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Energy Efficiency Trends in Canada 1990 to 2005

Canada

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Évolution de l'efficacité énergétique au Canada, 1990 à 2005.

Preface

This twelfth edition of *Energy Efficiency Trends in Canada* delivers on Canada's commitment to provide a comprehensive summary of secondary energy use and related greenhouse gas (GHG) emissions in Canada. It also tracks trends in energy efficiency. This year's edition is produced electronically only.

For more secondary energy use statistics, see the comprehensive energy use database. The database includes most of the historical energy use and GHG emissions data used by Natural Resource Canada's (NRCan's) Office of Energy Efficiency (OEE). This database can be viewed at oee.nrcan.gc.ca/tables07.

This report covers the five sectors analysed by the OEE, which are the residential, commercial/institutional, industrial, transportation and agriculture sectors. The 2005 period is the most recent year for which data is available.

For more information about 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 Naïma Behidj, Johanne Bernier, Samuel Blais, Dominic Demers, Sébastien Genest, Ann Kowal, David McNabb, Raymond Messom and Shane Norup, who are staff of the Demand Policy and Analysis Division of the OEE. Jean-Francois Bilodeau was responsible for the report while David McNabb and Tim McIntosh provided the overall direction.

For more information, contact

Office of Energy Efficiency
Natural Resources Canada
580 Booth Street, 18th Floor
Ottawa ON K1A 0E4

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Chapter 1: Introduction

Canadians spent $152 billion on energy in 2005.

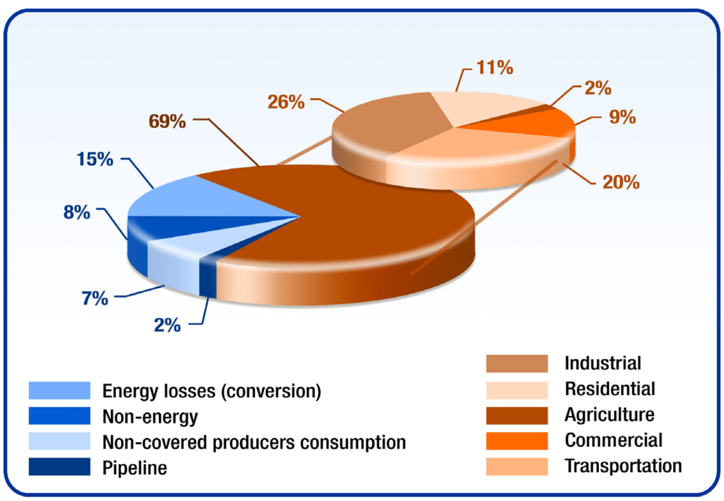
Energy accounts for a large segment of spending by households, businesses and industries alike. In 2005, Canadians spent about $152 billion on energy to heat and cool their homes and offices and to operate their appliances, cars and industrial processes. This amount is equivalent to about 14 percent of the country's gross domestic product (GDP).

This report provides an overview of Canada's secondary energy use and related GHG emissions. In addition to providing detailed information about energy intensity and energy efficiency levels in 2005, this report also analyses the energy intensity and efficiency trends between 1990 and 2005. Such monitoring aids the OEE in promoting energy efficiency in all aspects of Canadian life. It contributes toward the goal of improving our natural environment through knowledge and understanding.

Measurement of energy

To compare sources of energy, all energy consumption data presented in this report are expressed in joules. One joule is equivalent to the work required to produce one watt of power continuously for one second. One petajoule (PJ), which is a million billion (10^{15}) joules, is equivalent to the energy required by 8900 households (excluding transportation requirements) over one year.

Figure 1.1 Primary and secondary energy use by sector, 2005 (percent)



Two types of energy use

There are two general types of energy use: primary and secondary. Primary energy use (see Figure 1.1) encompasses the total requirements for all users of energy. This includes secondary energy use. Additionally, primary energy use refers to the energy required to transform one form of energy to another (e.g. coal to electricity).

It also includes the energy used to bring energy supplies to the consumer (e.g. pipeline). Further, it entails the energy used to feed industrial production processes (e.g. the natural gas used by the chemical industries). In 2005, the total amount of primary energy consumed was estimated at 12 369 PJ (see Appendix A, "Reconciliation of data" for more details).

Secondary energy[1] use (see Figure 1.1) is the energy used by final consumers in various sectors of the economy. This includes, for example, the energy used by vehicles in the transportation sector. Secondary energy use encompasses energy required to heat and cool homes or businesses in the residential and commercial/institutional sectors. Commercially, it comprises energy required to run machinery in the industrial and agricultural sectors. Secondary energy use accounted for 69 percent of the primary energy use in 2005, or 8475 PJ.

This report focuses on secondary energy use and assesses trends in this category. The energy used to generate electricity is also included, to allow the link of electricity emissions to the appropriate final user of electricity. This mapping of GHG emissions to appropriate electricity consumers is discussed in more detail in the section "GHG emissions."

All subsequent references in this report to "energy" should be interpreted as secondary energy.

[1] Secondary energy use covered in this report excludes pipeline energy consumption, natural gas (non-marketable gas, marketable gas and flared), and non-energy use (feedstock).

GHG emissions

This report also analyses energy-related GHG emissions, including carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). CO_2 represents more than 97 percent of Canada's energy-related GHG emissions.

Total Canadian GHG emissions are estimated to have been 747.5 megatonnes (Mt) in 2005; of this, 66 percent (or 495 Mt) resulted from secondary energy use (including electricity-related GHG emissions).[2]

Unlike other fuels used at the end-use level, electricity use does not produce any GHG emissions at the source of consumption. GHG emissions related to electricity are emitted at the point of generation. These are sometimes referred to as indirect emissions.

Therefore, it is a common practice in energy end-use analysis to allocate GHG emissions associated with electricity production to the sector that uses that electricity. This allocation is done by multiplying the amount of electricity used by a national average emission factor that reflects the average mix of fuels used to generate electricity in Canada.

Environment Canada's *National Inventory Report, 1990–2004 – Greenhouse Gas Sources and Sinks in Canada* has more information about total Canadian GHG emissions. This GHG inventory was prepared according to the specifications of the Intergovernmental Panel on Climate Change, accounting for all types of GHG emissions in Canada. However, NRCan's OEE developed a sectoral mapping that is more suited to energy end-use analysis.

All subsequent references in this report to GHG emissions are expressed in tonnes of carbon dioxide equivalent (CO_2e). They include only emissions directly attributable to secondary energy use and indirect emissions attributable to electricity used as final demand, unless otherwise specified.

Energy intensity and energy efficiency

The term energy intensity is used frequently throughout this report. Energy intensity is the ratio of energy use per unit of activity. Because energy intensity is a simple calculation for which data are readily available, it is often used as a proxy for energy efficiency. However, this practice can be misleading: in addition to pure energy efficiency, energy intensity captures the impact of many factors that influence energy demand, such as weather or structural change.

Because of this inherent shortfall in energy intensity measure, the OEE tracks energy efficiency to gauge changes in energy demand due to changes in activity, economic structure, service level and weather. In summary, the energy efficiency measure factors out these items from the energy intensity calculation.

