting were more pronounced in the freight segment since freight truck activity is growing significantly faster than rail and marine.
- energy efficiency – improvements in energy efficiency worked to decrease energy use by 15.7 percent (280 petajoules).

Without improvements in energy efficiency, increases attributable to activity and structure would have led to an increase in transportation energy use of 41.2 percent (736 petajoules). However, as a result of improvements in energy efficiency, actual energy use increased by 25.7 percent. This change in energy use between 1990 and 2003, as well as the estimated energy savings due to energy efficiency, is shown in Figure 6-2.

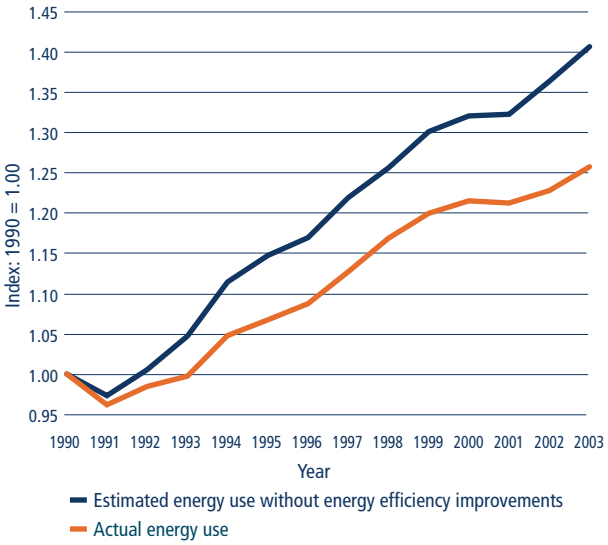
### FIGURE 6-1

Transportation Energy Use by Mode, 2003




### FIGURE 6-2

Transportation Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2003



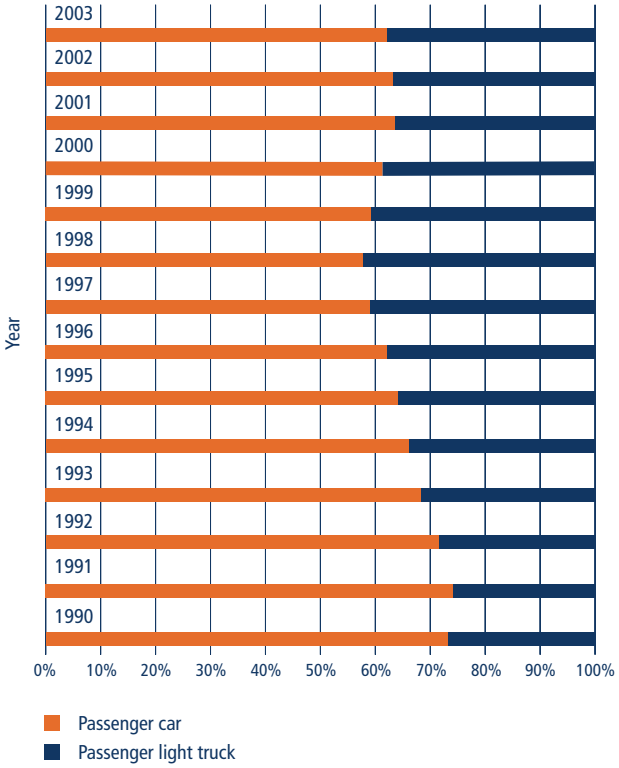
The transportation sector accounts for 27.9 percent (2361 petajoules) of secondary energy use and 33.6 percent (169 megatonnes) of greenhouse gas (GHG) emissions. From 1990 to 2003, transportation energy use increased by 25.7 percent, and GHG emissions increased by 25.0 percent. The change in GHG intensity of transportation energy use was negligible.

Figure 6-3 shows how the market share of new light trucks increased in the 1990s, reflecting the growth in popularity of minivans and sport-utility vehicles. Figure 6-4 demonstrates that, on a per-kilogram or per-unit-of-horsepower basis, fuel efficiency has improved markedly. However, average fuel economy has been stable because new vehicles continue to be heavier and have more powerful engines.

Figure 6-5 illustrates an improvement in trucking energy intensity despite an increase in average activity over 1990 to 2003. Improved fleet practices, caused by an increase in the competitiveness of the transportation sector and by the introduction of electronic engines, have significantly improved engine fuel efficiency in medium-duty and heavy-duty trucks.

## FIGURE 6-3

Market Shares of New Passenger Car and Light Truck Sales, 1990 to 2003

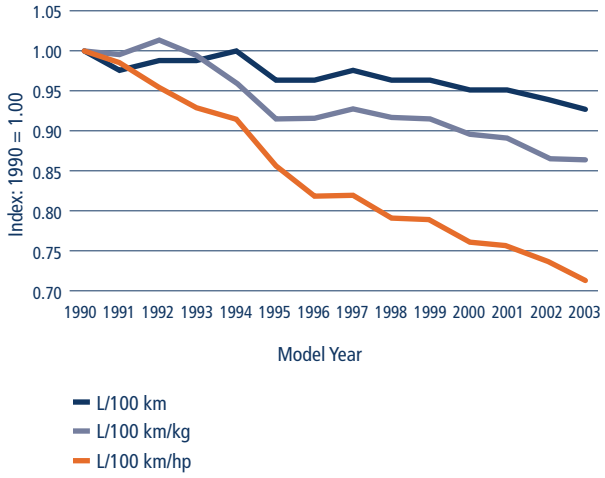



NRCan delivers initiatives in the following areas to increase the efficiency of motor vehicles and encourage the use of alternative fuels:

- vehicles
- transportation research and development
- alternative transportation fuels
- transportation technologies

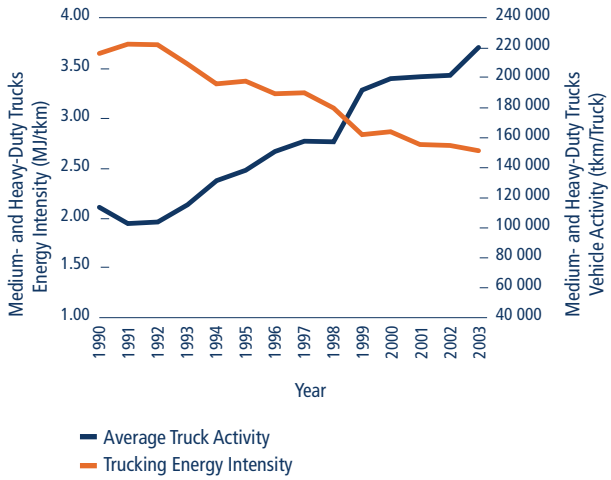
## FIGURE 6-4

New Car Fuel Efficiency, Normalized for Weight and Power, 1990 to 2003




## FIGURE 6-5

Trucking Energy Intensity and Average Activity per Truck, 1990 to 2003



## Vehicles: Vehicle Efficiency

**Objective: To improve the fuel efficiency and reduce the GHG emissions of new light-duty vehicles sold in Canada.**

The Motor Vehicle Fuel Efficiency Initiative is intended to bring about a 25 percent improvement in the fuel efficiency of new light-duty vehicles sold in Canada by 2010. NRCan has led negotiations with the automotive industry to a successful conclusion, reaching an agreement to reduce GHG emissions from this sector. The auto industry committed to a voluntary reduction in GHG emissions of 5.3 megatonnes (Mt) annually from light-duty vehicle use by 2010. This 5.3-Mt target exceeds the GHG emissions reductions being sought under the 25 percent target, by going beyond fuel consumption reductions and incorporating reductions in all GHG emissions associated with vehicle use.

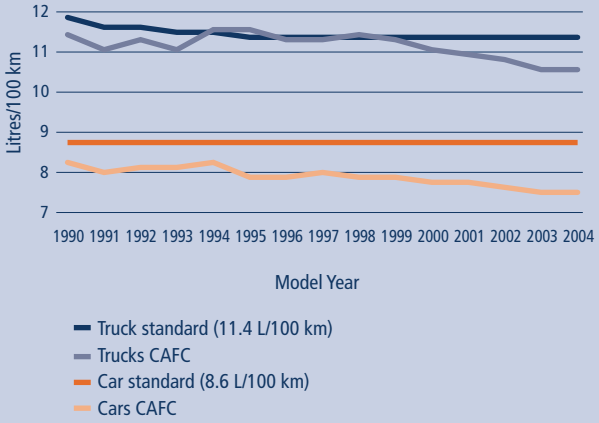
Key 2004–2005 Achievements

- Researched and analysed the level of effort and the cost implications to auto manufacturers of meeting the 25 percent target, based on different agreement types; analysed the sensitivity of fuel consumption to market shifts between different vehicle segments.
- Completed a joint study, between NRCan and U.S. Department of Energy, on the future potential of hybrid and diesel powertrains in the North American light-duty vehicle market.
- Completed negotiations with industry and finalized a Memorandum of Understanding to reduce GHG emissions from light-duty vehicles in Canada by 5.3 Mt by 2010.

*For more information:*
oee.nrcan.gc.ca/transportation/fuels/motorvehicles.cfm

**FIGURE 6-6**

Company Average Fuel Consumption (CAFC) vs. Canadian Voluntary Standards, 1990 to 2004



## Vehicles: EnerGuide for Vehicles

**Objective: To improve motor vehicle fuel efficiency by encouraging private motorists to purchase energy-efficient vehicles.**

EnerGuide for Vehicles promotes the purchase of fuel-efficient vehicles in order to reduce vehicle emissions and mitigate other vehicle-related environmental impacts. It offers a series of tools to help Canadian motorists consider fuel efficiency in their vehicle purchase decisions, and encourages buyers to choose the most fuel-efficient vehicle that meets their everyday needs.

Each year, the free *Fuel Consumption Guide* provides fuel consumption ratings and the estimated annual fuel cost, fuel consumption and carbon dioxide ($CO_2$) emissions for new passenger cars, light-duty pickup trucks, vans and special purpose vehicles sold in Canada. The EnerGuide label, which is affixed on the side window of new light-duty vehicles sold in Canada, provides specific fuel consumption information for each model. Every year, the EnerGuide for Vehicles Awards recognize the most fuel-efficient vehicles in nine categories. Awards are presented to the manufacturers.

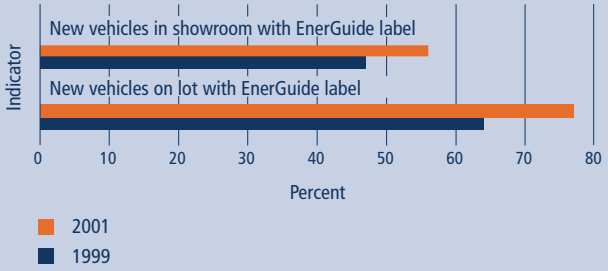
NRCan is also developing a New Vehicle Ranking System to provide a visible signal directing consumers and fleets to the purchase of fuel-efficient and low-$CO_2$-emitting vehicles.

Key 2004–2005 Achievements

- Attended major Canadian Auto Shows to highlight the impact of personal transportation on GHG emissions and to promote the purchase of energy-efficient vehicles. In particular, in collaboration with the One-Tonne Challenge, a new exhibit was launched at the Canadian International Auto Show in Toronto, Ontario, with the overall message for consumers: "*You're in the Driver's Seat, Making Smart Choices About Your Transportation.*"
- Distributed 300 000 copies of the 2005 *Fuel Consumption Guide* and tabletop display to 1189 Canadian Automobile Association retail offices, 3500 dealerships and other outlets across Canada.
- Initial consultations have occurred with stakeholders to discuss options for the New Vehicle Ranking System (NVRS). Research has been completed to identify key target audiences for marketing the NVRS.

