Energy Efficiency Trends in Canada

1990 to 2004

August 2006

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Canada

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Preface

This is the eleventh edition of *Energy Efficiency Trends in Canada*, which delivers on Canada's commitment to track trends in energy efficiency, energy use and related greenhouse gas (GHG) emissions. Improving energy efficiency reduces GHG emissions that contribute to climate change. For a statistical overview of Canada's sectoral energy markets, readers are referred to this report's companion document, *Energy Use Data Handbook, 1990 and 1998 to 2004*.

Energy Efficiency Trends in Canada, 1990 to 2004 covers the five sectors analyzed by Natural Resources Canada's Office of Energy Efficiency (OEE), i.e. the residential, commercial/institutional, industrial, transportation and electricity generation sectors.

A comprehensive database, including most of the historical energy use and GHG emissions data used by the OEE for its analysis, is available from the following Web site: *oee.nrcan.gc.ca/tables06*.

The CD – *Beyond Energy Efficiency: Data and Analysis* – contains electronic versions of this report, the *Energy Use Data Handbook* and the detailed data tables for Canada from the comprehensive database. It is available upon request.

If you require more information on this product or the services that the OEE offers, contact us by e-mail at *euc.cec@nrcan.gc.ca*.

This report was prepared by Naima Behidj, Johanne Bernier, Samuel Blais, Dominic Demers, Alexandre Drzymala, Sébastien Genest, Carolyn Ramsum and Katherine Sassi, who are staff of the Demand Policy and Analysis Division of the OEE, which is part of Natural Resources Canada. The project leader was Carolyn Ramsum, with Jean-François Bilodeau and Tim McIntosh providing overall direction.

For more information, contact

Jean-François Bilodeau
Chief, Market Analysis
Office of Energy Efficiency
Natural Resources Canada
580 Booth Street, 18th Floor
Ottawa ON K1A 0E4

E-mail: euc.cec@nrcan.gc.ca

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Chapter 1

Introduction

From 1990 to 2004, Canada's energy efficiency improved by an estimated 14 percent. In 2004 alone, these improvements reduced energy use by 902.7 petajoules, saving Canadians almost $14.5 billion and lowering greenhouse gas emissions by 53.6 megatonnes.

About Energy Use, Energy Efficiency and Greenhouse Gas Emissions

Determining the impact of energy efficiency improvements on energy consumption levels for a vehicle, piece of equipment or appliance is straightforward; it can easily be tested and measured. However, determining how these individual improvements integrate and affect energy consumption and resulting greenhouse gas (GHG) emissions is more complex.

This report addresses the complicated question of what impact energy efficiency is having in Canada. It provides an analysis of the impact of energy efficiency on secondary energy use – the energy that Canadians use to heat and cool their homes and workplaces and to operate their appliances, vehicles and factories – and on the generation of electricity.

A New Factorization Methodology for *Energy Efficiency Trends in Canada*

The analysis in this report is based on a factorization or decomposition technique. Since 1999, the Office of Energy Efficiency (OEE) has used a refined Laspeyres index methodology for this work. Though analytically sound, this technique produces residual terms that have become more and more problematic as the analysis period (beginning with the 1990 reference year) gets longer. This year, acting on the recommendations of a consultancy report, the OEE has adopted the residual-free Log-Mean Divisia Index I (LMDI I) methodology for its factorization analysis. The LMDI I method produces similar results to the refined Laspeyres technique, but eliminates the complication of allocating residual terms. For more information on this new technique and to see a comparison of results from LMDI I with the previously used refined Laspeyres method, please consult the "Factorization Methodology" section of the CD *Beyond Energy Efficiency: Data and Analysis*.

CHAPTER 1

Introduction

The analysis presented in this report uses a factorization method that separates the changes in the amount of energy used by the residential, commercial/institutional, industrial, transportation and electricity generation sectors of the economy into five factors. These factors are

1. **Activity:** Activity is defined differently in each sector. For instance, in the residential sector, it is defined as households and the floor space of residences; in the industrial sector, it is defined as a mix of industrial gross domestic product, gross output and industrial output such as tonnes of steel; and in the electricity generation sector, it is defined as gigawatt-hours produced.

2. **Structure:** Structure refers to change in the makeup of each sector. For example, in the industrial sector, a relative increase in activity in one industry over another is considered a structural change; in the electricity generation sector, a relative increase in production from one fuel process over another is considered a structural change.

3. **Weather:** Fluctuations in weather lead to changes in heating and cooling requirements. This effect is taken into account in the residential and commercial/institutional sectors, where heating and cooling account for a significant share of energy use.

4. **Service Level:** The increased penetration of auxiliary equipment in commercial/institutional buildings during the 1990s increased energy consumption for this end-use. Since we have only limited data on stocks, sales and unit energy consumption levels related to this equipment, an index has been estimated to capture the impact of these changes over time. This effect is measured only in the commercial/institutional sector.

5. **Energy Efficiency:** Energy efficiency refers to how effectively energy is being used, for example, for how long an appliance can be operated with a given amount of energy. For the electricity generation sector, it represents the conversion losses.

In this analysis, one complexity that arises is how to treat the secondary use of electricity that, unlike other fuels used at the end-use level, does not produce any GHG emissions. Thus it is common (but not universal) practice to allocate GHG emissions associated with electricity production to the sector that uses that electricity. This is achieved by multiplying the amount of electricity used by a national average emissions factor that reflects the average mix of fuels used to generate electricity in Canada. The sectors in this report are analyzed with and without this allocation.

Introduction

Total Canadian GHG emissions are estimated to have been 758.0 megatonnes[1] (Mt) in 2004; of this, 67 percent, or 505.4 Mt, resulted from secondary energy use (including electricity-related GHG emissions). GHG emissions resulting from secondary energy use are influenced by two principal factors: the amount of energy used and the GHG intensity of the energy used (the quantity of GHGs emitted per unit of energy). The sector-by-sector analysis in this report elaborates on these two principal factors and their impact on GHG emissions trends.

Chapter 2 provides an analysis of total secondary end-use energy efficiency, energy use and related GHG emissions trends. Chapters 3 to 7 describe the results of the sector-by-sector analysis of energy efficiency and GHG emissions. The appendix provides a glossary of terms.

Differences From Previous Reports

This report is the eleventh annual review of trends in energy use, energy efficiency and GHG emissions in Canada, using 1990 as the baseline year. It updates last year's *Energy Efficiency Trends in Canada, 1990 to 2003* and delivers on Canada's commitment to track trends in energy efficiency, energy use and related GHG emissions. In addition to the change in the factorization methodology (see the text box at beginning of this chapter), *Energy Efficiency Trends in Canada, 1990 to 2004* differs from previous reports in four key ways.

The first difference is in the commercial/institutional sector. This year, the OEE redesigned the commercial/institutional modelling framework to improve how energy is allocated among different activity types and to various end-uses in the commercial/institutional sector. As well, in the 2003 database, floor space data were redeveloped to be consistent with the North American Industry Classification System (NAICS). In this process, some floor space data were attributed to the industrial sector and therefore excluded from the 2003 database. This year, these floor space data were re-assessed and allocated to certain commercial/institutional activity types. Please see "Chapter 4. Commercial/Institutional Sector" for more information.

The second difference is in the industrial sector. This year, our data provider, Informetrica Limited, made significant revisions to our historical activity data, in particular to gross output (GO) data. Since more than half of the 49 industries analyzed in this report use GO as an activity driver, these changes have affected the factorization analysis in this sector. Please see "Chapter 5. Industrial Sector" for additional information.

1. **Environment Canada is responsible for Canada's official GHG inventory.**

The third difference is in the transportation sector where the OEE revised its estimate of historical truck stocks prior to 1994. In the passenger and freight transportation sub-sectors, the light truck stock was revised downward; whereas in freight transportation, the number of medium and heavy trucks was increased. These changes affected the allocation of energy use between the passenger and freight sub-sectors, as well as the activity data in the 1990 reference year. As a result, the factorization results presented for both sub-sectors, particularly passenger transportation, are different from previous reports. Please see "Chapter 6. Transportation Sector" for additional information.

The fourth difference is in the coverage of the report. Due to inadequate detail in energy and activity data, the agriculture sector will no longer be examined in this report. However, since agriculture is still a part of total secondary energy use, tables containing aggregate energy, GHG and gross domestic product (GDP) data for this sector will continue to be available from the comprehensive database on the OEE Web site: *oee.nrcan.gc.ca/tables06*.

In this document, due to rounding, the numbers in the figures may not add up to the reported totals.

Chapter 2

Total End-Use
SECTOR

Definition: The total end-use sector refers to an aggregation of the following five end-use sectors: residential, commercial/institutional, industrial, transportation and agriculture.

Between 1990 and 2004, secondary energy use – the energy that Canadians use to heat and cool their homes and workplaces and to operate their appliances, vehicles and factories – increased by 23 percent, from 6950.8 to 8543.3 petajoules (PJ). As a result, secondary energy-related GHGs (including GHGs related to electricity) increased 24 percent, from 407.8 to 505.4 Mt.

As Figure 2.1 indicates, if there had not been significant ongoing improvements in energy efficiency in all end-use sectors, secondary energy use would have increased by 36 percent between 1990 and 2004, instead of the observed 23 percent. These energy savings of 902.7 PJ are roughly equivalent to removing 13 million cars and passenger light trucks from the road.

> One petajoule is the amount of energy consumed by a small town of about 3700 people in a year for all uses, from housing and transportation to local services and industry.