The methodology of this factorization – the Log-Mean Divisia Index I (LMDI I) methodology – is an internationally recognized factorization analysis technique. It decomposes changes in energy use into the various drivers in each sector so that energy efficiency can be assessed.

In this report

This report describes secondary energy use in Canada, overall, and also at a sectoral level. For each sector, the status in 2005 of energy use and GHG emissions is described, followed by the trends in energy use and GHG emissions from 1990 to 2005. Finally, the overall and sector analysis provides the results of the factorization analysis and a detailed discussion of the trends in energy efficiency and energy intensity over the sample period.

New factorization methodology

The analysis in this report is based on a factorization (decomposition) technique. In last year's publication, the OEE updated the factorization technique from a refined Laspeyres index methodology to a Log-Mean Divisia Index I (LMDI I) methodology. Although both methods are theoretically sound, this update offered similar results but eliminated the complication of allocating a residual term, which the former technique produced. Based on further examination of a consultancy report, the LMDI I method was further improved in this year's publication. The improvement was accomplished through the incorporation of a rolling base year and the redefinition of structure at various levels. This change ensures that lower-level decomposition results sum to those estimated at higher levels. It consolidates the various definitions of structure at different levels and places less weight on 1990 data and energy consumption characteristics. As a result, effects estimated are easier to explain, understand and use, which adds value to the energy efficiency trend analysis. For more information about this update and to see a comparison of the results presented in this report and the LMDI I methodology implemented last year, e-mail us at euc.cec@nrcan.gc.ca.

[2] These figures are OEE estimates; Environment Canada is responsible for Canada's official GHG inventory.

Chapter 2: Energy use

Overview – Energy use and GHG emissions

The industrial sector accounts for the largest share of energy use in Canada, but is second to transportation in terms of share of GHG emissions.

Energy is used in all five sectors of the economy: residential, commercial, industrial, transportation and agriculture. In 2005, these sectors used a total of 8475 PJ of energy. The industrial sector accounted for the largest share of energy followed by transportation, residential, commercial/institutional and agriculture. Total GHG emissions associated with the energy use of the five sectors was 495 Mt in 2005.

One petajoule is approximately equal to the energy used by 8900 households in one year (excluding transportation).

Figures 2.1 and 2.2 show the distribution of secondary energy use and GHG emissions, by sectors. Emissions from the transportation and agriculture sectors exceeded their share of energy consumption because these sectors tended to use forms of energy that were more GHG intensive.

Figure 2.1 Secondary energy use by sector, 2005 (percent)

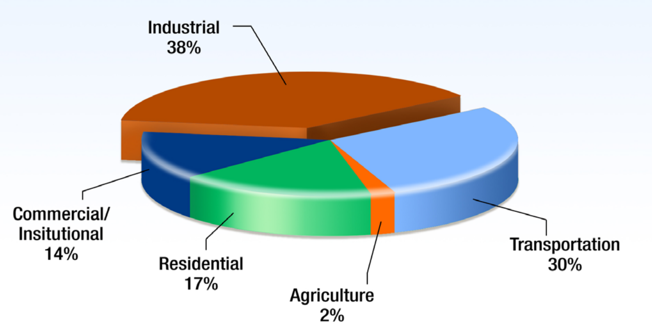
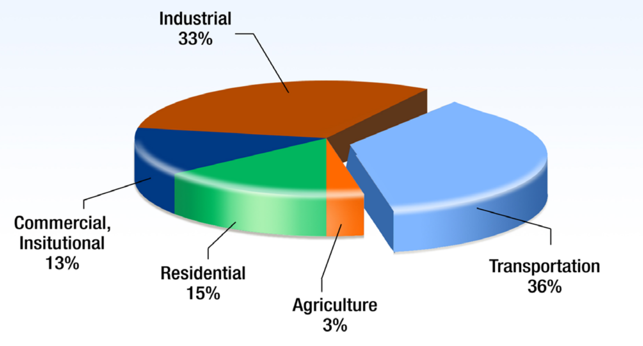


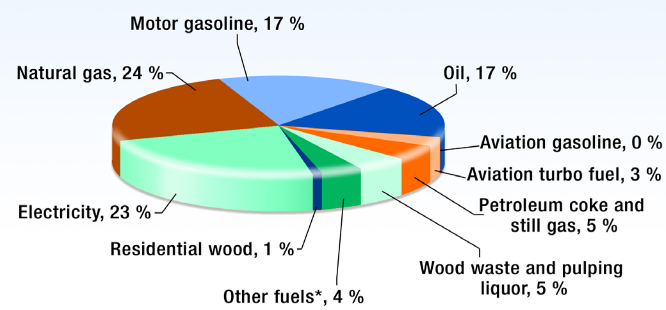
Figure 2.2 GHGs by sector, 2005 (percent)



Natural gas and electricity are the main types of end-use energy purchased in Canada.

In 2005, natural gas and electricity accounted for almost half the energy used in Canada. This was followed by motor gasoline and oil (diesel fuel oil, light fuel oil, kerosene and heavy fuel oil), which represented approximately 34 percent of fuel usage. Natural gas and electricity are used in all sectors of the economy while motor gasoline is mainly used in the transportation and agricultural sectors.

Figure 2.3 Secondary energy use by fuel, 2005 (percent)



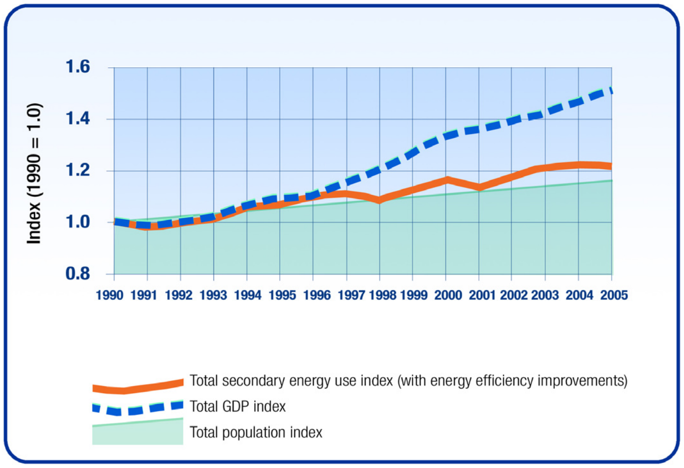
* Other fuels include coal, coke, coke oven gas, liquefied petroleum gas and gas plant natural gas liquids, steam, and waste fuels from the cement industry.

Trends – Energy use and GHG emissions

Energy use grew less rapidly than the economy, but more rapidly than the population.

Between 1990 and 2005, energy use in Canada increased by 22 percent, from 6952 PJ to 8475 PJ. At the same time, the Canadian population grew 17 percent (approximately 1 percent per year), and GDP increased 51 percent (more than 3 percent per year). More generally, energy use per unit of GDP declined, while energy use on a per capita basis increased.

Figure 2.4 Total secondary energy use, Canadian population and GDP, 1990-2005



Energy use has been growing fastest in the transportation and commercial/institutional sectors.

The industrial sector uses the most energy in our economy, consuming 3209 PJ of energy in 2005. But growth in energy use in the transportation and commercial/institutional sectors has outpaced all sectors. Over the 1990–2005 period, these two sectors each registered a 33 percent increase in energy use.