**FIGURE 6-7**

Vehicle Fuel Efficiency Awareness – EnerGuide Labels




*For more information:*
oee.nrcan.gc.ca/vehicles

## Vehicles: Personal Vehicles

**Objective: To improve motor vehicle fuel efficiency by encouraging private motorists to develop energy-efficient vehicle use and maintenance practices.**

Personal Vehicle information initiative promotes improving vehicle fuel efficiency in order to reduce vehicle emissions and mitigate other vehicle-related environmental impacts. The program helps motorists understand how driving and maintenance behaviours affect climate change and the environment. It encourages Canadians to adopt fuel-efficient driving techniques and maintenance practices. This initiative complements EnerGuide for Vehicles.

Key components include the newly launched Auto$mart "A New Point of View" Driver Educator kit, which provides instructors with the instruments (instructor's in-class materials, student workbook, instructor's in-car guide, video, CD-ROM, student tips cards, and fuel consumption calculator) to teach fuel-efficient driving to drivers; the Idle-Free Campaign, which seeks to curb vehicle idling; and the Be Tire Smart Campaign developed in collaboration with the Rubber Association of Canada, which seeks to have Canadians adopt good tire maintenance and inflation practices. Recently the initiative has been working in collaboration with Transport Canada to explore the potential for developing a program to encourage Canadian motorists to adopt good speed-management practices.

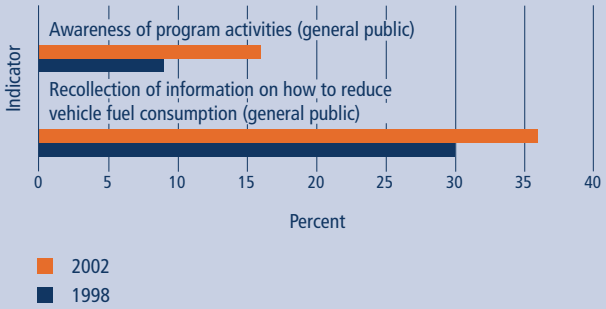
Key 2004–2005 Achievements

- Successfully launched a new driver educator program developed through stakeholder consultations (provinces, Canada Safety Council, Transport Canada, Road Safety Educators' Association, and driving school associations). Key achievements include the development of a phase-in approach to provincial driver training and examination; the revision of the Auto$mart Student Driver Kit to a driver educator-based Auto$mart "A New Point of View" Driver Educator kit; and the training of master trainers who are currently providing training to Canadian driving instructors on how to incorporate the materials into their existing curricula.
- Successfully completed an idling campaign with Better Environmentally Sound Transportation in the Greater Vancouver Regional District. Initiated multi-year collaborative agreements with the Clean Air Partnership and Halifax Regional Municipality to review and develop regulatory and voluntary approaches to idling behaviour and to conduct an Idle-Free campaign, respectively.
- Launched a national level "Be Tire Smart Week" and conducted regional campaigns in Quebec and British Columbia.

*For more information:*
vehicles.gc.ca

**FIGURE 6-8**

Vehicle Fuel Efficiency Awareness – Program Activities



## Vehicles: Fleet Vehicles

**Objective: To improve the fuel efficiency and reduce the GHG emissions in commercial and institutional road transportation fleet operations and all other non-Government of Canada vehicle fleets through energy efficiency practices and the use of alternative fuels.**

Fleet Vehicles provides information materials, workshops, technical demonstrations, driver training programs and special projects, such as the truck stop Idle-Free – Quiet Zone Campaign, to help fleet operators assess and pursue opportunities to increase energy efficiency in their operations. To increase market penetration of fuel-efficient and emission-reduction technologies, the Fleet Vehicles initiative also provides financial incentives to commercial fleets purchasing pre-selected anti-idling technologies and natural gas vehicles. NRCan delivers the Fleet Vehicles initiative in partnership with fleets, industry stakeholders and other levels of government.

Key 2004–2005 Achievements

- To date, the Fleet Vehicles initiative has registered over 3625 members. The annual truck stop Idle-Free – Quiet Zone Campaign was successfully conducted at more than 80 sites across Canada.
- A third driver-training curriculum has been added to the SmartDriver family of tools, SmartDriver for Transit. More than 200 000 new and experienced commercial drivers have been trained in highway and forestry trucking and the transit industry.
- The Commercial Transportation Energy Efficiency Rebate (CTEER) initiative has increased market penetration in its second year of existence. This initiative has provided more than $2.8 million in incentives, an increase of 235 percent in comparison to 2003–2004.
- Natural gas industry partners are piloting EPA-certified compressed natural gas conversion kits for light-duty vehicles and a Liquified Natural Gas Diesel engine for commercial trucking.

*For more information:*
fleetsmart.nrcan.gc.ca

**FIGURE 6-9**

Drivers Trained and Participation in the Fleet Vehicles Initiative 1997–1999 to 2003–2004

## Transportation Research and Development:
## Canadian Lightweight Materials Research Initiative (CliMRI)

**Objective: To develop low-density, high-strength, lightweight materials to achieve weight reductions in ground transportation vehicles.**

CLiMRI is a research network comprising 29 companies, eight universities and seven government departments and funding agencies. CLiMRI's goal is to develop and implement lightweight and high-strength materials in transportation applications for the purposes of (a) reducing GHG emissions through vehicle weight reduction and improving vehicle efficiency, and (b) enhancing the competitiveness of Canadian primary metals producers, automotive part manufacturers and suppliers.

Key 2004–2005 Achievements

- Magnesium is one of the lightest of all metals, but its use in automotive applications is currently limited to die-cast parts because of difficulties in producing magnesium in sheet form. CANMET-Materials Technology Laboratory (MTL) has developed a technique to simulate the twin-roll strip casting of magnesium sheet, and the material's performance is being assessed. Additionally, sand- and permanent-mould casting processes were optimized to produce high-integrity castings. These achievements show significant potential for increasing the use of magnesium in the automotive industry.
- Unlike aluminum, magnesium is prone to corrosion in the presence of chlorides such as road de-icing salt. Corrosion control is therefore a key enabling technology that will lead to wider-scale use of magnesium in automobiles. As part of a larger research program with the U.S. Department of Energy and automakers, CANMET-MTL is leading the corrosion control and coating assessment research for magnesium alloys. Environmentally friendly coatings were selected, and a new material was developed for spacer and washer applications between corrosion-prone areas. The team also helped automakers to prevent premature failures related to metal creep and corrosion fatigue, and contributed to the production of a magnesium engine cradle for the 2006 GM Corvette.
- Recent developments in hydroforming, a metal-shaping process that uses gas or water at high pressures to form tubes of sheet metal, have enabled significant productivity gains and weight reductions for complex structural automotive components. CANMET-MTL is working to extend the commercial use of hydroforming from conventional low-carbon steel to lightweight metals and ultra-high-strength steels. To achieve this goal, a suitable seam-welding process to join tubes made of these materials was developed. Prototype aluminum and high-strength steel tubes were successfully produced for evaluation by clients, and the team demonstrated that magnesium tubes can be shaped to make parts. Furthermore, the team demonstrated that the CANMET-MTL tube-forming method can produce tubes that exceed the quality of many other laboratories and industries in the United States and Europe.

*For more information:*
climri.nrcan.gc.ca/default_e.htm

## Transportation Research and Development: Fuel-Cell-Powered Mining Vehicles

**Objective: To develop the technology to replace diesel power by hydrogen fuel cell power in underground mining vehicles.**

NRCan has taken a co-leadership role in the North American Consortium for Fuel-Cell-Powered Mining Vehicles. Hydrogen fuel cell power systems are more efficient in delivering power than conventional diesel equipment. Retrofitting diesel-powered vehicles with hydrogen fuel cells should improve vehicle productivity, operating costs and the work environment for underground miners by eliminating toxic underground diesel emissions and by reducing heat and noise. Fuel cells have also been shown to have the potential to significantly reduce $CO_2$ or GHG emissions by up to one million tonnes per year (26 percent of the total $CO_2$ equivalent emitted by the mining extraction sector) and decrease operating costs by lowering mine ventilation needs.

Key 2004–2005 Achievements

- Reliability studies for the 4-tonne fuel cell locomotive in the underground environment were completed. Fine-tuning of the power plant improved overall efficiency and reduced operational constraints.
- The developmental project for the fuel cell underground mine loader is now at the power plant assembly stage and will follow with initial performance tests in an industrial environment by the end of 2005.
- An agreement in principle was reached for the development of a fuell cell underground light-duty mining vehicle, as well as a water electrolysis unit for hydrogen production. Light-duty mining vehicles are considered to be the most polluting of all the underground diesel mining vehicles.

*For more information:*
nrcan.gc.ca/mms/canmet-mtb/mmsl-lmsm/mines/mines-e.htm

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## Alternative Transportation Fuels: Future Fuels Initiative

**Objective: To increase Canada's fuel ethanol production and use in the transportation sector.**

The Future Fuels Initiative, co-managed with Agriculture and Agri-Food Canada, targets motorists, provinces and territories, and renewable fuel producers. The main activities under this initiative are public awareness campaigns, federal-provincial policy co-ordination, industry consultation and analytical work on feedstocks, production costs, greenhouse gas and socio-economic impacts. Additionally, the Initiative includes the National Biomass Ethanol Program, administered by Farm Credit Canada, which aims to overcome lender resistance to investing in ethanol plants due to the uncertainty of future excise tax policy.

Key 2004–2005 Achievements

- Completed detailed study that examined the factors affecting the success of the renewable fuels industry in Canada and presented the results via a workshop to industry, provincial and territorial officials and other stakeholders.
- Developed new public awareness materials for distribution to motorists via fuel distributor partners and other channels.
- Extended GHG emission and energy use modelling capabilities and contributed to important emission and health impact studies.

*For more information:*
vehiclefuels.gc.ca

## Alternative Transportation Fuels: Ethanol Expansion Program

**Objective: To expand fuel ethanol production and use in Canada.**

The Ethanol Expansion Program, co-managed with Agriculture and Agri-Food Canada, targets existing and potential fuel ethanol producers and supports the climate change plan goal of having 35 percent of Canadian gasoline contain 10 percent ethanol by 2010. The program provides contributions towards the construction of new fuel ethanol production facilities through a competitive solicitation process. Selection criteria measure the ability of projects to maximize ethanol production and use and reduce transportation GHG emissions. Additionally, the program is investigating how to develop a successful commercial cellulose-based ethanol industry in Canada (i.e. ethanol produced from agricultural residues or wood).

Key 2004–2005 Achievements

- Executed contribution agreements totalling $72 million for six new ethanol plants across Canada. These projects, for which investments total almost $0.5 billion, plan to produce over 650 million litres of fuel ethanol per year and more than quadruple Canadian supply by the end of 2006.
- Launched the second round of the program in December 2004, and commenced the evaluation of plant proposals that were received from across the country pursuant to the February 2005 deadline.
- Continued consultations with stakeholders regarding cellulosic ethanol industry development.

*For more information:*
vehiclefuels.gc.ca

## Alternative Transportation Fuels: Biodiesel Initiative

**Objective: To support increased biodiesel production and use in Canada's transportation sector.**

The Biodiesel Initiative supports the Government of Canada's proposed target of 500 million litres of biodiesel production per year by 2010. The main components of this initiative are research and development, technical and socio-economic studies, end-use demonstrations and testing, stakeholder education and standards development.

Key 2004–2005 Achievements

- Developed national fuel quality specifications for 1 to 5 percent biodiesel blends and continued work on standardization of fuel quality and content on B-2, B-5, B-20 blends and B-100 emissions analysis, fuels specifications and fuel property analysis.
- Completed marine demonstration consisting of 12 cruisers running on various blends of biodiesel.
- Contributed to biodiesel plant feasibility studies across Canada as well as information dissemination to industry stakeholders.

