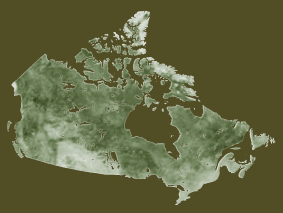

Improving Energy Performance in Canada

Report to Parliament Under the *Energy Efficiency Act*
For the Fiscal Year 2005–2006

CANADA'S **NATURAL RESOURCES**
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Published by the authority of the Minister of Natural Resources
Government of Canada

Aussi disponible en français sous le titre :
Améliorer le rendement énergétique au Canada –
Rapport au Parlement en vertu de la *Loi sur l'efficacité énergétique*, pour l'année financière 2005-2006

Cat. No. M141-10/2006E-PDF
ISBN 978-0-662-44054-3

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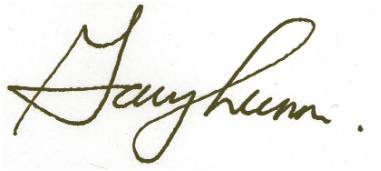
Her Excellency the Right Honourable Michaëlle Jean
C.C., C.M.M., C.O.M., C.D.
Governor General and Commander-in-Chief of Canada

Your Excellency,

I have the honour to present the *Report to Parliament Under the* Energy Efficiency Act for the fiscal year ending March 31, 2006, in accordance with Section 36 of the Act.

Respectfully submitted,



The Honourable Gary Lunn
Minister of Natural Resources

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Minister's Foreword

This Report to Parliament describes our Government's efforts to promote new energy technologies, clean energy sources and energy efficiency.

As Canada emerges as an energy superpower, our next challenge is to become a clean energy superpower. To do this, we must address the fact that the greatest source of untapped energy is the energy we waste. We must also increase our use of renewable energy and our investment in science and technology to make conventional energy cleaner.

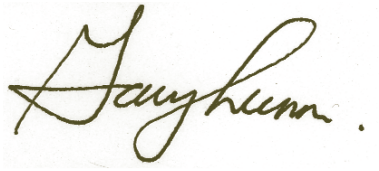
Over the coming year, we will implement our ecoENERGY Initiatives. Investments in science and technology will make it possible to use clean energy technologies to reduce greenhouse gas emissions and smog. Investments in renewable energy will offer cleaner and more diversified energy choices to Canadians. Finally, energy-efficiency programs and regulations will give Canadians the tools they need to make informed choices to protect and improve the environment in their daily activities.

The production and use of energy are just two areas in which this Government is taking decisive action. By introducing the Clean Air Act, Canada's New Government created a comprehensive and integrated approach to tackling air pollution and greenhouse gases. This Act will regulate emissions from every sector in Canada for the first time in history. Our Government will work with all stakeholders to implement this commitment in a fair, effective and timely manner.

Also included in the Clean Air Act are amendments to Canada's energy-efficiency regulations. The proposed new regulatory requirements will affect the energy efficiency of 30 products, such as traffic signals, battery chargers and commercial clothes washers.

These proposed amendments will help Canada remain a world leader in the number of products that are regulated for energy efficiency. New standards will have energy savings equivalent to the energy usage in all households in a city the size of Windsor, Ontario.

The Government of Canada is committed to making real progress on reducing emissions and providing cleaner air to benefit all Canadians.



The Honourable Gary Lunn, P.C., M.P.
Minister of Natural Resources

Executive Summary

Canadians spent almost $135 billion in 2004 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 2004, the latest year for which figures are available, primary energy use increased by 27.9 percent.
- In 2004, secondary use accounted for 68.5 percent of primary energy use and produced 66.6 percent (505 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 2004. Transportation is second (28.9 percent), followed by residential (16.6 percent), commercial/institutional (13.7 percent) and agriculture (2.4 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 uses 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 impacts such as those of weather variations and changes in the structure of the economy. 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 2004 are estimated to have reduced GHG emissions by almost 53.6 megatonnes and decreased energy expenditures by an average of $14.5 billion in 2004 alone.

Over this period, the residential sector recorded a 21.0 percent increase in energy efficiency. The figures for transportation (17.6 percent), industry (11.5 percent) and the commercial/institutional (0.4 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. Over the short term, changes to less GHG-intensive fuels (e.g. from coal to natural gas) can help reduce GHG emissions. However, over the long term, reducing GHG emissions further will require more widespread use of alternative energy.

In recent years, the production of energy derived from alternative sources has increased significantly. Between 1990 and 2003, the last year for which data are available, the amount of electricity generated from the sun, wind and biomass increased by 302 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 2005–2006. 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, Standards and Labelling

- Volume of Monthly Import Documents
- Estimated Impact of *Energy Efficiency Regulations*, 2010 and 2020 (aggregate annual savings)
- ENERGY STAR® Qualified Appliances as a Percentage of Total Category Sales in Canada, 1999 to 2004
- ENERGY STAR Awareness Levels in Canada, 2005

Housing

- Annual Heating Consumption for Houses Constructed to Different Standards
- Average Energy Consumption per Household, Pre-1946 to 2001–2006 Construction
- Average Energy Consumption of New Appliances, 1990 and 2004 Models
- Number of Eligible R-2000 Housing Starts, 1990 to 2005
- National Trends in Air Leakage in Houses, Pre-1945 to 2000–2006 Construction
- Evaluations Under EnerGuide for Houses, 1998 to 2005
- Residential Energy Use and Energy Savings per Household, Pre-1945 to 2000–2006

Buildings

- Energy Use in Commercial Buildings, 2005
- Estimated Average Energy Savings by Type of Building Under the Commercial Building Incentive Program, 2005
- EnerGuide for Existing Buildings – Incentive Retrofit Projects, 1998 to 2005

Industry

- CIPEC Energy Intensity Index, 1990 to 2004
- Estimated CIPEC Energy Savings, 2001 to 2005
- Industrial Dollars to $ense Participants, 1997 to 2005

Transportation

- Company Average Fuel Consumption (CAFC) vs. Canadian Voluntary Standards, 1990 to 2005
- Vehicle Fuel Efficiency – EnerGuide Labelling
- Vehicle Fuel Efficiency Awareness – Program Activities
- Number of Idling Reduction Devices Purchased and Claimed Under the Commercial Transportation Energy Efficiency Rebate (CTEER) Initiative
- Participation in the Fleet Vehicles Initiative, 1998 to 2005
- Drivers Trained, 1998 to 2004

Renewable Energy

- Electricity Generation Capacity From Renewable Sources (Includes Hydro)
- Canadian Wind Power Capacity, 1990 to 2005
- REDI for Business Projects Completed, 1998 to 2005

Federal House in Order

- GHG Emissions Reductions From Federal Operations, 1990 to 2010
- Annual Energy Savings From Energy Technology Applications Group, 1991 to 2005
- Federal Fleet Size and Fuel Consumption, 1995 to 2004
- Purchases of Alternative Fuel Vehicles (Including Hybrids) for the Federal Fleet, 1997 to 2004

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 and improve the Canadian economy.

A complete list of NRCan's efficiency and alternative energy (EAE) initiatives in 2005–2006 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, development and demonstration (R,D&D) initiatives;
- the Electricity Resources Branch, which delivers market transformation initiatives for renewable energy; and
- the Science Branch of the Canadian Forest Service, which undertakes research and development (R&D) in the use of forest biomass for energy.

In its efforts to improve energy efficiency and increase the use of alternative energy, NRCan emphasizes partnership and cooperation with stakeholders such as other levels of government, the private sector and non-governmental organizations. With this approach, the demand side of the energy market moves toward more energy-efficient capital stock, production processes and operating practices without reducing service or comfort levels. On the supply side, Canada participates in developing technology for tapping renewable energy resources and alternative transportation fuels as well as for increasing the energy efficiency of energy production.

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

Policy Instruments

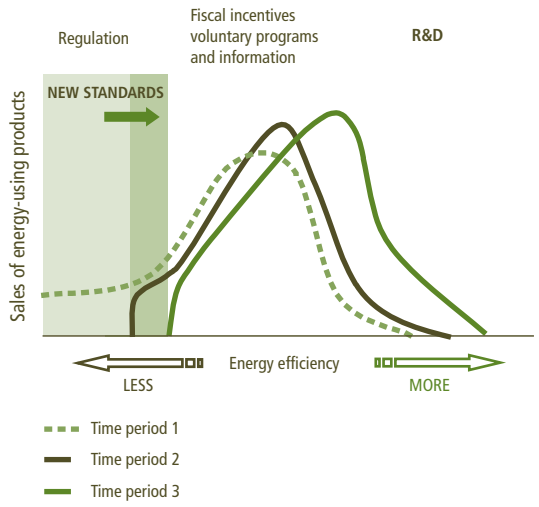
NRCan's key policy instruments are as follows:

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

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. Energy performance regulations eliminate less efficient products from the market. Fiscal incentives, voluntary programs and information increase the take-up of existing opportunities to use energy more efficiently. R&D increases the opportunities for achieving greater levels of efficiency in a particular type of energy use.

FIGURE 1

Moving the Market



Regulation

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

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, contracting out research activities to other organizations and carrying out the federal funding initiatives listed in Chapter 9, which are the only federal interdepartmental S&T investment funds with a focus on the energy sector and its economic and environmental effects.

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.

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

- program outputs
- program outcomes
- market outcomes

Program outputs are the items produced regularly, such as information and marketing materials, demonstration projects, financial incentives and regulations. Program outputs are designed to lead to **program outcomes** – namely, changes in the behaviour of groups targeted by a program. These groups may be either energy users or producers of energy-using equipment or structures. For example, program outcomes occur when consumers purchase more energy-efficient appliances than they would have if there were no program. Other important factors that influence consumer behaviour include product price, household income, personal taste and 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 leading to a market outcome is a

householder's purchase of a more energy-efficient appliance, resulting in 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 resulting from reduced electricity use, this could also lead to a decline in GHG emissions.

Data Collection and Analysis

In 1991, NRCan launched the National Energy Use Database (NEUD) initiative to help the department improve its knowledge of energy consumption and energy efficiency at the end-use level in Canada and to support NRCan's analytical expertise. The NEUD initiative plays a number of crucial roles directly related to NRCan program activities; however, its most important role is to secure the development of a reliable, Canada-wide information base on energy consumption at the end-use level for all energy-consuming sectors.

The NEUD initiative consists of several broad components that typically involve conducting large- and small-scale surveys of the stocks and characteristics of energy-using equipment and buildings (both commercial/institutional buildings and residential dwellings), observing Canadians' behaviour with respect to energy use, monitoring the adoption of new technologies in the marketplace, and participating in the development of energy end-use data and analysis centres (DACs) across Canada.

The main objective of the DACs is to create a base of expertise for the analysis of energy consumption at the end-use level in Canada. The DACs are mandated to improve the accessibility and comparability of existing data on the evolution of energy consumption and its impact on environmental quality. Three DACs currently exist: the transportation centre at Université Laval in Québec City, Quebec; the industrial centre at Simon Fraser University in Burnaby, British Columbia; and the buildings centre at the University of Alberta in Edmonton, Alberta.

The centres have made significant contributions to NEUD's mandate of improving knowledge of energy consumption and energy efficiency at the end-use level in Canada. For example, the transportation centre at Université Laval and the industrial centre at Simon Fraser University used a discrete choice model in 2005–2006 to analyse consumers' preferences for personal vehicles when they are faced with new technologies and alternative fuels. The results will be used to forecast the adoption of new technologies and alternative fuels, and the potential reductions in energy use and GHG emissions.

GHG Emissions and Climate Change

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

In This Report

This thirteenth 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 has also fostered the development of industries that have a particularly strong energy demand.

Canadians spent almost $135 billion in 2004 on energy to heat and cool their homes and offices and to operate their appliances, cars and industrial processes. This represents 12.9 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 27.9 percent between 1990 and 2004, from 9743 petajoules to 12 463 petajoules.

Secondary energy use (8543 petajoules) accounted for 68.5 percent of primary energy use in 2004. It was responsible for 66.6 percent (505 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 accounts for most 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 2004, secondary energy use increased by 22.9 percent and related GHG emissions increased by 23.9 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 2004. The transportation sector is the second largest energy user at 28.9 percent, followed by the residential sector at 16.6 percent, the commercial/institutional sector at 13.7 percent and the agriculture sector at 2.4 percent.

Energy Intensity / Energy Efficiency

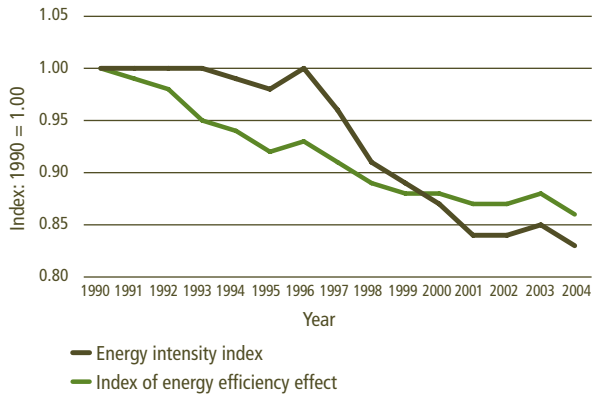
Aggregate energy intensity is the ratio of energy use per unit of GDP or, alternatively, energy use per capita. Aggregate energy intensity is sometimes used as a proxy for energy efficiency because it is simple and straightforward and the data for the calculation are readily available. However, this measure is misleading because, in addition to pure energy efficiency, intensity captures impacts such as weather variations and changes in the structure of the economy.

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 2004. The indexes present improvements in energy intensity and efficiency as a downward trend.

FIGURE 1-1

Energy Intensity and the Energy Efficiency Effect, 1990 to 2004



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. This rate was similar to that of the United States and was the fourth fastest rate among the 13 countries included in the report (surpassed by the Czech Republic, Hungary and Turkey).

TABLE 1-1

Energy Intensities for Selected IEA Countries, 2003

	GJ* per capita		GJ* per $1,000 of GDP**
Luxembourg	375.4	Czech Republic	18.5
Canada	261.4	Hungary	15.4
United States	226.0	Turkey	11.9
Finland	210.8	Canada	10.8
Norway	192.0	Korea	10.0
Belgium	172.2	New Zealand	9.5
Sweden	167.3	Finland	8.7
Netherlands	160.3	Portugal	8.1
Australia	151.2	Luxembourg	8.0
New Zealand	137.8	Belgium	7.6

*Gigajoules

**GDP is in constant 1995 US$ converted at exchange rate

Trends in Energy Efficiency

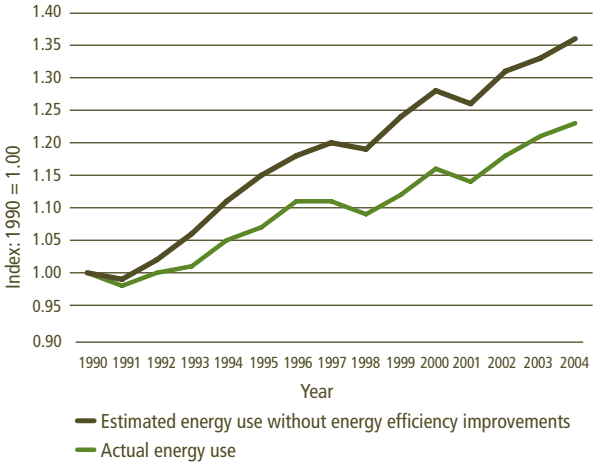
Every year, NRCan publishes *Energy Efficiency Trends in Canada*, which reports on changes in energy use (and GHG emissions) and the contribution of the following key factors to these changes:

- 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) increases 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 owing 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 may 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.

FIGURE 1-2

Secondary Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2004



Secondary energy use increased between 1990 and 2004 (from 6951 to 8543 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 35.9 percent. However, as a result of a 13.6 percent (903 petajoules) improvement in energy efficiency,[1] actual secondary energy use increased by 22.9 percent to 8543 petajoules.

The change in energy use between 1990 and 2004, 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 $14.5 billion in 2004 and a reduction in GHG emissions of almost 54 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 (21.0 percent), followed by the transportation sector (17.6 percent), industrial sector (11.5 percent), and commercial/institutional sector (0.4 percent).[2]

[1] Based on the OEE Index.

[2] 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 2004*.

TABLE 1-2

Explanation of Changes in Secondary Energy Use, 1990 to 2004

	Sectors					
	Residential	Commercial/ Institutional	Industrial	Transportation	Total**	% Change
1990 energy use (PJ)*	1289.4	867.0	2717.4	1877.9	6950.8	
2004 energy use (PJ)	1420.8	1171.2	3277.5	2465.1	8543.3	
Change in energy use (PJ)	131.5	304.2	560.1	587.2	1592.5	22.9%
Explanatory factor (change due to)						
Activity	331.02	218.55	1097.78	669.98	2317.33	33.3%
Weather	25.56	10.95	n/a	n/a	36.51	0.5%
Structure	45.96	3.26	–223.86	197.43	22.80	0.3%
Service level	n/a	75.47	n/a	n/a	75.47	1.1%
Energy efficiency	–271.06	–3.05	–313.86	–314.69	–902.66	–13.0%
Other factors		–1.01		34.49	43.03	0.6%

*Petajoules

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

Trends in Renewable Energy

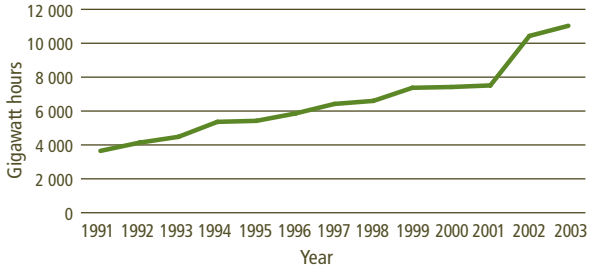
As previously noted, changes in the fuel mix used by the Canadian economy can reduce GHG intensity. Although over the near term this can be achieved by moving from more to less GHG-intensive fuels (e.g. from coal to natural gas), over the longer term the use of renewable energy sources is expected to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

Figure 1-3 shows the trend in the use of electricity generated non-hydro renewable energy sources such as wind, solar and biomass in Canada, indicating a 302 percent increase over the period 1991–2003. Although representing only a small component of overall electricity use, the proportion of electricity generated from these renewable energy sources increased from 0.8 percent to 1.9 percent over the same period, representing a 257 percent increase in its share. While most of this production was derived from biomass, the share of wind power is increasing rapidly.

The graph does not include hydro sources, either conventional or small (less than 50 megawatts). The former accounts for 58.6 percent of electricity generated in Canada; installed capacity is about 68 gigawatts. The small hydro installed generating capacity of 3300 megawatts provided about 2 percent of electricity generated in Canada.

FIGURE 1-3

Electricity Production From Non-Hydro Renewable Sources, 1991 to 2003



Chapter 2: Equipment, Standards and Labelling

Introduction

Natural Resources Canada's (NRCan's) wide range of energy efficiency initiatives includes 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 on performance and labelling requirements for energy-using products that are imported into Canada or shipped across provincial borders for the purpose of sale or lease.