Figure 2.1 Secondary Energy Use, With and Without Energy Efficiency Improvements, 1990–2004 (index 1990 = 1.0)

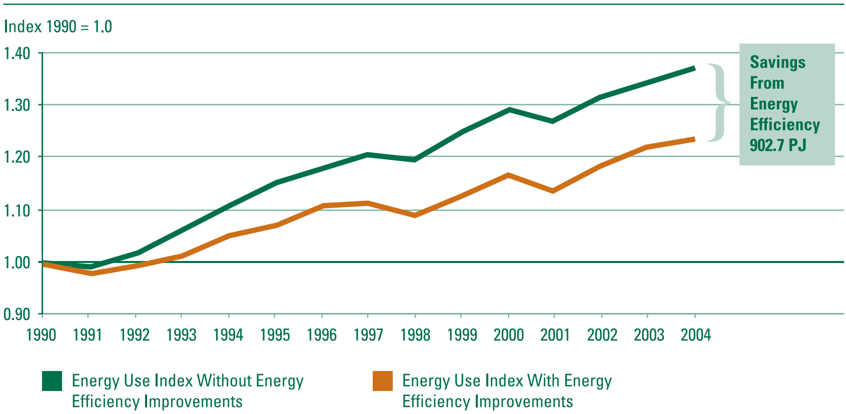
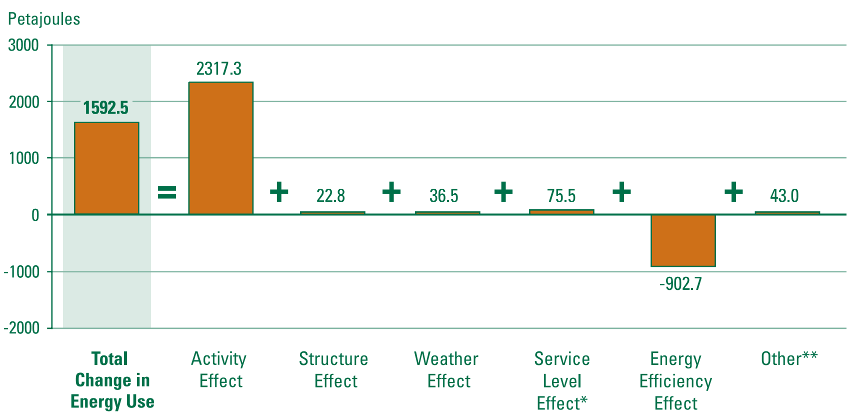


Figure 2.2 indicates that the following influenced the change in energy use and related GHGs between 1990 and 2004:

- a 35 percent increase in activity (comprising commercial/institutional and residential floor space, number of households, passenger- and tonne-kilometres, industrial GDP, GO and physical production) resulted in a 2317.3 PJ increase in energy and a corresponding 135.5 Mt increase in GHG emissions;
- changes in the structure of most sectors in the economy increased energy use; however, these increases were mostly offset by a shift in the industrial sector towards industries that are less energy intensive – the net result was an increase of 22.8 PJ and a corresponding 5.4 Mt increase in GHG emissions;
- in 2004, the winter was 3 percent colder than in 1990, but the summer was 11 percent cooler; the net result was a 36.5 PJ increase in secondary energy demand and a 2.0 Mt increase in GHG emissions;
- changes in auxiliary equipment service level (e.g. increased use of computers, printers and photocopiers in the commercial/institutional sector) raised energy use by 75.5 PJ and increased related GHG emissions by 4.4 Mt; and
- improvements in energy efficiency saved 902.7 PJ of energy and 53.6 Mt of GHG emissions.

Figure 2.2 Impact of Activity, Structure, Weather, Service Level and Energy Efficiency on the Change in Energy Use, 1990–2004 (petajoules)

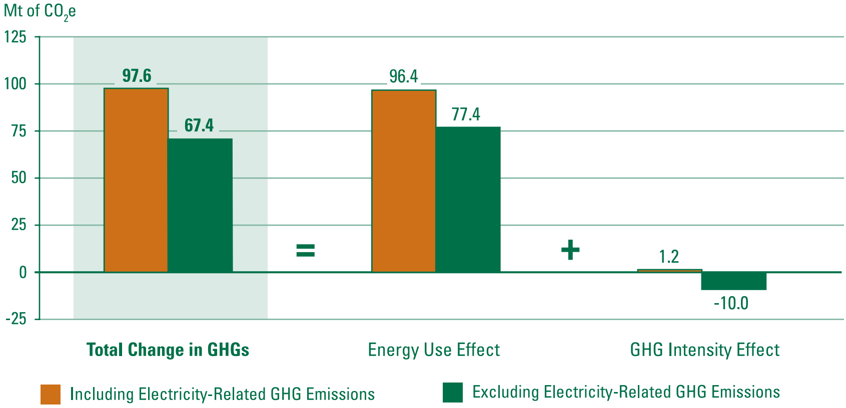


* "Service Level Effect" refers to the service level of auxiliary equipment in the commercial/institutional sector.

** "Other" refers to street lighting, non-commercial airline aviation, off-road transportation and agriculture, which are included in the "Total Change in Energy Use," but are excluded from the factorization analysis.

Overall, when GHGs related to electricity production are included, increased secondary energy use resulted in increased GHG emissions. The GHG intensity of the energy changed little over the period as fuel switching towards less GHG-intensive fuels offset a higher GHG intensity in electricity production. As Figure 2.3 shows, GHG emissions from secondary energy use were 24 percent, or 97.6 Mt, higher in 2004 than in 1990.

Figure 2.3 Impact of Energy Use and GHG Intensity on the Change in GHG Emissions, Including and Excluding Electricity-Related GHG Emissions, 1990–2004 (megatonnes of CO_2 equivalent)



The emissions of one tonne of carbon dioxide (CO_2) would fill the volume of approximately two average-sized houses in Canada – meaning that one megatonne would fill about 2 million average-sized houses.

When electricity-related GHG emissions are excluded, GHG emissions from secondary energy rose by 21 percent, or 67.4 Mt (Figure 2.3). Increases in GHGs due to additional energy use were offset by a 2 percent decrease in the GHG intensity of energy consumed. This was the result of a relative increase in the consumption of biomass and declines in the use of heavy fuel oil, coke and coke oven gas.

Figures 2.4, 2.5 and 2.6 show total energy use and GHG emissions in 1990 and 2004 for all end-use sectors of the economy. The observed increases in energy use and GHGs are to be expected, given the substantial growth of activity (GDP, floor space, etc.) in the various sectors.

Figure 2.4 Energy Use by Sector, 1990 and 2004 (petajoules)

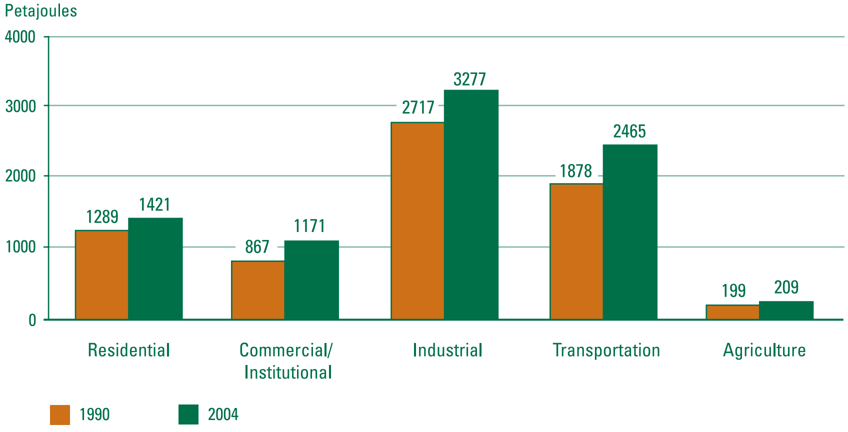


Figure 2.5 GHG Emissions, Including Electricity-Related Emissions, by Sector, 1990 and 2004 (megatonnes of CO_2 equivalent)

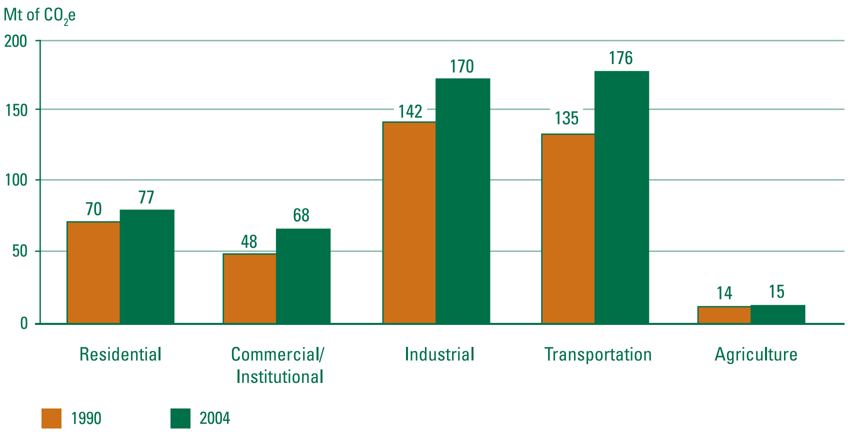
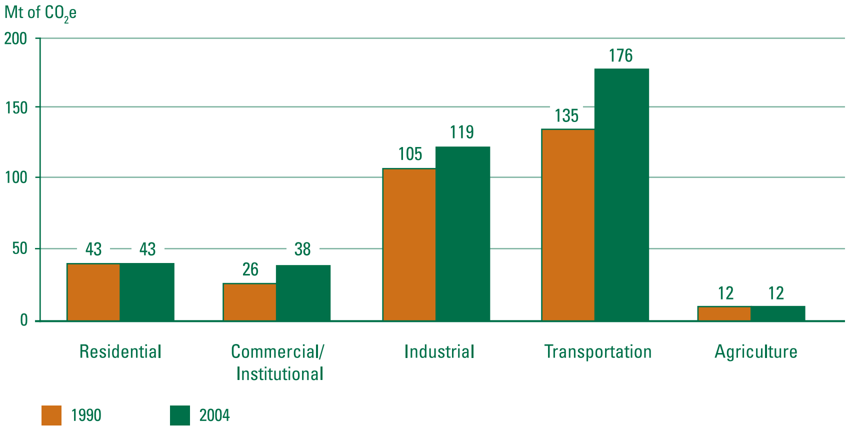


Figure 2.6 GHG Emissions, Excluding Electricity-Related Emissions, by Sector, 1990 and 2004 (megatonnes of CO_2 equivalent)



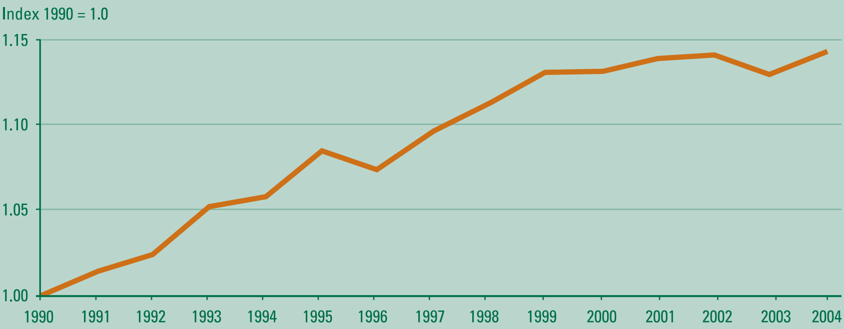
The following chapters describe how changes in activity, structure, weather, service level and energy efficiency influenced changes in energy use, as well as how energy use and the GHG intensity of fuels affected changes in energy-related GHG emissions for the residential, commercial/institutional, industrial, transportation and electricity generation sectors.

The OEE Energy Efficiency Index

In this report, the impact of energy efficiency on energy consumption is estimated for the residential, commercial/institutional, industrial[1] and transportation sectors over the 1990–2004 period. These variations in energy efficiency are aggregated into a single index of energy efficiency for Canada, which is called the OEE Energy Efficiency Index.