*For more information:*
vehiclefuels.gc.ca

## Transportation Technologies: Canadian Transportation Fuel Cell Alliance

**Objective: To demonstrate and evaluate different processes for the production and delivery of hydrogen to fuel cell vehicles at fuelling stations and to participate in the development of codes and standards.**

The Canadian Transportation Fuel Cell Alliance (CTFCA) is a private-public sector initiative composed of technology developers, fuel providers, auto manufacturers, federal and provincial/territorial governments, academia and non-governmental organization representatives. The CTFCA's work contributes to a reduction in GHG emissions by encouraging advancements in hydrogen and fuel cell technologies through demonstration projects that evaluate the technical, economic and environmental feasibility of different hydrogen fuelling options for fuel cell vehicles. The initiative also establishes a supporting framework for hydrogen fuelling by assisting in the development of codes and standards as well as certification and training programs.

Key 2004–2005 Achievements

- Initiated the construction of three of the "Hydrogen Highway" fuelling stations in British Columbia and took receipt of five Ford Focus fuel cell cars for three years of on-road testing and evaluation in the Vancouver and Victoria areas.
- Documented the regulatory development process in Canada as it relates to hydrogen standards, developed an emergency response guide for hydrogen vehicles and hydrogen fuelling stations, completed a study of the scientific principles used in the development of safety factors used in the design of hydrogen stations, and produced a Web-based computer model for the virtual design of hydrogen fuelling stations.
- Expanded the capability of NRCan's GHGenius model used to evaluate the GHG and criteria air contaminant emissions, on a life-cycle basis.

*For more information:*
nrcan.gc.ca/es/etb/ctfca/index.html

## Transportation Technologies:
## Hydrogen, Fuel Cells and Transportation Energy Program

**Objective: In partnership with industry, to develop and deploy leading-edge hydrogen and transportation technologies that reduce GHG emissions, minimize other environmental impacts, increase the potential for job and economic growth and extend the life span of Canada's energy resource base.**

Program staff work with stakeholders in the domestic and international hydrogen and transportation industries, including 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.

Highlights of Hydrogen, Fuel Cells and Transportation Energy Program's work include

- Supporting Canadian industry in developing a world-leading water electrolysis technology for the production of hydrogen from clean renewable energy sources.
- Working in partnership with Canada's fuel cell industry over the last 20 years, which has established Canada as a world leader in fuel cell and refuelling technologies; for example, the world's first hydrogen fuel cell bus was demonstrated in Canada.
- Supporting student vehicle challenges since the 1980s, and bringing university and college students from across North America together with automotive manufacturers to modify existing vehicles to run on a variety of alternative fuels.
- The program has also supported the development of alternative transportation fuel technologies, for example, for natural gas and propane vehicles, which has led to a Canadian industry that is now exporting commercial products.

Key 2004–2005 Achievements

- Organization and sponsorship of world-class conferences, including the Windsor Workshop and the 2004 Canadian Hydrogen and Fuel Cells Conference and Trade Show.
- Development of hydrogen compressor based on metal hydrides to increase efficiency of gas compression.
- Support for Future Truck Student Challenge, in conjunction with the U.S. Department of Energy and the Ford Motor Company, to assist students in designing and implementing alternative fuel technologies.

*For more information:*
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_tet_e.html

# Chapter 7: Renewable Energy

## Renewable Energy Use

In 2003, renewable energy generation capacity from renewable sources accounted for approximately 62 percent of total Canadian electricity capacity (see Table 7-2). Most of the renewable energy used in Canada comes from either hydro-electricity or thermal energy from biomass such as wood-waste sources.

### Hydro-Electricity

Hydraulic power is a renewable energy based on the water cycle – evaporation, precipitation and flow of water toward the ocean. Canada has abundant water resources, and its geography provides many opportunities to produce low-cost energy. Tapping the energy from moving water has played an important role in the economic and social development of Canada for the past three centuries.

In 2003, hydro power accounted for about 60 percent of total electricity generation. Small-scale hydro-electric projects, with a capacity of 20 megawatts (MW) or less, constitute about 4 percent of Canada's electricity-generating capacity. Small-scale hydro has good potential for increased production.

### Biomass

Bioenergy is a renewable source of energy derived from organic substances known as biomass. Biomass is supplied by agricultural wastes (such as chaff, straw, grain screenings, husks and shells, food-processing residues and methane) and forestry wastes (such as logging slash, sawdust, black liquor from the pulping process and other industrial waste). Other biomass supplies include animal litter and manure, landfill gas methane, urban wastes to be incinerated and sewage for biogas. Bioenergy contributes about 6 percent of Canada's primary energy, mostly for industrial process heat, electricity generation and residential space heating. Corn and other agricultural products are also used to generate ethanol and biodiesels for the transportation market.

**TABLE 7-1**

Renewable Energy Markets and Technologies Used in Canada

| *Electricity* | *Thermal Energy* |
|---|---|
| Hydro-electricity | Biomass (e.g. roundwood, pellets, wood chips) |
| Tidal power | 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 turbines | |
| Photovoltaic systems | |
| *Mechanical Power* | *Transportation* |
| Wind water pumps | Biodiesel |
| | Ethanol from biomass |

**TABLE 7-2**

Electricity Generation Capacity From Renewable Sources (Includes Hydro)

| *Year* | *Renewable electricity generation capacity (MW)* | *% of total capacity* |
|---|---|---|
| 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 | 68 686 | 62 |
| 2000 | 69 005 | 62 |
| 2001 | 68 734 | 61 |
| 2002 | 70 895 | 62 |
| 2003 | 72 160 | 62 |

Bioenergy production represents Canada's second largest renewable energy source. Most bioenergy is produced from organic refuse and used with the facilities in which the energy conversion takes place. The pulp and paper industry produces and uses most of Canada's bioenergy. Industrially produced heat and electricity, independent power producers' electricity, electricity from urban wastes and residential wood heat are all considered commonplace in Canada's energy mix.

Home heating with wood usually takes the form of 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. About 3 million Canadian households use wood for home heating. Canadians usually prefer round-wood, but alternatives include wood chips and pellets.

## Earth Energy

As a result of the sun heating the surface of the planet, the temperature of the earth that is one or two metres below the surface remains fairly constant – between 5°C and 10°C. This is warmer than outside air during the winter and cooler than outside air during the middle of summer. A ground-source heat pump takes advantage of this temperature difference by using the earth or the ground water as a source of heat in the winter and as a "sink" for heat removed from indoor air in the summer. For this reason, ground-source heat pumps are known as earth energy systems (EESs).

During winter, EES installations remove heat from the earth using a liquid, typically an antifreeze solution, that circulates within an underground loop. It 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.

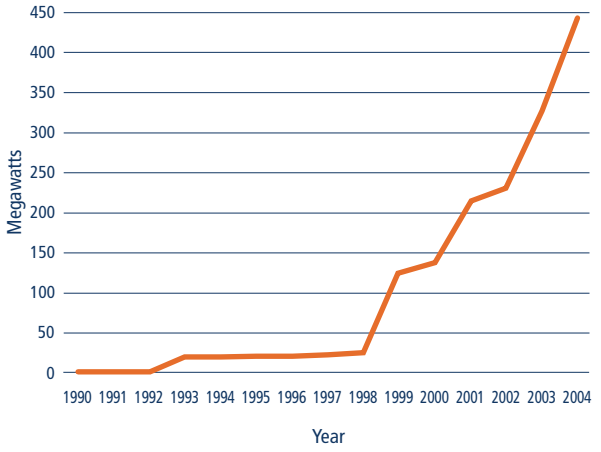
## Wind Energy

Wind turbines convert the kinetic energy of wind into electrical or mechanical energy. Canada has a large wind resource potential because of its large size and northern location. A 1992 study by Natural Resources Canada (NRCan) estimated the technical wind energy potential in Canada at about 28 000 megawatts. If developed, this could supply 11 percent of total Canadian electricity consumption. In 2004, wind energy accounted for less than 1 percent of Canada's total electricity generation (see Figure 7-1).

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.

**FIGURE 7-1**

Canadian Wind Power Capacity, 1990 to 2004



## Solar Energy

Three main technologies use energy from the sun:

- passive solar technologies is a term that means buildings are designed and located to maximize their reception of solar energy.
- active solar thermal systems convert solar radiation into thermal energy for heating air or water in residential, commercial and industrial applications.
- solar electric (photovoltaic) systems use solar radiation to produce electricity.

During the 1990s, NRCan assisted a Canadian company in developing a perforated solar absorber to preheat ventilation air and reduce a building's fuel requirements for space heating. This technology is more cost-effective than conventional solar air-heating technologies and is gaining acceptance in Canada and abroad. Systems have been installed on industrial and commercial/institutional buildings throughout Canada.

Canada's total photovoltaic (PV) power installed capacity increased by 18 percent in 2004 to 14 MW compared to 11.8 MW at the end of 2003. Total PV module sales in Canada (domestic and export) were at 2.14 MW. The average market growth has been 23 percent annually since 1992. In 2004, jobs grew by 24 percent to 765 positions with total revenues estimated at CAN$125 million, a 25 percent increase over 2003. The Spheral Solar Power Inc. facility opened in June 2004. This resulted in an increase in R&D investments by manufacturers up 300 percent in 2004 reaching CAN$30 million. The price of PV modules dropped to CAN$5.53 per watt in 2004, with a steady average decline of 12 percent per year since 1999.

Canada's commitment in 2004 to ratifying the Kyoto Protocol made possible the funding of climate change programs that have benefited PV. There has been a 15 percent increase in the total public (federal and provincial combined) R&D and demonstration budget that reached CAN$9.8 million in 2004. This funding focused on technology and innovation with a 2025 horizon.

NRCan delivers several initiatives to increase the use of small-scale renewable energy in Canada. The following is the array of NRCan renewable energy programs.

## Renewable Energy Programs: Initiative to Purchase Electricity From Emerging Renewable Energy Sources

**Objective: To purchase electricity from emerging renewable energy sources (ERES) that are certified by a third party as having low environmental impact, with the objective of reducing greenhouse gas (GHG) and other air pollution emissions associated with federal electricity consumption.**

Between 1998 and 2001, NRCan entered into three pilot projects to purchase electricity from ERES for federal facilities in Alberta, Prince Edward Island and Saskatchewan. The Government of Canada has pledged to purchase 20 percent of its electricity from ERES by 2010.

Key 2004–2005 Achievements

- The Government of Canada received its third full year of electricity from ERES in Saskatchewan and Prince Edward Island. An estimated 32.4 gigawatt hours (GWh) of electricity from ERES were delivered to the grid in Saskatchewan as well as 13 GWh in Prince Edward Island. These projects resulted in an estimated emissions reduction of 29 000 tonnes of GHGs in Saskatchewan and 11 000 tonnes in Prince Edward Island.
- NRCan also continued to receive 10 000 GWh of electricity from ENMAX Corporation in Alberta. This purchase resulted in GHG emissions reductions of about 9000 tonnes annually.
- Energy Ottawa was the successful bidder for a Request for Proposals in Ontario for the purchase of 90 GWh of electricity from renewable resources, annually, for a period of five years. The Government of Canada has been receiving supply from Energy Ottawa since May 2004.

*For more information:*
nrcan.gc.ca/redi

## Renewable Energy Programs: Photovoltaic and Hybrid Systems Program

**Objective: To support the development and application of solar photovoltaic technologies and the integration of distributed energy resources to the electrical grid in Canada.**

The program contributes to increasing the use of photovoltaic energy technologies in Canada by developing technologies and by facilitating the development of a Canadian-based globally competitive solar industry. It also contributes to the development of policies and programs.

In collaboration with Canadian industry and universities as well as international energy research organizations, the program undertakes research and development activities and fosters information exchanges that will encourage the adoption of photovoltaic-hybrid systems that produce electricity from solar energy and another energy source; conducts research to address the impact of decentralized energy on the electricity distribution network; validates the performance and safety of utility-interactive inverter products; supports the development of building-integrated photovoltaic technologies and systems; and facilitates the development and adoption of harmonized standards and codes for photovoltaic and distributed generation systems in Canada.