The first *Energy Efficiency Regulations* came into effect in February 1995, following extensive consultations with provincial governments, affected industries, utilities, environmental groups and others. The Regulations refer to national consensus performance standards developed by accredited standards writing organizations such as the Canadian Standards Association. Such standards 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 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 71 percent of the energy used in the residential sector in Canada and 50 percent of the energy used in the commercial/institutional sector. Regulated products include major household appliances, water heaters, heating and air-conditioning equipment, automatic icemakers, dehumidifiers, dry-type transformers, electric motors of 1 to 200 horsepower and certain lighting products. The Regulations 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 in situations 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. In the case of 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. For example, it checks if it will 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. During the period covered by this report, for example, significant analysis and consultation was conducted on new proposed standards for vending machines and commercial refrigeration products, on increased stringency of standards for residential and commercial air conditioners, and on proposals for broadening the scope of standards for refrigerators and transformers. Other administrative revisions were also discussed with affected stakeholders.

Canada's *Energy Efficiency Act* and *Energy Efficiency Regulations* support a number of labelling initiatives designed to help consumers and commercial/industrial procurement officials identify and purchase energy-efficient equipment that will save them money and reduce greenhouse gas (GHG) 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 enabling 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 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 that are prescribed in the Regulations and are also part of the ENERGY STAR initiative must meet levels of energy efficiency starting at 10 percent or more above 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 candidates for 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 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 (NAEWG), established jointly by Canada, the United States and Mexico. During the report period, consultations with the NAEWG were initiated on developing a common North American approach to reducing "stand-by loss" in many electricity-using products.

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. During the report period, Canada made a major contribution to maintaining the APEC standards information Web site.

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 specific enforcement measures in cases where 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 Administrative Monetary Penalty System of the Canada Border Services Agency (CBSA) for not providing required information on the prescribed product at the time of import; serious violations can be prosecuted.

To monitor compliance with the Regulations, NRCan captures information from two sources: energy efficiency reports and 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.

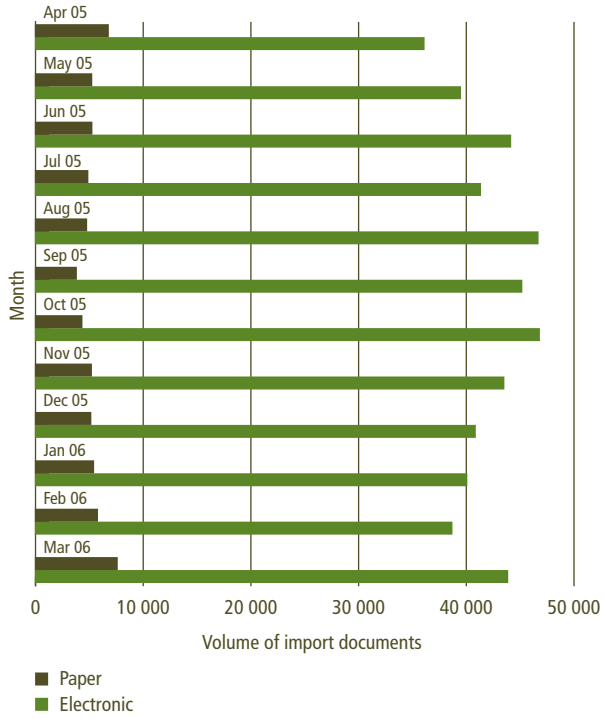
The Regulations require that, when importing a regulated product into Canada, dealers provide to CBSA officers specific product information on customs documents for all shipments (type of product, brand name, model number, name and address of dealer and purpose of import). Customs documents contain much 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 entering Canada meet the required energy performance levels and to take action when necessary.

Key 2005–2006 Achievements

- NRCan processed over 570 108 records (records from April 1, 2005, to March 31, 2006) relating to the importation of regulated energy-using products to Canada in 2005–2006. Figure 2-1 illustrates the volume of import documents received in paper form and electronically per month over the 2005–2006 fiscal year.
- Over 95 877 new or revised model numbers were submitted to NRCan for entry into NRCan's equipment database (records from April 1, 2004, to March 31, 2005) from energy efficiency reports received from dealers.

FIGURE 2-1

Volume of Monthly Import Documents



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 (see Table 2-1). This is equivalent to taking 4 million cars off the road. The net benefit to consumers from just the latest amendment prescribing 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 during the lifetime of the machines, which in some cases is 25 years.

TABLE 2-1

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

Product (amendment number in brackets)	Energy savings (petajoules)		CO_2 reductions (megatonnes)	
	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**

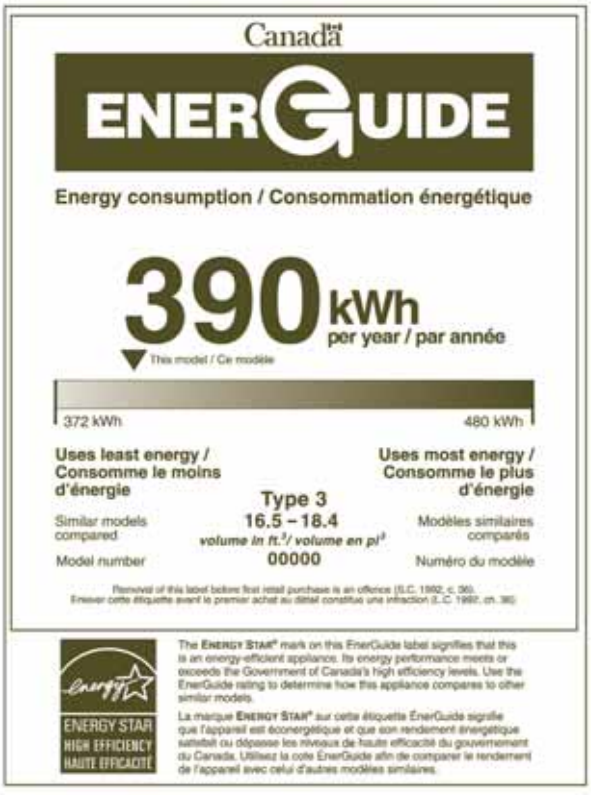
*Values different from Regulatory Impact Analysis Statement due to emission factor change (using 99.3)

Labelling and Promotion

Since 1978, the EnerGuide label (see Figure 2-2) has given Canadians an opportunity to compare the energy consumption of one appliance with that of another. In 1995, with the introduction of the *Energy Efficiency Regulations*, placing an EnerGuide label on major electrical household appliances and room air conditioners became mandatory. 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.

FIGURE 2-2

EnerGuide Label



A voluntary EnerGuide rating program was established in 1997 and included gas furnaces, central air conditioners, heat pumps and oil furnaces. In the fall of 2003, coincident with the requirement in Canada's *Energy Efficiency Regulations* to test, verify and report on fireplace efficiency, gas fireplaces were added to the EnerGuide rating program, and manufacturers were asked to integrate EnerGuide fireplace efficiency ratings in their brochures. Since these products are typically purchased from a product brochure or catalogue, prescribing a label on the product would not be useful. Manufacturers are encouraged to include an EnerGuide rating in product brochures or catalogues, so consumers can compare the efficiency of the product when they are in the buying process. All major distributors of such products for sale in Canada report the verified energy performance rating of their products, as tested to the standards referenced in the *Energy Efficiency Regulations*. The verified energy performance rating submitted corresponds to the EnerGuide rating published in the brochures or catalogue. 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 addition, program participants must provide shipment data and aggregate energy efficiency information to track the progress of the program and identify marketplace improvements that could result from labelling.

EnerGuide directories with energy ratings for major appliances and room air conditioners are published each year and distributed to consumers, retailers and appliance salespeople. In fulfilling requests for information, electric utilities and provincial governments also distribute the directories. On-line directories published on the Office of Energy Efficiency Web site for all appliances and heating and cooling equipment are available and updated monthly.

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

In 2001, responding to Canadians' desire for a labelling system designed to identify the best performers, Canada officially introduced ENERGY STAR, the international symbol for energy efficiency (see Figure 2-3). 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, along with Australia, New Zealand, Japan and Taiwan. The European Union has adopted ENERGY STAR for office equipment.

FIGURE 2-3

ENERGY STAR® Label

ENERGY STAR establishes high efficiency criteria and levels for selected products for the residential and commercial sectors. Product categories are selected 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 applied under the *Energy Efficiency Regulations* and are used to qualify products for the ENERGY STAR symbol.

Canada promotes specific product categories for which 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)
- Selected lighting products (currently not fixtures)
- Selected 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. Now that industry-accepted standards of high efficiency have been established, 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 were implemented in partnership with seven Canadian gas utilities and a non-government organization to address three major barriers to higher efficiency: awareness, accessibility to high-efficiency products and acceptance. From 2001 to March 2006, Canada cost-shared over 75 000 incentives to Canadian consumers for the purchase of high-efficiency, ENERGY STAR qualified gas-fired furnaces and boilers. The number of incentive-based installations represents approximately one quarter of the total gas furnace/boiler installations across Canada. The partners' contribution amounted to $15 million, and Canada's, $9.8 million. With NRCan's involvement, several utilities doubled the number of incentives and/or loan recipients that they would otherwise have disbursed without government participation or under their previous programs. The organizations also coordinated the delivery of coupons by manufacturers to complement the incentive. Canada's participation in this initiative also helped to increase the market penetration of high efficiency gas-fired furnaces and boilers and to widen the net of higher efficiency products to cover markets that traditionally support mid-standard-efficiency products.

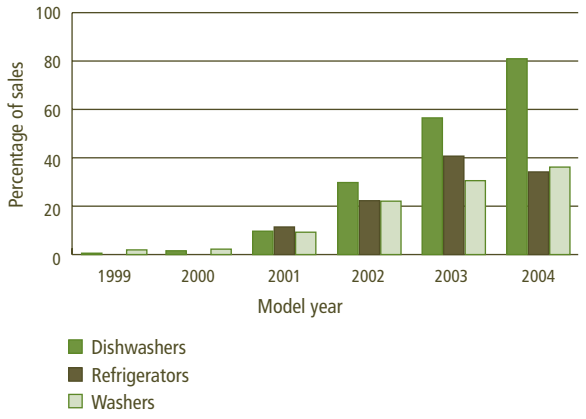
ENERGY STAR was also used as the basis for sales tax rebates in British Columbia for heating and cooling equipment, and in Saskatchewan for the purchase of qualifying appliances (refrigerators, dishwashers, clothes washers and freezers) and furnaces and boilers. Organizations across Canada have used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

Continuous efforts to promote ENERGY STAR qualified appliances have paid off. Industry figures for 2004 show an increase in market penetration from almost nil in 2000 to 34 percent for refrigerators and 81 percent for dishwashers (see Figure 2-4). The increase in market penetration indicates growing acceptance of ENERGY STAR as the brand for high efficiency and the willingness of manufacturers to raise product offerings to qualifying levels. In this regard, ENERGY STAR specifications and levels are periodically updated as product saturation is reached to encourage industry to strive for more

efficient products and thus maintain the relevance and credibility of the brand. Subsequent increases in qualifying levels for ENERGY STAR qualified products such as central air conditioners and heat pumps came into effect in 2006, and more stringent levels for clothes washers and dishwashers will come into effect in 2007.

FIGURE 2-4

ENERGY STAR Qualified Appliances as a Percentage of Total Category Sales in Canada, 1999 to 2004



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 is the department's support for the accelerated replacement and promotion of light-emitting diode (LED) exit signs for retrofit applications in Alberta. Exit signs operate around the clock; and for high-rise buildings, with a minimum of four signs per floor at approximately 25 watts per sign, these products represent a constant electrical draw and, therefore, an energy savings opportunity for building owners. The project objective was to target apartment building owners, stimulate demand for LED exit signs and increase awareness of the benefits of early replacement of standard incandescent exit signs with more efficient LED units consuming 5 watts per sign. The project also included recycling of the replaced units. The program influenced the conversion of 7311 incandescent exit signs with LED exit signs, yielding approximately 1.6 gigawatt hours per year of electricity savings, and 570 tonnes of carbon dioxide reductions. For all new installations, Canada's *Energy Efficiency Regulations* now require that exit signs meet the ENERGY STAR level of 5 watts per face.

Canada continues to promote ENERGY STAR guidelines for procurement officials. It has updated an interactive cost calculator that compares energy cost savings and GHG emissions reductions associated with the purchase of ENERGY STAR qualified products. A number of workshops were held across Canada, from Newfoundland and Labrador to Nunavut and the Northwest Territories, to make governments, institutions and city officials aware of the ENERGY STAR criteria and procurement tools. Canada is also working with housing agencies to help them identify energy savings in their properties and to specify ENERGY STAR qualified products at the time of replacement or retirement.

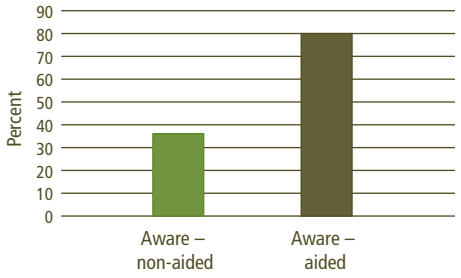
Canada continues to expand the types of products included in its ENERGY STAR agreement. For example, Canada recently included vending machines, commercial refrigeration, compact fluorescent lamps and commercial clothes washers in its exchange of letters with the United States government.

Key 2005–2006 Achievements

- Canada held its third annual meeting of ENERGY STAR participants and awarded plaques of recognition to nine forward-looking organizations, recognizing their commitment to producing, selling and promoting ENERGY STAR qualified products. Over 30 manufacturers and retailers were recruited as new ENERGY STAR participants, bringing the number to over 250 participants.
- Surveys on the awareness of ENERGY STAR have shown an increase in unaided awareness and understanding of the symbol. A survey of 2000 Canadians revealed that unaided awareness was 36 percent in 2005. Aided awareness of ENERGY STAR has reached 80 percent (refer to Figure 2-5). Recognition of ENERGY STAR has shifted from seeing the symbol on computer equipment to seeing it more often on major appliances.
- Market information submitted as part of the EnerGuide rating program for gas fireplaces shows that shipment of units with higher efficiency ratings has increased. In 2005, 85 percent of the units shipped ranged in efficiency from 50 to 69.9 percent. In 2004, 76 percent of the units shipped were in this efficiency range. In 2003, the percentage stood at 31 percent.

FIGURE 2-5

ENERGY STAR Awareness Levels in Canada, 2005



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 16.6 percent (1421 petajoules) of secondary energy use and 15.2 percent (77 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 81.6 percent of residential energy use, followed by the shares devoted to operating appliances, lighting and space cooling (see Figure 3-2).

Between 1990 and 2004, residential energy use increased by 10.2 percent, or 131 petajoules (from 1289 to 1421 petajoules). From 1990 to 2004, GHG emissions from the residential sector increased by 10.3 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 (331 petajoules).
- weather – the difference in temperature in 2004 compared to 1990 resulted in a 2.0 percent (26 petajoules) increase in energy use in 2004.
- structure – the percentage shares of energy end-uses changed over the period such that they increased energy use by 3.6 percent (46 petajoules).
- energy efficiency – improvements in energy efficiency decreased energy use by 21.0 percent (271 petajoules).

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 2004, 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 2004 models.

FIGURE 3-1

Canadian Households by Type of Dwelling, 2004

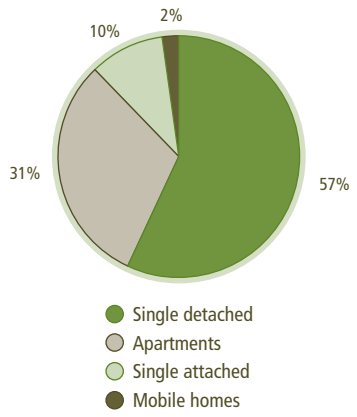
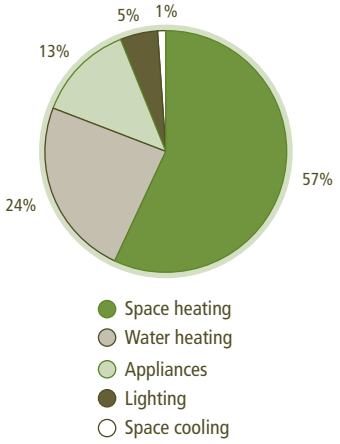


FIGURE 3-2

Residential Energy Use by Purpose, 2004



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 2004

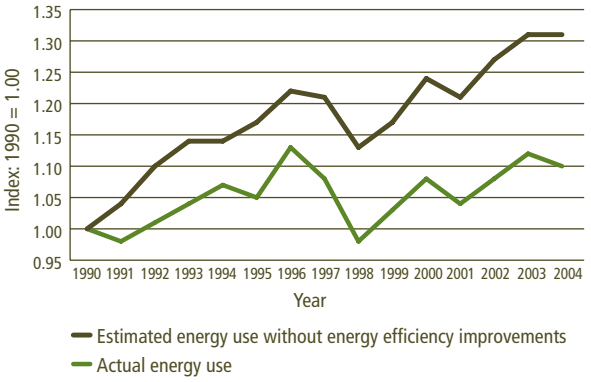
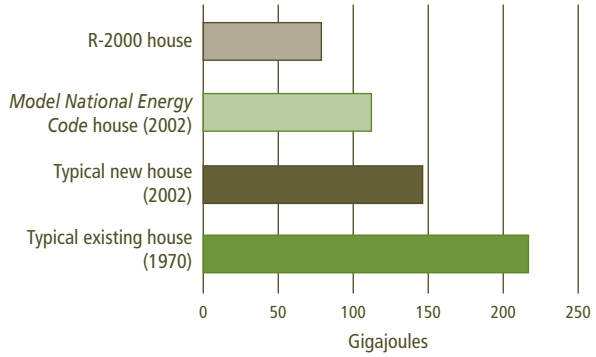


FIGURE 3-4

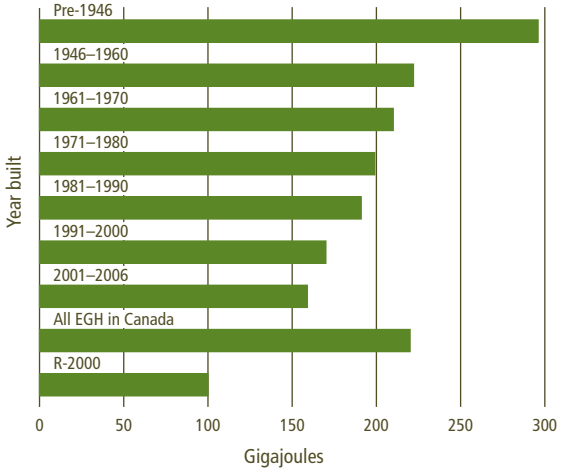
Annual Heating Consumption for Houses* Constructed to Different Standards



*198-m^2 one-storey, single detached house heated with natural gas, Ottawa, Ontario

FIGURE 3-5

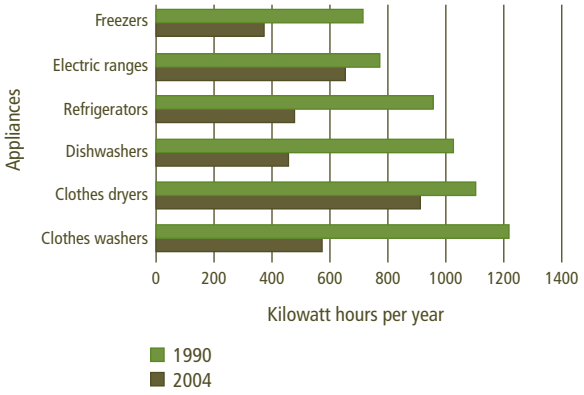
Average Energy Consumption per Household,* Pre-1946 to 2001–2006 Construction



*From R-2000 and EnerGuide for Houses (EGH) programs

FIGURE 3-6

Average Energy Consumption of New Appliances, 1990 and 2004 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 it 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 scheme is based on the R-2000 Standard and training, and it targets large-volume, mass-market builders.