Growth in energy use was reflected in growth of GHG emissions. Consequently, the commercial/institutional sector experienced the highest growth in emissions at 37 percent and the transportation sector the second highest at 32 percent.

Growth in emissions in the transportation sector allowed it to surpass the industrial sector in producing the most GHG emissions in our economy. This is the result even with electricity-related emissions included in the industrial sector. Several reasons may explain this, among them the trend to move more freight by road (trucks), increasing fossil fuel use.

Figure 2.5 Total secondary energy use and growth by sector, 1990 and 2005

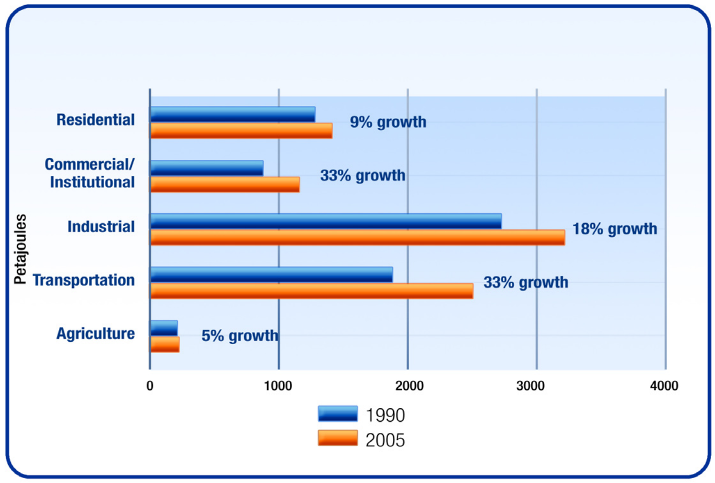
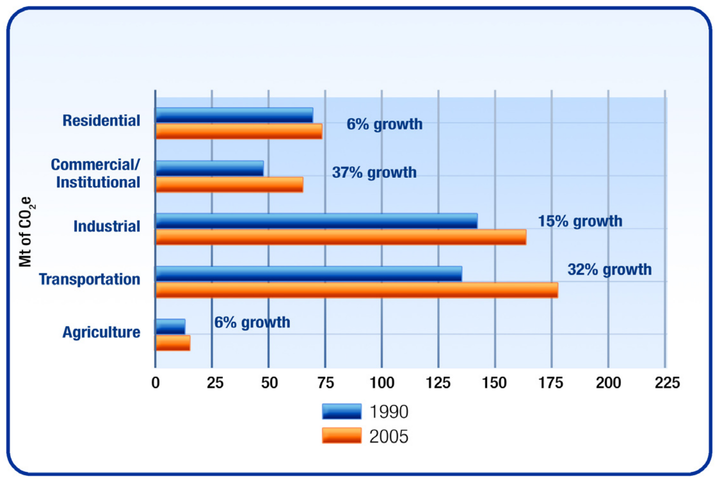


Figure 2.6 Total GHG emissions and growth by sector, 1990 and 2005



Energy intensity and efficiency

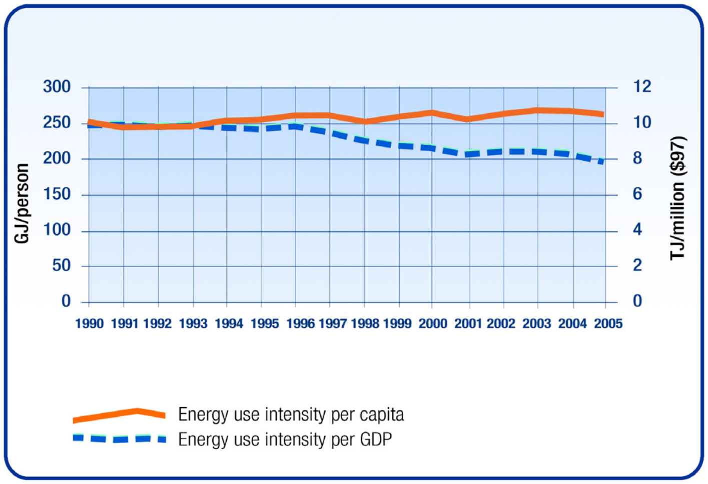
Canada improved its energy efficiency between 1990 and 2005. The following section discusses two indicators of energy efficiency: energy intensity and an energy efficiency measure using factorization.

Energy intensity

Canada's energy intensity improved 19 percent between 1990 and 2005. However, per capita, energy use increased 5 percent.

Energy intensity, when defined as the amount of energy required per unit of activity (GDP), improved 19 percent between 1990 and 2005. This reduction in energy intensity reflects an overall improvement in energy efficiency, which is how effectively energy is being used in producing one unit of GDP. More simply, if the economy in 2005 had produced the same level of GDP that it did in 1990, it would have used less energy.

Figure 2.7 Total secondary energy use intensity per capita and unit of GDP, 1990-2005



Conversely, the amount of energy required per capita, which is the energy intensity for each individual, increased 5 percent between 1990 and 2005. This upward trend reflects the increasing use of electronic appliances, increasing ownership of personal vehicles and increasing number of goods transported. In other words, Canada is producing goods more efficiently, but is using more energy-consuming goods per capita compared to 1990.

One of the greatest sources of untapped energy is the energy we waste. Isolating and tracking energy efficiency in the Canadian economy is carried out in a conscious effort to publicize this energy resource. That way, this analysis can examine all areas of the economy to determine what would have happened if there had been no improvements and identify areas that can continue to improve energy efficiency.

Energy efficiency

Energy efficiency improved 16 percent since 1990. These improvements reduced energy use by approximately 1100 PJ, decreased GHG emissions by 64 Mt and saved Canadians $20.1 billion in 2005.

Energy efficiency refers to how effectively energy is used to provide a certain level of service or output. To isolate the effect of energy efficiency in the economy, as well as in individual sectors, the analysis uses a factorization method. Factorization separates the changes in the amount of energy used into five effects: activity, structure, weather, service level and energy efficiency.

- **activity effect –** Activity is defined differently in each sector. For example, in the residential sector, it is defined as the number of households and the floor space of residences. In the industrial sector, it is defined as industrial GDP, gross output (GO) and physical industrial output, such as tonnes of steel.

- **structure effect –** Structure refers to changes 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.

- **weather effect –** Fluctuations in weather lead to changes in heating and cooling requirements. This is measured in terms of heating and cooling degree-days. 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.

- **service level effect –** Service levels refers to the penetration rate of devices and equipment. For example, the term denotes use of auxiliary equipment in commercial/institutional buildings and appliances in homes, or the amount of floor space cooled. Although these devices are becoming more efficient, the addition of more devices would represent an increase in service levels, which has tended to offset these gains in efficiency.

- **energy efficiency effect –** Energy efficiency refers to how effectively energy is being used, that is, using less energy to provide the same level of energy service. Energy efficiency gains occur primarily with improvements in technology or processes. An example would be insulating a home to use less energy for heating and cooling or replacing incandescent lights with fluorescent lights.

As Figure 2.8 indicates, without significant ongoing improvements in energy efficiency in end-use sectors, energy use would have increased 38 percent between 1990 and 2005, instead of 22 percent. These energy savings of 1096 PJ are equivalent to removing 16 million cars and passenger light trucks from the road.