Key 2004–2005 Achievements

- Partnered with the Royal Architectural Institute of Canada and the University of British Columbia to develop and deliver a series of professional development courses for technology and sustainable environmental design, focusing on the application of *Building Integrated Photovoltaic Technology* with 175 participants in six Canadian cities.
- Championed a national initiative to address the issue of two-way electricity metering and net-metering in collaboration with Measurement Canada and the Electro-Federation of Canada.
- Collaborated with utilities and research community to develop network benchmarks and completed studies to address the impact of decentralized energy resources when connecting and supplying electricity to the Canadian electricity distribution network.

*For more information:*
cetc-varennes.nrcan.gc.ca/en/er_re.html

## Renewable Energy Programs: Bioenergy Technology Program

**Objective: To support efforts by Canadian industry to develop bioenergy technologies.**

Technologies supported by this program include combustion, biochemical conversion of biomass to ethanol, thermochemical conversion of biomass to bio-oil and biogas, and biomass preparation and handling. Activities are directed toward improving the reliability and lowering the cost of technologies, disseminating information on technology feasibility and economics to potential users, and helping industry commercialize its products in domestic and foreign markets.

Key 2004–2005 Achievements

- With ongoing support from NRCan and other federal departments, Iogen Corporation is continuing on a successful path to full-scale commercialization of its process for producing fuel ethanol from agricultural residues, such as straw. Iogen's demonstration plant in Ottawa, Ontario, began producing ethanol from wheat straw in April 2004. The plant is the first of its scale in the world – designed to produce 3 to 4 million litres of ethanol per year.
- NRCan supported the University of Toronto in the development of an innovative technology that can convert seed oils, waste grease, animal fats and tallow into high-quality biodiesel fuel. The technology uses mild reactor conditions to yield a superior biodiesel with significant reductions in capital and operational cost. BIOX Corporation of Oakville, Ontario, licensed the process and successfully operated a one-million-litres-per-year pilot demonstration plant. BIOX has received support from Sustainable Development Technology Canada (SDTC) to build a 60-million-litres-per-year commercial demonstration plant.
- Through NRCan R&D support, Canadian biomass companies such as Ensyn, Enercam Dynamotive and Nexterra are advancing technologies toward commercialization. As a result of this support, many of those companies have moved toward the next level of commercialization and are now receiving funding from SDTC, the Federation of Canadian Municipalities, Technology Partnerships Canada and provincial and territorial agencies.

*For more information*:
canren.gc.ca/bio/index.asp

## Renewable Energy Programs: Renewable Energy Deployment Initiative (REDI)

**Objective: To stimulate the demand for renewable energy systems by helping the supply industry in its marketing and infrastructure development efforts, including the provision of financial incentives.**

REDI targets four systems: solar water heating, solar air heating, earth energy, and high-efficiency, low-emissions biomass combustion. REDI promotes these systems in the business, federal and industrial markets through three means: a financial incentive, market assessment, and information and awareness.

Key 2004–2005 Achievements

- REDI leveraged taxpayers' funds at the rate of 6:1 by distributing $3.2 million in REDI financial incentives among 95 projects valued at $21 million; the projects were completed in 2004–2005.
- REDI promoted innovation by supporting the commercialization of two new solar technologies: a glazed solar air-heating technology from Newfoundland and Labrador and a solar concentrator developed in Ottawa that combines solar heat and photovoltaic power and sets a new benchmark for efficiency of solar collectors. REDI also paid for testing of these new systems at the National Solar Test Facility and the National Research Council's Canadian Centre for Housing Technology.
- In collaboration with the solar industry and the Canadian Standards Association, REDI developed a new standard for solar water-heating systems.

*For more information:*
nrcan.gc.ca/redi

**TABLE 7-3**

REDI for Business Projects Completed, 1998–1999 to 2004–2005

| | *Number of projects completed* | *Estimated GHG reduction (tonnes $CO_2$/yr.)* | *Client investment* | *Federal incentive* |
|---|---|---|---|---|
| 1998–1999 | 8 | 2869.0 | $1,306,295 | $145,950 |
| 1999–2000 | 9 | 260.8 | $479,633 | $119,910 |
| 2000–2001 | 24 | 5825.4 | $1,849,918 | $327,078 |
| 2001–2002 | 43 | 21.7 | $5,827,561 | $1,197,965 |
| 2002–2003 | 33 | 5718.8 | $2,745,834 | $606,210 |
| 2003–2004 | 89 | 39 653.5 | $22,356,375 | $2,551,845 |
| 2004–2005 | 95 | 22 413.7 | $21,350,084 | $3,200,000 |
| **Total** | **301** | **76 762.9** | **$55,915,700** | **$8,148,958** |

## Renewable Energy Programs: Renewable Energy Technologies (RET) Program

**Objective: To promote energy diversity and support efforts by Canadian industry to develop renewable energy technologies.**

The Renewable Energy Technologies (RET) program aims to improve the economics and efficiency of renewable energy technologies, including small hydro (less than 20 megawatts), thermal solar and wind energy. It is actively involved in research and development to support the growth of the renewable energy industry in Canada. This growth will be achieved through: identifying and accelerating strategic research and development, development and deployment activities; fostering the commercialization of new technologies; identifying and developing opportunities for renewables integration; developing infrastructure to support innovation such as codes, policies and standards; developing linkages between utilities, industry and academia; resource assessment; supporting training and education; dissemination of results and findings; support of policy and programs; and international collaboration through the International Energy Agency (IEA).

Key 2004–2005 Achievements

- Launched the Drake Landing Solar Community on March 30, 2005. This seasonal solar thermal storage project, conceived and led by RET, is a 52-home subdivision in Alberta that will capture solar energy in the summer and store it for use in the winter. The solar district heating system will meet 90 percent of the community's residential space heating needs, a result unprecedented anywhere in the world.
- Played a key role in refurbishing the 100-year-old small hydro generating station at Chaudière Falls on the Ottawa River, in partnership with Energy Ottawa. Energy Ottawa has won a contract to supply $9 million worth of "green power" to the federal government from hydroelectric generating stations – the largest agreement of its kind in Ontario.
- Supported Yukon Energy Corporation and Vuntut Development Corporation, an Aboriginal organization, in carrying out a wind and icing monitoring project on Crow Mountain near the community of Old Crow, Yukon, north of the Arctic Circle. The results of this project will help reduce the climatic barriers to using wind energy in the North and develop expertise in wind resource assessment in severe conditions.

*For more information:*
canren.gc.ca

## Renewable Energy Programs: Wind Power Production Incentive (WPPI)

**Objective: The WPPI is a 15-year, $260-million program to support the installation of 1000 megawatts of new wind energy capacity or the production of 2.6 terrawatt-hours by March 31, 2007.**

The WPPI encourages electric utilities, independent power producers and other stakeholders to gain experience in wind power, an emerging energy source. The incentive is approximately $0.01per kilowatt hour of production and represents about half of the current cost of the premium charged for wind energy in Canada for facilities where good wind resources exist. Eligible recipients can receive the incentive for 10 years.

Key 2004–2005 Achievements

- Two new wind energy projects were commissioned in fiscal year 2004–2005. Both projects are located in Alberta. These projects contributed about 100 megawatts of new wind energy capacity. Since its introduction in 2002, more than 206 megawatts of new wind power has been commissioned under the WPPI program, representing 11 projects and a total financial commitment of $79 million.
- In the October 2004 Speech from the Throne, the Government of Canada made a commitment to quadruple the Wind Power Production Incentive program. In the 2005 Federal Budget, the Government of Canada announced that it would invest an additional $920 million over 15 years to increase the WPPI target to 4000 megawatts.

*For more information:*
canren.gc.ca

## Renewable Energy Programs: Market Incentive Program (MIP)

**Objective: The MIP is a $25-million program to stimulate emerging markets for renewable electricity. Funding is available until March 31, 2007.**

Under the program, electric utilities, retailers and marketers submit proposals for consideration by NRCan and Environment Canada for projects to develop market-based programs and promote the sale of electricity from emerging renewable sources, having low environmental impact, to residential and small-business customers. The Government of Canada is to provide a short-term financial incentive of up to 40 percent of the eligible costs of an approved project, to a maximum contribution of $5 million per recipient.

The program's carbon dioxide reduction objectives are 1.4 megatonnes per year by 2010.

Key 2004–2005 Achievements

- Signed six contribution agreements for marketing initiatives in Alberta (2), Manitoba, Ontario (2) and Nunavut bringing the total number of agreements to nine.
- NRCan commissioned a broad study to formulate a program development strategy, given the success factors and barriers to green power marketing.
- Environment Canada commissioned a study to review and assess the implementation and effectiveness of customer rebate programs and determine whether a customer rebate program could improve the success of green power marketing in Canada.

*For more information:*
reed.nrcan.gc.ca

## Renewable Energy Programs: ENergy from the FORest (ENFOR)

**Objective: To improve the understanding of the role of biomass production for energy and to improve biomass productivity from natural forests and from plantations growing willow and poplar.**

ENFOR, managed by the Canadian Forest Service (CFS) of NRCan, undertakes research and development (R&D) on the production and harvesting of forest biomass for energy through the private sector, universities or CFS research centres. ENFOR also investigates the broader environmental effects of harvesting from forests and short-rotation plantation culture, focusing on sustaining forest productivity and improving the sequestration and storage of atmospheric carbon in forest ecosystems. ENFOR also supports research on information systems to determine the quantity and quality of biomass in Canadian forests.

Key 2004–2005 Achievements

- Major successes include additional refinement of the Forest Biomass Inventory of Canada; the modelling of whole-tree harvesting/nutrient cycling; the Carbon Budget Model of the Canadian Forest Sector; and the development and testing of species, clones and the establishment and fertilization of energy plantations.
- The IEA publication titled "Benefits of Bioenergy" provides an overview of the wide range of biomass sources and conversion technologies available. It also provides case studies from the Member Countries of practical bioenergy solutions. These are highlighted because they satisfy both energy demands and wider sustainable development outcomes. The brochure is available on the IEA Bioenergy Web site at www.ieabioenergy.com/media.php.
- Several species/varieties of willow and poplar have been assessed and are being tested for production in Ontario, Quebec and the Prairie provinces. Plantation establishment has been successful in many regions and growth and yield data is being gathered. Industry in western Canada is now engaged in the large-scale planting of fast-growing poplars.

*For more information:*
nrcan.gc.ca/cfs-scf/science/resrch/bioenergy

# Chapter 8: Federal House in Order

## Introduction

The Government of Canada is the country's largest single enterprise. It is working to get its house in order by setting a target of a 31 percent reduction in greenhouse gas (GHG) emissions from its own operations by 2010.

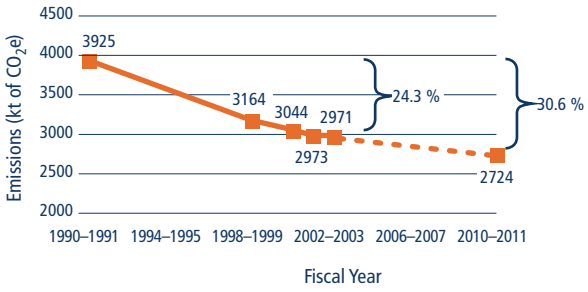
Since 1990, through building retrofits, better fleet management, strategic "green power" purchases and the downsizing of operations, the Government of Canada has already achieved a 24 percent emissions reduction. The Government of Canada will reduce its net emissions by a further 12 percent by 2010.

The Government of Canada will achieve its goal by additional building retrofits, fuel switching, improved fleet management, energy-efficient procurement and increased use of renewable energy within government operations. Moreover, the Government of Canada can help to "create the market" for certain new technologies on the verge of becoming viable. Key departments, which are responsible for 95 percent of government GHG emissions, have been assigned specific targets and must report annually on their progress.

The task of target sharing entails assigning specific targets to the 11 largest emitting departments based on the emission-reduction opportunities identified within each organization. Natural Resources Canada (NRCan) is taking a lead role in managing this task and in providing programs and support to departments and agencies that will help them achieve their targets. A leadership component of the Federal House in Order initiative encourages the reduction of all federal emissions by engaging the active participation of the departments, agencies and Crown corporations that were not designated with a target.