Key 2005–2006 Achievements

- Sixty tract builders and 75 new professionals received training in revisions to EnerGuide for New Houses and R-2000 Standard. Over 3000 builders and industry professionals were trained. Over 172 000 publications about the R-2000 Standard, ENERGY STAR® and EnerGuide for New Houses were distributed.
- ENERGY STAR technical specifications were finalized in cooperation with industry and other stakeholders. Methodology for multi-unit application of the R-2000 Standard was completed.
- In 2005–2006, 480 homes were certified R-2000, and 8700 homes across Canada were built under provincial and territorial initiatives that use the R-2000 Standard and training – for example, Built Green Alberta, Novo climat in Quebec and the Yukon Green Home.

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 2005

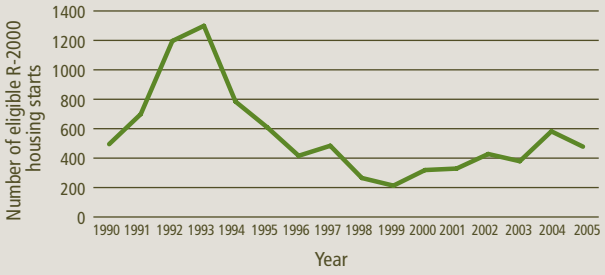
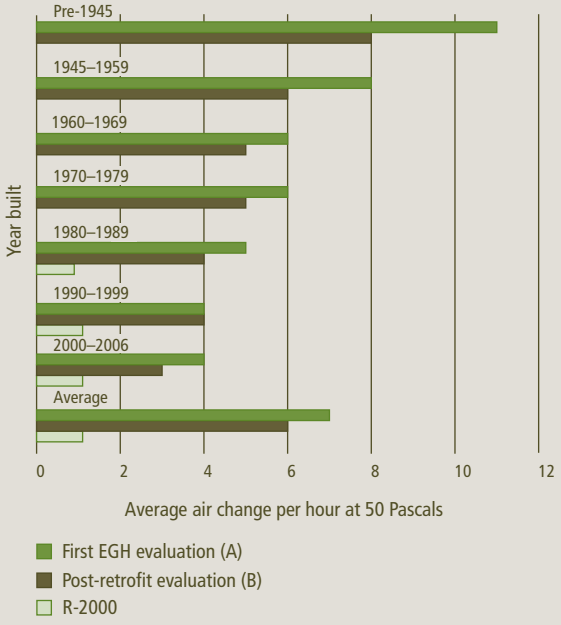


FIGURE 3-8

National Trends in Air Leakage in Houses, Pre-1945 to 2000–2006 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 to help achieve cost-effective reductions in 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, 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 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 2005–2006 Achievements

- ēKOCOMFORT™ integrated mechanical systems were adapted for use in the Drake Landing Solar Community to make use of the lower-temperature heat delivered from its innovative seasonal storage residential district system. The project is bringing together whole-house design expertise from the housing program, R-2000 construction practices, and technologies like its ēKOCOMFORT™ systems.
- Through accelerated research, development and commercialization with industry partners, a new zoned comfort system has been fast-tracked into the marketplace. This system delivers heating and cooling directly to spaces when and as required, and it is already attracting interest from builders and utilities.
- Innovative lighting research on compact fluorescent lights was undertaken at the CCHT, demonstrating the energy-saving potential of this technology and its impacts on whole-house energy consumption.

For more information:
sbc.nrcan.gc.ca/housing/housing_e.asp

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 technology transfer initiative that has successfully increased the demand for Canadian energy-efficient housing technologies and building practices in international markets. Canadian companies have adapted their products and services to meeting increasingly higher environmental standards of energy efficiency demanded by foreign markets. The program adapts world-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 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 Foreign Affairs and International Trade Canada. Industry members also contribute to the success of the program through in-kind and financial contributions (member fees).

CETC has facilitated and provided expert advice to Canadian housing exporters to redesign wall systems to incorporate high levels of insulation and airtightness for markets unfamiliar with energy-efficient wood frame construction; to redesign wall systems to reduce cooling loads in hot humid climates; to establish optimal specifications for high performance windows for both heating and cooling climates; and to develop strategies to incorporate innovative mechanical heat recovery ventilation systems into the design. In-house tools such as HOT2000™ have been used to optimize and position Super E packages as an attractive energy-efficient option for foreign markets.

The Super E House Program is attracting demand and generating real economic benefits for Canada – at least $35 million to date. There are 85 Canadian and international companies involved in the program and over 345 houses have been built or are under construction. Future orders are in the range of 1500 units over the next four years, amounting to well over $150 million in potential sales. Super E is active with projects in Japan, the United Kingdom, Ireland, China and Iceland. Interest has been expressed by French, Spanish, Korean and Taiwanese concerns.

Key 2005–2006 Achievements

- Delivery of the first 100 units under a five-year contract for 1400 Super E units with Berekely homes in the U.K. This represents $100 million in revenue to the Canadian supplier.
- Nine new Canadian members and 11 new foreign members joined the Super E consortium, which now has 39 Canadian members partnered with 46 overseas companies. In 2005, 138 houses were registered as completed or under construction, raising the total number of registered units from 207 at the end of 2004 to 345 at the end of 2005 – an increase of well over 50 percent. This included six high profile openings (three in the United Kingdom, one in Japan, one in China and one in Iceland).
- Demand increased for Super E from other countries such as China, Korea, France, Iceland and Spain. The first Super E project in Iceland was completed, a demonstration Super E initiative was launched in Shanghai, China, and four Chinese developers joined the Super E consortium.

For more information:
www.super-e.com/html/canada/English/about-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) provided 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. Under this incentive, homeowners qualified for a non-taxable grant representing 10 to 20 percent of their retrofit expenditures. The grant was based on the differential improvement in the house's energy rating, as measured by a pre- and post-renovation EGH energy evaluation.

The EGH Retrofit Incentive program has been discontinued as of May 12, 2006. Property owners who had a pre-retrofit evaluation performed prior to this date can have a post-retrofit evaluation and still qualify for a grant until March 31, 2007.

Key 2005–2006 Achievements

- One national promotional campaign was held, reaching 5.7 million Canadians, and many provincial campaigns took place through partnerships with local utilities.
- Procedures for the application of EGH to multi-unit housing were completed.
- Over 79 000 houses were evaluated and labelled and more than 31 800 homes completed their energy-related retrofits. Over 30 000 grants totalling $24 million were awarded, reducing energy consumption by an average of 28 percent in post-retrofit homes and GHGs by 4.1 tonnes per house per year. Achieved cumulative GHG reductions of 0.7 megatonnes per year as of March 31, 2006; the target for March 2007 is 0.8 megatonnes per year.

FIGURE 3-9

Evaluations Under EnerGuide for Houses, 1998 to 2005

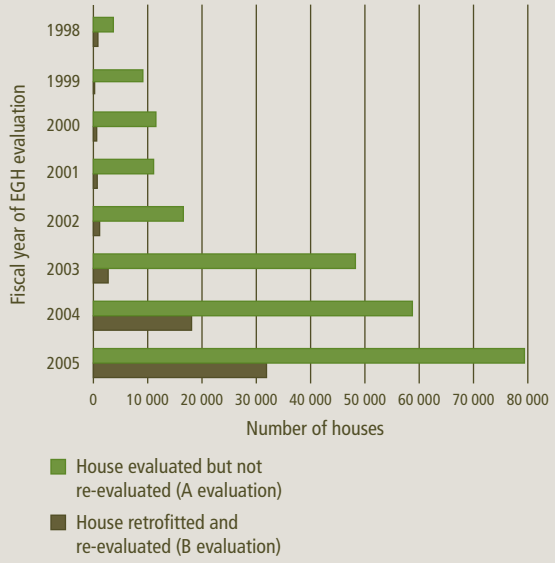
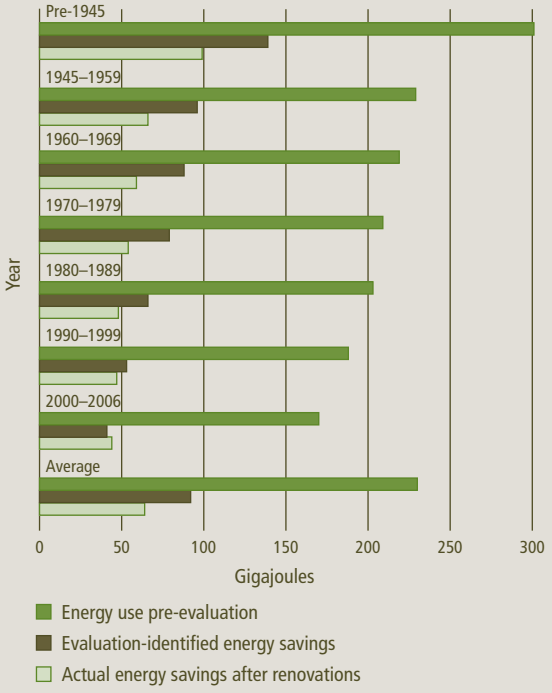


FIGURE 3-10

Residential Energy Use and Energy Savings per Household, Pre-1945 to 2000–2006



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 2004, the total commercial/institutional sector accounted for 13.7 percent (1171 petajoules) of secondary energy use and 13.4 percent (67.9 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). Offices account for one third of commercial/institutional sector energy demand. Educational services, health care and social assistance, retail trade, and accommodation and food services account for another 49 percent of that demand. Natural Resources Canada's (NRCan's) initiatives address all of these major energy-using activity types.

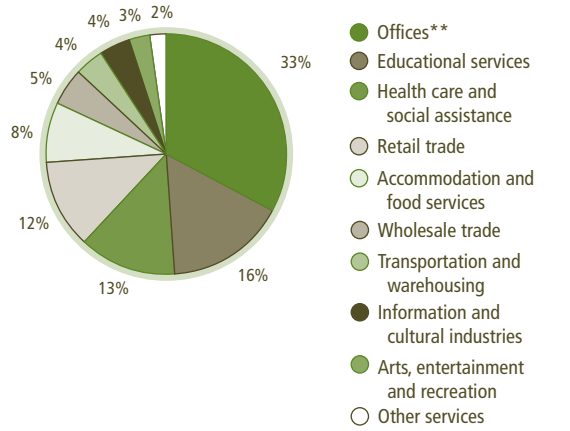
Energy is used for six purposes in commercial/institutional activities. The largest of these is space heating, which accounts for more than half of energy use in this sector (see Figure 4-2). Each of the remaining five uses of energy accounts for between 6 and 14 percent of energy demand in this sector.

Between 1990 and 2004, commercial/institutional energy use, excluding street lighting, increased by 35.6 percent, or 305 petajoules (from 858 to 1163 petajoules). However, GHG emissions from the sector rose by 42.0 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.

During 1990–2004, 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

FIGURE 4-1

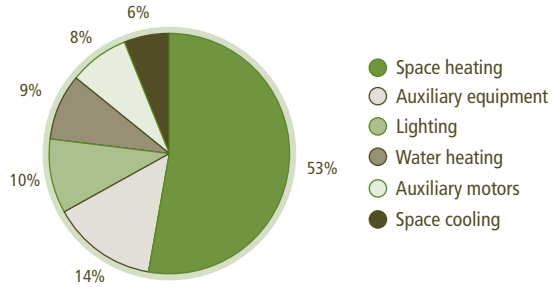
Commercial/Institutional Energy Use by Activity Type,* 2004



*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,* 2004



*Excludes street lighting

- activity – a 24.4 percent increase in floor space resulted in a 219-petajoule increase in energy use.
- weather – the difference in temperature in 2004 compared to 1990 resulted in a 1.3 percent increase in energy use (11 petajoules).
- structure – a shift in activity resulted in a 0.4 percent increase in energy use (3 petajoules).
- service level – a higher service level for end-users resulted in an 8.8 percent increase in energy use (75 petajoules).
- energy efficiency – a 0.4 percent improvement in energy efficiency resulted in a decrease of 3 petajoules. See the text box, "Possible Underestimation of the Energy Efficiency Effect," for additional explanation.

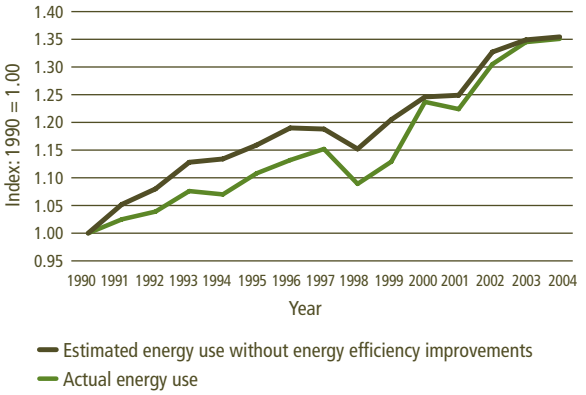
The change in energy use during 1990–2004, as well as the estimated energy savings due to energy efficiency, is shown in Figure 4-3.

Possible Underestimation of the Energy Efficiency Effect

Between 1999 and 2004, energy use in the commercial/institutional sector increased by 20 percent, whereas floor space (activity driver) increased much more slowly, about 8 percent. This rapid growth in energy use since 1999, mostly due to heavy fuel oil (188 percent rise), light fuel oil and kerosene (95 percent rise), has led to sharp decreases in the energy efficiency effect since 1999. Statistics Canada has been unable to ascertain the reason (or reasons) for these spikes in petroleum use, particularly heavy fuel oil. Some of the change may be due to legitimate fuel switching away from natural gas, which sharply increased in price in 2000, to light fuel oil. However, there is some evidence that fuel marketers (included in the commercial/institutional sector) are buying petroleum products from refineries and then re-selling the fuel to other sectors (e.g. industrial, transportation). As a result, some heavy fuel oil, light fuel oil and kerosene may be erroneously attributed to the commercial/institutional sector. There is inadequate information to determine and to improve the quality of the reported commercial/institutional data at this time.

FIGURE 4-3

Commercial/Institutional Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2004



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)
- communities

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 36 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.

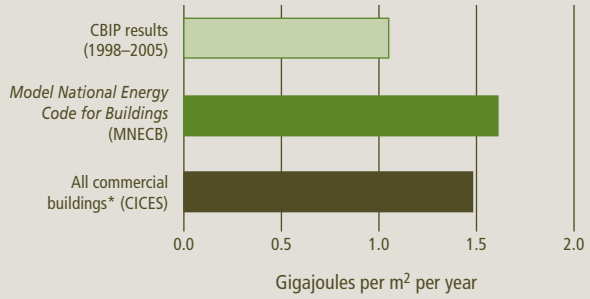
Key 2005–2006 Achievements

- Incentives were given to 207 projects, representing 4.1 percent of building starts and 15 percent of construction floor space in 2005–2006.
- CBIP cooperated with 22 organizations during 2005–2006, launching new collaborative ventures with the Toronto Waterfront Revitalization Corporation, the Toronto Community Housing Corporation and the Canadian Urban Institute.
- Over 900 new users registered to use CBIP's simulation software in 2005–2006, bringing the total number of users to over 5000.

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

FIGURE 4-4

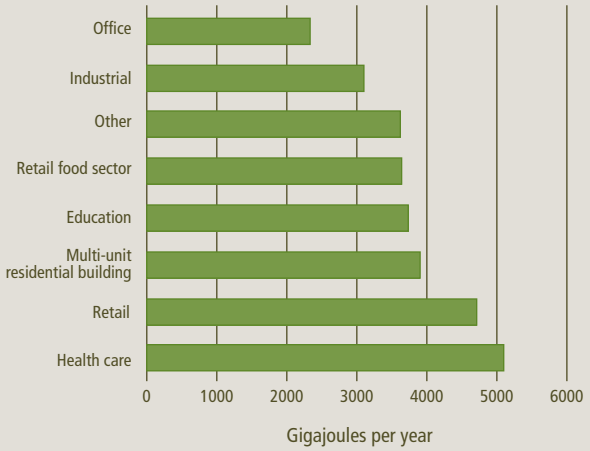
Energy Use in Commercial Buildings, 2005



* Source: Commerical and Institutional Consumption of Energy Survey (CICES), December 2005, NRCan data using CBIP building mix

FIGURE 4-5

Estimated Average Energy Savings by Type of Building Under the Commercial Building Incentive Program, 2005



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 the additional costs involved in initial attempts to produce energy-efficient designs and achieve building/process integration. The design is assessed against a reference generated from the MNECB.

Key 2005–2006 Achievements

- Six contribution agreements were signed, bringing to 26 the number of projects supported since the launch of the program in 2002.
- Five case studies were prepared, a new IBIP Web site was completed, and a new technical guide was issued.

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 its C-2000 Program for Advanced Commercial Buildings – which was a small demonstration program for high-performance buildings – CANMET Energy Technology Centre (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, helping industry and associations to develop optimized, energy-efficient green buildings and green building programs.

The program also develops guidelines, provides technical support and develops downloadable simulation software tools to support other NRCan programs such as CBIP.

NRCan launched the Green Building Challenge (GBC) in 1996 (now managed by a third party) and organized "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 2005–2006 Achievements

- NRCan experts continue to provide technical support to the new 600 000-square-foot downtown Winnipeg office for Manitoba Hydro. The $188-million project, due for completion in 2007, is the largest and final participant in the C-2000 Program for Advanced Commercial Buildings. Designed by the C-2000 Integrated Design Process, it focuses on providing the healthiest office space, world-class energy efficiency, and signature architecture and urban design, while staying within market-based costs.
- NRCan successfully proposed to the Canadian Commission on Building and Fire Codes that the MNECB 1997 be updated. NRCan was tasked by the commission to lead a feasibility study for the code update. To this end, NRCan created a national consortium of provincial and federal organizations that are either actively involved in or initiating the development of energy efficiency measures for regulatory and program purposes.

- NRCan spearheaded research to develop a revolutionary façade system that integrates photovoltaic panels. This Building Integrated PhotoVoltaics system was used in the new Public Works and Government Services Canada Greystone office building in Yellowknife, providing 33.5 kilowatts of electricity to this 70 000-square-foot building that opened in October 2005.

For more information:
sbc.nrcan.gc.ca/buildings/buildings_e.asp

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

Existing Buildings: EnerGuide for Existing Buildings

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

EnerGuide for Existing Buildings (EEB), formerly the Energy Innovators Initiative, 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 EEB by sending a letter to the Minister of Natural Resources from senior management stating their commitment to energy efficiency. Currently, over 2800 commercial, institutional and multi-unit residential organizations across Canada are members.

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

Key 2005–2006 Achievements

- Recruited more than 500 organizations as members, an increase of about 2 percent of floor space in targeted sectors.
- Twenty-one partnerships were established through contribution agreements with member-based associations and stakeholders.
- EEB funded 140 energy retrofit implementation projects (see Table 4-1) and more than 215 retrofit planning activities in commercial businesses, public institutions and multi-unit residential buildings.