Figure 2.8 Secondary energy use, with or without energy efficiency improvements, 1990-2005

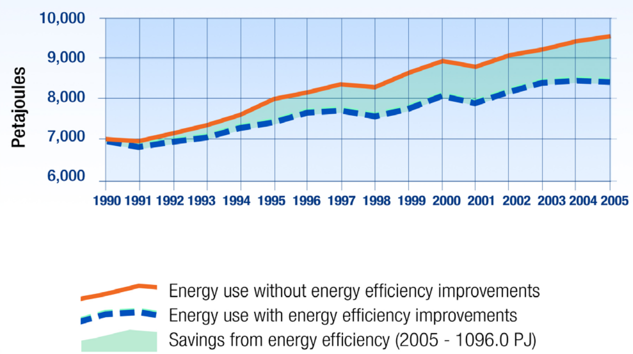
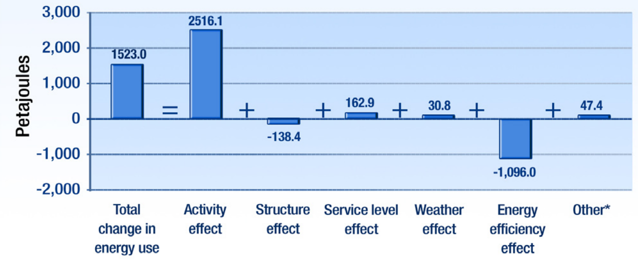


Figure 2.9 Impact of activity, structure, service level, weather and energy efficiency effects on change in energy use, 1990-2005



* Other refers to street lighting, non-commercial airline aviation, off-road transportation and agriculture, which are included in the Total change in energy use column above but are excluded from the factorization analysis.

Figure 2.9 illustrates the relative impact of each effect on energy use over the 1990–2005 period for the economy as a whole. The following is a summary of and rationale for the results:

- **activity effect –** The GDP of Canada grew 51 percent between 1990 and 2005. This activity increase is estimated to have increased energy use by 36 percent, or 2516 PJ, with a corresponding 147 Mt increase in GHG-related emissions.

- **structure effect –** Over the 1990–2005 period, a shift in production toward industries that are less energy intensive resulted in a decrease of 138.4 PJ and an 8.1 Mt decrease in GHG emissions.

- **weather effect –** In 2005, winter temperatures were similar to those of 1990 but the summer was warmer. The result was an overall increase in energy demand for temperature control of 30.8 PJ and a 1.8 Mt increase in GHG-related emissions.

- **service level effect –** From 1990 to 2005, changes in service level (e.g. increased use of computers, printers and photocopiers in the commercial/institutional sector) raised energy use by 162.9 PJ, and increased GHG-related emissions by 9.5 Mt.

- **energy efficiency effect –** As noted above, improvements in energy efficiency saved 1096 PJ of energy and 64.0 Mt of GHG-related emissions from 1990 to 2005.

We can apply this analysis to each sector, residential, commercial/institutional, industrial and transportation.

Chapter 3: Residential sector

Overview – Residential energy use and GHG emissions

In Canada, 78 percent of all residential energy use is for space heating and water heating.

In 2005, Canadians spent $26.8 billion on household energy needs. Total household energy use was 17 percent of all energy used and 15 percent of all GHGs emitted in Canada. The energy used was 1402 PJ and 73.8 Mt of GHGs were emitted by the residential sector.

In 2005, average household emissions were equivalent to the emissions of the average number of vehicles per household (1.3 light-duty vehicles). This contrasts with 1990 when the average household had emissions equivalent to 0.9 light-duty vehicles.

Figure 3.1 Energy use by sector, 2005 (percent)

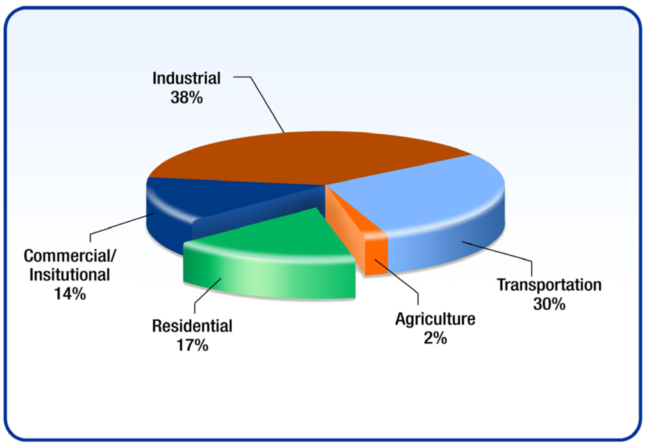
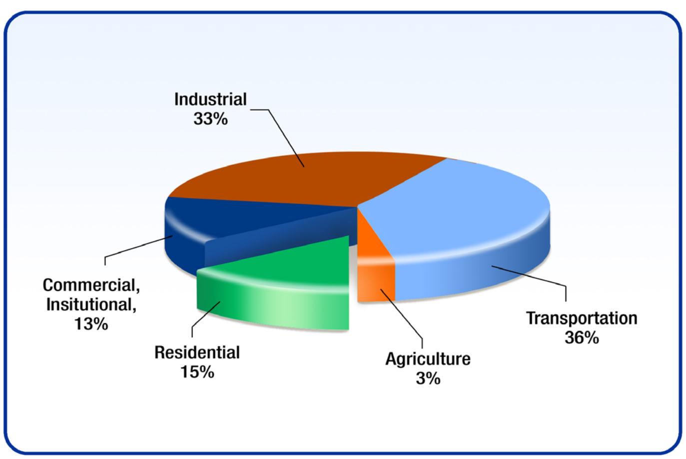
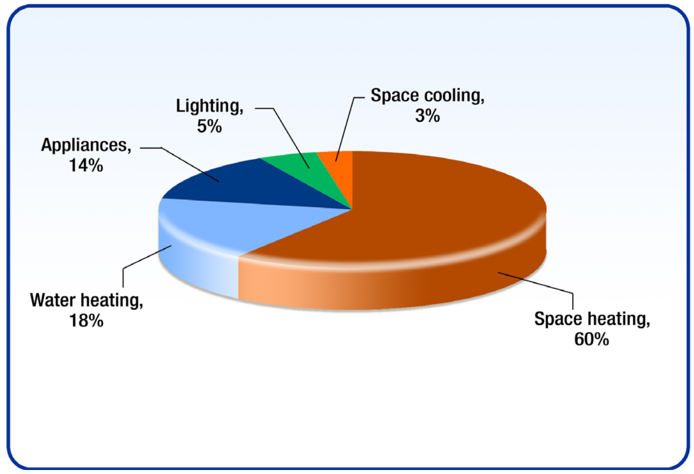


Figure 3.2 GHG emissions by sector, 2005 (percent)



Natural gas and electricity together accounted for 85 percent of all residential energy use in 2005. Wood, heating oil and propane were the other sources of energy being used. Within a household, these forms of energy were used for a variety of activities, as seen in Figure 3.3. Space and water heating account for the majority of Canada's residential use (78 percent), followed by appliances, lighting and air conditioning.