**FIGURE 8-1**

GHG Emissions Reductions From Federal Operations, 1990 to 2010



## Federal Buildings Initiative (FBI)

**Objective: To assist Government of Canada organizations to implement energy efficiency improvements, leading to reduced energy use, GHG emissions and operating costs.**

The Federal Buildings Initiative (FBI) facilitates comprehensive energy efficiency upgrades and building retrofits for departments, agencies and Crown corporations of the Government of Canada. The FBI provides advice and consultation on project opportunities, model performance contracting documents, celebration and recognition opportunities, and a national network for energy management training. In facilitating public-private partnerships, the FBI manages a qualified list of energy management firms that provide a turnkey service to federal organizations, including project engineering and construction, third-party private sector financing, project monitoring, and employee training and awareness. FBI program officers work with federal organizations from project inception through to contract award and project monitoring and verification.

Key 2004–2005 Achievements

- The Royal Canadian Mint signed its first FBI contract for a project at its Sussex Drive location in Ottawa. The $8-million investment will result in guaranteed energy and water savings of $787,000 annually.
- New and incremental investment by the private sector in FBI projects of $12.8 million.
- Project opportunities were developed with first-time federal clients, including the Canadian Museum of Nature, the Canada Mortgage and Housing Corporation, and Fisheries and Oceans Canada.

*For more information:*
oee.nrcan.gc.ca/fbi/home_page.cfm

## Energy Technology Applications Group

**Objective: To provide technical and project management services to assist federal facilities to implement energy-reduction projects.**

The Energy Technology Applications Group's (ETAG's) extensive experience in building energy systems and access to the engineering and scientific network within the CANMET Energy Technology Centre (CETC) ensures that environmentally responsible technologies are considered when federal government clients replace or modify their energy systems. ETAG changed its name from the Federal Industrial Boiler Program (FIBP) in 2004 to better reflect the range of energy technologies that it deals with and its role as technical support and liaison between federal facilities and the energy technology groups within CETC. Since its inception in 1991, the ETAG (then FIBP) has worked with such departments as Agriculture and Agri-Food Canada, Correctional Service Canada (CSC), Environment Canada, the Department of Foreign Affairs and International Trade (now divided into Foreign Affairs Canada and International Trade Canada) and National Defence to reduce their energy costs. Through projects implemented by ETAG, GHG emissions are reduced by an average of 4.7 kilotonnes per year.

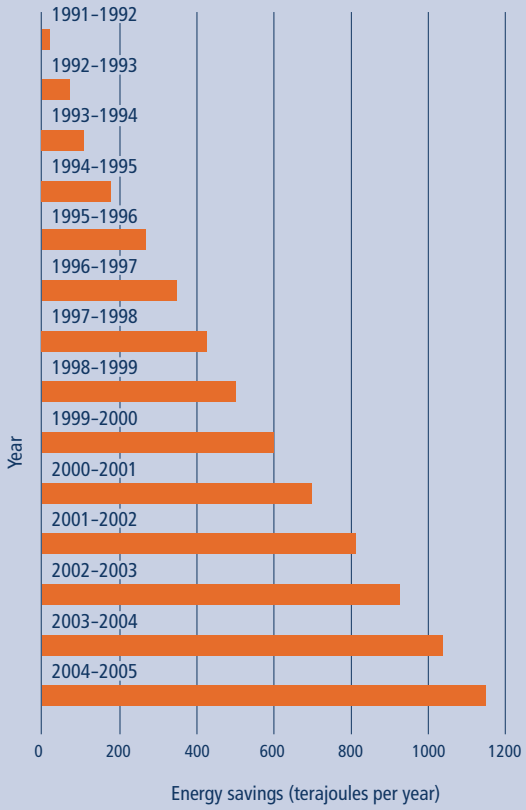
Key 2004–2005 Achievements

- Worked with CSC to continue its Federal House in Order-sponsored wind power projects. ETAG managed the installation of three wind monitoring towers at CSC's most promising sites – Dorchester, New Brunswick; Port Cartier, Quebec; and Drumheller, Alberta. Analysis of the wind data and the site electrical profile indicates 250-kilowatt wind turbines are appropriate. Funding is in place for two sites. ETAG will be proceeding with detailed project engineering. Once implemented, the wind turbines will reduce annual carbon dioxide emissions by 450 000 kilograms.
- Worked with CSC sites in the area of Kingston, Ontario, to review heating plant operations and develop options to reduce energy use, operating costs and environmental emissions. After conducting a feasability study for Joyceville Institution, ETAG developed the technical requirements for a new boiler and control system upgrade that will be implemented in 2005. The project will cost $450,000.
- Conducted efficiency and emission testing at Canadian Forces Base Greenwood's new heating plant to determine performance of low-nitrogen-oxide burner technology. The performance data was presented in discussions with Environment Canada regarding updating nitrogen oxide emission guidelines from federal government operations when burning heavy fuel oil.

*For more information:*
etag-gate.ca

**FIGURE 8-2**

Annual Energy Savings From the ETAG, 1991–1992 to 2004–2005



## Federal Vehicles Initiative

**Objective: To assist federal government departments to increase the energy efficiency of their motor vehicle fleets and reduce the environmental impact of federal vehicle operations and to promote the *Alternative Fuels Act* within the federal fleet.**

The Federal Vehicles Initiative provides fleet managers with an assessment of fleets as well as technical advice and encouragement on acquiring and using alternative transportation fuels. Four departments participate in planning and reporting on the initiative: Environment Canada, NRCan, Public Works and Government Services Canada, and Treasury Board of Canada Secretariat. NRCan is responsible for implementing the program.

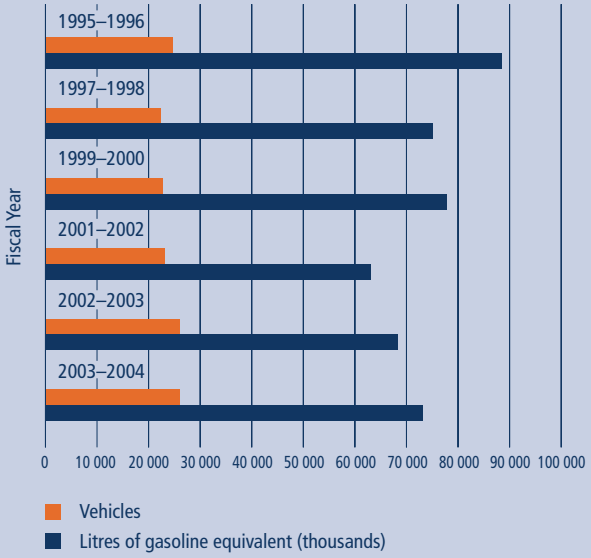
Key 2004–2005 Achievements

- Established two new E85 bulk fuel sites.
- Trained 1445 federal vehicle operators at workshops; trained an additional 205 operators on-line.
- Assisted in purchasing 682 Leadership Vehicles (497 alternative fuel vehicles and 185 hybrid vehicles).

*For more information:*
oee.nrcan.gc.ca/communities-government/transporation/federal/mandate.cfm

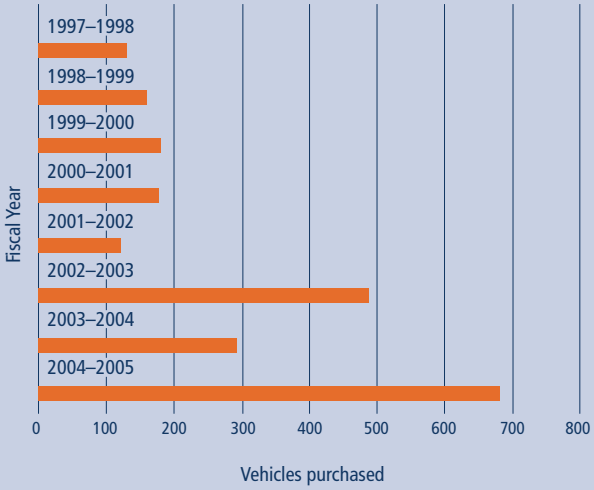
### FIGURE 8-3

Federal Fleet Size and Fuel Consumption, 1995–1996 to 2003–2004




### FIGURE 8-4

Purchases of Alternative Fuel Vehicles (Including Hybrids) for the Federal Fleet, 1997–1998 to 2004–2005



# Chapter 9: General Programs

## Outreach

**Objective: To increase Canadians' awareness and understanding of climate change and the link to energy use, and to encourage Canadians to take action.**

The Outreach program provides information and activities to encourage Canadians to integrate energy efficiency into their energy-use decisions. Outreach supplements program communications activities with publications, exhibits, joint projects and the Office of Energy Efficiency Web site.

The Outreach program targets youth as future energy consumers by investing in joint initiatives in the education sector and through promotional projects. Public information activities increase awareness of the environmental impact of energy use. They also encourage consumers to adopt energy-efficient practices and to switch to alternative forms of energy.

As a component of the Outreach program, the One-Tonne Challenge was launched in March 2004. The One-Tonne Challenge is co-managed with Environment Canada, with input from and coordination with other departments, such as Transport Canada. The One-Tonne Challenge asks Canadians to reduce greenhouse gas (GHG) emissions by one tonne. Canadians are challenged to use less energy, to reduce waste and to conserve water and other resources. Reduced emissions will protect the climate and result in cleaner air and healthier communities for all Canadians.

Key 2004–2005 Achievements

- Interest and demand for energy efficiency information has continued to increase – 53 percent increase in the volume of publications distributed (now at 5.6 million) and 30 percent increase in visits to the Web site (2 million).
- The One-Tonne Challenge was introduced to the Canadian public and potential partners, including a successful advertising campaign noted by over 50 percent of Canadians. Activity levels in the first year of the program are high with over 1.7 million Web site visits, 55 000 on-line pledges, distribution of 900 000 One-Tonne Challenge guides and more than 20 partners actively involved in the program.

*For more information:*
oee.nrcan.gc.ca/corporate/programs.cfm#Outreach

## RETScreen® International Clean Energy Decision Support Centre

**Objective: To build the capacity of planners, decision-makers and industry to implement renewable energy and energy efficiency projects.**

This objective is achieved by developing decision-making tools that reduce the cost of pre-feasibility studies, by disseminating knowledge to help people make better decisions, and by training people to better analyse the technical and financial viability of possible projects.

Key 2004–2005 Achievements

- Increased the number of users of the RETScreen International Clean Energy Project Analysis Software to more than 56 000 people in 206 countries, with the number of people benefiting from this decision-support and capacity-building tool now growing at more than 300 new users every week.
- Released a number of new or improved RETScreen tools, including a new Combined Heat and Power (CHP) Software Model, a Chinese version of the Photovoltaic Project Software Model, and a new on-line e-learning course.
- Published the results from an independent RETScreen impact assessment that determined that RETScreen International has had a significant impact in the short time that the software and related tools have been available, including saving stakeholders an estimated $240 million in Canada and $600 million worldwide through the use of the RETScreen software and related tools.

*For more information:*
retscreen.net

## Program of Energy Research and Development (PERD)

**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.**

The PERD budget for 2004–2005 was approximately $58 million. Natural Resources Canada (NRCan) allocated $41 million to energy R&D programs managed and performed in the department, approximately 50 percent of which contributed to improved energy efficiency in Canada.

Examples of funded projects are included in the performance reporting in Chapters 3 to 7 of this report. The remaining $17 million was allocated to 10 federal departments that are partners in the PERD.

*For more information:*
www2.nrcan.gc.ca/es/oerd/english/View.asp?x=665

## Climate Change Technology Development and Innovation Program (of the *Government of Canada Action Plan 2000 on Climate Change*)

**Objective: To accelerate the development of cost-effective R&D mitigation technologies in multiple sectors, building the intellectual foundation for long-term technological advances, building alliances and partnerships and demonstrating federal leadership towards sustainable development.**

The Climate Change Technology Development and Innovation Program received $20 million over six years (2001–2006) as a part of the *Government of Canada Action Plan 2000 on Climate Change*.