For more information:
oee.nrcan.gc.ca/existingbuildings

TABLE 4-1

EnerGuide for Existing Buildings – Incentive Retrofit Projects, 1998 to 2005

Fiscal year	Number of retrofit projects signed	Energy cost savings (millions of dollars)	Eligible client investment (millions of dollars)	Federal incentive (millions of dollars)
1998	12	$5.70	$54.70	$2.60
1999	35	$16.80	$137.70	$5.50
2000	4	$5.40	$8.70	$0.60
2001	30	$10.60	$58.20	$3.74
2002	59	$19.40	$139.60	$8.40
2003	70	$20.90	$132.60	$8.80
2004	169	$36.70	$220.00	$16.90
2005	140	$23.00	$138.48	$12.06
Total	**519**	**$138.50**	**$889.98**	**$58.66**

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. It 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, recover and upgrade the heat rejected by the refrigeration system, and adapt the system 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 2005–2006 Achievements

- Launched and is successfully operating a demonstration project involving innovative integrated HVAC and refrigeration technologies at an existing Loblaws supermarket in Ottawa, Ontario. CETC–Varennes provided technical support for the design and installation phases of the project and is carrying out performance analysis of the system.
- Invited to sit on the Vancouver Olympic Committee to provide expertise for the design of sustainable refrigerated facilities for the Olympics (e.g. ice and curling rinks).
- As part of the deployment program, partnerships with provincial governments and utilities have been established with British Columbia and Manitoba, in addition to the existing partnership in Quebec. More than 15 training sessions and workshops were held across Canada to create awareness of and build capacity for 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 recommissioning, 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 2005–2006 Achievements

- Launched demonstration projects of the Continuous Building Optimization approach at several demonstration sites across Canada.
- Training workshop on Continuous Building Optimization performed in Manitoba, in collaboration with Manitoba Hydro.
- Continuous Building Optimization approach and benefits presented to major city representatives, provincial energy managers and to the Conference of the Parties to the Convention (COP-11) delegations.

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, CETC 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*. CETC is involved in all aspects of the software development process, from design and programming to distribution, maintenance, and user training and support.

CETC developed the next generation of residential energy analysis software, HOT3000™. This is 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 2005–2006 Achievements

- The capacity to model multi-unit residential buildings was added to NRCan's HOT2000 residential energy analysis software.
- CETC continued to play a leading role in developing and validating methods for modelling cogeneration systems by chairing a research annex for the International Energy Agency. The work includes developing models for fuel cells, Stirling Engines, and internal combustion engines within a whole-building simulation program and thus making significant advances in the analysis and study of distributed generation systems for buildings.
- Using CETC software, 200 000 houses and over 500 commercial buildings have been simulated for improved energy efficiency to date.

For more information:
sbc.nrcan.gc.ca/simulation_R_and_D/simulation_R_and_D_e.asp

Equipment: Distributed Energy Program

Objective: The science and technology direction under this program is to support activities that will lay the foundation for increased use of decentralized energy systems, including electric storage by 2025. These systems will increase the reliability of, and reduce air emissions including GHGs from, Canada's electric power system at an acceptable economic cost to Canadians.

Key 2005–2006 Achievements

- In a joint program with Environment Canada and the cities of Calgary and Kelowna, CETC designed and constructed a trailer that extracted and cleaned landfill gas and produced utility power using a 30-kilowatt microturbine. After 5000 hours of operation on the Calgary landfill site, the trailer was moved to Kelowna, where it has been upgraded by Kelowna to a 3-turbine system.
- In association with Enbridge Gas Distribution and CETC–Varennes, code changes were made to facilitate development of small on-site power plants that served a dual role as providers of both on-site heat and power, and emergency power service.
- A joint program was initiated with the National Research Council and Canadian companies to evaluate and test new electric storage systems and develop new routes to market for these technologies.

For more information:
sbc.nrcan.gc.ca

Equipment: Integrated Energy Systems Laboratory

Objective: To develop advanced concepts and technologies for energy-efficient and low-polluting gas- and oil-fired heating systems for residential and commercial applications.

An area of concentration is integrated systems, where multiple functions are served by one energy source. Significant effort is being expended on ultra-high-efficiency present- and next-generation (ēKOCOMFORT™-type) systems combining space heating, water heating and ventilation. The laboratory can determine the performance of up to six prototype integrated systems. One such unit under development is a high-efficiency condensing fireplace. Another is a highly modulating integrated space-water-ventilating system with advanced learning-based controls.

The laboratory works closely with equipment manufacturers, energy suppliers, end-users, policy and program developers and standards organizations in ensuring rapid development and implementation of the most suitable energy-efficient equipment for the Canadian market.

The laboratory also works on next-generation integrated systems with self-generated electricity using advanced, non-conventional technologies. Prototype thermophotovoltaic and thermoelectric cascaded systems are under development. Here, electricity is generated with no moving parts and the heat is recovered for space/water applications. Gas lighting, whereby light is generated by a highly luminous flame and then transported to applications through light pipes, while the heat is recovered for space/water applications, offers tenfold GHG reductions. Alternative fuels, such as alcohol, bio-fuel and hydrogen are being examined for high-efficiency combustion applications for buildings.

Key 2005–2006 Achievements

- Characterized and developed performance criteria for next generation tankless water heaters with 25 percent energy savings compared to conventional gas-fired water heaters. Worked closely with gas utilities to define criteria for incentive programs for the installation of high-efficiency combustion equipment in residential and commercial applications.
- Optimized fan coil control and monitored performance for high efficiency and homeowner satisfaction as an essential component of the Drake Landing Solar Community project.
- Characterized the high potential for energy efficiency gains exceeding 25 percent with most commercial combustion equipment (rooftops, unit heaters and boilers) with design and operational advances.

For more information:
sbc.nrcan.gc.ca

Communities: Communities and Neighbourhoods Program

Objective: To develop and demonstrate practical decision-making tools, processes and best practices that help communities and developers select more efficient energy, waste and water technologies and design solutions that support each community's journey towards a sustainable energy future.

Communities impact about 50 percent of energy consumption in Canada. Within communities, buildings consume 63 percent of all natural gas (including 9 percent used for electricity) and 53 percent of all electricity, which also means that they account for roughly 53 percent of the coal burned for electricity production. The program examines how communities can function as an integrated energy-consuming whole while contributing to municipalities' broader goals of encouraging more sustainable development. The goal is to contribute to sustainable development initiatives by stakeholder groups by supporting the development and use of practical decision-making tools, processes and best practices that will help communities and developers select appropriate energy-efficient technologies and design solutions and help guide each community's journey towards a sustainable energy future.

The Communities and Neighbourhoods Program works with provincial governments, municipal stakeholders, other government departments and private sector developers to facilitate the adoption of sustainable community development principles and community energy systems. Opportunities to effect change arise through innovative projects that are geared to the Canadian context and are launched in the following areas: combined heat and power technologies; district energy generation systems (including integration of renewables); computational and other tools that consider energy consumption within and emissions from the community from a system's perspective; processes that guide the creation of community strategies based upon energy efficiency and the reduction of GHGs; methods that assist decision-makers to differentiate between urban development alternatives on the basis of their environmental impact on the community; and community energy standards that support policies, codes and technical standards for energy-efficient development practices.

Key 2005–2006 Achievements

- A number of large-scale district energy systems are under construction or at the design stage across Canada. A range of technologies are being demonstrated to reduce energy consumption, including gas-fired combined heat and power, ground-source heat pumps, and lake-cooling and solar thermal applications.
- NRCan's *Community Energy Planning Guide* was released in May 2005 and has prompted a number of municipalities to develop municipal energy plans.
- A model Sustainable Urban Planning process developed in consultation with municipal and developer stakeholders will be applied in a pilot large-scale, sustainable urban development in Edmonton, Alberta.

For more information:
sbc.nrcan.gc.ca

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 (3277 petajoules) of secondary energy use and 33.6 percent (170 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 26.7 percent of total industrial energy demand in 2004 (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, aluminum, pulp and paper, iron and steel, and chemicals – this share is higher than 11 percent (see Figure 5-2). For cement, in particular, the share is as high as 38.7 percent.

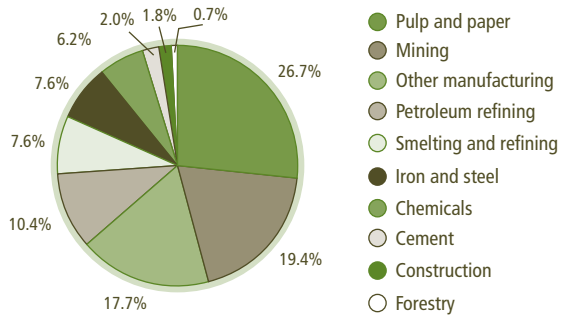
Actual industrial energy use increased by 20.6 percent (560 petajoules) between 1990 and 2004. This increase was driven by a 40.4 percent increase in industrial activity, measured as a combination of physical units of production, gross output and gross domestic product (GDP). However, some of this increase 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 40.4 percent increase in industrial activity resulting in a 1098-petajoule increase in energy use.
- structure – the change in the mix of activity toward less energy-intensive industries resulted in a 224-petajoule decrease in energy use.

FIGURE 5-1

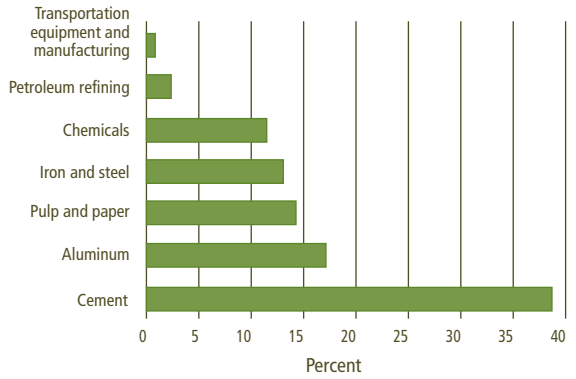
Industrial Energy Use by Sub-Sector – Including Electricity Related Emissions,* 2004



*Note: The above sub-sectors reflect the current definitions in the *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, 2004

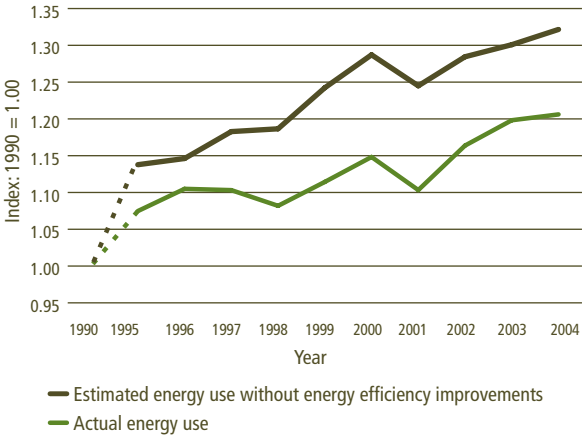


- energy efficiency – due to an 11.5 percent improvement in energy efficiency, the industrial sector avoided 314 petajoules of energy use between 1990 and 2004.

The change in energy use between 1990 and 2004 and the estimated energy savings due to energy efficiency are shown in Figure 5-3.

FIGURE 5-3

Industrial Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2004



Between 1990 and 2004, industrial GHG emissions including electricity-related emissions increased by 19.7 percent. Excluding electricity-related emissions, industrial GHG emissions increased by 13.2 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 2.7 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)

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 productivity and 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, including the mining, manufacturing, forestry, construction, upstream oil and gas, and electricity generation sectors.

CIPEC's network comprises 26 sector task forces (including four regional) that share information and best practices; more than 1000 Industrial Energy Innovators (companies that have made a written voluntary commitment to become more energy efficient and support Canada's climate change initiatives); and partnerships with 52 industry associations that disseminate information and advice on energy efficiency to their members.

CIPEC's multi-faceted approach focuses on introducing technological innovations, bringing about behavioural change, and shifting organizational culture to generate a sustainable market transformation. Tools and services offered through CIPEC include energy fora and conferences; communications products including Web sites and newsletters, technical guidebooks, energy benchmarking and best practices studies; Dollars to $ense energy management workshops; cost-shared energy audits and Process Integration studies; and provision of technical information relating to the eligibility of renewable energy and/or energy efficiency systems for accelerated capital cost allowances under Class 43.1 and Class 43.2 of the *Income Tax Act*.

Key 2005–2006 Achievements

- Between 1990 and 2004, CIPEC industries improved their energy intensity by 9.1 percent and avoided 29.5 megatonnes of GHG emissions (see Figure 5-4). Adoption of CIPEC tools and services between 2001 and 2005 is estimated to have saved 13.5 petajoules in 2005 (see Figure 5-5).
- Recruited 338 new Industrial Energy Innovators, bringing the total number of facilities and companies registered to more than 1000. Initiated 221 industrial energy audits, which is more than double the target of 100 set for this Action Plan 2000 measure.
- As shown in Figure 5-6, 1051 industrial clients participated in Dollars to $ense energy management workshops. The jump between 2003 and 2004 was due to the significant increase in customized workshops.

FIGURE 5-4

CIPEC Energy Intensity Index, 1990 to 2004

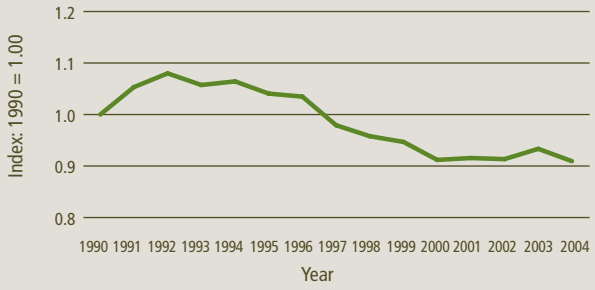
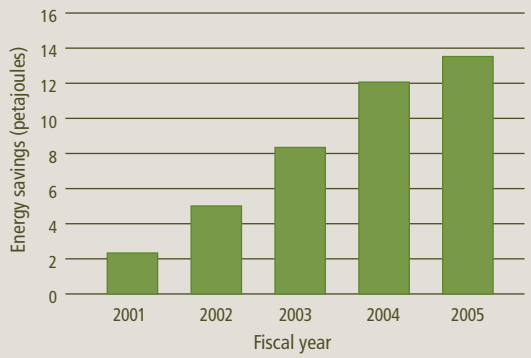


FIGURE 5-5

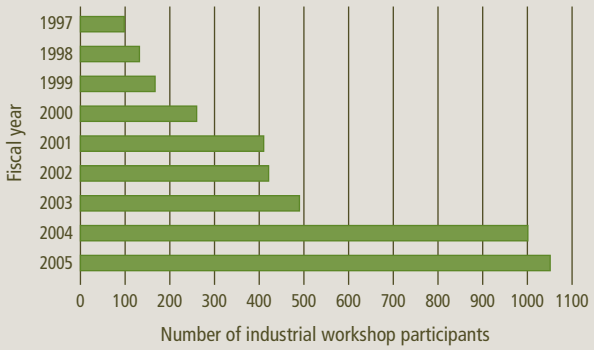
Estimated CIPEC Energy Savings, 2001 to 2005



For more information:
oee.nrcan.gc.ca/industrial/cipec.cfm

FIGURE 5-6

Industrial Dollars to $ense Participants, 1997 to 2005



Industrial Processes and Technologies: Clean Electric 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 of and reducing emissions from existing fossil fuel power plants and on developing new advanced cycles for conversion of fossil fuels to electricity with complete or nearly complete capture and elimination of carbon dioxide (CO_2) and other emissions. Issues covered by other research projects include the transport and storage of CO_2.

Key 2005–2006 Achievements

- Developed a coordinated and integrated approach to address opportunities and priorities related to industrial combustion processes with the potential to reduce energy use and emissions by between 15 and 50 percent. Government and industry players have shown considerable interest in participating.
- The U.S. Department of Energy has recognized the new Pressurized Gasification Laboratory as the world's foremost small pilot-scale research facility.
- Developed a new generation of computational fluid dynamics software, simulated 12 coal-fired boilers, and established training courses as part of an international collaborative venture to reduce CO_2 emissions from utility boilers in China.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/Groups/clean_electric_power_generation_e.htm

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 2005–2006 Achievements

- Developed technology for desulphurizing diesel fuel that is produced by thermally cracking waste lubricating oil. A bench-scale continuous processing unit was commissioned for testing the CANDES process. The project has support from the waste oil recycling industry.
- Completed catalyst evaluation for producing olefins by catalytic cracking of hydrocarbon feedstocks. Catalyst testing was conducted for Valeo, a technology development company with proprietary catalyst technology. The results will be used to secure industrial partnerships.
- Developed a direct ammonia fuel cell for efficient combined heat and power applications. Bench-scale fuel cell development is being undertaken by three federal labs.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/Groups/Research%20Programs/processing_and_environmental_catalysis_e.htm

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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 energy efficiency and productivity while reducing 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 with due consideration for energy, economy and environmental factors. It seeks to meet its objective by conducting leveraged research and development through national and international cooperation. Furthermore, the Program disseminates technical information to encourage adoption of these techniques and 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 2005–2006 Achievements

- NRCan designed, proposed and demonstrated a national PI program to publicize, promote and implement sound PI practices in the Canadian industry infrastructure (both large final emitter and non-large final emitter sectors). Under such a comprehensive program, GHGs would be reduced by an estimated 10 megatonnes of CO_2 equivalent per year, businesses would become more competitive by reducing their energy and water expenditures resulting in annual energy-cost savings of about $1 billion, the implementation of identified savings would result in significant economic spin-offs of around $6 billion and a reduced environmental footprint, and Canadian industry

stakeholders would be given the knowledge and tools needed to make PI standard practice in Canada. The program represents a major opportunity to change the way energy analysis is currently conducted in the industry, thereby improving productivity and competitiveness.

- Development of guidelines for Combined Energy and Water Optimization for the pulp and paper industry. A clear methodology was developed to identify and improve water and energy utilization in Kraft mills, with a novel approach to the analysis of non-isothermal mixing points, which can be a very significant source of energy losses in the pulp and paper industry. Also prepared an opportunity analysis document for projects around the site-wide energy and water optimization theme for the oil sands, based on successful experiences in the pulp and paper sector.
- Struck a partnership with the Natural Sciences and Engineering Research Council of Canada Environmental Design Engineering Chair and initiated an agreement with École Polytechnique de Montréal and several leading pulp and paper companies to create a unique body of expertise in the area of pulp and paper. The Chair's project is entitled "Optimizing the Carbon Value Chain in the Pulp and Paper Process Biorefinery." It will use its core competency in PI to evaluate how pulp and paper mills can evolve so that they not only survive but also prosper.

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. The funds are repayable if the project is commercially successful. Program clients from all industrial sectors range from small- and medium-sized companies to multinational corporations.

Key 2005–2006 Achievements

- With the financial support of IERD, MagCasTec Inc. of Strathroy, Ontario, is developing an ingot preheater for the magnesium and aluminum casting industries that will preheat ingots with waste heat from the top of melting furnaces rather than electric heaters. It is projected that a preheater will reduce electricity consumption by 1.7 terajoules per year and GHG emissions associated with electricity generation by 94 tonnes per year. In magnesium casting applications, it is projected that each preheater will reduce sulphur hexafluoride consumption by 10 percent for a CO_2 equivalent reduction of 28 000 tonnes per year.
- Mining Technologies International of Sudbury, Ontario, is developing an energy-efficient diesel/electric hybrid scoop tram for mining operations. This hybrid system alone could improve the air quality in the underground mine environment by a factor of 60 percent. Potential annual energy savings range from 824 gigajoules in the first year of commercialization to 272 terajoules in year 10. Cumulative savings are of the order of 1.4 petajoules over the same period.
- S.O.E. Inc. of St-Mathieu-de-Beloeil, Quebec, is developing a new toroidal, continuously variable transmission to increase the efficiency of diesel engines operating generator sets. Projected energy savings for genset application are 15 to 25 percent (setup-dependent), with an engine life increase of 25 percent. Potential energy savings over 10 years are 46 petajoules, with a CO_2 reduction of 9.4 megatonnes.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/Publications/ierdpublications/factsheet_industry_energy_r&d_e.htm

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 and prototypes and for 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 generated by a project.