Figure 3.3 Distribution of residential energy use by end-use, 2005 (percent)



Trends – Residential energy use and GHG emissions

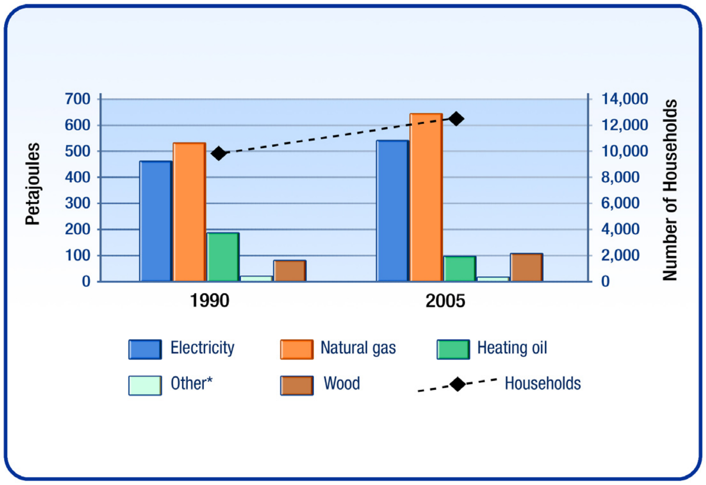
Population growth and fewer people per household stimulated a rise in the number of households and a 9 percent increase in residential energy demand from 1990 to 2005.

Between 1990 and 2005, residential energy use increased 9 percent or 116 PJ, from 1286 PJ to 1402 PJ. The associated GHG emissions grew 6 percent, from 69.4 Mt to 73.8 Mt. During the period, the population grew 17 percent (4.6 million people) and housing stock grew 27 percent (2.7 million households).

The 2.7 million households added in Canada since 1990 was significant and represented more than the number of households in Quebec in 1990 or three times the number of households in Alberta in 1990.

The mix of energy used in the residential sector has changed slightly over the period. Specifically, natural gas and electricity have become even more dominant and heating oil use has declined. These increases were largely the result of increased availability of natural gas and lower natural gas prices relative to oil.

Figure 3.4 Residential energy use by fuel type and number of household, 1990 and 2005



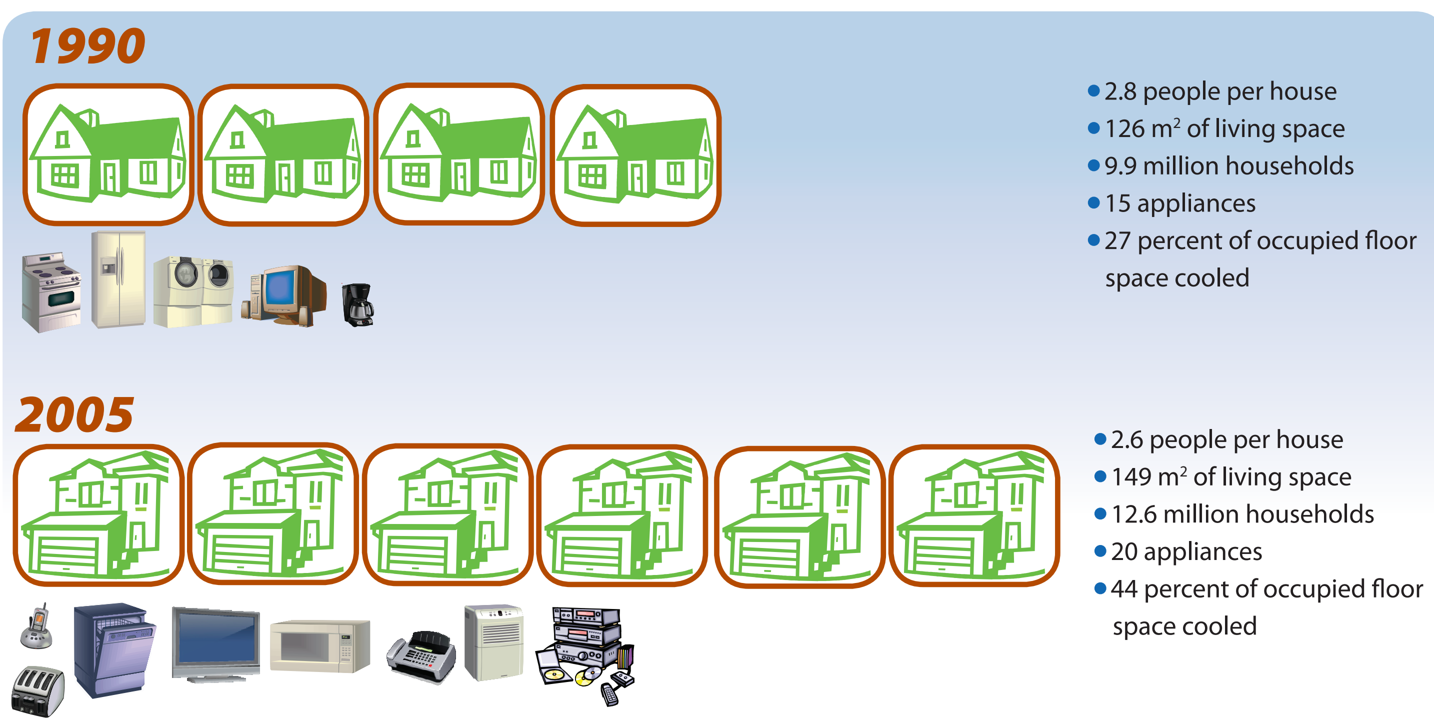
Canada has an aging population that tends to remain in their homes longer, in many cases long after their children have moved out. A falling birth rate and more young people living in single person households have contributed to a reduction in individuals per household from 2.8 in 1990 to 2.6 in 2005. This trend, coupled with population growth, has meant more dwellings built and therefore more energy consumed.

Canadians also used more devices that consume energy. For example, since 1990, Canadians use more minor appliances such as computers, televisions and microwaves, and choose to cool their homes during the summer months. These choices increased residential energy demand. The impact of these changes and the choices made by Canadians are further discussed in the following section, where each end-use is examined.

Canadians have bigger homes with fewer people living in them.

The choices Canadians made with respect to their living space also contributed to an increase in energy use. For example, homes built in 2005 were 149 square metres (m^2) on average. Homes built in 1990 had 126 m^2 of living space. Therefore, new homes are 19 percent bigger than homes built in 1990.

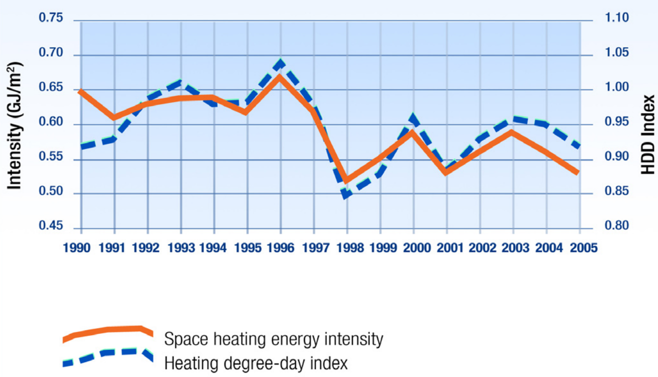
Figure 3.5 Residential energy indicators, 1990 and 2005



Trends – Residential space heating energy use and GHG emissions

Despite an 18 percent gain in space heating energy efficiency, total space heating energy use increased 8 percent between 1990 and 2005.