Key 2004–2005 Achievements

- Conducted a pilot demonstration project regarding the sequestration of carbon dioxide in oil sands tailings, a technology that may reduce greenhouse gases and could also be used in the disposal process of tailings.
- Tested digester and cogeneration systems and processes for more efficient hog manure management.
- Published research papers documenting the physical, thermal and geochemical characteristics of gas-hydrate-bearing sediments. Gas hydrates are a naturally occurring "ice-like" combination of natural gas and water that could provide an immense resource of natural gas from the world's oceans and polar regions.

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## International Initiative for Technology Development Program

**Objective: To identify and develop technology transfer projects and facilitate the expansion of market opportunities for climate change technologies.**

The International Initiative for Technology Development Program received $10 million over six years (2001–2006) as part of the *Government of Canada Action Plan 2000 on Climate Change*.

Key 2004–2005 Achievements

- Provided technology and project listings to the Web-based information clearing house of the United Nations Framework Convention on Climate Change.
- Completed four Requests for Proposals that provided funding for 20 feasibility studies.

## Climate Change Technology and Innovation Research and Development (T&I R&D)

**Objective: To contribute to the *Climate Change Plan for Canada*'s objective to "advance promising GHG technologies through R&D, demonstration and early adoption initiatives to achieve long-term GHG reductions and strengthen Canada's technology capacity."**

Implemented in 2003 with $115 million over five years of federal funding, T&I R&D is based on long-term strategic planning that takes into account expected energy futures and visions to the year 2025. R&D is conducted in the five strategic areas of cleaner fossil fuels, advanced end-use efficiency technologies in buildings, transportation and industry, decentralized energy production (including renewables), biotechnology and the hydrogen economy.

The T&I R&D budget for 2004–2005 was $10 million. NRCan allocated $8 million to energy R&D programs managed and performed in the department. Key NRCan R&D achievements that contributed to improved energy efficiency in Canada are included in the performance reporting in Chapters 3 to 7 of this report. The remaining $2 million was allocated to six federal departments that are partners in T&I R&D.

# Chapter 10: Cooperation

## Introduction

This chapter describes Natural Resources Canada's (NRCan's) cooperation with respect to efficiency and alternative energy (EAE) during the reporting period at the provincial/territorial and international levels. Examples of program cooperation are set out in previous chapters in the Key Achievements sections of specific EAE program initiatives. It also should be noted that municipal governments and agencies participate in NRCan's EAE measures as clients (e.g. for training workshops; as recipients of financial incentives) and partners (e.g. in anti-idling projects). NRCan also participates in ventures led by municipal organizations (e.g. Green Municipal Fund, as explained in the accompanying textbox) and provincially/territorially regulated electricity and provincially regulated natural gas utilities.

### Green Municipal Fund

- The Green Municipal Funds were created in Budget 2000 by an endowment of $125 million to the Federation of Canadian Municipalities (FCM) to support municipal government action to reduce greenhouse gases, cut pollution and improve the quality of life. The funds were doubled in Budget 2001 for a total of $250 million – $50 million for the Green Municipal Enabling Fund and $200 million for the Green Municipal Investment Fund.
- The Government of Canada signed an Agreement with the FCM, a non-profit organization, to deliver the Green Municipal Fund. Under the agreement, the Government of Canada (NRCan and Environment Canada) shares in the governance of the Green Municipal Fund, along with representatives from the public and private sectors, including municipal officials and technical experts, through participation on a Peer Review Committee and a governing Council. The FCM Board of Directors approves projects based on Council's recommendations.

## Federal-Provincial and Federal-Territorial Cooperation

Provincial and territorial governments assisted the delivery of a substantial number of EAE programs during the reporting period to reduce energy costs, increase competitiveness, improve air quality and generate economic and trade opportunities. Coordination between the federal and provincial/territorial levels is essential to avoid duplication and ensure efficient program delivery. During the reporting period, the governments cooperated at the general level and at the level of specific program initiatives.

### Cooperation Agreements

NRCan's Letter of Cooperation (LOC) on EAE with the Agence de l'efficacité énergétique du Québec during the reporting period ensures an efficient consultation and exchange of information between the two governments, and helps the coordination of EAE activities in the province and the creation of opportunities for joint projects. The management committee established under the LOC met during the year to review policy and program developments, progress on joint program initiatives and areas for further cooperation. The LOC played a considerable role in facilitating the conduct of three activities in particular:

- management of the licensing agreement for delivery of EnerGuide for Houses.
- the processing of projects submitted to the Energy Innovators Initiative and the Commercial Building Incentive Program by public organizations in Quebec; this cooperation framework is also being applied to other NRCan programs aimed at the public sector in Quebec.
- management of an agreement relating to the Programme d'intervention en réfrigération dans les arenas du Québec, under which NRCan has provided technical support for the implementation of innovative refrigeration systems in Quebec's ice rinks.

NRCan's LOC on energy efficiency and renewable energy with the Government of Yukon facilitates information exchange and the creation of opportunities for joint projects in Yukon, including partnering with the Yukon Development Corporation to create the Canada-Yukon Energy Solutions Centre in Whitehorse. The Centre provides access to relevant technical services and programs for the Yukon population and undertakes outreach and public education activities.

The Government of Canada contributes to the Arctic Energy Alliance to promote energy efficiency and renewable energy in the Northwest Territories and to facilitate opportunities for EAE projects. The Alliance also is the delivery agent in the Northwest Territories for the EnerGuide for Houses initiative.

The Government of Canada promotes energy efficiency and renewable energy in Alberta by working with Climate Change Central, a not-for-profit corporation which is funded by a multi-stakeholder base, including the Government of Alberta.

### National Advisory Council on Energy Efficiency (NACEE)

NRCan created NACEE in April 1998 to advise and guide the Office of Energy Efficiency (OEE) on the most effective way to achieve its mission. Its membership is drawn from across Canada and all economic sectors, including provincial/territorial officials and representatives of electricity and natural gas utilities, who have the opportunity to comment on the OEE's business plan and programs. NACEE met three times during 2004–2005.

## International Cooperation

NRCan cooperates with several international organizations and foreign governments in EAE program areas. Canada benefits from this cooperation:

- by learning about improved ways of designing and delivering EAE programs to meet policy objectives
- through the harmonization of energy efficiency tests and performance standards that helps reduce barriers to trade in energy-using products

### International Energy Agency (IEA)

The IEA, based in Paris, France, is an autonomous agency within the framework of the Organization for Economic Co-operation and Development. The IEA carries out a comprehensive program of energy cooperation among its 26 member countries, including Canada. IEA member governments have committed to sharing energy information, coordinating energy policies and cooperating in the development of rational energy programs. 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 Cooperation (SLT) is the key committee on the policy side. It 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 Energy Efficiency Working Party (EEWP) of the SLT undertakes IEA work on specific issues related to energy efficiency. Canada is represented at the EEWP by NRCan's OEE.

Canada's international energy research and development objectives are mainly advanced through the IEA's Working Parties, implementing agreements and the Committee for Energy Research and Technology (CERT), chaired by NRCan. Canada participates in 31 of the IEA's 40 implementing agreements, i.e. R&D collaboration programs.

NRCan is a member of the Centre for Analysis and Dissemination of Demonstrated Energy Technologies (CADDET), established under the IEA Agreement on Energy and Environmental Technologies Information Centres. CADDET is an international information network that helps managers, engineers, architects and researchers find out about energy-using technologies that have worked in other countries.

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

## United Nations

RETScreen® International is managed under the leadership of NRCan's CANMET Energy Technology Centre – Varennes (CETC–Varennes) through cost- and task-shared collaborations with other governments and multilateral organizations, and with technical support from experts in industry, government and academia. Key partners are the United Nations Environment Programme's Energy Unit of the Division of Technology, Industry and Economics; Global Environment Facility-sponsored Sustainable Alternatives Network; Risoe Centre on Energy, Climate and Sustainable Development; and the Solar and Wind Energy Resource Assessment project. Other international partners include the World Bank's Prototype Carbon Fund; the National Aeronautics and Space Administration's Langley Research Center; the Barbados Ministry of Energy and Public Utilities; the United States Agency for International Development; and the Korean Institute for Energy Research.

## China

In February 2001, Canada and China signed a Memorandum of Understanding (MOU) on Energy Cooperation. In January 2003, they signed an MOU on climate change and the Clean Development Mechanism. Energy efficiency is among the areas of cooperation identified in both MOUs.

## Mexico

NRCan signed a MOU on EAE cooperation 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 enhancing trade, investment and exchanges (technical and other) related to energy-efficient products, energy management services and alternative energy goods and services.

In 2004–2005, NRCan, in cooperation with CONAE (The Mexican National Commission for Energy Savings) organized an energy efficiency workshop in Saltillo, Mexico, under the MOU. NRCan officials participated in the workshop.

## United States

NRCan and the U.S. Department of Energy (DOE) have an MOU on road transportation, energy efficiency and alternative fuels. It provides a formal mechanism for negotiating and harmonizing North American policy on fuel efficiency, fuel quality and alternative transportation fuels. The MOU provides a framework for joint projects and studies in areas of mutual interest, such as the costs and market potential of hybrid electric-powered and diesel-powered vehicles. The MOU facilitates bilateral discussion of a broad range of issues in the motor vehicle and fuels policy area and affords access to technology assessments and policy-related studies conducted for the DOE by its national laboratories.

Canada also cooperates with the U.S. DOE on energy R&D in the areas of fuel cells, fossil fuels, bioenergy, community systems and microgeneration, nuclear fission, and carbon sequestration. Discussions took place in 2004 to replace a Memorandum of Understanding, the original mechanism for Canada-U.S. energy R&D collaboration, with a Bilateral Collaboration Treaty in Energy Research and Development.

## United States and Mexico

NRCan continues to participate with the United States and Mexico in the North American Energy Working Group's (NAEWG's) Energy Efficiency Experts Group to promote the harmonization of energy efficiency test methods, mutual recognition of conformity assessment systems for energy efficiency standards and cooperation on trilateral energy efficiency labelling programs. During the review period, work was initiated to compare test standards for central air conditioners and transformers and other products. Mexico continued to review implementation of ENERGY STAR® and adoption of a new approach, developed in Canada and the U.S., for promoting the replacement of inefficient electric motors. A trilateral stakeholder meeting was held in conjunction with the annual meeting of the Council for the Harmonization of Electrotechnical Standards for the Nations of the Americas, which provided feedback on ways for more effective interaction between the group and the NAEWG.

Also under the umbrella of the NAEWG, Canada, the United States and Mexico have been charged with implementing an initiative that will contribute to accelerating the adoption of affordable and appropriate sustainable housing solutions for rapidly growing regions of Mexico. In early 2004, the CANMET Energy Technology Centre (CETC) of NRCan was nominated as the lead of the NAEWG Science and Technology Experts Group for a sustainable housing project in Mexico known as La Casa Nueva/La Comunidad Nueva (LCN).

In October 2004, Prime Minister Paul Martin and President Vincente Fox established the Canada-Mexico Partnership (CMP). The CMP is designed to be a high-level public-private sector alliance that would serve as a mechanism for identifying policies for facilitating cooperation, enhancing investment and creating opportunities for Canadian entrepreneurs to take part in projects that contribute to the socio-economic development of Mexican society.

Three themes were identified as priorities under the CMP. These are

- Housing and Urban Development
- Competitiveness
- Human Capital

The Housing and Urban Development theme is being led by two agencies, Canada Mortgage and Housing Corporation (CMHC) for issues related to housing, and Industry Canada's Sustainable Cities Initiative for issues related to urban development. Within the housing technology theme, a number of activities related to housing technology, energy efficiency, renewable energy and sustainable communities were identified as areas of interest by Mexico. As a result of previous and ongoing technology cooperation activities by CETC in Mexico through the NAEWG-LCN initiative, CMHC invited CETC to help develop the Terms of Reference for the housing technology activities under the CMP and further requested the involvement and technical input of CETC in furthering specific activities under the housing technology working group under the CMP.