Over the 1990–2004 period, the index presented in Figure 2.7 trended upward, growing by about 1 percent per year. As a result, energy efficiency improved by 14 percent over the period. This translates into energy savings of 902.7 PJ and GHG savings of 53.6 Mt in 2004. A small dip in the index in 2003 is mainly due to the industrial sector, where energy efficiency improvements were checked by increases in energy intensity in some industries and lower levels of capacity utilization in manufacturing.

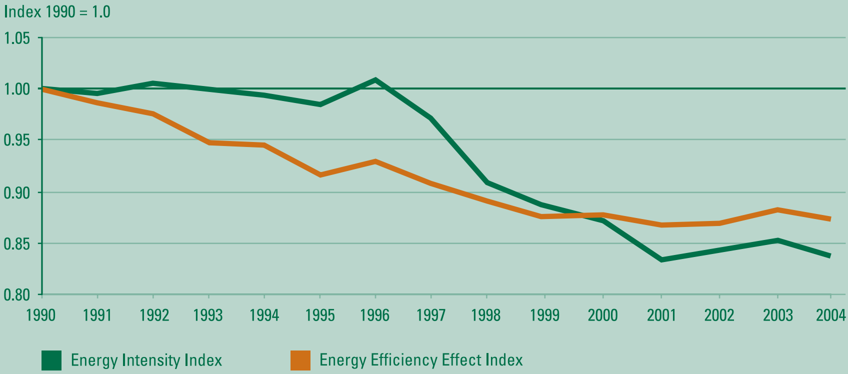
Figure 2.7 The OEE Energy Efficiency Index 1990–2004 (index 1990 = 1.0)



1. In the industrial sector, NAICS-based data for some industries are not available from Statistics Canada between 1991 and 1994. To calculate an energy efficiency estimate for these years, where detailed industry data were not available, in its place, we took known aggregated energy and GO data for that particular grouping (e.g. pulp and paper, chemicals and other manufacturing) as well as the detailed industries where data for this period were available, and then applied the same LMDI I factorization approach used to calculate the energy efficiency effect for the 49 detailed industries over the 1990, 1995 to 2004 period. The result was a reasonable proxy of the energy efficiency effect in the industrial sector during the 1991 to 1994 period.

The OEE Energy Efficiency Index provides a better estimate of changes in energy efficiency than the commonly used ratio of energy use per unit of GDP, or energy intensity. This ratio captures not only changes in energy efficiency, but also other factors such as weather variations and changes in the structure of the economy. Figure 2.8 shows these two measures in index form. The Energy Efficiency Effect Index in Figure 2.8 is the mirror image of the OEE Index presented in Figure 2.7; the line was transposed so it can be more easily compared to the Energy Intensity Index.

Figure 2.8 Changes in Energy Intensity and the Energy Efficiency Effect, 1990–2004 (index 1990 = 1.0)



As illustrated in Figure 2.8, intensity underestimates the efficiency effect in Canada in the early 1990s and overestimates its impact in the latter part of the period. Before 1998, intensity improvements appear to be modest because colder weather (1992–1997) and a shift towards more energy intensive industries (1990–1996) masked energy efficiency progress. In 2000, the intensity index dipped below the index for the energy efficiency effect. A switch to less energy intensive industries, which began in the mid-1990s, combined with energy efficiency improvements accelerated the observed decline in energy intensity.

Residential

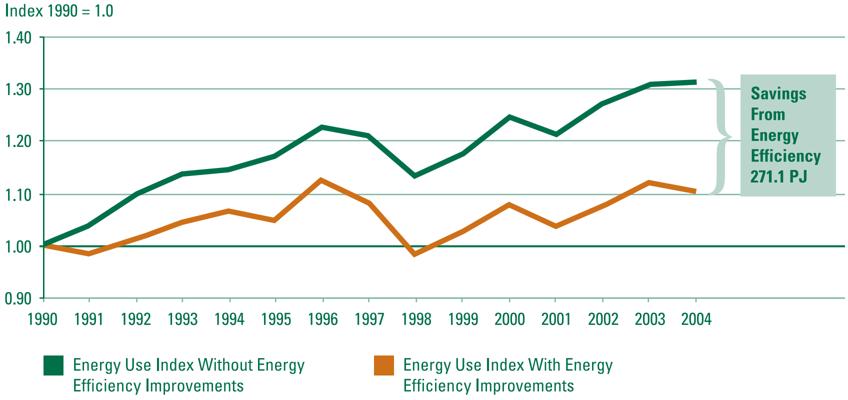
SECTOR

Chapter 3

Definition: The residential sector in Canada includes four major types of dwellings: single detached homes, single attached homes, apartments and mobile homes. Households use energy primarily for space and water heating, the operation of appliances, lighting and space cooling.

Between 1990 and 2004, residential energy use increased by 10 percent, from 1289.4 to 1420.8 PJ. As a result, residential energy-related GHGs (including those related to electricity) also increased by 10 percent, from 69.5 to 76.7 Mt. Without energy efficiency improvements, energy use would have risen by 31 percent between 1990 and 2004, instead of the observed 10 percent (Figure 3.1).

Figure 3.1 Energy Use, With and Without Energy Efficiency Improvements, 1990–2004 (index 1990 = 1.0)



Energy efficiency in the residential sector improved by 21 percent from 1990 to 2004.

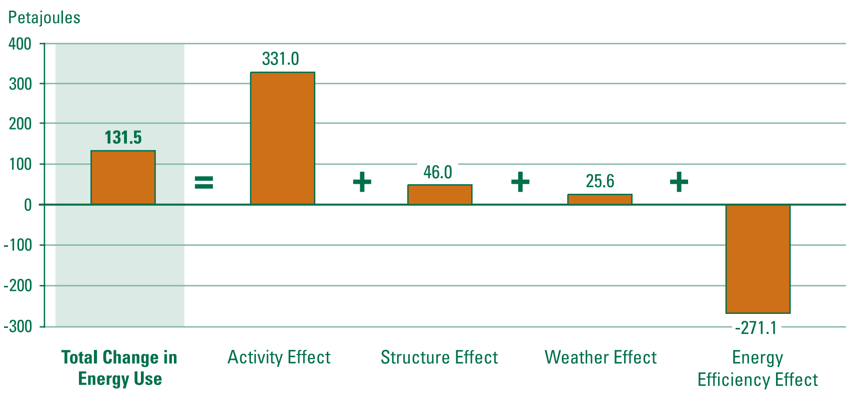
Energy efficiency savings in 2004 alone were:

- 271.1 PJ of energy
- $4.7 billion in energy costs
- 14.6 Mt of energy-related GHGs

As Figure 3.2 indicates, the following influenced the change in energy use and related GHGs between 1990 and 2004:

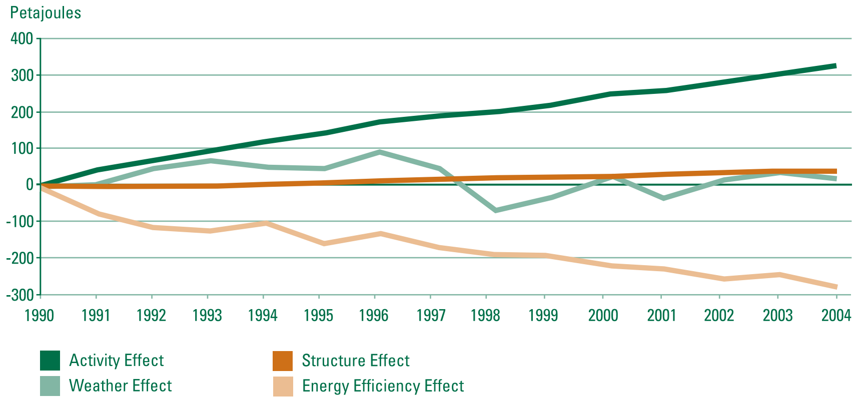
- activity, defined as a mix of households and floor space, increased by 26 percent, resulting in a 331.0 PJ increase in energy and a corresponding 17.9 Mt increase in GHG emissions. Growth in activity was driven by a 29 percent increase in floor area and by a rise of 25 percent in the number of households;
- changes in the structure (e.g. mix of end-uses); specifically, increases in the relative energy shares of water heating, lighting and space cooling resulted in the sector using an additional 46.0 PJ of energy and emitting 2.5 Mt more GHGs;
- in 2004, the winter was colder than in 1990, but the summer was cooler. The net result was that energy demand for space conditioning increased by 25.6 PJ and GHG emissions rose by 1.4 Mt; and
- improvements to the thermal envelope of houses and to the efficiency of residential appliances and space and water heating equipment led to an overall energy efficiency gain in the residential sector, saving 271.1 PJ of energy and 14.6 Mt of GHG emissions.

Figure 3.2 Impact of Activity, Structure, Weather and Energy Efficiency on the Change in Energy Use, 1990–2004 (petajoules)



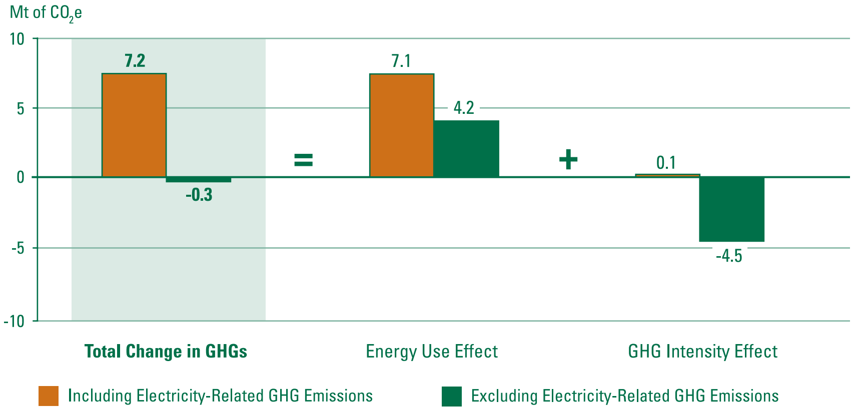
As Figure 3.3 shows, steady growth in activity and, to a lesser degree, structure (or the mix of end-uses) are the main reasons for increases in residential energy use over time. Energy efficiency improvements, however, helped to offset much of the impact of activity and structure. Weather is the only factor for which there is no discernible trend over the period.

Figure 3.3 Changes in Energy Use Due to Activity, Structure, Weather and Energy Efficiency, 1990–2004 (petajoules)



When GHGs related to electricity are included, increased energy consumption and a rise in the average GHG intensity of fuels used to generate electricity were responsible for the overall increase in GHG emissions in the sector. As Figure 3.4 shows, GHG emissions from the residential sector were 10 percent, or 7.2 Mt, higher in 2004 than they were in 1990.