Figure 3.6 Space heating energy intensity and heating degree-day index, 1990-2005



The amount of energy used by the residential sector to heat each square metre of living space decreased 18 percent between 1990 and 2005. It decreased from 0.65 gigajoules per square metre (GJ/m^2) to 0.53 GJ/m^2. This decrease occurred mainly because more people chose natural gas over oil systems, and because natural gas furnaces became more efficient over this period.

Energy efficiency gains were realized because, to a large extent, less efficient systems were replaced with regulated medium and high efficiency systems. From 1990 to 2005, medium and high efficiency oil and gas systems increased their share of the oil and gas market from 6 percent to 48 percent.

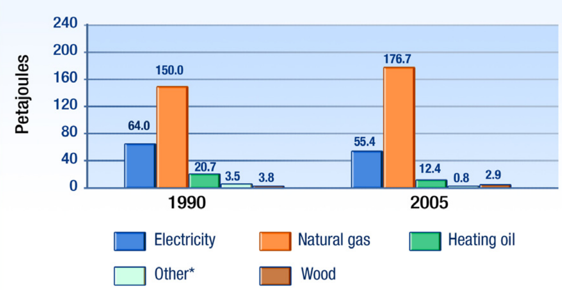
The amount of energy used to heat each square metre of living space in a Canadian home decreased. This was not enough to compensate for the fact that the number of households increased. Additionally, the average Canadian home was larger in 2005 than it was in 1990. Consequently, the energy required to heat all the dwellings in Canada increased from 782.7 PJ in 1990 to 846.1 PJ in 2005.

Trends – Residential water heating energy use and GHG emissions

Less energy is required per household for hot water due to increased use of natural gas and newer, more efficient water heaters.

Canadians shifted from using oil-fired water heaters to those that use natural gas and that are, on average, more energy efficient. In addition, current minimum energy performance standards mean that new water heaters use less energy than older models. As older stock is replaced by new stock, energy efficiency gains are realized. These changes resulted in an 18 percent decrease in the energy used per household for heating water (from 24.2 GJ per household to 19.7 GJ).

Figure 3.7 Water heating energy use by fuel type, 1990-2005



* Other includes coal and propane

Although there was a decrease in the energy used to heat water on a per household basis, a growing housing stock offset energy intensity improvements from new, more efficient equipment. The result was an overall increase of 4 percent in residential water heating energy use from 239 PJ to 248.2 PJ.

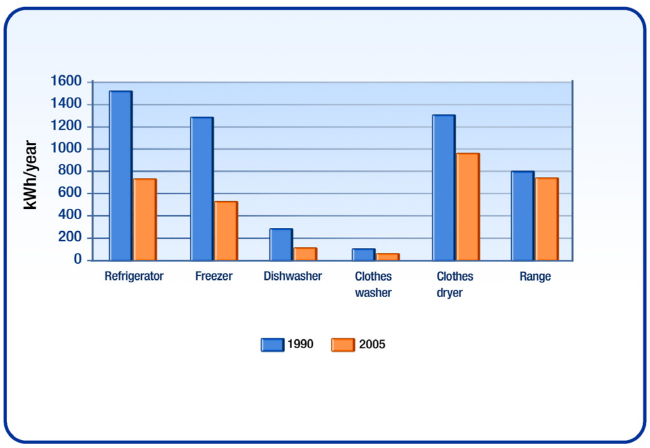
Trends – Residential appliance energy use and GHG emissions

The increased number of minor appliances offsets the benefits of the energy efficiency gains of major appliances.

The number of major appliances operated in Canada between 1990 and 2005 increased 38 percent. However, the total amount of energy that households used to power major appliances decreased 17 percent over the same period. In fact, the average unit energy use of all major household appliances decreased every year from 1990 to 2005.

The largest percentage decrease was in the unit energy use of dishwashers (see Figure 3.8), which in 2005 used 61 percent less energy than in 1990 (from 282 kilowatt hours [kWh] per year to 111 kWh per year).[3] A new fridge in 1990 used an average of 956 kWh per year versus 469 kWh per year in 2005, a decrease of 51 percent. These improvements in efficiency were due mainly to the introduction of minimum efficiency standards in the 1990s.

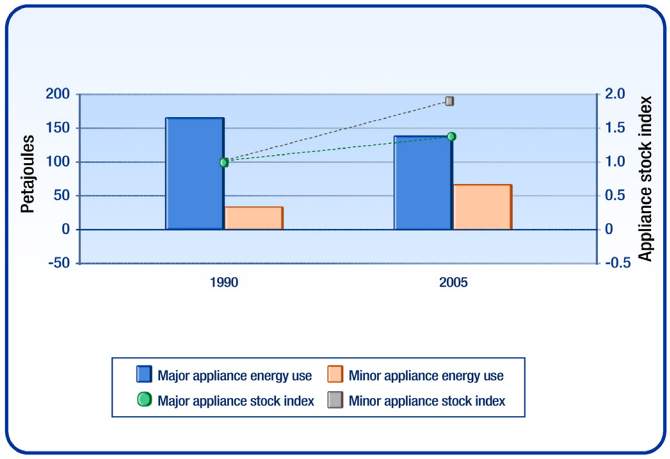
Figure 3.8 Unit energy consumption of major electric appliance stock, 1990 and 2005



In contrast to trends for major appliances, energy use for smaller appliances such as televisions, VCRs, DVDs, stereo systems and personal computers more than doubled (105 percent). This increase more than offset energy use reduction from major appliances. One example of the rapid growth in minor appliances is the increased penetration of personal computers. In 1990, computers were present in fewer than one of six households, but by 2005 were in more than five of seven households in Canada.

Energy demand for powering all household minor appliances more than doubled between 1990 and 2005. This increase of 33 PJ is equivalent to the energy required to provide lighting to almost half the homes in Canada in 2005.

Figure 3.9 Residential energy use and appliance stock index by appliance type, 1990 and 2005



Trends – Space cooling and GHG emissions

More Canadians live in air-conditioned homes during the summer months.

The amount of occupied floor space with space cooling more than doubled between 1990 and 2005. The percentage of floor space with space cooling went from 27 percent in 1990 to 44 percent in 2005. As a result, the energy required for cooling Canadian households rose from 11.6 PJ to 36.5 PJ over the period.

The increase in energy used for space cooling would have been more pronounced if not for efficiency improvements associated with room and central air conditioners. These cooled 33 percent and 16 percent of the space cooled stock, respectively.

[3] Excludes hot water requirements.