In parallel, Industry Canada's Sustainable Cities Initiative is undertaking a number of targeted projects in the cities of Matamoros and Reynosa, Mexico, to foster sustainable solutions to many of the energy and environmental pressures facing most Mexican cities. These activities are being brought under the umbrella of the CMP. Sustainable and energy-efficient housing is one of the priority areas identified under the Sustainable Cities Initiative. CETC has been invited to assist and manage the implementation of the sustainable housing elements of the Sustainable Cities Initiative, leveraging and providing a bridge between the housing technology working group under the CMP and the NAEWG-LCN activities.

# Appendix 1: NRCan's Efficiency and Alternative Energy Initiatives and Expenditures, 2004–2005

| | (millions of dollars) |
|---|---|
| **Energy Efficiency – Equipment** | **$9.2** |
| Energy Efficiency Standards and Regulations | |
| Equipment Labelling and Promotion | |
| EnerGuide for Industry | |
| Mine Ventilation | |
| **Energy Efficiency – Housing and Buildings** | **$76.8** |
| R-2000 Standard and EnerGuide for (New) Houses | |
| Super E™ House Program | |
| EnerGuide for Houses and Retrofit Incentives | |
| Housing Energy Technology Program | |
| Commercial Building Incentive Program | |
| Industrial Building Incentive Program | |
| Green Buildings Program | |
| Federal Buildings Initiative | |
| Energy Technology Applications Group | |
| Energy Innovators Initiative | |
| Refrigeration Action Program for Buildings | |
| Buildings Program – Intelligent Buildings | |
| Building Energy Simulation Program | |
| Community Energy Systems Program | |
| **Energy Efficiency – Industry** | **$30.1** |
| Industrial Energy Efficiency (Canadian Industry Program for Energy Conservation; Industrial Energy Innovators) | |
| Cleaner Fossil Fuel Power Generation | |
| Processing and Environmental Catalysis Program | |
| Industrial System Optimization Program | |
| Industry Energy Research and Development Program | |
| Emerging Technologies Program | |
| Industrial Energy Innovation | |
| Minerals and Metals Program | |

| | (millions of dollars) |
|---|---|
| **Energy Efficiency – Transportation** | **$16.1** |
| Vehicle Efficiency | |
| EnerGuide For Vehicles | |
| Personal Vehicles | |
| Fleet Vehicles | |
| Federal Vehicles Initiative | |
| Canadian Lightweight Materials Research Initiative | |
| **Alternative Energy – Transportation** | **$54.2** |
| Fuel-Cell-Powered Mining Vehicles | |
| Future Fuels Initiative | |
| Ethanol Expansion Program | |
| Biodiesel Initiative | |
| Canadian Transportation Fuel Cell Alliance | |
| Hydrogen Fuel Cells and Transportation Energy Program | |
| **Alternative Energy – Renewable Energy Sources** | **$21.9** |
| Initiative to Purchase Electricity From Emerging Renewable Energy Sources | |
| Photovoltaic and Hybrid Systems Program | |
| Bioenergy Technology Program | |
| Renewable Energy Deployment Initiative | |
| Renewable Energy Technologies Program | |
| Wind Power Production Incentive | |
| Market Incentive Program | |
| ENergy from the FORest (ENFOR) | |
| **General Programs**[1] | **$26.8** |
| Outreach | |
| RETScreen® International Clean Energy Decision Support Centre | |
| National Energy Use Database | |
| **Total** | **$235.1** |

[1] Totals allocated for funding programs in Chapter 9 are reflected in the relevant program entries.

# Appendix 2: Data Presented in Report

The aggregate energy use data presented in this report are taken from Statistics Canada's *Report on Energy Supply–Demand in Canada* (RESD). Differences exist between this report and *Canada's Emissions Outlook: An Update* (CEO Update) concerning the sector allocations of RESD energy use data. The CEO Update's sector allocation is based on Environment Canada's *Trends in Canada's Greenhouse Gas Emissions 1990–1997*, whereas this report 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 B of NRCan's *Energy Use Data Handbook, 1990 and 1997 to 2003*.

FIGURE 1-1: Canada: Changes in Energy Intensity and the Energy Efficiency Effect, 1990 to 2003

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Intensity Index | 1.00 | 1.00 | 1.00 | 1.00 | 0.99 | 0.98 | 1.00 | 0.96 | 0.91 | 0.89 | 0.87 | 0.84 | 0.84 | 0.85 |
| Index of Energy Efficiency Effect | 1.00 | 0.98 | 0.97 | 0.94 | 0.94 | 0.92 | 0.93 | 0.91 | 0.89 | 0.88 | 0.87 | 0.87 | 0.87 | 0.87 |

FIGURE 1-2: Secondary Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2003

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Estimated energy use without energy efficiency improvements | 1.00 | 1.00 | 1.03 | 1.07 | 1.12 | 1.15 | 1.18 | 1.20 | 1.20 | 1.25 | 1.29 | 1.27 | 1.31 | 1.34 |
| 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 |

FIGURE 1-3: Electricity Production From Renewable Sources (GWh), 1991 to 2001

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GWh | 3649 | 4134 | 4477 | 5362 | 5422 | 5855 | 6419 | 6599 | 7372 | 7418 | 7512 |

FIGURE 2-1: Monthly Import Volumes

| | Apr 04 | May 04 | Jun 04 | Jul 04 | Aug 04 | Sep 04 | Oct 04 | Nov 04 | Dec 04 | Jan 05 | Feb 05 | Mar 05 | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Paper | 9193 | 7456 | 8046 | 6035 | 6236 | 6751 | 7080 | 5537 | 4967 | 5215 | 3531 | 4866 | **74 913** |
| Electronic | 24 929 | 26 792 | 28 730 | 30 563 | 30 279 | 29 339 | 31 518 | 29 647 | 29 294 | 29 519 | 30 266 | 34 672 | **355 548** |

FIGURE 2-7: Awareness Levels of ENERGY STAR in Canada

| | Nov 01 | Jan 03 | Sep 03 | Nov 04 |
|---|---|---|---|---|
| Aware – Aided | 26 | 32 | 40 | 44 |
| Aware – Non-aided | 13 | 17 | 25 | 29 |

FIGURE 2-8: ENERGY STAR Qualified Appliances as a Percent of Total Category Sales in Canada in 2003

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Refrigerators | 24.1 | 21.3 | 24.7 | 27.4 | 35.5 | 36.7 | 37.7 | 40.4 | 42.2 | 47.6 | 45.9 | 46.1 |
| Clothes washers | 25.6 | 20.6 | 23.2 | 21.4 | 23.6 | 23.0 | 22.5 | 21.9 | 24.4 | 26.1 | 29.9 | 25.0 |
| Dishwashers | 33.2 | 31.5 | 30.8 | 36.5 | 41.5 | 46.7 | 47.3 | 50.7 | 60.7 | 63.5 | 65.5 | 66.7 |

FIGURE 3-1: Canadian Households by Type of Dwelling, 2003

| | Number of households | Percentage |
|---|---|---|
| Single detached | 6 908 256 | 57 |
| Apartments | 3 777 289 | 31 |
| Single attached | 1 271 438 | 10 |
| Mobile homes | 257 148 | 2 |
| **Total** | **12 214 130** | **100** |

FIGURE 3-2: Residential Energy Use by Purpose, 2003

| | Energy Use (PJ) | Percentage |
|---|---|---|
| Space heating | 873.4 | 60 |
| Water heating | 311.8 | 21 |
| Appliances | 189.0 | 13 |
| Lighting | 65.6 | 5 |
| Space cooling | 17.7 | 1 |
| **Total** | **1457.6** | **100** |

FIGURE 3-3: Residential Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2003

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Estimated energy use without energy efficiency improvements | 1.00 | 1.04 | 1.10 | 1.14 | 1.15 | 1.17 | 1.23 | 1.21 | 1.13 | 1.18 | 1.25 | 1.22 | 1.28 | 1.32 |
| Actual energy use | 1.00 | 0.98 | 1.01 | 1.04 | 1.07 | 1.05 | 1.13 | 1.08 | 0.99 | 1.03 | 1.08 | 1.04 | 1.08 | 1.13 |

FIGURE 3-4: Annual Heating Consumption for Houses Constructed to Different Standards

| Description | EnerGuide for Houses Annual Heating Consumption (MJ) |
|---|---|
| Typical house built to R-2000 Standard | 78 747 |
| House built to *Model National Energy Code* (2002) | 112 101 |
| Typical new house (2002) | 146 274 |
| Typical existing house (1970) | 216 812 |

FIGURE 3-5: Average Energy Consumption per Household, Pre-1946 to 2001–2004 Construction

| Year Built | Average Energy Consumption (GJ) |
|---|---|
| Pre-1946 | 297 |
| 1946–1960 | 221 |
| 1961–1970 | 210 |
| 1971–1980 | 201 |
| 1981–1990 | 191 |
| 1991–2000 | 169 |
| 2001–2004 | 158 |
| All EGH in Canada | 220 |
| R-2000 | 100 |

FIGURE 3-6: Average Energy Consumption of New Appliances*, 1990 and 2003 Models

| | 1990 | 2003 |
|---|---|---|
| Clothes washers | 1218 | 708.4 |
| Clothes dryers | 1103 | 914.2 |
| Refrigerators | 956 | 487.1 |
| Dishwashers | 1026 | 523.9 |
| Ranges | 772 | 709.4 |
| Freezers | 714 | 369.1 |

* kWh/yr.

FIGURE 3-7: Number of Eligible R-2000 Housing Starts, 1990 to 2004

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of R-2000 Houses | 495 | 699 | 1196 | 1299 | 784 | 610 | 416 | 484 | 265 | 213 | 319 | 329 | 428 | 379 | 582 |

FIGURE 3-8: National Trends in Air Leakage, Pre-1945 to 2000–2004 Construction

| Year Built | First EGH Evaluation (A) | Post-Retrofit Evaluation (B) | R-2000 |
|---|---|---|---|
| Pre-1945 | 11 | 8 | n.a. |
| 1945–1959 | 8 | 6 | n.a. |
| 1960–1969 | 6 | 5 | n.a. |
| 1970–1979 | 6 | 5 | n.a. |
| 1980–1989 | 5 | 5 | 0.9 |
| 1990–1999 | 5 | 4 | 1.1 |
| 2000–2004 | 4 | 3 | 1.1 |
| Average | 7 | 6 | 1.1 |

FIGURE 3-9: Evaluations Under EnerGuide for Houses, 1998–1999 to 2004–2005

| Year of EGH Evaluation | 1998–1999 | 1999–2000 | 2000–2001 | 2001–2002 | 2002–2003 | 2003–2004 | 2004–2005 |
|---|---|---|---|---|---|---|---|
| Houses evaluated but not re-evaluated (A evaluation) | 3675 | 9111 | 11 510 | 11 088 | 16 564 | 48 260 | 58 760 |
| Houses retrofitted and re-evaluated (B evaluation) | 832 | 226 | 607 | 709 | 1153 | 2724 | 18 081 |

FIGURE 3-10: Residential Energy Use and Energy Savings per Household*, Pre-1945 to 2000–2004

| | Pre-1945 | 1945–1959 | 1960–1969 | 1970–1979 | 1980–1989 | 1990–1999 | 2000–2004 | Average |
|---|---|---|---|---|---|---|---|---|
| Energy use pre-evaluation | 299 | 229 | 222 | 213 | 206 | 190 | 182 | 231 |
| Evaluation-identified energy savings | 134 | 94 | 89 | 81 | 68 | 51 | 46 | 91 |
| Actual energy savings after renovations | 91 | 62 | 58 | 53 | 46 | 38 | 36 | 61 |