Key 2005–2006 Achievements

- ETP supported Sirex Engineering of Bolton, Ontario, for the development and demonstration of an automated production line to recycle and convert post-industrial cross-linked polyethylene foam scrap into laminated sheet foam products. The process will save energy and will reduce GHG emissions by not having to make new foam. Emissions will be further reduced because incineration of scrap foam will be cut back, and there will be less pressure on landfills because less scrap will be transported to them.
- Groupe Énerstat of Bromptonville, Quebec, with contributions from ETP, completed a field trial of its phase-change thermal storage system in the chilled water plant at the IBM Canada Ltée. plant in Bromont, Quebec. The system reduced electrical annual energy and natural gas energy inputs for the plant by 19 terajoules for a combined energy savings of 46 percent and an estimated annual GHG emissions reduction of 232 tonnes.
- With the financial support of ETP, Custom Dry Kiln (CDK) of Port Coquitlam, British Columbia, was able to demonstrate that dehumidification lumber kilns were substantially more energy efficient than traditional lumber drying kilns when drying large quantities of softwood dimensional lumber (2.1 gigajoules per thousand board feet compared with 2.4 gigajoules per thousand board feet). Additionally, CDK showed that dehumidification kilns make it possible to capture a high proportion of volatile organic compounds (VOCs) released by the lumber in the condensate, leaving relatively low levels of VOCs in the kiln atmosphere.

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

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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 and emissions of other air pollutants, while enhancing competitiveness and profitability.

Industrial combustion processes are the major sources of industrial GHG emissions. Because most industrial furnaces operate at extremely low thermal efficiencies of 15 to 50 percent, there are major opportunities to improve industrial energy efficiency and productivity while significantly reducing GHG emissions.

NRCan's work in this area includes changing the interaction of the combustion system within the process through advanced tools and technologies. NRCan 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 in order to achieve potential energy and GHG reductions of 10 to 50 percent and more. In addition, NRCan is engaged in developing generic tools and technologies that cross industry sectors, fuels and furnaces.

Key 2005–2006 Achievements

- Developed a computer model of a football-field-sized induration furnace and validated the model with field

data. In doing so, identified the opportunity for major reductions in energy consumption (>50 percent) and comparable reductions in pollutant emissions, including GHGs, with the potential for dramatic operating cost savings.
- Using advanced laser-based flame analysis, developed a novel burner suitable for converting a large energy-intensive industrial glass furnace from expensive natural gas to waste petroleum coke, with no change in production or product quality. With successful adoption on one furnace, the client is now converting all of its furnaces using this concept.
- Developed a sophisticated computer model for flame visualization, using movie animation techniques, which will facilitate intuitive data analysis for performance enhancement and energy savings. The tool will enable rapid transfer and acceptance of computational fluid dynamic modelling results directly by plant and consulting engineers and equipment designers of industrial combustion facilities.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/Groups/industrial_innovation_e.htm

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 with supplementary cementing materials (SCMs), and by assessing alternate production processes.

The Minerals and Metals Program is managed by CANMET Mineral Technology Branch and is part of the *Government of Canada Action Plan 2000 on Climate Change*. This five-year program, which was assigned a GHG emissions reduction target of 1.65 million tonnes of CO_2 equivalent per year by 2010, wrapped up in March 2006. It consisted of (1) the Enhanced Recycling component, which 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 component, which supports activities to increase the use of SCMs in concrete and thus replace portland cement (thereby reducing the GHG emissions of concrete production) and which examines processes to gain a greater understanding of them and thereby generate new emission reduction opportunities in the minerals and metals industry sector.

Key 2005–2006 Achievements

- As part of the wrap-up of the Enhanced Recycling Program, a two-day workshop was held in Ottawa to discuss the performance of the program and next steps, which involved providing input for a "National Strategy on Resource Recovery and Recycling." The workshop was attended by 65 experts from across Canada and a report was produced outlining key issues for future consideration.
- In partnership with Environment Canada and ICF Consulting, the Minerals and Metals Program supported the development of a study entitled *Determination of the Impact of Waste Management Activities on Greenhouse Gas Emissions*, which will be an important tool for decision-makers comparing the GHG implications of different end-of-life management strategies for materials found in the waste stream.
- The Association of Canadian Industries Recycling Coal Ash presented a cross-Canada series of workshops with a regional focus to demonstrate the latest information on the technical and performance benefits of SCMs in concrete, as well as new industry guidelines/standards and their significance for practices.

For more information:
recycle.nrcan.gc.ca
nrcan.gc.ca/mms/canmet-mtb/mtl/research/concrete_e.htm
scm.gc.ca

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.

Ventilation is required in underground mines to maintain a safe working environment because it dilutes and removes harmful pollutants (dusts and gases) and provides a thermally suitable working climate. However, providing sufficient suitable ventilation can account for 40 percent of the energy consumed underground by a mining operation. Mine ventilation systems naturally include some redundancy to accommodate all the available production locations. The degree and implications of this oversupply are highly dependent on the individual mine, mineral and mining method. Metal mines that were traditionally designed to operate at maximum delivery – i.e. peak demand across all potential production locations 24 hours a day, 7 days a week – are now starting to adjust ventilation systems to match actual production needs. 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. Optimizing energy use, GHG emission reductions and cost is not a straightforward proposition, as it depends on the specific consumption profile (i.e. electricity versus heating fuels and primary versus secondary delivery systems), the design criteria and geographic location of each mine and therefore requires evaluation on a case-by-case basis.

Key 2005–2006 Achievements

- In order to assess potential cost, energy requirements and GHG reduction strategies, CANMET – Mining and Mineral Science Laboratories continued to develop a process-based modelling approach for determining ventilation needs as a function of the life of the mine. This will enable mine management to select, on an on-demand basis, the level of ventilation that is appropriate to support production and to dilute contamination. The same model could be used to better evaluate the benefit of various ventilation reduction options, such as fuel cells and other clean engine technologies. A model for one type of mine has been completed.
- The implementation of ventilation on demand at an Inco mine continues. The mine has installed monitoring information to track vehicle movement and energy usage, along with a proof-of-concept automated secondary ventilation system.

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 54.1 percent and 42.0 percent, respectively, of transportation energy use, with off-road representing only 3.9 percent in 2004. 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 78.3 percent of total transportation energy use in 2004. Of this amount, 56.8 percent was passenger energy use and 43.2 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 31.3 percent (587 petajoules) over 1990 to 2004 (see Figure 6-2). Passenger transportation energy use increased by 17.1 percent (195 petajoules), while freight transportation energy use increased by 51.1 percent (350 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 35.7 percent (670 petajoules). The freight and passenger segments contributed to this increase by 52.0 percent and 48.0 percent, respectively.
- structure – shifts between modes of transport within both the freight and passenger segments resulted in an increase of 10.5 percent in transportation energy use (197 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 16.8 percent (315 petajoules).

Without improvements in energy efficiency, increases attributable to activity and structure would have led to an increase in transportation energy use of 48.0 percent (867 petajoules). However, as a result of improvements in energy efficiency, actual energy use increased by 31.3 percent. This change in energy use between 1990 and 2004, 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, 2004

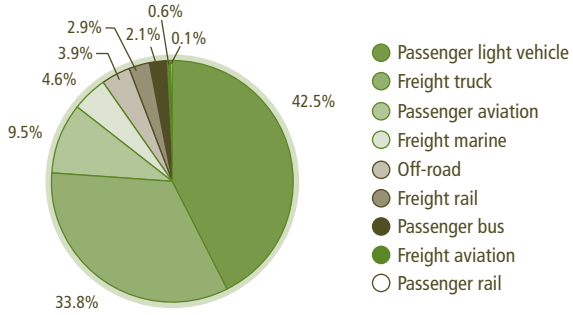
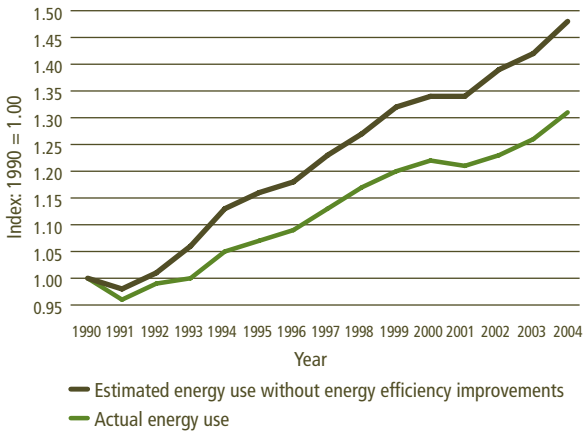


FIGURE 6-2

Transportation Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2004



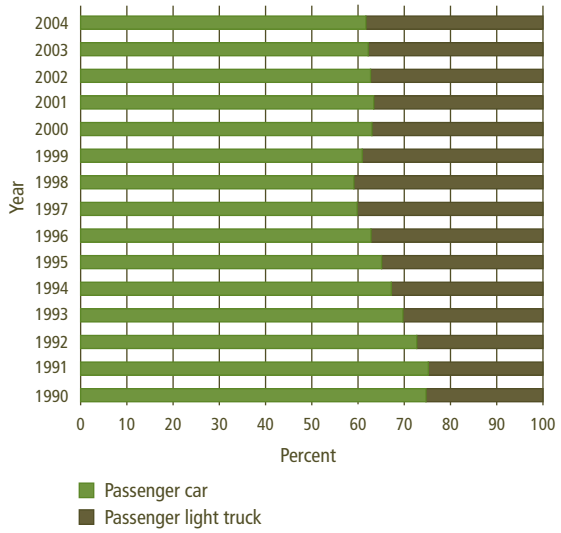
The transportation sector accounts for 28.9 percent (2465 petajoules) of secondary energy use and 34.9 percent (176 megatonnes) of greenhouse gas (GHG) emissions. From 1990 to 2004, transportation energy use increased by 31.3 percent, and GHG emissions increased by 30.6 percent. The change in GHG intensity 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.

Figures 6-5 and 6-6 illustrate an improvement in trucking energy intensity despite an increase in average activity over 1990 to 2004. 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 2004



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

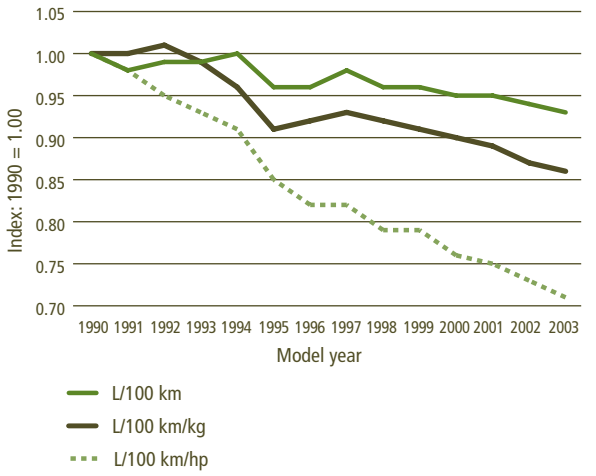


FIGURE 6-5

Average Activity per Truck (tonne kilometres/truck), 1990 to 2004

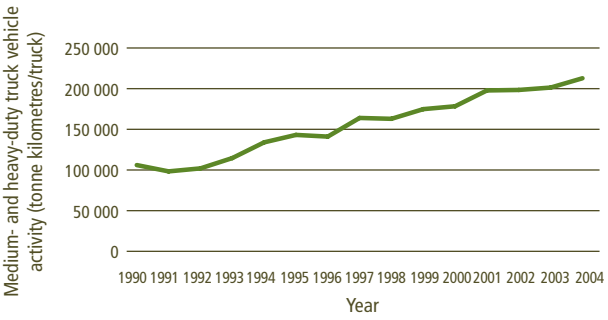
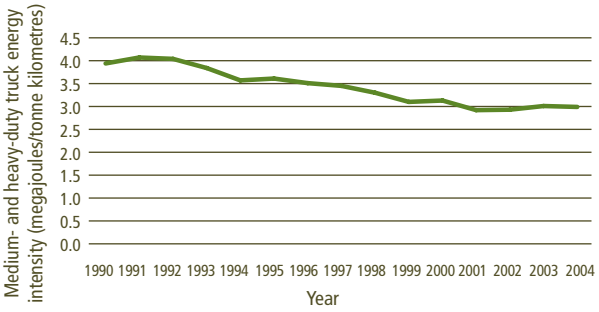


FIGURE 6-6

Trucking Energy Intensity, 1990 to 2004



Vehicles: Vehicle Efficiency

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

The goal of the Motor Vehicle Fuel Efficiency Initiative is to bring about a 25 percent improvement in the fuel efficiency of new light-duty vehicles sold in Canada by 2010. NRCan 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 goes beyond fuel consumption reductions by incorporating reductions in all GHG emissions associated with vehicle use.

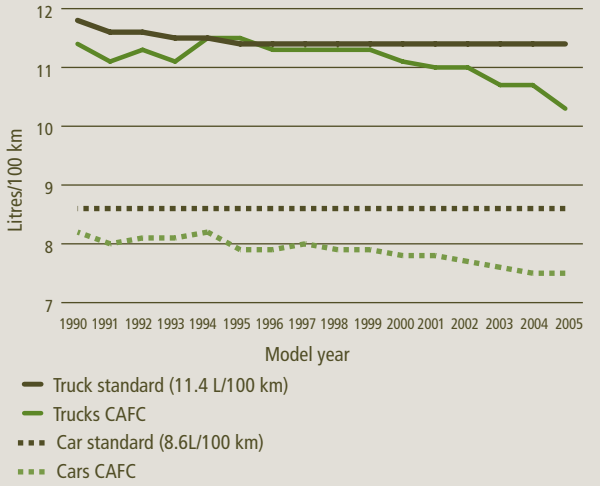
Key 2005–2006 Achievements

- Established the Joint GHG Memorandum of Understanding (MOU) Committee, a committee responsible for tracking automotive industry progress towards the 5.3-Mt reduction target by 2010:
  - Terms of Reference and Operational Plan finalized
  - Committee's first progress update produced
  - Committee's communications strategy developed
  - Stakeholder engagement options put forward by government members of the Committee
- Developed an accounting tool for use by Joint GHG MOU Committee to track industry's progress towards the 5.3-Mt reduction target:
  - Identified data needed to track progress and assessed submission and reporting requirements
  - Completed accounting framework and review of data sources to populate the accounting tool

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

FIGURE 6-7

Company Average Fuel Consumption (CAFC) vs. Canadian Voluntary Standards, 1990 to 2005*



*2002–2005 data are estimates

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 to 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.

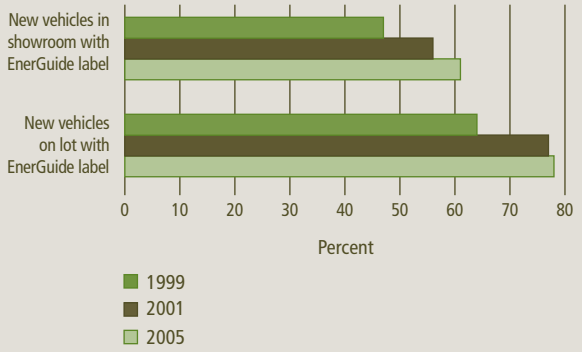
A buyer's guide for fuel-efficient vehicles is being prepared. This new tool will educate automobile consumers about the impact of vehicles on the environment and help them select the most fuel-efficient vehicle that meets their everyday needs.

Key 2005–2006 Achievements

- NRCan completed a marketing study to determine the most effective strategy for raising Canadians' awareness. Elements of the strategy are already in the implementation phase and include partnerships with dealership associations and participation at auto shows:
  - In collaboration with the Canadian Automobile Dealership Association, partnerships and pilot projects were developed with the Montreal Association of New Car Dealers and the Manitoba Motor Dealers Association to promote fuel-efficient vehicles.
  - EnerGuide for Vehicles exhibited at the Toronto, Montréal and Vancouver major auto shows, as well as the Lanark Auto Show, the Barrie Auto Show, the AJAC Test-Fest, the Conference of the Parties to the Convention (COP-11), the Calgary Auto Show, and the Québec City auto show.
- Over 325 000 copies of the *Fuel Consumption Guide* were distributed, including 186 000 to 3386 new car dealerships and 53 000 to 1412 Canadian Automobile Association offices.
- NRCan presented a New Vehicle Recognition System to Government Industry Motor Vehicle Efficiency Committee. Its purpose is to provide a visible signal directing consumers and fleets to the purchase of fuel-efficient and low-CO_2-emitting vehicles.

FIGURE 6-8

Vehicle Fuel Efficiency – EnerGuide Labelling



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

Vehicles: Personal Vehicles

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

The Personal Vehicles information initiative promotes improvements in vehicle fuel efficiency, reductions in vehicle emissions, and the mitigation of other vehicle-related environmental impacts. The initiative helps motorists understand how driving and maintenance behaviours affect GHG emissions and the environment. It encourages Canadians to adopt energy-conserving driving techniques and maintenance practices. The initiative complements EnerGuide for Vehicles.

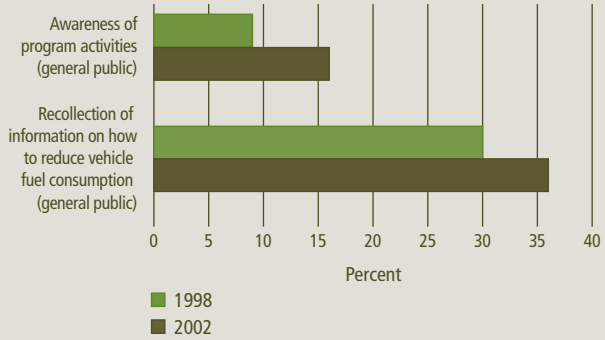
Key components include the Auto$mart "A New Point of View" Driver Educator kit, which provides instructors with the instruments (instructor's in-class materials, student workbook, instructor's in-car guide, video, CD-ROM, and student tips cards) to teach fuel-efficient driving to drivers; the Idle-Free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

Key 2005–2006 Achievements

- Provided Auto$mart Train-the-Trainer workshops to 835 driving instructors of the 2172 driver educators who received the Auto$mart "A New Point of View" driver education resource kit. Since its launch in 2005, driving instructors have trained 130 320 new drivers on safe, fuel-efficient vehicle operating practices. Negotiated with provinces and territories to encourage the adoption of fuel conservation and efficiency components into their driver education and licensing infrastructure. Since 2002, a total of 23 fuel efficiency components have been implemented in various jurisdictions across Canada.
- Completed an Idle-Free campaign with the Halifax Regional Municipality and initiated an Idle-Free campaign with the City of Vancouver. Completed the development of regulatory and voluntary approaches to addressing idling with the Clean Air Partnership. Since its launch in 2001, the Idle-Free initiative has cooperated with nine municipalities, six community groups, and other organizations to deliver idle-free campaigns to over 9.8 million Canadians.
- Extended the Be Tire Smart campaign, in association with the Rubber Association of Canada, Nova Scotia and Alberta. The over 100 articles on the campaigns have had a circulation of 7.2 million and reached 16.3 million Canadians.