Figure 3.4 Impact of Energy Use and GHG Intensity on the Change in GHG Emissions, Including and Excluding Electricity-Related GHG Emissions, 1990–2004 (megatonnes of CO_2 equivalent)



When electricity-related GHG emissions are excluded, GHGs decreased by 0.3 Mt, or almost 1 percent, between 1990 and 2004 (Figure 3.4). Fuel switching from heating oil and propane to natural gas and wood resulted in a 10 percent decrease in GHG intensity over the period. This decrease more than offset higher GHGs from increased energy use.

Commercial/ Institutional
SECTOR

Chapter 4

Definition: The commercial/institutional sector in Canada includes activities related to trade, finance, real estate, public administration, education and commercial services (including tourism). These activities have been grouped into 10 activity types based on NAICS. Although street lighting is included in total energy use for the sector, it is excluded from the factorization analysis because it is not associated with floor space activity.

Changes to the Commercial/Institutional End-Use Model (CEUM) and Floor Space Data

To continually improve our analysis, this year, the OEE has refined and improved the modelling framework (CEUM) and revised its floor space data. First, the OEE reviewed CEUM and implemented a redesign to improve how energy is allocated among different activity types and to various end-uses in the commercial/institutional sector. Second, some NAICS floor space data previously attributed to the industrial sector, and therefore excluded from the 2003 database, were re-assessed and allocated to certain commercial/institutional activity types (e.g. offices, transportation and warehousing). Given these changes, energy allocations in this year's database are different from what was presented in previous reports.

Between 1990 and 2004, energy use in the commercial/institutional sector rose by 35 percent, from 867.0 PJ to 1171.2 PJ. As a result, energy-related GHG emissions (including those related to electricity and street lighting) grew by 42 percent, from 47.8 Mt to 67.9 Mt. As shown in Figure 4.1, since about 2000, observed energy efficiency improvements in the commercial/institutional sector have been modest. See the text box, "Possible Underestimation of the Energy Efficiency Effect," for additional explanation.

Commercial/Institutional Sector

Figure 4.1 Energy Use, With and Without Energy Efficiency Improvements, 1990–2004 (index 1990 = 1.0)

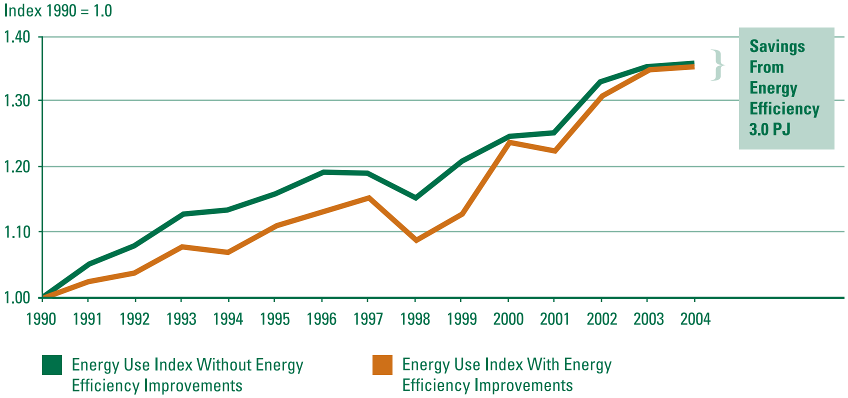
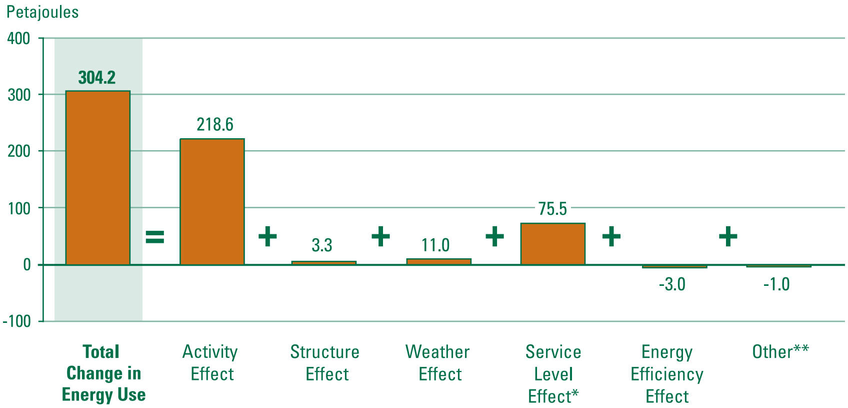


Figure 4.2 shows the various factors influencing changes in energy use and related GHG emissions between 1990 and 2004:

- a 24 percent increase in activity (floor space), a by-product of growth in the Canadian economy,[1] led to an increase of 218.6 PJ in energy use and 12.7 Mt in GHG emissions;
- structural changes in the sector (the mix of activity types) increased energy use by 3.3 PJ, and GHG emissions by 0.2 Mt;
- the winter in 2004 was colder than in 1990, but the summer was cooler. The net result was an 11.0 PJ increase in energy demand in the commercial/institutional sector for space conditioning. GHG-related emissions rose by 0.6 Mt;
- an increase in the service level of auxiliary equipment, or the penetration rates of office equipment (e.g. computers, fax machines and photocopiers), led to a 75.5 PJ increase in energy use and a 4.4 Mt increase in GHG emissions; and
- improvements in the energy efficiency of the commercial/institutional sector saved 3.0 PJ of energy and 0.2 Mt of GHG emissions. See the text box, "Possible Underestimation of the Energy Efficiency Effect," for additional explanation.

1. There is often a delay of two to three years between the decision to build (determined by economic conditions at that time) and the physical completion of new floor space.

Figure 4.2 Impact of Activity, Structure, Weather, Service Level and Energy Efficiency on the Change in Energy Use, 1990–2004 (petajoules)



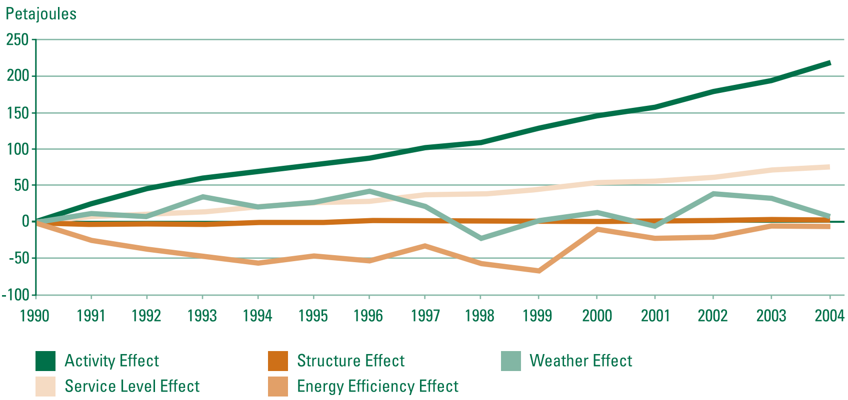
* "Service Level Effect" refers to the service level of auxiliary equipment in the commercial/institutional sector.
** "Other" refers to street lighting, which is included in the "Total Change in Energy Use," but excluded from the factorization analysis.

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 data (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 (STC) 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. However, there is inadequate information to determine the extent of the problem. NRCan is currently working with STC to better understand the data trends and to improve the quality of the reported commercial/institutional data.

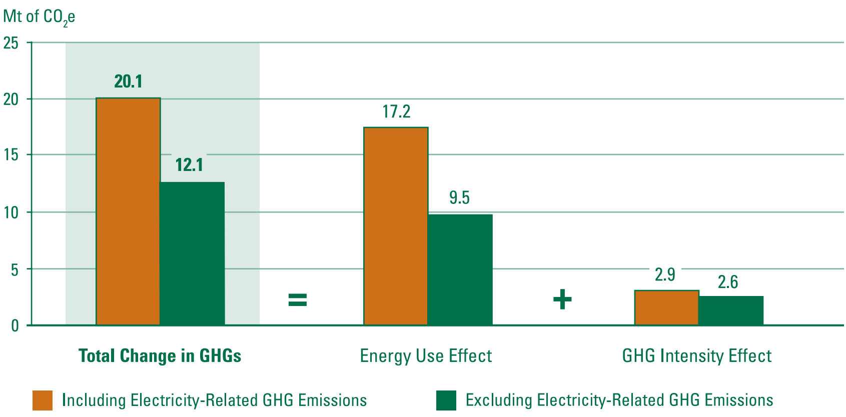
Figure 4.3 shows the effects of activity, structure, weather, service level and energy efficiency on energy use. The impact of structural changes was marginal and there were no clearly defined climate-based trends. Steady increases in activity and, to a lesser degree, service level contributed most to increases in energy use between 1990 and 2004. Energy efficiency has slowed down this rate of increase, but since 1999, this offset has been getting smaller. In the early part of the period, fuel switching away from oil towards natural gas helped to improve energy efficiency. After 1999, due to a relative decrease in electricity consumption combined with a sharp increase in natural gas prices, there appears to have been some fuel switching back towards light fuel oil, reversing some of these earlier efficiency gains. Large increases in heavy fuel oil use since 2001, including a large spike in 2003, further contributed to this decline in energy efficiency.

Figure 4.3 Changes in Energy Use Due to Activity, Structure, Weather, Service Level and Energy Efficiency, 1990–2004 (petajoules)



As illustrated in Figure 4.4, the commercial/institutional sector recorded a 42 percent, or 20.1 Mt, increase in GHG emissions, including those related to electricity, between 1990 and 2004. Most of the increase was due to higher energy consumption, though a rise in GHG intensity also played a role. Despite a decrease in the electricity share during the analysis period, a higher GHG intensity in electricity production as well as additional use of heavy fuel oil contributed to the increase in GHG intensity in the commercial/institutional sector.

Figure 4.4 Impact of Energy Use and GHG Intensity on the Change in GHG Emissions, Including and Excluding Electricity-Related GHG Emissions, 1990–2004 (megatonnes of CO_2 equivalent)



When electricity-related GHG emissions are excluded, GHG emissions were 47 percent, or 12.1 Mt, higher in 2004 than in 1990 (Figure 4.4). The increase in GHG intensity was due to a shift towards heavy fuel oil in the energy mix.