* Gigajoules

FIGURE 4-1: Commercial/Institutional Energy Use by Activity Type*, 2003

| End Use | Energy Use | Percentage |
|---|---|---|
| Offices** | 497.7 | 43 |
| Retail Trade | 157.4 | 13 |
| Health Care and Social Assistance | 135.2 | 12 |
| Educational Services | 117.8 | 10 |
| Accommodation and Food Services | 74.3 | 6 |
| Wholesale Trade | 58.8 | 5 |
| Transportation and Warehousing | 36.9 | 3 |
| Information and Cultural Industries | 35.0 | 3 |
| Arts, Entertainment and Recreation | 34.8 | 3 |
| Other Services | 24.0 | 2 |
| **Total** | **1171.91** | **100** |

* Excludes street lighting

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

FIGURE 4-2: Commercial/Institutional Energy Use by Purpose*, 2003

| End Use | Energy Use | Percentage |
|---|---|---|
| Space heating | 644.05 | 55 |
| Lighting | 158.12 | 13 |
| Auxilary motor | 114.11 | 10 |
| Auxilary equipment | 106.06 | 9 |
| Water heating | 76.21 | 7 |
| Space cooling | 73.37 | 6 |
| **Total** | **1171.91** | **100** |

* Excludes street lighting

FIGURE 4-3: Commercial/Institutional Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2003

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Estimated energy use without energy efficiency improvements | 1.00 | 1.05 | 1.08 | 1.13 | 1.13 | 1.16 | 1.19 | 1.19 | 1.16 | 1.21 | 1.26 | 1.25 | 1.33 | 1.37 |
| 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 | 1.36 |

FIGURE 4-4: Energy Use in Commercial Buildings

| | Gigajoules per $m^2$ per year |
|---|---|
| CBIP results | 0.85 |
| *Model National Energy Code for Buildings* | 1.32 |
| New buildings* | 1.33 |
| All buildings * | 1.59 |

* Source: Commerical and Institutional Building Energy Use Survey (CIBEUS), 2000. Estimates relate only to the surveyed area of populations over 175 000, and in Atlantic Canada to populations over 50 000.

FIGURE 4-5: Estimated Average GHG Reductions by Type of Institution Under CBIP, 2004

| Building type | Number | Annual GHG Savings* (tonnes/year) | Average GHG savings (tonnes/year) 2004 |
|---|---|---|---|
| Municipal | 15 | 1644 | 110 |
| Retail | 103 | 18 549 | 180 |
| MURB | 34 | 5600 | 182 |
| Office | 110 | 21 214 | 195 |
| Education | 166 | 33 265 | 200 |
| Other | 27 | 5512 | 204 |
| Health | 70 | 17 580 | 251 |
| Industrial | 16 | 4653 | 291 |
| **Total** | **541** | **108 016** | |

* for average size building

FIGURE 5-1: Industrial Energy Use by Sub-Sector, 2003

| | Percent of Industrial Energy Use |
|---|---|
| Pulp and paper | 26.2 |
| Mining | 19.4 |
| Other manufacturing | 17.4 |
| Petroleum refining | 11.6 |
| Smelting and refining | 8.1 |
| Iron and steel | 7.2 |
| Chemicals | 5.9 |
| Cement | 1.9 |
| Construction | 1.7 |
| Forestry | 0.6 |

FIGURE 5-2: Cost of Energy to Manufacturing Industries as a Percentage of Total Production Cost, 2003

| Industry | Energy Cost / Total Production Cost |
|---|---|
| Cement | 38.49 |
| Pulp and paper | 13.91 |
| Chemicals | 13.25 |
| Iron and steel | 12.85 |
| Aluminum | 12.50 |
| Petroleum refining | 2.41 |
| Transportation equipment manufacturing | 0.86 |

FIGURE 5-3: Industrial Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2003

| | 1990 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|
| Estimated energy use without energy efficiency improvements | 1.00 | 1.15 | 1.16 | 1.20 | 1.21 | 1.26 | 1.31 | 1.27 | 1.30 | 1.32 |
| Actual energy use | 1.00 | 1.07 | 1.10 | 1.10 | 1.08 | 1.11 | 1.15 | 1.10 | 1.16 | 1.19 |

FIGURE 5-4: CIPEC Energy Intensity Index, 1990 to 2003

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 0.91 |

FIGURE 5-5: Industrial Energy Innovators, 1995–1996 to 2004–2005

| | 1995–1996 | 1996–1997 | 1997–1998 | 1998–1999 | 1999–2000 | 2000–2001 | 2001–2002 | 2002–2003 | 2003–2004 | 2004–2005 |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of Industrial Energy Innovators | 176 | 203 | 208 | 212 | 227 | 280 | 305 | 382 | 529 | 653 |

FIGURE 6-1: Transportation Energy Use by Mode, 2003

| | Energy Use (PJ) | Percentage |
|---|---|---|
| Passenger light vehicle | 1055.5 | 44.7 |
| Freight truck | 757.8 | 32.1 |
| Passenger aviation | 211.9 | 9.0 |
| Freight marine | 103.1 | 4.4 |
| Off-road | 93.1 | 3.9 |
| Freight rail | 71.2 | 3.0 |
| Passenger bus | 52.4 | 2.2 |
| Freight aviation | 13.8 | 0.6 |
| Passenger rail | 2.6 | 0.1 |
| **Total** | **2361.3** | **100.0** |

FIGURE 6-2: Transportation Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2003

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Estimated energy use without energy efficiency improvements | 1.00 | 0.97 | 1.01 | 1.05 | 1.11 | 1.15 | 1.17 | 1.22 | 1.26 | 1.30 | 1.32 | 1.32 | 1.36 | 1.41 |
| 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 |

FIGURE 6-3: Market Shares of New Passenger Car and Light Truck Sales, 1990 to 2003

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Passenger car market share (%) | 72.1 | 72.7 | 70.9 | 67.7 | 65.7 | 63.5 | 61.1 | 58.0 | 57.3 | 59.3 | 60.6 | 62.7 | 62.1 | 61.6 |
| Passenger light truck market share (%) | 27.9 | 27.3 | 29.1 | 32.3 | 34.3 | 36.5 | 38.9 | 42.0 | 42.7 | 40.7 | 39.4 | 37.3 | 37.9 | 38.4 |

FIGURE 6-4: New Car Fuel Efficiency, Normalized for Weight and Power, 1990 to 2003

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L/100 km | 1.00 | 0.98 | 0.99 | 0.99 | 1.00 | 0.96 | 0.96 | 0.98 | 0.96 | 0.96 | 0.95 | 0.95 | 0.94 | 0.93 |
| L/100 km/kg | 1.00 | 1.00 | 1.01 | 0.99 | 0.96 | 0.91 | 0.92 | 0.93 | 0.92 | 0.91 | 0.90 | 0.89 | 0.87 | 0.86 |
| L/100 km/hp | 1.00 | 0.98 | 0.95 | 0.93 | 0.91 | 0.85 | 0.82 | 0.82 | 0.79 | 0.79 | 0.76 | 0.75 | 0.73 | 0.71 |

FIGURE 6-5: Trucking Intensity and Average Activity per Truck, 1990 to 2003

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Activity (tkm/truck) | 113 598 | 102 723 | 103 801 | 115 315 | 131 042 | 138 426 | 150 912 | 157 785 | 157 395 | 192 004 | 199 674 | 200 876 | 201 773 | 220 489 |
| Energy Intensity (MJ/tkm) | 3.65 | 3.74 | 3.73 | 3.54 | 3.34 | 3.37 | 3.24 | 3.25 | 3.10 | 2.83 | 2.86 | 2.73 | 2.72 | 2.67 |

FIGURE 6-6: Company Average Fuel Consumption (CAFC) vs. Canadian Voluntary Standards, 1990 to 2004

| Truck 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 | 11.4 | 8.6 | 7.9 |
| 1999 | 11.4 | 11.3 | 8.6 | 7.9 |
| 2000 | 11.4 | 11.1 | 8.6 | 7.8 |
| 2001 | 11.4 | 11.0 | 8.6 | 7.8 |
| 2002 | 11.4 | 10.9 | 8.6 | 7.7 |
| 2003 | 11.4 | 10.7 | 8.6 | 7.6 |
| 2004 | 11.4 | 10.7 | 8.6 | 7.6 |

FIGURE 6-7: Vehicle Fuel Efficiency Awareness – EnerGuide Labels

| Year | New vehicles on lot with EnerGuide label (%) | New vehicles in showroom with EnerGuide label (%) |
|---|---|---|
| 1999 | 64 | 47 |
| 2001 | 77 | 56 |

FIGURE 6-8: Vehicle Fuel Efficiency Awareness – Program Activities

| Year | Recollection of information on how to reduce vehicle fuel consumption (general public) (%) | Awareness of program activities (general public) (%) |
|---|---|---|
| 1998 | 30 | 9 |
| 2002 | 36 | 16 |

FIGURE 6-9: Drivers Trained and Participation in the Fleet Vehicle Initiative*, 1997–1999 to 2003–2004

| | Drivers Trained | Members |
|---|---|---|
| 1997–1999 | 51 000 | 946 |
| 1999–2000 | 53 000 | 1068 |
| 2000–2001 | 112 846 | 1643 |
| 2001–2002 | 125 000 | 2707 |
| 2002–2003 | 149 000 | 2805 |
| 2003–2004 | 160 000 | 3267 |

* Currently updating all information in the membership database (more than 3800 entries) to ensure performance indicator consistency and accuracy. Drivers trained estimate should be considered only as a preliminary result.

FIGURE 7-1: Canadian Wind Power Capacity, 1990 to 2004

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wind Power Capacity (MW) | 0 | 0 | 0 | 19 | 19 | 20 | 20 | 21 | 24 | 124 | 137 | 214 | 230 | 327 | 444 |

FIGURE 8-1: GHG Emissions Reductions From Federal Operations, 1990 to 2010

| | 1990 | 1998 | 2000 | 2001 | 2002 | 2010 Target |
|---|---|---|---|---|---|---|
| GHG Emissions (kt of $CO_2e$) | 3925 | 3164 | 3044 | 2973 | 2968 | 2724 |

FIGURE 8-2: Annual Energy Savings From the ETAG, 1991–1992 to 2004–2005

| | 1991–1992 | 1992–1993 | 1993–1994 | 1994–1995 | 1995–1996 | 1996–1997 | 1997–1998 | 1998–1999 | 1999–2000 | 2000–2001 | 2001–2002 | 2002–2003 | 2003–2004 | 2004–2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Annual additions | 20 | 50 | 40 | 70 | 90 | 80 | 77 | 77 | 93 | 103 | 112 | 117 | 110 | 110 |
| Annual (cumulative) | 20 | 70 | 110 | 180 | 270 | 350 | 427 | 504 | 597 | 700 | 812 | 929 | 1039 | 1149 |

FIGURE 8-3: Federal Fleet Size and Fuel Consumption, 1995–1996 to 2003–2004

| | 1995–1996 | 1997–1998 | 1999–2000 | 2001–2002 | 2002–2003 | 2003–2004 |
|---|---|---|---|---|---|---|
| Vehicles | 24 854 | 22 796 | 22 462 | 23 313 | 26 233 | 26 233 |
| Litres of gasoline equivalent (thousands) | 88 725 | 75 684 | 78 281 | 63 300 | 68 619 | 73 616 |

FIGURE 8-4: Purchases of Alternative Fuel Vehicles (Including Hybrids) for the Federal Fleet, 1997–1998 to 2004–2005

| | 1997–1998 | 1998–1999 | 1999–2000 | 2000–2001 | 2001–2002 | 2002–2003 | 2003–2004 | 2004–2005 |
|---|---|---|---|---|---|---|---|---|
| Annual purchases | 131 | 161 | 181 | 180 | 126 | 489 | 293 | 682 |

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