FIGURE 6-9

Vehicle Fuel Efficiency Awareness – Program Activities



For more information:
vehicles.gc.ca

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 and manager 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 (see Figure 6-10). NRCan delivers the Fleet Vehicles initiative in partnership with fleets, industry stakeholders and other levels of government.

Key 2005–2006 Achievements

- To date, the Fleet Vehicles initiative has registered over 4733 members (see Figure 6-11). The annual truck stop Idle-Free – Quiet Zone Campaign was successfully conducted at more than 80 sites across Canada.
- A fourth driver training curriculum, "SmartDriver for Motor Coach," has been added to the SmartDriver family of tools. The Fleet Vehicles initiative has also introduced a new SmartDriver Self-Study Module.
- The Fleet Vehicles initiative and the U.S. Environmental Protection Agency signed a Memorandum of Understanding under which the freight industry in both countries would be encouraged/assisted to undertake voluntary actions to reduce fuel consumption and protect the environment with verifiable emissions reductions and, at the same time, cooperation and expansion of current activities would be promoted.

For more information:
fleetsmart.nrcan.gc.ca

FIGURE 6-10

Number of Idling Reduction Devices Purchased and Claimed Under Commercial Transportation Energy Efficiency Rebate (CTEER) Initiative

	2004–2005*	2005–2006
Auxiliary Power Units (APUs)	1342	5376
Heaters	9323	1202

*2004–2005 total includes initial six-month program launch in 2003–2004

FIGURE 6-11

Participation in the Fleet Vehicles Initiative, 1998 to 2005

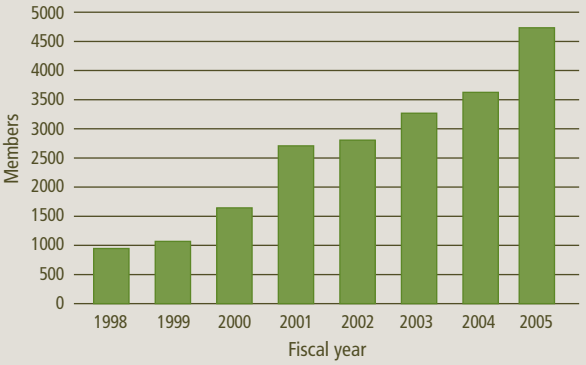
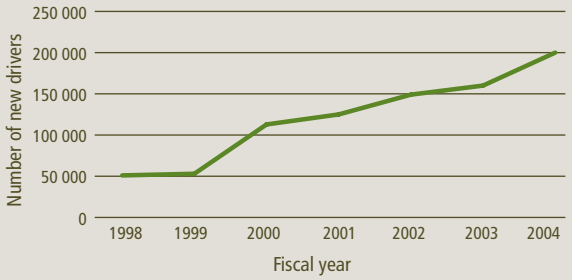


FIGURE 6-12

Drivers Trained, 1998 to 2004*



*Estimates based on NRCan internal data

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 with transportation applications for the purpose of reducing GHG emissions through vehicle weight reduction and improving vehicle efficiency, and enhancing the competitiveness of Canadian primary metals producers, automotive part manufacturers and suppliers.

Key 2005–2006 Achievements

- Magnesium sheet alloys are increasingly being considered for automotive applications because of the potential for weight reduction, fuel economy improvement and emission reduction. To facilitate the use of magnesium sheet alloy for automotive applications, it is necessary to characterize formability as a function of temperature and deformation rate for the different alloys and thermo-mechanical processing routes of interest. CANMET Material Technologies Laboratory (MTL) has developed a method to evaluate the warm sheet formability of standard magnesium alloys such as Mg AZ31 as well as new alloys as they are developed at CANMET-MTL and elsewhere. Finding and developing technologies for the protection of galvanic corrosion of magnesium alloys is also important. CANMET-MTL, in partnership with its stakeholders, has developed technologies to mitigate the surface corrosion of magnesium alloys.
- There is interest in using titanium for automotive applications due to its high strength, low density and excellent resistance to corrosion and oxidation. CANMET-MTL developed a metal powder injection moulding process to produce titanium alloys. The weight saving through direct replacement in existing automotive component designs or preferably in new designs using titanium would be about 50 percent.
- A feasibility study on adopting lightweight thermal structural panels for long-haul refrigeration trailers was completed. The results indicated that using the new panels could generate a 10 percent improvement in thermal efficiency and GHG emission reductions and that replacing the current floor panels with lightweight thermal panels could result in the greatest weight reduction.

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 with 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 reducing heat and noise. Fuel cells have also been shown to have the potential to reduce CO_2 or GHG emissions by up to one million tonnes per year (26 percent of the total CO_2 equivalent emitted by mining extraction) and decrease operating costs by lowering mine ventilation needs.

Key 2005–2006 Achievements

- A major study on hydrogen production and delivery requirements for underground mining established the best methods for fuel cell mine vehicles and for underground Canadian mining operations.
- The development project on the fuel cell underground mine loader is now at the power-plant-testing stage; the vehicle integration stage and initial surface performance tests will follow.
- An agreement in principle was reached with Canada Economic Development and the Canadian Transportation Fuel Cell Alliance (NRCan) for initial funding to establish a hydrogen storage and delivery infrastructure and full-scale operational research at CANMET Mining and Mineral Sciences Laboratories' underground experimental mine in Val d'Or, Quebec. Also, significant project planning has been carried out with Canada Economic Development, Industry Canada and the hydrogen and mining industries to establish the ground-breaking mining Hydrogen Production and Delivery Research Consortium. It will carry out large-scale projects on hydrogen storage and utilization and the development of standards to facilitate full technology introduction, and support commercialization of Canadian technology into the Canadian and international mining industry.

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

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, is contributing to the construction costs of new fuel ethanol production facilities across Canada. Projects were selected through two rounds of competitive solicitation in 2004 and 2005 based on their ability to maximize ethanol production and reduce transportation GHG emissions. On average, program contributions account for less than 15 percent of the total plant construction costs, and contribution agreements contain repayment terms based on project profitability.

Key 2005–2006 Achievements

- As of June 2006, five new ethanol plants across the country had commenced construction, with four of these expected to be completed in 2006.
- These projects, for which private-sector investments total over half a billion dollars, plan a total capacity of over 600 million litres of ethanol per year, which will more than quadruple domestic production.
- When blended in gasoline, this additional ethanol will reduce life-cycle GHG emissions by an estimated 0.8 Mt per year.

For more information:
vehiclefuels.gc.ca

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 industry stakeholders. The main activities are federal-provincial policy coordination, industry consultation, public awareness campaigns and analytical work on feedstocks, production costs, emissions and socio-economic impacts.

Key 2005–2006 Achievements

- Through the Council of Energy Ministers' Working Group on Renewable Fuels, joint federal-provincial-territorial analysis and consultations were conducted in support of the development of a national strategy for renewable fuels.
- Extensive consultations on renewable fuels policy and programs were conducted with industry stakeholders including agricultural producers, renewable fuel producers, fuel distributors and end-users, as well as environmental non-governmental organizations.
- Capabilities for life-cycle modelling of the energy and emission implications of traditional and alternative fuels were enhanced and extended.

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 2005–2006 Achievements

- Initiated a Canadian Biodiesel Distribution Infrastructure Roadmap to address the potential roadblocks and propose solutions and options to ensure the successful, sustainable growth of the Canadian biodiesel industry.
- Launched the Biofuels Quality Registry and the Proficiency Testing Program with the Alberta Research Council (www.biofuels.arc.ab.ca) to conduct fuel-quality testing of biodiesel samples, track fuel quality metrics to provide input for the development of an industry protocol and standard for fuel analysis, and evaluate the performance of laboratories on physical testing of biodiesel.
- Completed research to evaluate the technical and economic potential of possible feedstock sources, including extraction of corn oil during the fuel ethanol corn dry-milling process and conversion of the oil into biodiesel and/or other value-added products.

For more information:
vehiclefuels.gc.ca

Transportation Technologies: Canadian Transportation Fuel Cell Alliance

Objective: To demonstrate and evaluate various processes for producing hydrogen and delivering it to fuel cell vehicles at fuelling stations, to develop and demonstrate hydrogen-fuelled vehicles, and to participate in the development of codes and standards.

NRCan's Canadian Transportation Fuel Cell Alliance (CTFCA) is a private-public sector initiative involving technology developers, fuel providers, auto manufacturers, federal and provincial/territorial governments, academia and non-governmental organization representatives. The CTFCA contributes to a reduction in GHG emissions by encouraging advances 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 2005–2006 Achievements

- Completed the construction of three of the seven "Hydrogen Highway" fuelling stations in British Columbia and started construction of a fourth station. The five Ford Focus fuel cell cars successfully completed the first of three years of on-road testing and evaluation in the Vancouver and Victoria areas.
- Purolator Courier Ltd. took delivery of a hydrogen fuel-cell-powered delivery van in May 2005 and initiated a series of on-road performance tests that will be continued in the spring of 2006 in downtown Toronto. As well, a hydrogen fuelling station to serve the vehicle was installed at the Purolator depot in West Toronto.
- Prepared the new Canadian Hydrogen Installation Code, which will govern the installation of hydrogen-generating equipment, hydrogen-using equipment such as fuel cells, hydrogen-dispensing equipment, hydrogen storage containers, hydrogen-piping systems and related accessories.

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

Transportation Technologies: Hydrogen, Fuel Cells and Transportation Energy Program

Objective: In partnership with industry, to develop and deploy leading-edge hydrogen, fuel cell 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 the program's work include the following:

- Supporting Canadian industry in developing a world-class 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 and establishing 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.
- Supporting the development of alternative transportation fuel technologies, for instance, for natural gas and propane vehicles, which has led to a new Canadian industry that is now exporting commercial products.

Key 2005–2006 Achievements

- Development of microstructured fuel cell with over 2500 hours operating time at 1 watt.
- Introduction of Canadian natural gas vehicle technology into India. The technology was developed under this program.
- Support for Challenge X competition, in conjunction with the U.S. Department of Energy and General Motors, to assist students in designing and implementing hybrid electric vehicle technologies. The University of Waterloo placed first in the June 2005 competition with its fuel cell vehicle design.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/Groups/hyfate_e.htm

Chapter 7: Renewable Energy

Renewable Energy Use

In 2004, 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 2004, hydro power accounted for about 59 percent of Canada's total electricity generation. Small-scale hydro-electric projects, with a capacity of 50 megawatts (MW) or less, constitute about 2.5 percent of Canada's electricity-generating capacity. Small-scale hydro has considerable 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, dedicated feedstocks from agriculture and forest origin, 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 (megawatts)	Percent 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
2004	72 783	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 in 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.

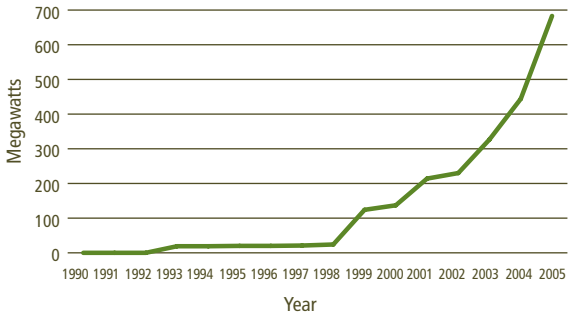
Wind Energy

Wind turbines convert the kinetic energy of wind into electrical or mechanical energy. Canada's land mass and coastal waters combine to provide a wind resource with extraordinary potential. While Canada has not achieved the level of wind generation seen in other countries, recent policy developments have spurred record growth in the Canadian wind generation industry (see Figure 7-1). In 2004, wind energy accounted for about 0.3 percent of Canada's total electricity generation, up from 0.2 percent in 2003. Despite significant additions in recent years, wind energy contributed only 0.4 percent of the total electrical generating capacity in Canada in 2004.

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 2005



Source: Canadian Wind Energy Association

Solar Energy

Three main technologies use energy from the sun:

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

During the 1990s, Natural Resources Canada (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 25 percent in 2005 to 17.6 MW from 14 MW at the end of 2004. Total PV module sales by Canada (domestic and export) were at 4.6 MW. The average market growth has been 25 percent annually since 1992. In 2005, jobs grew by 32 percent to 865 positions, with total revenues estimated at CAN$165 million, a 32 percent increase over 2004. Investments in research and development (R&D), manufacturing capacity, and acquisitions in PV-related business have not increased significantly over 2004, reaching a total of CAN$31 million, of which 30 percent were investments in R&D activities. The weighted average price of PV modules dropped to CAN$4.31 per watt in 2005, with a steady average decline of 12 percent per year since 1999. The total public (federal and provincial combined) R&D and demonstration budget reached CAN$6.7 million in 2005. 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: Wind Power Production Incentive (WPPI)

Objective: The WPPI is a 15-year, $260-million program to support the installation of 1000 MW of new wind energy capacity or the production of 2.6 terawatt 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 $0.01 per kilowatt hour of production, and eligible recipients can receive the incentive on 10 years of production.

Key 2005–2006 Achievements

- Six new wind energy projects were commissioned in fiscal year 2005–2006: two are located in Ontario, two in Quebec, one in Saskatchewan and one in Manitoba. These projects contributed 436 MW of new wind energy capacity, and represent a total financial contribution over 10 years of more than $150 million.
- Since WPPI's introduction in 2002, about 670 MW of wind power capacity have been commissioned, representing 18 projects and a total financial commitment of $239 million.

For more information:
canren.gc.ca/wppi

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

Objective: To purchase electricity from emerging renewable energy sources (ERES) 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 2005–2006 Achievements

- About 90 gigawatt hours (GWh) of electricity from ERES were generated in Ontario through an agreement with Energy Ottawa.
- Also, 56 GWh of electricity from ERES continued to be generated for federal facilities in Alberta, Saskatchewan and Prince Edward Island, resulting in about 50 000 tonnes of GHG emissions reductions.
- Consultations took place in British Columbia, New Brunswick, Newfoundland and Labrador, and Nova Scotia.

For more information:
reed.nrcan.gc.ca

Renewable Energy Programs: Photovoltaic and Hybrid Systems Program

Objective: To support the development and application of solar PV technologies in Canada.

The program contributes to increasing the use of PV 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 R&D activities and fosters information exchanges leading to the adoption of PV-hybrid systems that produce electricity from solar energy and another energy source; validates the performance and safety of utility-interactive inverter products; supports the development of building-integrated PV technologies and systems; and facilitates the development and adoption of harmonized standards and codes for PV systems in Canada.

Key 2005–2006 Achievements

- Collaborated with Concordia University on the development of a national research network on "solar buildings" that was approved in 2005. This will help build the scientific knowledge required to develop a zero-energy solar home and low-energy solar building optimizing daylighting, solar heat and solar electricity through an integrated design approach. The Solar Building Research Network now includes 10 universities and three government research centres.
- Partnered with PV manufacturers on projects that led to growth in the Canadian PV industry, employing over 900 people in 2005. These activities included R&D investments in the novel Spheral Solar Power Technology being developed by Automation Tooling System in Cambridge, Ontario, and novel power electronic products for PV-hybrid generation system being developed by XANTREX in Burnaby, British Columbia.

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 market its products in Canada and abroad.

Key 2005–2006 Achievements

- As the result of a major cost-shared project with NRCan, Iogen Corporation significantly improved the efficiency of the cellulose enzymes used in the company's process for producing fuel ethanol from cellulosic biomass. Iogen estimates that use of the more efficient enzymes will lower the cost of ethanol production from agricultural residues by 30 percent.
- NRCan supported the University of Toronto in developing an innovative technology to 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 costs. BIOX Corporation of Oakville, Ontario, licensed the process and successfully operated a one-million-litres-per-year pilot demonstration plant. BIOX, with Sustainable Development Technology Canada support, is opening a 60-million-litres-per-year commercial demonstration plant.
- Through NRCan R&D support, Canadian biomass companies such as Ensyn, Enerkem and Nexterra are moving their technologies toward commercialization. As a result of this support, many of these companies have moved to the next level of commercialization and are now in various stages of commissioning. Ensyn is commissioning a 70-tonne-per-day biomass pyrolysis biorefinery in Renfrew, Ontario. Nexterra is working with Tolko Industries, a forest products company, to set up a gasification process that will use Tolko's forest residues to replace natural gas in lumber kilns. Enerkem has completed a technology assessment program with the City of Edmonton for a municipal solid waste gasification project.

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 and cooling, earth energy, and high-efficiency, low-emission biomass combustion. REDI promotes these systems in the business, federal and industrial markets through various means: a financial incentive, industry infrastructure development, a partnership with a utility coalition, market assessment, and information provision and awareness-raising activities.

Key 2005–2006 Achievements

- Experienced a record level of interest, completing 134 projects and receiving its 800th application (see Table 7-3). Published two important market documents: *The REDI Strategic Business Plan to March 2007* and *A Survey of Active-Solar Thermal Collectors, Industry and Markets in Canada*.
- Oversaw four solar domestic water-heating pilot projects in regions across Canada.
- Completed a successful $4-million, multi-year partnership with the Canadian Geo-Exchange Coalition to promote ground-source heat pumps in Canada.

For more information:
nrcan.gc.ca/redi

TABLE 7-3

REDI for Business Projects Completed, 1998 to 2005

Fiscal year	Number of projects completed	Estimated GHG reduction (tonnes CO_2/yr.)	Client investment	Federal incentive
1998	8	2 869.0	$1,306,295	$145,950
1999	9	260.8	$479,633	$119,910
2000	24	5 825.4	$1,849,918	$327,078
2001	43	21.7	$5,827,561	$1,197,965
2002	33	5 718.8	$2,745,834	$606,210
2003	89	39 653.5	$22,356,375	$2,551,845
2004	65	47 447.0	$11,200,942	$2,250,421
2005	134	34 060.3	$27,588,936	$4,014,779
Total	**405**	**135 856.5**	**$73,355,494**	**$11,214,158**

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 wind energy, small hydro (less than 20 MW), and thermal solar. It is actively involved in R&D to support the growth of the renewable energy industry in Canada. Growth will be achieved by:

- identifying and accelerating strategic R&D, 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
- conducting resource assessments
- supporting training and education
- disseminating results and findings
- supporting policy and programs
- engaging in international cooperation through the International Energy Agency

Key 2005–2006 Achievements

- Construction began in 2005 on the Drake Landing Solar Community, a 52-home subdivision in Okotoks, Alberta, south of Calgary. This seasonal solar thermal storage project, designed and led by CANMET Energy Technology Centre (CETC), 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. In November 2005, the project was awarded a Gold Award by the United Nations at the International Awards for Liveable Communities in Spain. It was also recognized as the Best New Idea of 2005 at the Annual Awards Gala held by the Calgary Home Builders Association.

- NRCan played a major role in establishing the Laval Hydro Turbine Industry Research Consortia in partnership with the Natural Sciences and Engineering Research Council of Canada, major Canadian hydroturbine manufacturers and utilities. The facility is centred at the Laval University Hydraulic Machinery Laboratory (LAMH). The LAMH is a leading independent hydro turbine R&D facility in North America, and it has grown through the steady support of the RET Program. It will address the shortcomings in efforts to develop a strong Canadian R&D centre in the hydroelectric field by validating new, higher-efficiency hydro turbine designs.