Industrial
SECTOR

Chapter 5

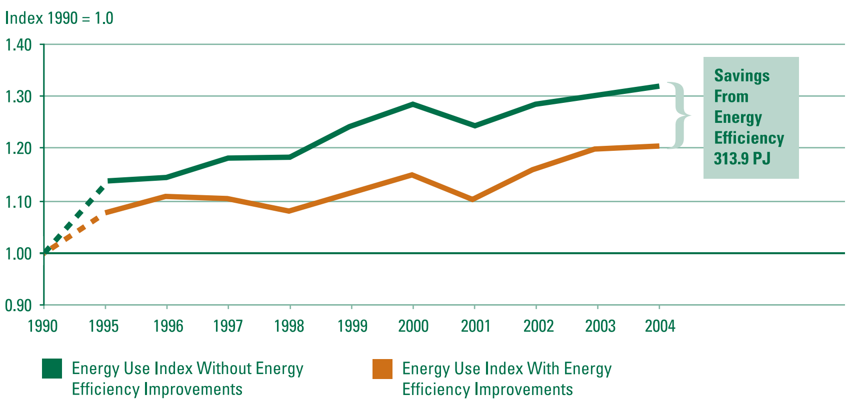
Definition: The Canadian industrial sector includes all manufacturing industries, all mining activities, forestry and construction.

Changes to Gross Domestic Product and Gross Output Data

Much of the activity data used by the OEE for analysis in the industrial sector come from Informetrica Limited. Recently, Informetrica Limited revamped the Informetrica model, adding new investment, import, export and consumption categories as well as improving its estimation techniques, particularly with respect to prices. As a result, this year, there have been some revisions to historical GDP and significant changes to the estimates of industrial GO that are used in this report.

Between 1990 and 2004, industrial energy use increased by 21 percent, from 2717.4 PJ to 3277.5 PJ. As a result, industrial energy-related GHGs (including those related to electricity) increased by 20 percent, from 141.7 Mt to 169.7 Mt. Without improvements in energy efficiency, energy use would have increased by 32 percent between 1990 and 2004, instead of the observed 21 percent (Figure 5.1).

Figure 5.1 Energy Use, With and Without Energy Efficiency Improvements, 1990–2004 (index 1990 = 1.0)

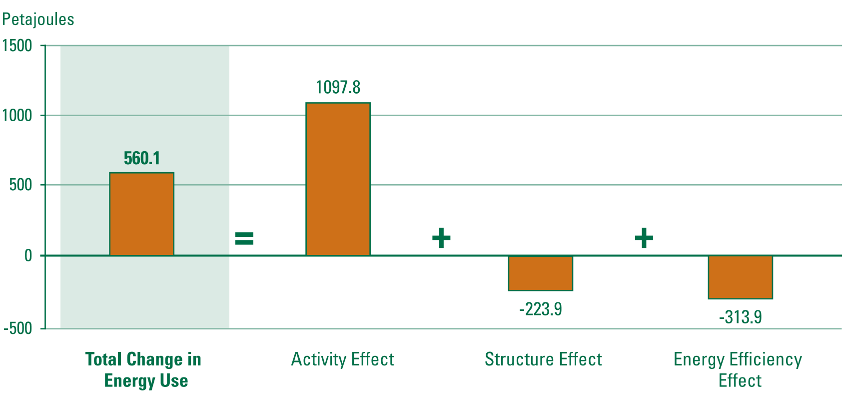


This year, Informetrica Limited made substantial changes to the industrial GO data used in this report (see text box at the beginning of this chapter). Since GO is the activity driver for more than half of the 49 industries analyzed by the OEE, this has had a significant impact on the factorization analysis presented in Figure 5.2. Compared with previous reports, the activity and structure effects have been reduced because, based on better information, growth rates in the historical series for GO were revised down in many less energy intensive manufacturing industries. As a result, the energy efficiency effect is also smaller.

As Figure 5.2 indicates, the following influenced the change in energy use and related GHGs between 1990 and 2004:

- a 40 percent increase in industrial activity (i.e. a mix of GDP, GO and production units) resulted in a 1097.8 PJ increase in energy use and a corresponding 56.8 Mt increase in GHG emissions;
- structural changes in the industrial sector; specifically, a relative decrease in the activity share of energy intensive industries helped the sector to reduce its energy use and GHG emissions by 223.9 PJ and 11.6 Mt, respectively. Note that industries that consume more than 6 MJ per dollar of GDP (e.g. pulp and paper, petroleum refining and upstream mining) represented 42 percent of industrial GDP in 1990, but accounted for 34 percent in 2004; and
- improvements in the energy efficiency of the industrial sector avoided 313.9 PJ of energy use and 16.2 Mt of GHG emissions.

Figure 5.2 Impact of Activity, Structure and Energy Efficiency on the Change in Energy Use, 1990–2004 (petajoules)

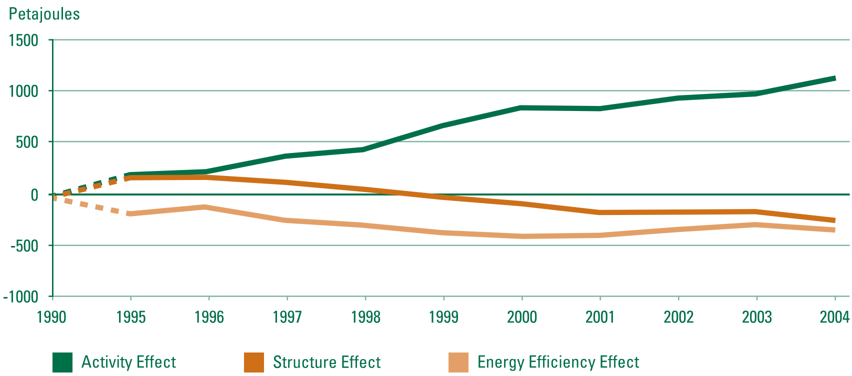


Between 1995 and 2004, increases in energy use due to robust activity growth were partially offset by a shift towards less energy intensive industries in the industrial structure and significant energy efficiency improvements (Figure 5.3). However, since 2001, this energy efficiency effect has been getting smaller. Between 2000 and 2004, increases in energy intensity in industries such as upstream mining, fertilizer and forestry have masked the progress made by other industries, helping to explain this decline in energy efficiency. Other contributing factors include lower levels of capacity utilization (ratio of actual output to potential output) since 2000 in the sector as a whole. Lower production levels mean fixed energy costs are spread over fewer units of output, decreasing overall efficiency levels.

Energy efficiency in the industrial sector improved by 12 percent from 1990 to 2004.

Energy efficiency savings in 2004 alone were:
- 313.9 PJ of energy
- $3.1 billion in energy costs
- 16.2 Mt of energy-related GHGs

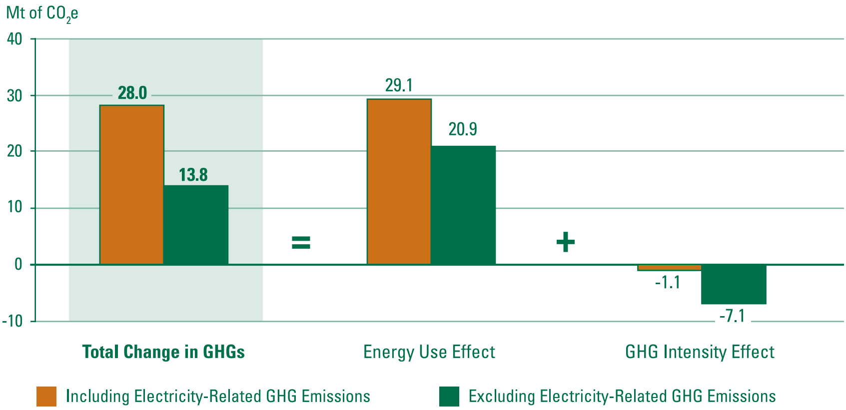
Figure 5.3 Changes in Energy Use Due to Activity, Structure and Energy Efficiency, 1990–2004* (petajoules)



* For the 2001 reporting year, the *Industrial Consumption of Energy Survey* was converted to NAICS. Statistics Canada, at the request of the OEE, revisited the historical series and developed NAICS-based industrial data for 1990 and 1995 to 2000. However, NAICS-based data for some industries are not currently available for 1991 to 1994, hence the gap in the analysis for this period.

As Figure 5.4 shows, GHG emissions from the industrial sector, including GHGs related to electricity, were 20 percent, or 28.0 Mt, higher in 2004 than in 1990. This increase in GHGs was due to higher energy consumption. The change in GHG intensity was small because fuel switching towards less GHG intensive fuels in the industrial sector was offset by a higher GHG intensity in electricity production.

Figure 5.4 Impact of Energy Use and GHG Intensity on the Change in GHG Emissions, Including and Excluding Electricity-Related GHG Emissions, 1990–2004 (megatonnes of CO_2 equivalent)



When GHG emissions related to electricity are excluded, GHG emissions increased by 13 percent, or 13.8 Mt, between 1990 and 2004 (Figure 5.4). The relative increase in the use of biomass and the decline in the use of heavy fuel oil, coke and coke oven gas led to a 6 percent decrease in GHG intensity between 1990 and 2004.

Transportation
SECTOR

Chapter 6

Definition: The transportation sector includes activities related to the transport of passengers and freight by road, rail, marine and air. It also includes off-road vehicles, such as snowmobiles and lawn mowers.

Non-commercial airline aviation and off-road energy use are included in total transportation figures. However, they are not related to the movement of either freight or passengers and, as such, are not included in the factorization analysis.

Changes to Truck Stock in the Transportation End-Use Model (TEUM)

This year, the OEE revised its historical truck stock prior to 1994. First, to bring TEUM's light truck stock estimates for 1990 more in line with other data sources *(Canadian Vehicles in Operation Census* and Statistics Canada), they were revised downwards by about a million vehicles. Second, the backcast for medium- and heavy-duty truck stocks prior to 1994 was adjusted. Previously, we used Statistics Canada's *Road Motor Vehicles: Registrations*, which reports a single aggregate truck stock, comprised mostly of light trucks. This year, we drew on the U.S. Department of Energy's *Transportation Energy Data Book, Edition 24*, which reports truck stock data broken out by truck type, permitting us to develop more appropriate growth rates for medium and heavy truck stocks during the 1976 to 1993 period.

These truck stock revisions resulted in changes to the estimates of passenger- and tonne-kilometres by mode prior to 1994. As a result, compared with previous reports, light truck energy use in both the passenger and freight sub-sectors is lower, whereas car energy use in passenger as well as medium and heavy truck energy use in freight is higher in the pre-1994 period.

Transportation Sector

Overview

Between 1990 and 2004, the amount of energy used by the transportation sector increased by 31 percent, from 1877.9 PJ to 2465.1 PJ. As a result, energy-related GHGs rose by 31 percent, from 135.0 Mt to 176.4 Mt.

As shown in Figure 6.1, passenger transportation was the transportation sub-sector that consumed the most energy in 2004 with 54 percent, while freight transportation accounted for 42 percent and off-road vehicles accounted for 4 percent. In terms of growth (Figure 6.2), however, freight transportation was the fastest growing sub-sector, accounting for 60 percent of the change in energy use for total transportation. Of interest, light and heavy trucks, with a combined increase of 524.8 PJ, represented 89 percent of net transportation energy growth.