Figure 3.10 Space cooling stock and energy use, 1990-2005

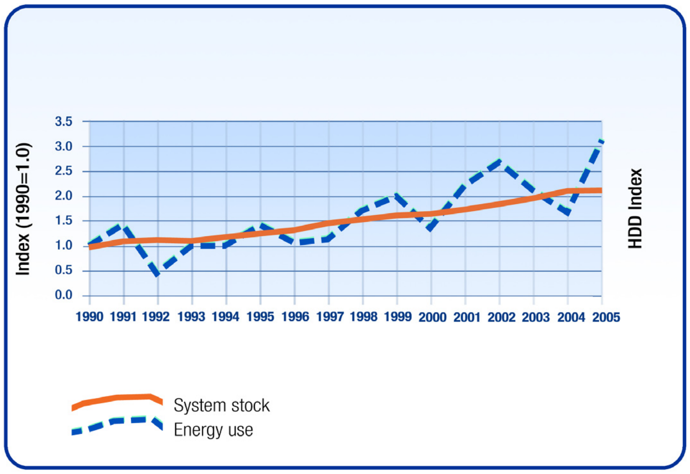
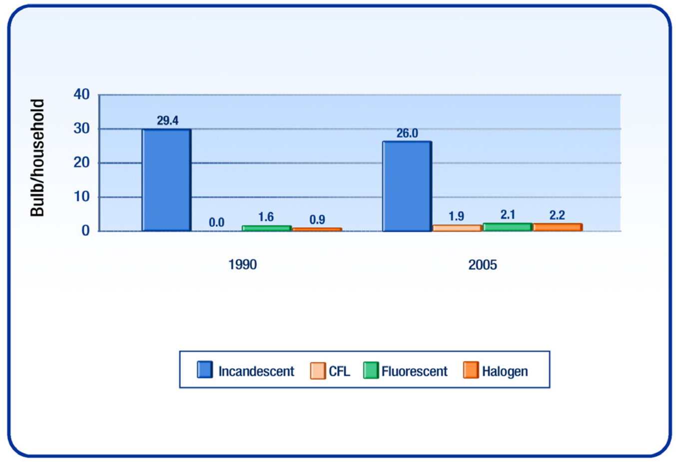


Figure 3.11 Number of light bulbs per household by bulb type, 1990 and 2005



Trends – Lighting energy use and GHG emissions

The market share of energy-efficient lighting alternatives increased between 1990 and 2005.

Despite a drop in lighting intensity, the energy required to light all households in Canada increased 23 percent, from 55.7 PJ to 68.4 PJ. This was due to the 27 percent increase in the number of households. The energy required to light each household in Canada decreased 3 percent, from 5.6 GJ to 5.4 GJ.

Some of the decrease in lighting intensity can be associated with the increased use of compact fluorescent lamps (CFLs), also known as compact fluorescent light bulbs, which use less energy to produce a certain level of light (Figure 3.11). CFLs represented 6 percent of light bulbs used in 2005[4] but were present in 32 percent of Canadian households in 2003.[5]

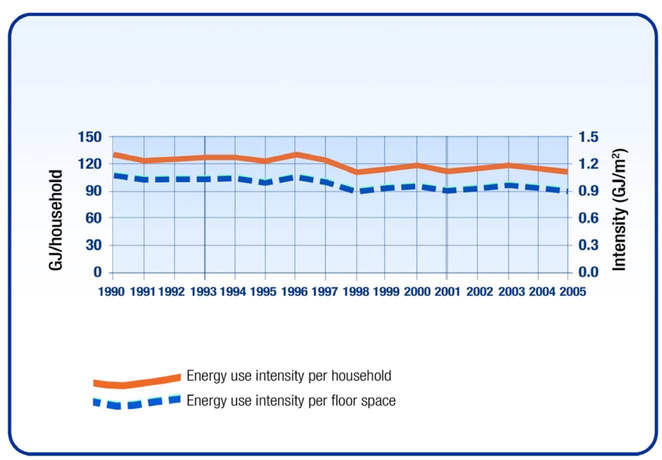
Residential energy intensity and efficiency

Energy intensity

The average household reduced its energy use by 14 percent.

In the residential sector, energy intensity is usually expressed as energy consumed per household. It can also be expressed as energy consumed per square metre of house area. Energy intensity decreased 14 percent, from 130.0 GJ per household in 1990 to 111.4 GJ in 2005. This occurred despite the average household operating more appliances, becoming larger, and increasing their use of space cooling. Energy intensity per square metre decreased 17 percent from 1.1 GJ to 0.9 GJ.

Figure 3.12 Residential energy intensity per household and floor space, 1990-2005



[4] Assumes CFLs entered the residential lighting market in 2000 and various bulb types are perfect substitutes. Trends are extrapolated from data collected from Natural Resource Canada, *Survey of Household Energy Use: 2003*, Ottawa, December 2005.

[5] Natural Resource Canada, *Survey of Household Energy Use: 2003*, Ottawa, December 2005.

Energy efficiency

Energy efficiency improvements resulted in an energy savings of $6.1 billion in the residential sector.

Energy efficiency improvements in the residential sector have resulted in significant savings between 1990 and 2005. These improvements include changes to the residential thermal envelope (insulation, windows, etc.) or changes to the efficiency of energy-consuming items in the home, such as furnaces, appliances and lighting.

Energy efficiency in the residential sector improved 25 percent from 1990 to 2005, allowing Canadians to save $6.1 billion in energy costs in 2005 and 320.9 PJ of energy.

These energy efficiency savings translate into an average savings of $488 per Canadian household in 2005.

Figure 3.13 Residential energy use, with and without energy efficiency improvements, 1990-2005

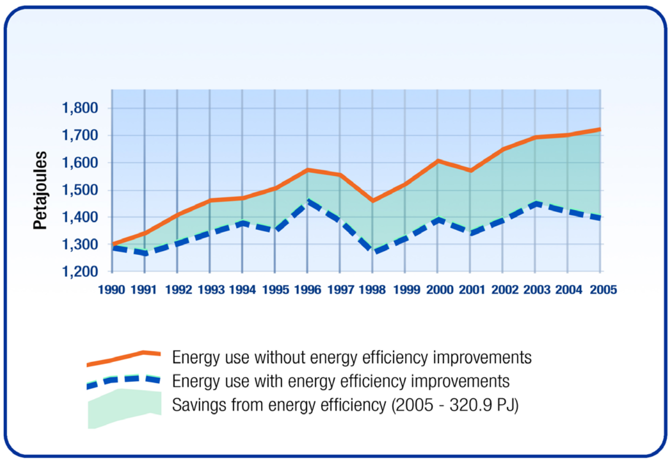


Figure 3.14 illustrates the influence that various factors had on the change in residential energy use between 1990 and 2005. These effects are the

- **activity effect** – As measured by combining a mix of households and floor space, energy use increased 30 percent (353 PJ). Growth in activity was driven by a 31 percent increase in floor area and by a rise of 27 percent in the number of households.

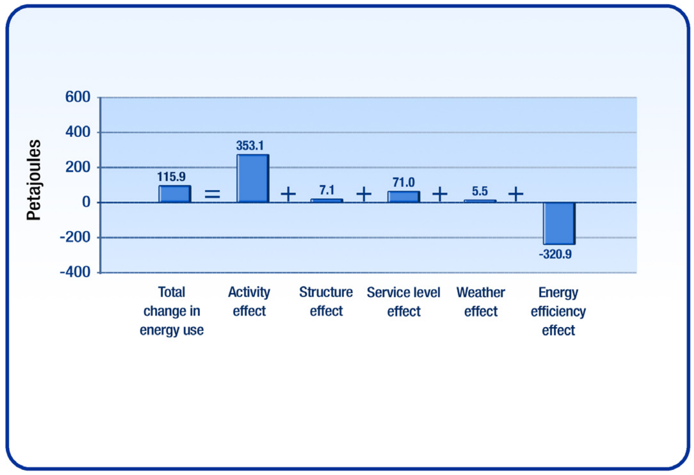
- **structure effect** – The increase in the relative share of households by dwelling type resulted in the sector using an additional 7.1 PJ of energy.