- NRCan played a key role in the successful installation of the first-ever Wind-Diesel Integrated Control System (WDICS) on Ramea Island, Newfoundland and Labrador. The system consists of six 65-kilowatt wind turbines that will produce about 1 million kilowatt hours of electricity per year. The electricity will be fed to the local grid and will provide about 17 percent of Ramea's electrical load, while reducing carbon dioxide (CO_2) emissions by 750 tonnes per year. WDICS, a sophisticated control system for the integration of wind and diesel power generation, was developed with the support of CETC–Ottawa at the Atlantic Wind Test Site.

For more information:
canren.gc.ca

Renewable Energy Programs: Market Incentive Program (MIP)

Objective: The MIP was a $25-million program to stimulate emerging markets for renewable electricity.

Under the program, electric utilities, retailers and marketers submitted 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 provided 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 CO_2 reduction objectives were 1.4 megatonnes per year by 2010.

Key 2005–2006 Achievements

- Agreement with SelectPower contributes to almost 1 million kilowatt hours of electricity from wind input into the Ontario energy supply, and information provided to consumers on small wind, solar and earth energy.
- TransAlta developed a Green Power Marketing Tool Kit for use by utilities and green power sellers.
- This program was completed on March 31, 2006, as per the original program framework.

For more information:
reed.nrcan.gc.ca

Renewable Energy Programs: Canadian Biomass Innovation Network (CBIN)

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

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

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

- PERD "Bio-Based Energy Systems and Technologies" POL program
- Biotechnology R&D component of the new "Technology and Innovation (T&I)" Initiative

Key 2005–2006 Achievements

- In 2005, the Municipality of Boisbriand founded the CERVEAU (*Centre d'expérimentation et de recherche sur les végétaux pour l'environnement et l'aménagement urbain*), a non-profit organization dedicated to the development and the promotion of the use of fast-growing tree and shrub species for environmental ends. The municipality put forward public funds to acquire several hectares of land on its territory. This land was then changed from its original residential vocation to plantation sites.
- Optimization of operating parameters could lead to increased efficiency and reduced criteria emissions. Paprican has developed a boiler optimization protocol and, to test the protocol, has performed trials on 10 wood waste fired boilers for baseline testing and optimized 7 units with an average increase in steam from wood waste of over 20 percent with a dramatic decrease in CO_2 emissions and carbon in ash. The results have created great interest from many other facilities wishing to participate.
- Successful production of first-generation materials based on wheat and pea starches. Different families of blends with bio-based polylactic acid and polycaprolacone are fully biodegradable and offer a full range of properties depending on the starch and plasticizer content. A number of film, sheet and molded prototypes have been produced using conventional plastic processing equipment to demonstrate the feasibility and potential of these materials for the fabrication of consumer products.

For more information:
cbin.gc.ca

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.

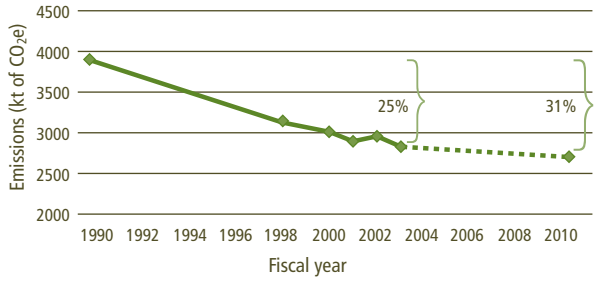
Since 1990, through building retrofits, better fleet management, strategic "green power" purchases and the downsizing of operations, the Government of Canada has already achieved a 25 percent emissions reduction. The Government of Canada will reduce its net emissions by a further 6 percent by 2010 (see Figure 8-1).

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 emission reduction 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 to help them achieve their targets. The 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 2005–2006 Achievements

- Canadian Forces Base Halifax was awarded its second FBI energy efficiency project. Private sector investment of $12 million is expected to generate over $2 million annually in energy cost savings. The base's first project, implemented in 1995 with an investment of $11 million, has realized close to $2 million in energy savings each year.
- The private sector made new and incremental investments of $19.9 million in FBI projects.
- FBI energy efficiency projects awarded in 2005–2006 will reduce the federal government's annual utility bills by $3.1 million.

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

Energy Technology Applications Group (ETAG)

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

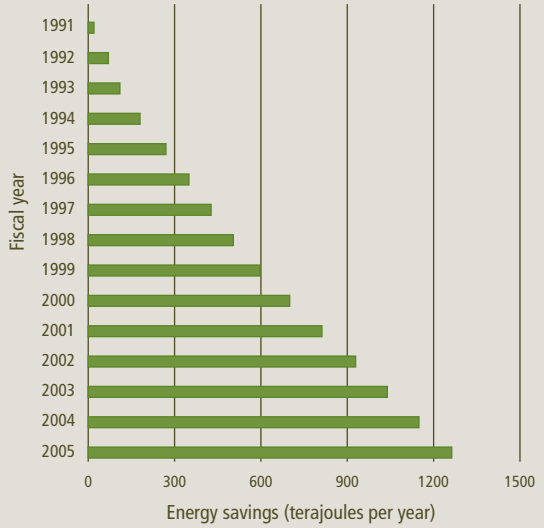
The experience gained by the Energy Technology Applications Group (ETAG) in building energy systems and access to the engineering and scientific network within NRCan ensures that environmentally responsible technologies are considered when federal government clients replace or modify their energy systems. ETAG used to be called the Federal Industrial Boiler Program but changed its name 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, it has worked with such departments as Agriculture and Agri-Food Canada (AAFC), Correctional Service Canada (CSC), Environment Canada, Foreign Affairs and International Trade Canada and the Department of National Defence to reduce their energy costs. Through projects implemented by ETAG, GHG emissions have been reduced by an average of 4.7 kilotonnes per year.

Key 2005–2006 Achievements

- Worked with CSC to continue its Federal House in Order-sponsored wind power projects. With the wind data accumulated over the past year, ETAG issued a feasability report; and as a result, CSC decided to proceed with purchasing and installing two 600-kilowatt turbines: one at Dorchester, New Brunswick, and another at Drumheller, Alberta. ETAG wrote the technical specifications and worked with the CSC project team to issue the request for proposal and evaluate the proposals received.
- CSC made a commitment in its 2003 Sustainable Development Strategy to reduce nitrogen oxide emissions in the Québec City-Windsor corridor and the Lower Fraser Valley by 10 percent from 2003 levels. ETAG has been working with CSC to develop an annual monitoring and boiler efficiency optimization program for the heating plants in these areas to meet that commitment. From the plant optimization, CSC will reduce its annual carbon dioxide (equivalent) emissions by 200 000 kilograms.
- ETAG worked with AAFC, providing technical and project assistance on a variety of sites and technologies. It performed a refit study of the heating and cooling plant at AAFC's research facility in Swift Current, Saskatchewan, identifying opportunities to save $100,000 and reduce carbon dioxide (equivalent) emissions by 600 000 kilograms per year. With ETAG's assistance, AAFC is moving ahead with installing a 50-kilowatt wind turbine at the Harrington research centre in Prince Edward Island. The project is expected to reduce annual carbon dioxide (equivalent) emissions by 43 000 kilograms.

FIGURE 8-2

Annual Energy Savings From Energy Technology Applications Group, 1991 to 2005



For more information:
etag-gate.ca

Federal Fleet Initiative (FFI)

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

The Federal Fleet Initiative (FFI) provides tools and information to federal fleet managers and drivers to help them respond to climate change and to improve the overall efficiency of their fleets. This program resides at Natural Resources Canada and is steered by an interdepartmental committee consisting of the 11 largest emitting federal departments. This committee meets on a regular basis to discuss fleet management and operational issues and activities. Treasury Board Secretariat, through the Motor Vehicle Policy, outlines new objectives and requirements of efficiency and environmental performance facing the federal fleet and the FFI assists departments in meeting these requirements.

Key 2005–2006 Achievements

- Increased the penetration of ethanol-85 (E85) fuel across the federal fleet by subsidizing 371 251 litres of E85 fuel to federal fleets (as of April 2005).
- Trained 1143 federal vehicle operators at workshops; trained an additional 1566 operators on-line. Assisted in purchasing 144 Leadership Vehicles (E85 and hybrid vehicles).
- Funded 11 demonstration projects – testing new technology applications across the federal fleet.

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

FIGURE 8-3

Federal Fleet Size and Fuel Consumption, 1995 to 2004

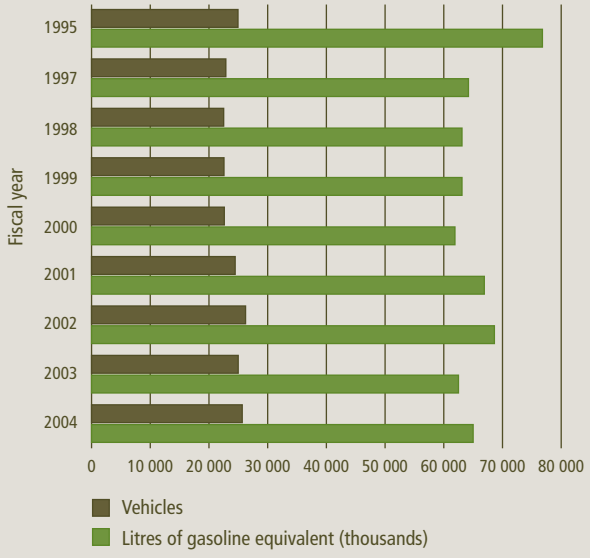


FIGURE 8-4

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

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 (OEE) 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.

The One-Tonne Challenge was launched in March 2004 as a component of the Outreach program. The Challenge was co-managed with Environment Canada, with input from and coordination with other departments such as Transport Canada. It was discontinued as of March 31, 2006.

Key 2005–2006 Achievements

- Distributed over 5.6 million energy efficiency publications and information tools, an increase of 27 percent over 2004–2005. OEE Web site visits were up almost 53 percent from 2004–2005.
- The on-line Energy and Environment Calendar Club continues to grow in popularity with more than 190 000 visits during 2005–2006, a 25 percent increase over the previous year.
- The 2005 One-Tonne Challenge Tracking Survey – Phase II found that over the year awareness of the One-Tonne Challenge jumped fourfold, from 15 percent to 60 percent of the adult population.

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 potential projects.

Key 2005–2006 Achievements

- Increased the number of users of the RETScreen International Clean Energy Project Analysis Software to more than 79 000 people in 213 countries. The number of people benefiting from this decision-support and capacity-building tool is growing at more than 400 new users every week. RETScreen is quickly becoming the de facto international standard for clean energy project pre-feasibility analysis.
- Released a number of new or improved RETScreen software and training tools, including a new multilingual version of the Combined Heat and Power software model and training course in 21 languages (including Chinese, Spanish, Russian and Hindi) covering roughly two thirds of the world's population.
- Initiated development of a major new version of the RETScreen Software. In RETScreen Version 4, the software's capabilities are being expanded from renewable energy, cogeneration and district energy to include a full array of financially viable clean power, heating and cooling technologies and energy efficiency measures. To enhance the software's international appeal, action is being taken in cooperation with NASA to increase the amount of climate data required by the tool to cover the entire surface of the planet, and the entire software suite is being translated into 21 languages.

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 2005–2006 was approximately $57 million. Natural Resources Canada allocated $38.5 million to energy R&D programs managed and performed in the department, approximately 50 percent aimed at improving energy efficiency in Canada. Efficiencies are sought in energy production, distribution and end-use. Production encompasses both fossil fuels and alternative sources, including biomass.

Examples of funded projects are highlighted in the performance reporting in Chapters 3 to 7 of this document. The remaining $18.5 million has been allocated to 12 federal departments that are PERD partners.

For more information:
www2.nrcan.gc.ca/ES/OERD/english

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).

Key 2005–2006 Achievements

- Published the *Clean Coal Technology Roadmap* and the *CO_2 Capture and Storage Technology Roadmap*. Technology roadmaps are designed to deliver a forecasting tool for determining future market needs, promoting cooperation, and planning the best approach to advancing promising climate change technologies.
- Novel Next Generation Technology Initiative completed the last request for proposals. This initiative sponsored basic research in climate change technologies at universities, federal laboratories and provincial laboratories. As of March 31, 2006, the initiative has sponsored 21 projects at universities across Canada and 34 projects in provincial and federal laboratories.

Canadian Initiative for International Technology Transfer (CIITT) (of the *Government of Canada Action Plan 2000 on Climate Change*)

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

The Canadian Initiative for International Technology Transfer received $10 million over six years (2001–2006). The program has developed six initiatives to maximize international technology opportunities for Canada's small- and medium-sized enterprises through on-site technology promotion offices at Canadian embassies in Mexico, India and Poland (Poland covers six Eastern European countries), technology transfer feasibility studies by the private sector, workshops, missions and statistical monitoring of climate change technologies.

Key 2005–2006 Achievements

- Formal evaluation showed that 12 out of 22 feasibility studies funded are likely to proceed to implementation. This would result in $100 million in exports for Canada and reductions of over 500 000 tonnes of carbon dioxide.
- The Clean Energy Portal, created in 2003, actively promotes Canadian companies to foreign businesses, investors and governments through the Portal. The Portal uses Internet services and information technology advancements to enhance communication links and activity between individuals, institutes, industry and government stakeholders, which accelerates and promotes the commercialization and technology transfer of climate- and clean-energy-related technologies. The Clean Energy Portal averaged 61 223 hits per day from May 2005 to March 2006.

For more information:
cleanenergy.gc.ca

Climate Change Technology and Innovation Research and Development (T&I R&D Government of Canada Climate Change Plan – 2003)

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

Implemented in 2003 with $115 million in federal funding over five years, T&I R&D is based on long-term strategic planning that takes into account expected energy futures and visions to 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 2005–2006 was $25 million. Natural Resources Canada (NRCan) allocated $18.5 million to energy R&D programs managed and performed in the department. Key NRCan R&D achievements contributing to improved energy efficiency in Canada are included in the performance reporting in Chapters 3 to 7. The remaining $6.5 million was allocated to eight federal departments that are T&I R&D partners.

Chapter 10: Cooperation

Introduction

This chapter describes Natural Resources Canada's (NRCan's) cooperation on efficiency and alternative energy (EAE) with the provinces and territories and internationally during the reporting period. Examples of program cooperation on specific EAE initiatives are given in the Key Achievements sections of earlier chapters. It should be noted that municipal governments and agencies participate in NRCan's EAE measures as clients (for training workshops, as recipients of financial incentives, etc.) and as partners (e.g. in anti-idling projects), and that 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 Fund was created in Budget 2000 by an endowment of $125 million to the Federation of Canadian Municipalities (FCM) in support of municipal government action to reduce greenhouse gases, cut pollution and improve the quality of life. The funds were doubled to $250 million in Budget 2001. In March 2005, a $300 million increase in FCM funding was approved, bringing the total up to $550 million. The funds were shared between NRCan and Environment Canada.
- 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) participates in governance of the fund, along with representatives from the public and private sectors, including municipal officials and technical experts, through a peer review committee and an advisory council. The FCM Board of Directors approves projects based on the council's recommendations.

There are several institutions in Canada that address energy efficiency issues in broad terms, including the three data and analysis centres established by NRCan, the host universities and other partners. These centres are also sponsored by other federal departments, provincial government agencies and various associations and energy supply utilities. They facilitate access to data on energy use in the industry, transportation and building sectors, monitor the quality of data, and investigate methods to improve data collection and analysis. The goal of another institution, the Canadian Centre for Energy Information, is to engage North Americans in critical inquiry and enlightened discussion on energy and energy-related issues affecting their quality of life. A third institution, the Canadian Energy Efficiency Alliance, is a non-profit organization established to promote the efficient use of energy in Canada.

There are three national consultative bodies in the area of energy efficiency:

- ADM Steering Committee on Energy Efficiency (ASCEE), established under the Council of Energy Ministers;
- Demand Side Management Working Group (DSM WG); and
- Office of Energy Efficiency (OEE) National Advisory Council on Energy Efficiency (NACEE).

In 2004, federal, provincial and territorial energy ministers decided that the ASCEE should be formed and tasked with establishing a coordinated and complementary agenda for energy efficiency in the built environment, industry and transportation sectors. The ASCEE held five meetings in 2005–2006 with representatives of the federal government, eight provinces, industry, and environmental non-governmental organizations.

The previously existing DSM WG is now under the auspices of the ASCEE. It began its work in 2003 and its members represent NRCan, industry and seven provinces and territories. The DSM WG undertook joint work and completed various studies related to demand side management, including the identification of the

DSM potential, regulatory process and framework. The DSM WG also created an "Energy Code Collaborative" to oversee work on energy codes for buildings and houses, produced an inventory of energy efficiency programs for low-income households, and fostered cooperation between jurisdictions in this area.

The ASCEE sponsored the formation of a federal/provincial working group on transportation energy in 2005 to seek opportunities for stronger cooperation among governments in harmonizing policies and programs that can impact energy efficiency and to make recommendations to ministers on the need for government action. The Transportation Working Group on Energy Efficiency (TWGEE) comprises senior federal and provincial government officials. Members come from a variety of departments (primarily energy and transportation), representing the interdisciplinary nature of the transportation energy efficiency issue. The primary role of TWGEE is to guide discussions and work toward a long-term, integrated approach to accelerating transportation energy efficiency nationally.

NRCan created NACEE in April 1998 to advise and guide the OEE on the most effective way to achieve its mission. Its membership is drawn from across Canada and all economic sectors and includes 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 2005–2006.

Federal-Provincial and Federal-Territorial Cooperation

Recently there has been renewed interest in increased energy efficiency as a means of maximizing service from the existing energy supply capacity in the country. Provincial and territorial governments helped to deliver a substantial number of EAE programs during the reporting period to reduce energy costs, increase competitiveness, improve air quality and generate economic opportunities. Coordination between the federal and provincial/territorial levels is essential to avoid duplication and ensure efficient program delivery. During the reporting period, governments cooperated on energy efficiency in general and on specific program initiatives.

All provinces and territories engage in energy efficiency activities and/or deliver programs in their respective jurisdictions. In some provinces and territories, specific organizations are mandated to promote energy efficiency. For example, Energy Solutions Alberta, under Climate Change Central, is a focus for information and action on energy efficiency and conservation in Alberta. In Saskatchewan, the Office of Energy Conservation's mandate is to encourage and support voluntary action by the public and by industry through public information, energy efficiency demonstrations, and the development of pilot projects. The Ontario Power Authority recently established the Conservation Bureau with a mandate to provide leadership in planning and coordinating measures for electricity conservation and load management. The Energy Efficiency and Conservation Agency of New Brunswick was created in late 2005 to influence efficient energy use, help control energy expenses and lessen the impact of energy use on the environment. The Canada-Yukon Energy Solutions Centre is a service and program delivery agency for federal and Yukon government programs on energy efficiency and green power. The Arctic Energy Alliance promotes energy efficiency and renewable energy in the Northwest Territories. The Nunavut Energy Centre promotes energy efficiency and renewable energy in Nunavut.