Figure 6.1 Distribution of Transportation Energy Use by Sub-Sector, 2004 (percent)

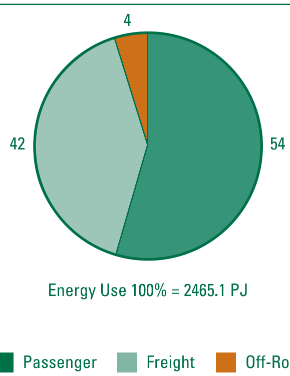
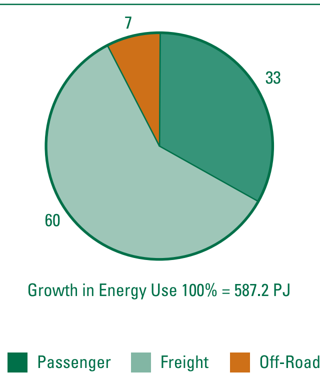


Figure 6.2 Changes in Transportation Energy Use by Sub-Sector, 1990–2004 (percent)



Energy efficiency in the transportation sector improved by 18 percent from 1990 to 2004.

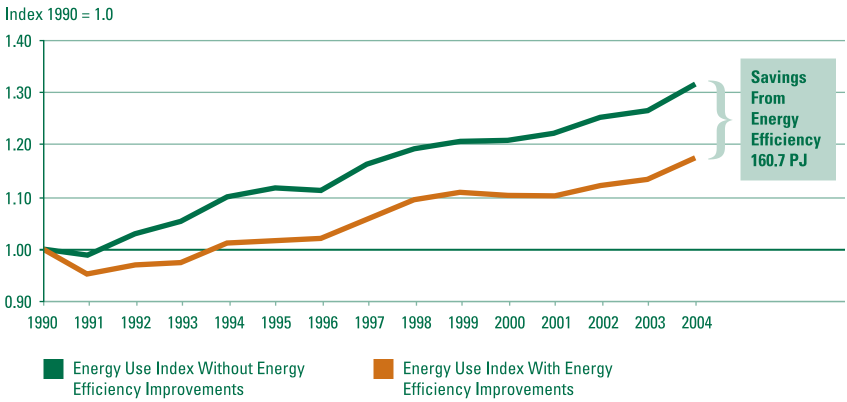
Energy efficiency savings in 2004 alone were:

- 314.7 PJ of energy
- $6.6 billion in energy costs
- 22.6 Mt of energy-related GHGs

Passenger Transportation

The amount of energy used for passenger travel increased by 17 percent, rising from 1139.5 PJ in 1990 to 1334.3 PJ in 2004. Likewise, energy-related GHG emissions increased by 16 percent, from 81.2 Mt to 94.3 Mt.[1] Without energy efficiency improvements, energy use would have increased by 31 percent between 1990 and 2004, instead of the observed 17 percent (Figure 6.3).

Figure 6.3 Energy Use, With and Without Energy Efficiency Improvements, 1990–2004 (index 1990 = 1.0)



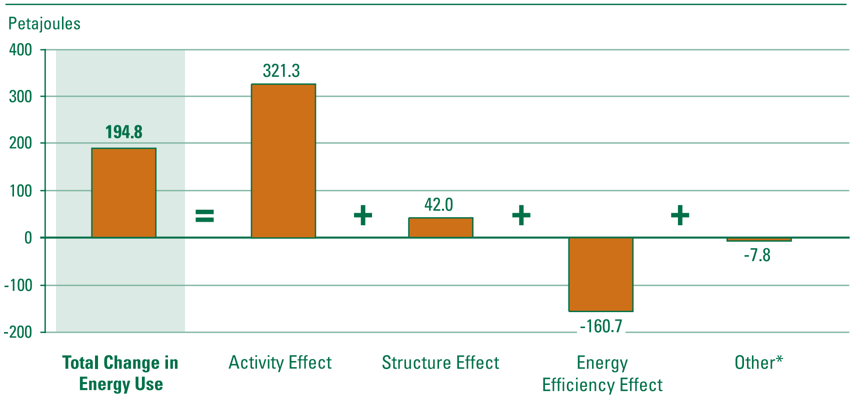
This year, the historical series for light truck stock prior to 1994 was revised downwards, which led to changes in how passenger-kilometres were allocated among modes (see the text box at the beginning of this chapter). As a result, cars now account for a greater share of total passenger-kilometres in the 1990 reference year. This will impact on the factorization analysis for the 1990 to 2004 period presented in Figure 6.4. Compared to previous reports, the structure effect is larger because the magnitude of the shift to light trucks relative to 1990 is more pronounced. In addition, to offset this larger structure effect, the energy efficiency effect will also increase.

1. This includes GHG emissions related to electricity use. Electricity accounts for only 0.3 percent of total passenger transportation energy use and is used, for the most part, for urban transit.

As Figure 6.4 indicates, the following influenced the change in energy use and related GHGs between 1990 and 2004:

- a 31 percent increase in passenger-kilometres travelled (activity) resulted in a 321.3 PJ increase in energy use and a corresponding 22.7 Mt increase in GHG emissions. Light truck and air transportation led growth in passenger-kilometres, with respective increases of 127 percent and 70 percent during the analysis period;
- changes to the mix of transportation modes, or the relative shares of passenger-kilometres held by air, rail and road, are used to measure changes in structure. The popularity of minivans and sport utility vehicles (SUVs) has considerably increased the activity share of light trucks compared to other modes, resulting in a 42.0 PJ increase in energy consumption and a 3.0 Mt increase in related GHG emissions; and
- improvements in the overall energy efficiency of passenger transportation saved 160.7 PJ of energy and 11.4 Mt of related GHGs. Despite the increasing popularity of larger and heavier light-duty vehicles with greater horsepower, the light-duty vehicle segment (e.g. cars, light trucks and motorcycles) of passenger transportation helped save 126.9 PJ, while air transportation avoided 28.6 PJ.

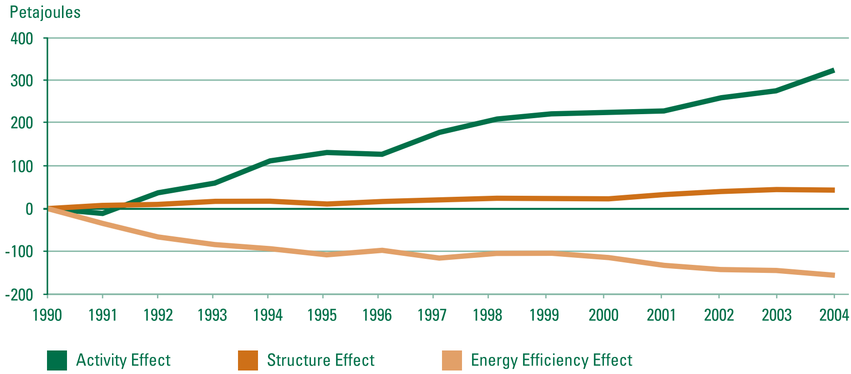
Figure 6.4 Impact of Activity, Structure and Energy Efficiency on the Change in Energy Use, 1990–2004 (petajoules)



* "Other" refers to non-commercial airline aviation, which is included in the "Total Change in Energy Use" but is excluded from the factorization analysis.

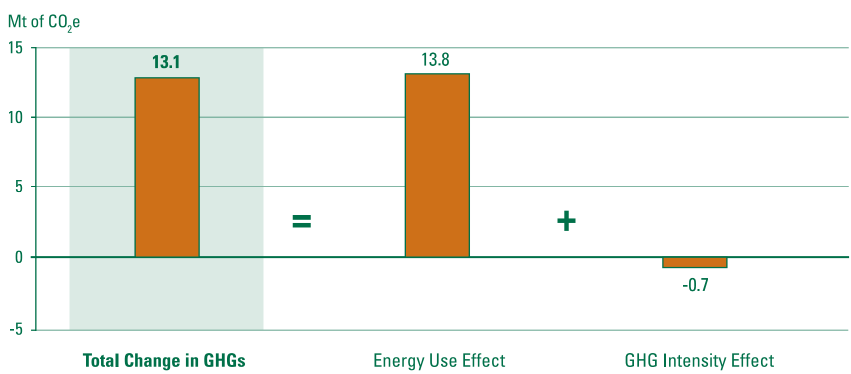
Figure 6.5 shows the evolution of passenger transportation activity, structure and energy efficiency on changes in energy use over the 1990–2004 period. Overall, although significant energy efficiency improvement in the passenger transportation sub-sector has been achieved since 1990, it has only partially offset increases in energy use due to higher demand for travel (activity) and the choice of more energy intensive transportation modes such as light trucks (structure).

Figure 6.5 Changes in Energy Use Due to Activity, Structure and Energy Efficiency, 1990–2004 (petajoules)



As Figure 6.6 shows, GHG emissions from passenger transportation were 16 percent, or 13.1 Mt, higher in 2004 than in 1990. This increase was due to higher energy consumption, as the GHG intensity of the energy used decreased only slightly over the period.

Figure 6.6 Impact of Energy Use and GHG Intensity on the Change in GHG Emissions, 1990–2004 (megatonnes of CO_2 equivalent)

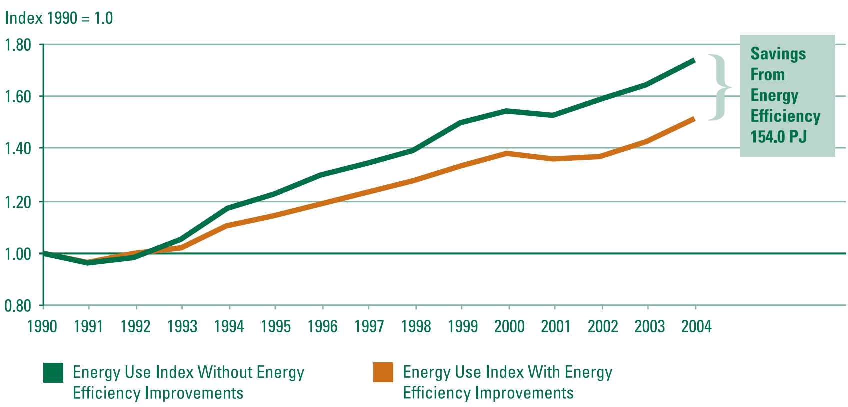


Freight Transportation

The freight sector in Canada includes four modes: road (trucks), rail, marine and air. In 2004, road transportation accounted for 81 percent of the energy used by freight transportation, followed by marine at 11 percent, rail at 7 percent and air at 1 percent. Of the total GHG emissions from freight transportation, road produced 79 percent; marine, 11 percent; rail, 8 percent; and air, 1 percent.

Between 1990 and 2004, energy use by freight transportation increased by 51 percent, from 685.1 PJ to 1035.2 PJ. As a result, energy-related GHGs produced by freight transportation were 51 percent higher, from 50.1 Mt in 1990 to 75.4 Mt in 2004. Without energy efficiency improvements, energy use would have increased by 74 percent between 1990 and 2004, instead of the observed 51 percent (Figure 6.7).

Figure 6.7 Energy Use, With and Without Energy Efficiency Improvements, 1990–2004 (index 1990 = 1.0)



This year, the composition of the freight truck stock prior to 1994 was revisited; in particular, the size of the light truck fleet was reduced, while the number of medium and heavy trucks was increased (see the text box at the beginning of this chapter). A smaller light truck stock prior to 1994 means light trucks will have a smaller share of tonne-kilometres in the 1990 reference year. This will impact on the factorization results for the 1990 to 2004 period presented in Figure 6.8. Compared to previous reports, the structure effect will be somewhat larger because light trucks are more energy intensive on a per tonne-kilometre basis than any other mode, so the shift towards all trucks (including light) since 1990 will appear more pronounced.

As Figure 6.8 indicates, the following influenced the change in energy use and related GHGs between 1990 and 2004:

- a 51 percent increase in activity (the number of tonne-kilometres moved) was spurred by free trade and the deregulation of the trucking and rail industries. Increased activity resulted in a 348.6 PJ increase in energy use and a corresponding 25.4 Mt increase in GHG emissions;
- changes in the structure of freight transportation (shifts in activity between modes) – specifically, an increase in the share of freight moved by heavy trucks relative to other modes – was due to growth in international trade and customer requirements for just-in-time delivery. Since trucks are more energy intensive per tonne-kilometre than other modes, the sub-sector used an additional 155.4 PJ of energy and emitted 11.3 Mt more GHGs; and
- improvements in the energy efficiency of freight transportation led to savings of 154.0 PJ of energy and 11.2 Mt of GHGs. Heavy trucks were a major contributor, saving about 75.1 PJ.

Figure 6.8 Impact of Activity, Structure and Energy Efficiency on the Change in Energy Use, 1990–2004 (petajoules)

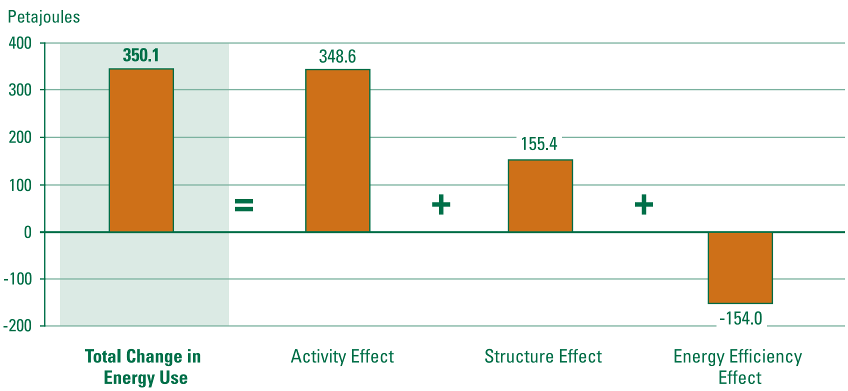
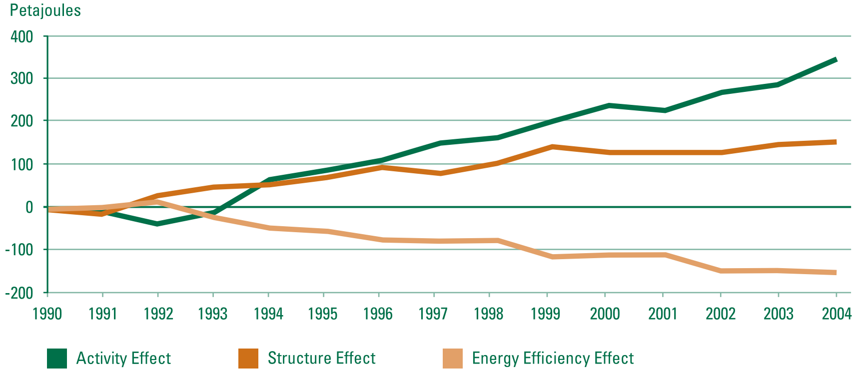


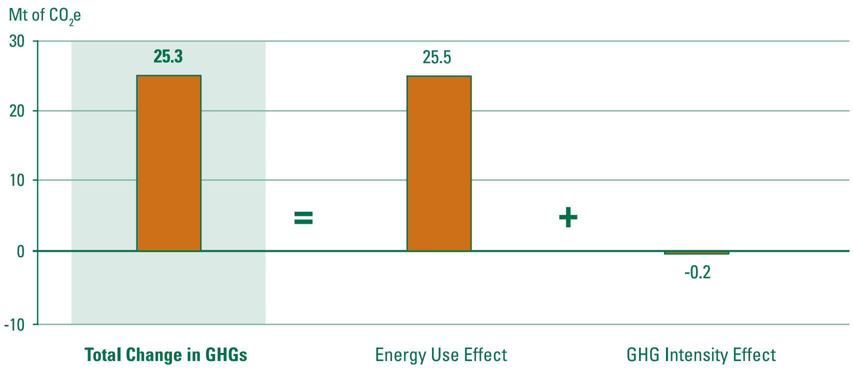
Figure 6.9 shows the evolution of freight transportation activity, structure and energy efficiency on changes in energy use over the 1990 to 2004 period. Increases in energy use due to robust growth in freight activity and the increased use of heavy trucks to move goods (structure) were only partially offset by significant improvements in energy efficiency.

Figure 6.9 Changes in Energy Use Due to Activity, Structure and Energy Efficiency, 1990–2004 (petajoules)



Increased GHG emissions in freight transportation were due to higher energy consumption, since the GHG intensity of the energy used decreased only slightly over the period. As Figure 6.10 shows, GHG emissions from freight transportation were 51 percent, or 25.3 Mt, higher in 2004 than in 1990.

Figure 6.10 Impact of Energy Use and GHG Intensity on the Change in GHG Emissions, 1990–2004 (megatonnes of CO_2 equivalent)



Electricity Generation

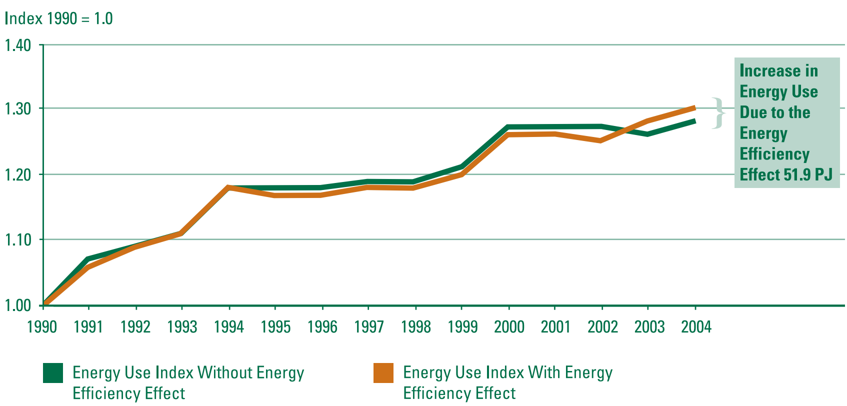
SECTOR

Chapter 7

Definition: *The electricity generation sector includes the transformation of other forms of energy (fossil fuels, hydro, nuclear, etc.) into electrical energy by utilities and industrial generators.*

Between 1990 and 2004, energy used to generate electricity increased by 30 percent, from 3002.0 PJ to 3903.0 PJ, while energy-related GHGs increased by 36 percent, from 94.6 Mt to 128.8 Mt. Due to a variety of circumstances, there was a break in the historical trend – a modest decrease in energy efficiency in 2003 and 2004. As a result, energy use rose by 30 percent between 1990 and 2004, instead of the 28 percent that would have occurred without the energy efficiency effect (Figure 7.1).

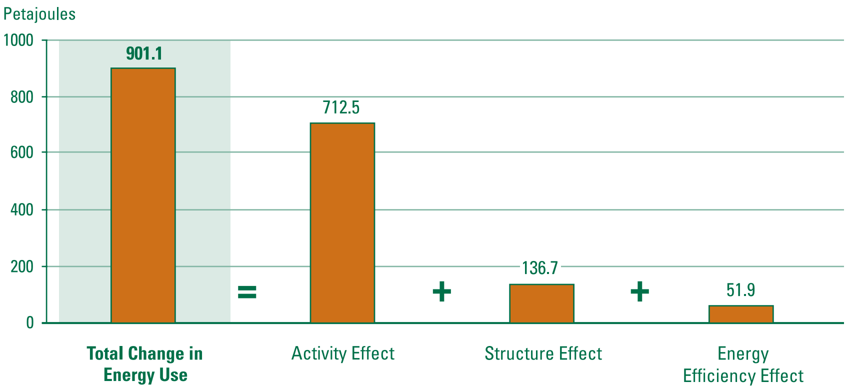
Figure 7.1 Energy Use, With and Without Energy Efficiency Effect, 1990–2004 (index 1990 = 1.0)



As Figure 7.2 indicates, the following influenced the change in energy use and related GHGs between 1990 and 2004:

- a 23 percent increase in the amount of electricity generated led to a 712.5 PJ increase in energy and a corresponding 23.5 Mt increase in GHG emissions;
- structural changes in the electricity generation sector (the mix of electricity production by energy source) – in particular, a relative decrease in the share of hydro production combined with higher shares for more energy intensive natural gas-, biomass- and petroleum coke-fired generation – resulted in a 136.7 PJ increase in energy use and a corresponding 4.5 Mt rise in GHG emissions; and
- different from previous reports, the energy efficiency effect in the electricity generation sector led to a 51.9 PJ increase in energy use and a 1.7 Mt increase in energy-related GHG emissions. This result is due to a number of factors; most importantly, in some provinces, coal-fired and other plants used to meet peak demand were started and stopped more often than in the past, which impacted negatively on their performance efficiency.

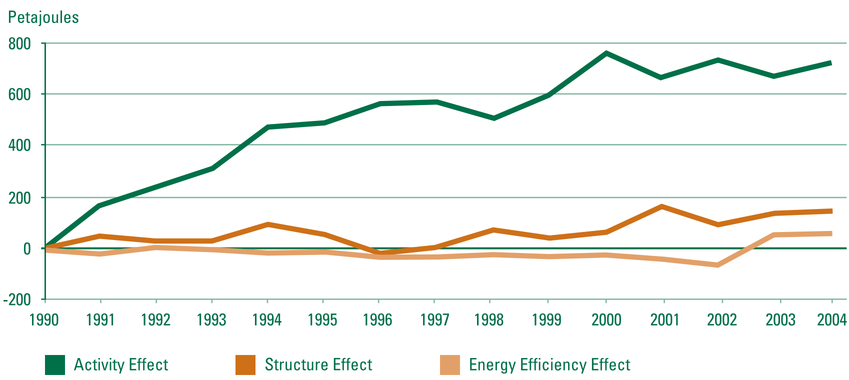
Figure 7.2 Impact of Activity, Structure and Energy Efficiency on the Change in Energy Use, 1990–2004 (petajoules)



In 2004, methane collected from Canadian landfill sites was used to produce approximately 647.1 gigawatt-hours of electricity, enough to supply electricity to roughly 53,000 Canadian households for a year.