Cooperation Agreements

NRCan's Letter of Cooperation (LOC) on EAE with the Agence de l'efficacité énergétique du Québec provides for efficient consultation and exchange of information between the two governments, coordination of EAE activities in Quebec, and 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 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 targeting the Quebec public sector
- management of an agreement relating to the Programme d'intervention en réfrigération dans les arénas du Québec, under which NRCan has provided technical support for the implementation of innovative refrigeration systems in Quebec'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 the Yukon, including the establishment of 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 provide opportunities for EAE projects. The Alliance is also the delivery agent in the Northwest Territories for R-2000. Through the contribution agreement with the Qulliq Energy Corporation, the Government of Canada contributes to the Nunavut Energy Centre, which promotes energy efficiency and renewable energy in Nunavut.

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

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 working with others on the harmonization of energy efficiency tests and performance standards to reduce barriers to trade in energy-using products

International Energy Agency (IEA)

The IEA, based in Paris, is an autonomous agency 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 Co-operation (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. The OEE represents Canada on the EEWP.

Canada's international energy research and development objectives are advanced primarily through the IEA's Working Parties and the Committee on Energy Research and Technology, chaired by NRCan. Canada is a signatory to 31 of the IEA's 40 implementing agreements for research and development (R&D) cooperation programs.

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

Canada also cooperates with research centres in member countries on several agreements and programs on 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 collaborative ventures with other governments and multilateral organizations, and with technical

support from more than 200 experts representing industry, government and academia. Key partners are the Energy Unit of the United Nations Environment Program (UNEP) and the UNEP-Global Environment Facility-sponsored Solar and Wind Energy Resource Assessment (SWERA) project. Other key international partners include NASA's Langley Research Center and the World Bank's Prototype Carbon Fund.

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 an 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 and investment as well as technical and other exchanges related to energy-efficient products, energy management services and alternative energy goods and services.

Under the MOU on EAE, officials of Mexico's National Commission for Energy Savings (CONAE) participated in an industrial energy efficiency conference held in May 2005 in Ottawa. Also under the MOU, NRCan organized an energy efficiency workshop in cooperation with CONAE in Puebla City, Mexico. The workshop was held in March 2006.

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 has been cooperating with the U.S. DOE under an MOU on energy R&D in the areas of fuel cells, fossil fuels, bioenergy, community systems and microgeneration, nuclear fission, and carbon sequestration.

United States and Mexico

NRCan continues to participate with the United States and Mexico in the Energy Efficiency Experts Group of the North American Energy Working Group (NAEWG) to promote the harmonization of energy efficiency test methods, mutual recognition of conformity assessment systems for energy efficiency standards, and cooperation on trilateral energy efficiency labelling programs. In 2005–2006, work under NAEWG primarily involved coordinating the energy sector commitment to the Security and Prosperity Initiative. In addition to ongoing standards and program collaboration, a project has been implemented to develop a North American approach to standby loss by electricity-using products.

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, NRCan's CANMET Energy Technology Centre (CETC) was given the lead role within the NAEWG Science and Technology Experts Group for a sustainable housing project in Mexico known as La Casa Nueva / La Comunidad Nueva (LCN).

A Canada-Mexico Partnership (CMP) was established in October 2004. The CMP is designed to be a high-level public-private sector alliance 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:

- 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. Mexico identified a number of activities related to housing technology, energy efficiency, renewable energy and sustainable communities as areas of interest. As a result of CETC's previous and ongoing technology cooperation activities in Mexico under the NAEWG-LCN initiative, CMHC invited the centre to help develop the terms of reference for housing technology activities under the CMP and asked for its involvement and technical input in furthering specific activities of the CMP housing technology working group.

At the same time, 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. NRCan's CETC has been invited to assist and manage the implementation of the sustainable housing components of the Sustainable Cities Initiative, leveraging and providing a bridge between the CMP housing technology working group and the NAEWG-LCN.

Appendix 1: NRCan's Efficiency and Alternative Energy Initiatives and Expenditures, 2005–2006

	(millions of dollars)
Energy Efficiency – Equipment	**$16.5**
Energy Efficiency Standards and Regulations	
Equipment Labelling and Promotion	
EnerGuide for Industry	
Mine Ventilation	
Energy Efficiency – Housing and Buildings[1]	**$107.4**
R-2000 Standard and EnerGuide for (New) Houses	
Housing Energy Technology Program	
Super E™ House Program	
EnerGuide for Houses and Retrofit Incentives	
Commercial Building Incentive Program	
Industrial Building Incentive Program	
Green Buildings Program	
EnerGuide for Existing Buildings	
Refrigeration Action Program for Buildings	
Buildings Program – Intelligent Buildings	
Building Energy Simulation Program	
Distributed Energy Program	
Integrated Energy Systems Laboratory	
Communities and Neighbourhoods Program	
Federal Buildings Initiative	
Energy Technology Applications Group	
Energy Efficiency – Industry	**$34.3**
Industrial Energy Efficiency (Canadian Industry Program for Energy Conservation; Industrial Energy Innovators)	
Clean Electric 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	**$21.5**
Vehicle Efficiency	
EnerGuide for Vehicles	
Personal Vehicles	
Fleet Vehicles	
Canadian Lightweight Materials Research Initiative	
Federal Fleet Initiative	
Alternative Energy – Transportation	**$49.8**
Fuel-Cell-Powered Mining Vehicles	
Ethanol Expansion Program	
Future Fuels Initiative	
Biodiesel Initiative	
Canadian Transportation Fuel Cell Alliance	
Hydrogen, Fuel Cells and Transportation Energy Program	
Alternative Energy – Renewable Energy Sources	**$43.3**
Wind Power Production Incentive	
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	
Market Incentive Program	
Canadian Biomass Innovation Network	
General Programs[2]	**$16.4**
Outreach	
RETScreen® International Clean Energy Decision Support Centre	
National Energy Use Database	
Total	**$289.2**

[1] In addition to the resources cited here, $150 million was provided to the Green Municipal Fund that is managed by the Federation of Canadian Municipalities.

[2] 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 A of Natural Resources Canada's *Energy Use Data Handbook, 1990 and 1997 to 2004*.

FIGURE 1-1: Energy Intensity and the Energy Efficiency Effect, 1990 to 2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Energy 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	0.83
Index of energy efficiency effect	1.00	0.99	0.98	0.95	0.94	0.92	0.93	0.91	0.89	0.88	0.88	0.87	0.87	0.88	0.86

FIGURE 1-2: Secondary Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Estimated energy use without energy efficiency improvements	1.00	0.99	1.02	1.06	1.11	1.15	1.18	1.20	1.19	1.24	1.28	1.26	1.31	1.33	1.36
Actual energy use	1.00	0.98	1.00	1.01	1.05	1.07	1.11	1.11	1.09	1.12	1.16	1.14	1.18	1.21	1.23

FIGURE 1-3: Electricity Production From Non-Hydro Renewable Sources, 1991 to 2003

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
GWh	3649	4134	4477	5362	5422	5855	6419	6599	7372	7418	7512	10 430	11 030

FIGURE 2-1: Volume of Monthly Import Documents

	Paper	Electronic
Apr-05	6 745	36 064
May-05	5 207	39 447
Jun-05	5 221	44 106
Jul-05	4 845	41 303
Aug-05	4 731	46 648
Sep-05	3 778	45 142
Oct-05	4 296	46 773
Nov-05	5 175	43 475
Dec-05	5 121	40 821
Jan-06	5 378	40 034
Feb-06	5 742	38 653
Mar-06	7 574	43 829
Total	**63 813**	**506 295**

FIGURE 2-4: ENERGY STAR Qualified Appliances as a Percentage of Total Category Sales in Canada, 1999 to 2004

Appliance	1999	2000	2001	2002	2003	2004
Dishwashers	0.56	1.57	9.66	29.77	56.50	80.95
Refrigerators	–	–	11.40	22.26	40.68	34.16
Washers	1.93	2.24	9.24	22.07	30.55	36.16

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

	Percent
Aware – non-aided	36
Aware – aided	80

FIGURE 3-1: Canadian Households by Type of Dwelling, 2004

	Number of households	Percentage
Single detached	7 030 118	57
Apartments	3 823 562	31
Single attached	1 270 266	10
Mobile homes	250 684	2
Total	**12 374 630**	**100**

FIGURE 3-2: Residential Energy Use by Purpose, 2004

	Energy use (petajoules)	Percentage
Space heating	811.1	57
Water heating	347.7	24
Appliances	185.5	13
Lighting	63.8	5
Space cooling	12.7	1
Total	**1420.8**	**100**

FIGURE 3-3: Residential Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Estimated energy use without energy efficiency improvements	1.00	1.04	1.10	1.14	1.14	1.17	1.22	1.21	1.13	1.17	1.24	1.21	1.27	1.31	1.31
Actual energy use	1.00	0.98	1.01	1.04	1.07	1.05	1.13	1.08	0.98	1.03	1.08	1.04	1.08	1.12	1.10

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

Description	Annual heating consumption (GJ)
Typical existing house (1970)	216.812
Typical new house (2002)	146.274
Model National Energy Code house (2002)	112.101
R-2000 house	78.747

FIGURE 3-5: Average Energy Consumption per Household, Pre-1946 to 2001–2006 Construction

Year built	Average energy consumption (GJ)	EGH rating
Pre-1946	296	44
1946–1960	222	56
1961–1970	210	60
1971–1980	199	62
1981–1990	191	65
1991–2000	170	69
2001–2006	159	72
All EGH in Canada	220	58
R-2000	100	82

FIGURE 3-6: Average Energy Consumption* of New Appliances, 1990 and 2004 Models

	1990	2004
Clothes washers	1218	573
Clothes dryers	1103	912
Dishwashers	1026	457
Refrigerators	956	478
Electric ranges	772	653
Freezers	714	373

*kWh/yr.

FIGURE 3-7: Number of Eligible R-2000 Housing Starts, 1990 to 2005

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Number of eligible R-2000 housing starts	495	699	1196	1299	784	610	416	484	265	213	319	329	428	379	582	478

FIGURE 3-8: National Trends in Air Leakage in Houses, Pre-1945 to 2000–2006 Construction

Year built	Average air change at 50 Pa: 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	4	0.9
1990–1999	4	4	1.1
2000–2006	4	3	1.1
Average	7	6	1.1

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

Fiscal year of EGH evaluation	1998	1999	2000	2001	2002	2003	2004	2005
House evaluated but not re-evaluated (A evaluation)	3672	9106	11 509	11 087	16 561	48 250	58 742	79 380
Houses retrofitted and re-evaluated (B evaluation)	832	225	607	709	1 144	2 718	18 076	31 878

FIGURE 3-10: Residential Energy Use and Energy Savings per Household, Pre-1945 to 2000–2006

	Pre-1945	1945–1959	1960–1969	1970–1979	1980–1989	1990–1999	2000–2006	Average
Energy use pre-evaluation (GJ)	301	229	219	209	203	188	170	230
Evaluation-identified energy savings (GJ)	139	96	88	79	66	53	41	92
Actual energy savings after renovations (GJ)	99	66	59	54	48	47	44	64

FIGURE 4-1: Commercial/Institutional Energy Use by Activity Type, 2004

	Energy use (petajoules)	Percentage
Offices	383.6	33
Educational services	183.5	16
Health care and social assistance	151.7	13
Retail trade	142.1	12
Accommodation and food services	89.5	8
Wholesale trade	53.8	5
Transportation and warehousing	52.0	4
Information and cultural industries	42.8	4
Arts, entertainment and recreation	38.5	3
Other services	25.7	2
Total	**1163.2**	**100**

FIGURE 4-2: Commercial/Institutional Energy Use by Purpose, 2004

End use	Energy use (petajoules)	Percentage
Space heating	614.18	53
Auxiliary equipment	165.39	14
Lighting	114.99	10
Water heating	102.71	9
Auxiliary motors	97.26	8
Space cooling	68.76	6
Total	**1163.28**	**100**

FIGURE 4-3: Commercial/Institutional Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Estimated energy use without energy efficiency improvements	1.00	1.05	1.08	1.13	1.13	1.16	1.19	1.19	1.15	1.21	1.25	1.25	1.33	1.35	1.35
Actual energy use	1.00	1.03	1.04	1.08	1.07	1.11	1.13	1.15	1.09	1.13	1.24	1.22	1.31	1.35	1.35

FIGURE 4-4: Energy Use in Commercial Buildings, 2005

	Gigajoules per m^2 per year
CBIP results (1998–2005)	1.05
Model National Energy Code for Buildings (MNECB)	1.61
All commercial buildings (CICES)	1.48

FIGURE 4-5: Estimated Average Energy Savings by Type of Building Under the Commercial Building Incentive Program, 2005

Building type	Average energy savings (GJ/year)
Health care	5098
Retail	4712
Multi-unit residential building	3904
Education	3734
Retail food sector	3640
Other	3621
Industrial	3101
Office	2333

FIGURE 5-1: Industrial Energy Use by Sub-Sector – Including Electricity Related Emissions, 2004

	Percent of industrial energy use (%)
Pulp and paper	26.7
Mining	19.4
Other manufacturing	17.7
Petroleum refining	10.4
Smelting and refining	7.6
Iron and steel	7.6
Chemicals	6.2
Cement	2.0
Construction	1.8
Forestry	0.7
Total	**100.0**

FIGURE 5-2: Cost of Energy to Manufacturing Industries as a Percentage of Total Production Cost, 2004

Industry	Energy cost / total production cost (%)
Cement	38.70
Aluminum	17.13
Pulp and paper	14.27
Iron and steel	13.06
Chemicals	11.48
Petroleum refining	2.36
Transportation equipment and manufacturing	0.84

FIGURE 5-3: Industrial Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2004

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Estimated energy use without energy efficiency improvements	1.00	1.14	1.15	1.18	1.17	1.24	1.29	1.24	1.28	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	1.20	1.21

FIGURE 5-4: CIPEC Energy Intensity Index, 1990 to 2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
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	0.92	0.91	0.93	0.91

FIGURE 5-5: Estimated CIPEC Energy Savings, 2001 to 2005

Energy savings	2001	2002	2003	2004	2005
Program total (petajoules)	2.33	5.01	8.34	12.06	13.52

FIGURE 5-6: Industrial Dollars to $ense Participants, 1997 to 2005

	1997	1998	1999	2000	2001	2002	2003	2004	2005
Number of industrial workshop participants	98	132	167	260	410	421	490	1001	1051

FIGURE 6-1: Transportation Energy Use by Mode, 2004

	Energy use (petajoules)	Percentage
Passenger light vehicle	1046.6	42.5
Freight truck	833.5	33.8
Passenger aviation	234.1	9.5
Freight marine	114.2	4.6
Off-road	95.7	3.9
Freight rail	72.5	2.9
Passenger bus	51.0	2.1
Freight aviation	15.0	0.6
Passenger rail	2.6	0.1
Total	**2465.1**	**100.0**

FIGURE 6-2: Transportation Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Estimated energy use without energy efficiency improvements	1.00	0.98	1.01	1.06	1.13	1.16	1.18	1.23	1.27	1.32	1.34	1.34	1.39	1.42	1.48
Actual energy use	1.00	0.96	0.99	1.00	1.05	1.07	1.09	1.13	1.17	1.20	1.22	1.21	1.23	1.26	1.31

FIGURE 6-3: Market Shares of New Passenger Car and Light Truck Sales, 1990 to 2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Passenger car market share (%)	74.7	75.2	72.7	69.7	67.2	65.1	62.8	59.8	59.1	60.9	63.0	63.4	62.7	62.2	61.7
Passenger light truck market share (%)	25.3	24.8	27.3	30.3	32.8	34.9	37.2	40.2	40.9	39.1	37.0	36.6	37.3	37.8	38.3

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: Average Activity per Truck (tonne kilometres/truck), 1990 to 2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Medium- and heavy-duty truck vehicle activity	106 043	98 293	101 971	114 639	133 970	143 129	141 053	163 972	162 918	174 813	178 340	197 788	198 401	201 338	212 776

FIGURE 6-6: Trucking Energy Intensity, 1990 to 2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Medium- and heavy-duty truck energy intensity	3.94	4.07	4.04	3.84	3.57	3.61	3.51	3.45	3.30	3.10	3.13	2.92	2.93	3.01	2.99

FIGURE 6-7: Company Average Fuel Consumption (CAFC) vs. Canadian Voluntary Standards, 1990 to 2005

Model year	Truck standard (11.4 L/100 km)	Trucks CAFC	Car standard (8.6 L/100 km)	Cars CAFC
1990	11.8	11.4	8.6	8.2
1991	11.6	11.1	8.6	8.0
1992	11.6	11.3	8.6	8.1
1993	11.5	11.1	8.6	8.1
1994	11.5	11.5	8.6	8.2
1995	11.4	11.5	8.6	7.9
1996	11.4	11.3	8.6	7.9
1997	11.4	11.3	8.6	8.0
1998	11.4	11.3	8.6	7.9
1999	11.4	11.3	8.6	7.9
2000	11.4	11.1	8.6	7.8
2001	11.4	11.0	8.6	7.8
2002	11.4	11.0	8.6	7.7
2003	11.4	10.7	8.6	7.6
2004	11.4	10.7	8.6	7.5
2005	11.4	10.3	8.6	7.5

FIGURE 6-8: Vehicle Fuel Efficiency – EnerGuide Labelling

	Percentage of New Vehicles with EnerGuide Label Affixed	
	New vehicles on lot with EnerGuide label	New vehicles in showroom with EnerGuide label
1999	64	47
2001	77	56
2005	78	61

FIGURE 6-9: Vehicle Fuel Efficiency Awareness – Program Activities

	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 6-10: Number of Idling Reduction Devices Purchased and Claimed Under Commercial Transportation Energy Efficiency Rebate (CTEER) Initiative

	2004–2005	2005–2006
Auxiliary Power Units (APUs)	1342	5376
Heaters	9323	1202

FIGURE 6-11: Participation in the Fleet Vehicles Initiative, 1998 to 2005

	Members
1998	946
1999	1068
2000	1643
2001	2707
2002	2805
2003	3267
2004	3625
2005	4733

FIGURE 6-12: Drivers Trained, 1998 to 2004

	Number of new drivers
1998	51 000
1999	53 000
2000	112 846
2001	125 000
2002	149 000
2003	160 000
2004	200 000

FIGURE 7-1: Canadian Wind Power Capacity, 1990 to 2005

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Wind power capacity (MW)	0	0	0	19	19	20	20	21	24	124	137	214	230	327	444	683

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

Fiscal year	Emissions (kt of CO_2e)
1990	3895
1998	3140
2000	3012
2001	2895
2002	2957
2003	2829
Target 2010	2703

FIGURE 8-2: Annual Energy Savings From Energy Technology Applications Group, 1991 to 2005

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Annual (cumulative)	20	70	110	180	270	350	427	504	597	700	812	929	1039	1149	1263

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

	1995	1997	1998	1999	2000	2001	2002	2003	2004
Vehicles	24 944	22 873	22 505	22 558	22 611	24 463	26 233	24 981	25 666
Litres of gasoline equivalent (thousands)	76 800	64 200	63 100	63 100	61 900	66 900	68 619	62 500	65 000

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

Fiscal year	1997	1998	1999	2000	2001	2002	2003	2004
Vehicles purchased	131	161	181	83	170	521	365	529

Natural Resources Canada's Office of Energy Efficiency

Leading Canadians to Energy Efficiency at Home, at Work and on the Road

Improving Energy Performance in Canada – Report to Parliament Under the *Energy Efficiency Act* 2005–2006

Canada