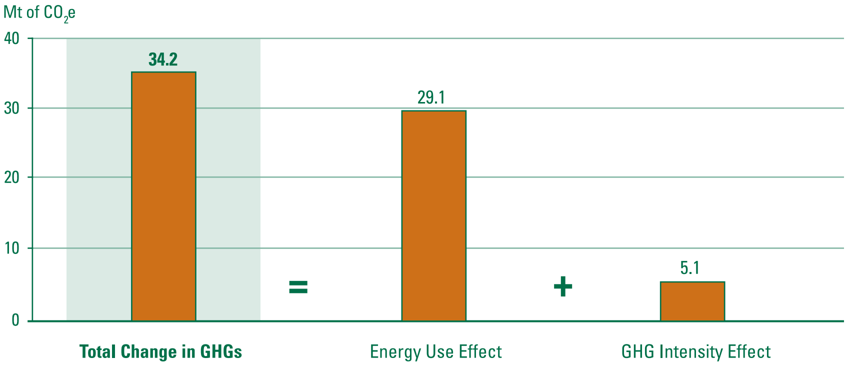
Overall, as Figure 7.3 shows, the increase in energy consumption between 1990 and 2004 was largely driven by the increase in activity, or the amount of electricity generated to meet the needs of the end-use sectors. The structure effect, which varies with changes to the production mix, has also been trending upwards in recent years. This is because hydro's share of total production has been in decline since 1996. To meet increased demand for electricity, suppliers are using more energy intensive processes such as natural gas-fired generation. In addition, the energy efficiency effect, contrary to historical trends, has contributed to increases in energy use since 2003. In 2003, hydro reservoirs in some provinces had low water levels, which resulted in a shortfall in electricity production. To maintain production levels, older, less efficient coal plants were used more often than in the past, impacting on overall energy efficiency in the electricity generation sector. In 2004, water levels returned to normal, but fossil fuel plants were not operating at their optimal efficiency due to the frequent starts and stops in production required, in that year, to meet electricity demand in the end-use sectors.

Figure 7.3 Changes in Energy Use Due to Activity, Structure and Energy Efficiency, 1990–2004 (petajoules)



As Figure 7.4 shows, GHG emissions from the electricity generation sector were 36 percent, or 34.2 Mt, higher in 2004 than in 1990. The increase was driven by higher energy consumption combined with an increase in the GHG intensity of the energy used. Compared with 1990, a relative increase in the production of electricity from natural gas and petroleum coke, and a relative decrease in GHG-neutral nuclear and hydro, resulted in a 5 percent rise in GHG intensity. However, this intensity effect is at its lowest level since 1997 because three nuclear reactors in Ontario, which had been shut down since the late 1990s, returned to service in 2003 and 2004, displacing electricity produced from coal and natural gas.

Figure 7.4 Impact of Energy Use and GHG Intensity on the Change in GHG Emissions, 1990–2004 (megatonnes of CO_2 equivalent)



Appendix
GLOSSARY OF TERMS

Activity: Term used to characterize major drivers of energy use in a sector (e.g. floor space area in the commercial/institutional sector).

Agriculture: The agriculture sector includes all types of farms, including livestock, field crops, grain and oilseed farms, as well as activities related to hunting and trapping. Energy used in this sector is for farm production and includes energy use by establishments engaged in agricultural activities and in providing services to agriculture. Agriculture energy use is included in total secondary energy use for Canada.

Auxiliary Equipment: Includes stand-alone equipment powered directly from an electrical outlet such as computers, photocopiers, refrigerators and desktop lamps. It also includes equipment that can be powered by natural gas, propane or other fuels, such as clothes dryers and cooking appliances.

Biomass: Includes wood waste and pulping liquor. Wood waste is a fuel consisting of bark, shavings, sawdust and low-grade lumber and lumber rejects from the operation of pulp mills, sawmills and plywood mills. Pulping liquor is a substance primarily made up of lignin and other wood constituents and chemicals that are by-products of the manufacture of chemical pulp. It can produce steam for industrial processes when burned in a boiler and/or produce electricity through thermal generation.

Capacity Utilization: The rates of capacity use are measures of the intensity with which industries use their production capacity. It is the ratio of an industry's actual output to its estimated potential output.

Carbon Dioxide (CO_2): A compound of carbon and oxygen formed whenever carbon is burned. Carbon dioxide is a colourless gas that absorbs infrared radiation, mostly at wavelengths between 12 and 18 microns. It behaves as a one-way filter, allowing incoming visible light to pass through in one direction, while preventing outgoing infrared radiation from passing in the opposite direction. The one-way filtering effect of carbon dioxide causes an excess of the infrared radiation to be trapped in the atmosphere; thus it acts as a "greenhouse" and has the potential to increase the surface temperature of the planet (see Greenhouse Gas).

End-Use: Any specific activity that requires energy (e.g. refrigeration, space heating, water heating and manufacturing processes).

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

Energy Intensity: The amount of energy used per unit of activity. Examples of activity measures in this report are households, floor space, passenger-kilometres, tonne-kilometres, physical units of production and constant dollar value of gross domestic product.

Energy Source: Any substance that supplies heat or power (e.g. petroleum, natural gas, coal, renewable energy and electricity).

Factorization Method: A statistical method, based on the Log-Mean Divisia Index I (LMDI I) approach, is used in this report to separate changes in energy use into five factors: activity, structure, weather, service level and energy efficiency.

Floor Space (area): The area enclosed by exterior walls of a building. In the residential sector, it excludes parking areas, basements or other floors below ground level; these areas are included in the commercial/institutional sector. It is measured in square metres.

Greenhouse Gas (GHG): A greenhouse gas absorbs and radiates heat in the lower atmosphere that otherwise would be lost in space. The greenhouse effect is essential for life on this planet, since it keeps average global temperatures high enough to support plant and animal growth. The main greenhouse gases are carbon dioxide (CO_2), methane (CH_4), chlorofluorocarbons (CFCs) and nitrous oxide (N_2O). By far the most abundant greenhouse gas is CO_2, accounting for about 70 percent of total greenhouse gas emissions (see Carbon Dioxide, Methane).

Greenhouse Gas Intensity: The amount of greenhouse gas emitted per unit of energy used.

Gross Domestic Product (GDP): The total value of goods and services produced within Canada during a given year. Also referred to as annual economic output or, more simply, output. To avoid counting the same output more than once, GDP includes only final goods and services – not those that are used to make another product. GDP figures are reported in constant 1997 dollars.

Gross Output (GO): The total value of goods and services produced by an industry. It is the sum of the industry's shipments plus the change in value due to labour and capital investment. Gross output figures are reported in constant 1997 dollars.

Heavy Truck: A truck with a gross vehicle weight that is more than, or equal to, 14,970 kg (33,001 lb.). The gross vehicle weight is the weight of the empty vehicle plus the maximum anticipated load weight.

Horsepower (hp): A unit of power commonly used for vehicle engines, equal to 75 metre kilograms-force per second; equal to 735.49875 watts.

Household: A person or a group of people occupying one dwelling unit is defined as a household. The number of households will, therefore, be equal to the number of occupied dwellings.

Kilowatt-hour (kWh): The commercial unit of electricity energy equivalent to 1000 watt-hours. A kilowatt-hour can best be visualized as the amount of electricity consumed by ten 100-watt bulbs burning for an hour. One kilowatt-hour equals 3.6 million joules (see Watt).

Light Truck: Truck of up to 3855 kg (8500 lb.) of gross vehicle weight. The gross vehicle weight is the weight of the empty vehicle plus the maximum anticipated load weight. This class of vehicles includes pickup trucks, minivans and sport utility vehicles.

Liquefied Petroleum Gases (LPG) and Gas Plant Natural Gas Liquids (NGL): Propane and butane are liquefied gases extracted from natural gas (i.e. gas plant NGL) or from refined petroleum products (i.e. LPG) at the processing plant.

Methane (CH_4): A very potent greenhouse gas, as the release of one tonne of methane has the same GHG impact as 21 tonnes of carbon dioxide. It has an energy content of 20.3 MJ/m^3 (see Greenhouse Gas).

North American Industry Classification System (NAICS): A classification system that categorizes establishments into groups with similar economic activities. The structure of NAICS, adopted by Statistics Canada in 1997 to replace the 1980 Standard Industrial Classification (SIC), has been developed by the statistical agencies of Canada, Mexico and the United States.

Passenger-kilometre (Pkm): An activity measure in the passenger transportation sub-sector describing the transportation of one passenger over a distance of one kilometre.

Petajoule (PJ): One petajoule equals 1×10^{15} joules. A joule is the international unit of measure of energy – the energy produced by a power of one watt flowing for a second. There are 3.6 million joules in one kilowatt-hour (see Kilowatt-hour).

Sector: The broadest category for which energy consumption and intensity are considered within the Canadian economy (e.g. residential, commercial/institutional, industrial, transportation, agriculture and electricity generation).

Service Level: Term used to characterize the increased penetration of auxiliary equipment in commercial/institutional buildings.

Space Cooling: Conditioning of room air for human comfort by a refrigeration unit (e.g. air conditioner or heat pump) or by the circulation of chilled water through a central- or district-cooling system.

Space Heating: The use of mechanical equipment to heat all or part of a building. Includes the principal space heating system and any supplementary equipment.

Standard Industrial Classification (SIC): A classification system that categorizes establishments into groups with similar economic activities.

Structure: Structure refers to change in the makeup of each sector. For example, in the industrial sector, a relative increase in output from one industry over another is considered a structural change; in the electricity generation sector, a relative increase in production from one fuel process over another is considered a structural change.

Tonne-kilometre (Tkm): An activity measure in the freight transportation sub-sector describing the transportation of one tonne over a distance of one kilometre.

Upstream Mining: The companies that explore for, develop and produce Canada's petroleum resources are known as the upstream sector of the petroleum industry.

Water Heating: The use of energy to heat water for hot running water, as well as the use of energy to heat water on stoves and in auxiliary water heating equipment for bathing, cleaning and other non-cooking applications.

Watt (W): A measure of power; for example, a 40-watt light bulb uses 40 watts of electricity (see Kilowatt-hour).