- **service-level effect** – The increased penetration rate of appliances and the increased floor space cooled by space cooling units were responsible for 71 PJ of the increase in energy.

- **weather effect** – In terms of degree days, the winter in 2005 was similar to the winter in 1990. However, the summer was warmer. The net result was that energy demand for temperature control in 2005 increased by 5.5 PJ compared to 1990.

- **energy efficiency effect** – Improvements to the thermal envelope of houses and to the efficiency of residential appliances and space and water heating equipment led to an overall energy efficiency gain in the residential sector. This saved 320.9 PJ of energy.

Figure 3.14 Impact of activity, structure, weather and energy efficiency on the change in residential energy use, 1990-2005



Chapter 4: Commercial/Institutional sector

Overview – Commercial/Institutional energy use and GHG emissions

In Canada, floor space for the entire commercial/institutional sector is equivalent to the area of the Island of Montréal.

Changes to the commercial/institutional historical floor space data

To continually improve our analysis, this year, the OEE reviewed the historical floor space estimates using the information provided by the *Commercial and Institutional Consumption of Energy Surveys* (CICES) for the reference years 2004 and 2005. These surveys were undertaken by Statistics Canada, on behalf of the OEE within Natural Resources Canada. A comparison between the floor space data provided by these surveys showed that CICES's floor space data were larger than previous estimates. This was especially true in the 2005 CICES, which had broader coverage than in 2004. In light of this information, the OEE reviewed the historical floor space estimates and, as a result, floor space estimates in this year's database are different from what was presented in previous reports.

In 2005, commercial business owners and institutions spent $23.8 billion on energy to provide services to Canadians. This represents approximately 3 percent of the value of goods produced by this sector. In 2005, this sector was responsible for 14 percent of the total energy use in Canada and produced 13 percent of the associated GHG emissions.

Figure 4.1 Total energy use by sector, 2005 (percent)

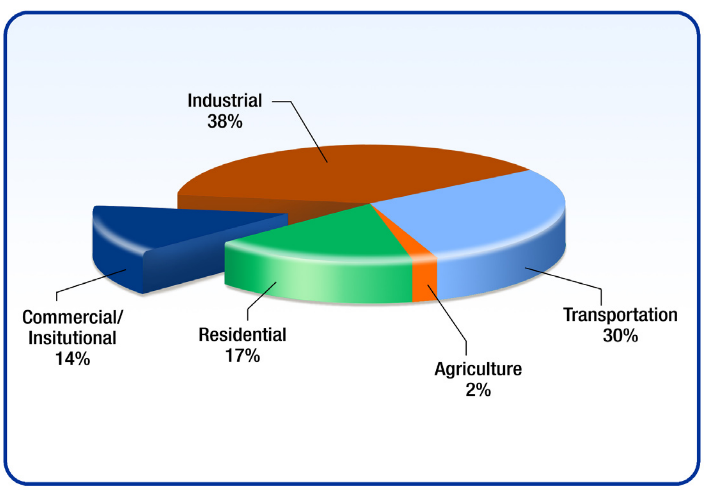
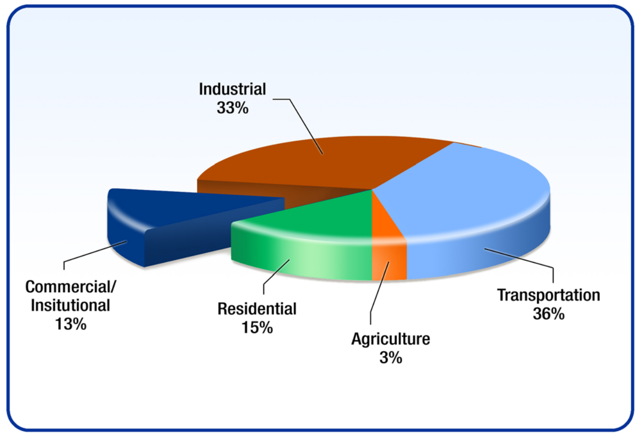


Figure 4.2 Total GHG emissions by sector, 2005 (percent)

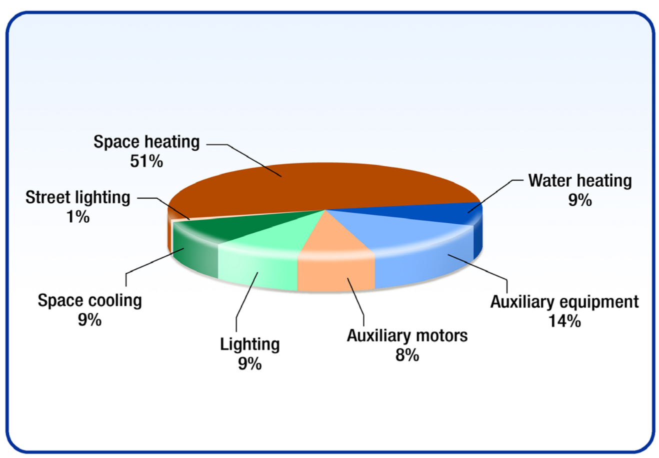


In the commercial/institutional sector,[6] energy is used for space heating, cooling, lighting, water heating, operating auxiliary equipment (such as computers) and auxiliary motors. Space heating accounts for the largest share of energy use in the sector with more than half of the total energy used for this purpose.

Included in the commercial/institutional sector are activities related to trade, finance, real estate, public administration, education and commercial services. These activities have been grouped into 10 subsectors (see Figure 4.4 for a complete listing of activities).

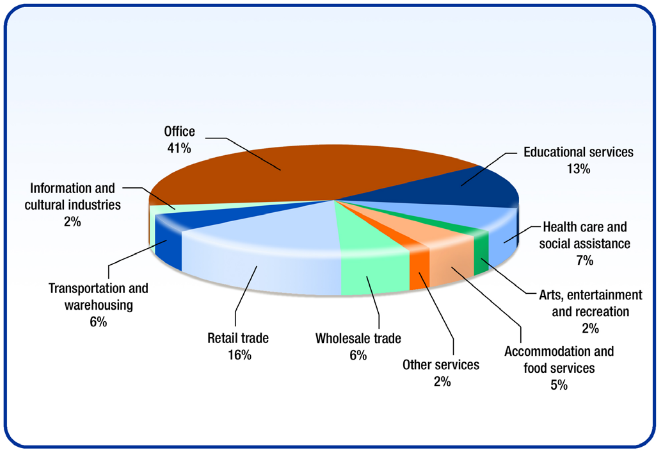
Together, offices, retail trade and educational services account for 70 percent of the total Canadian commercial square footage. In 2005, the floor space associated with commercial/institutional activities was estimated at 653.4 million (m^2).

Figure 4.3 Commercial energy use by end-use, 2005 (percent)



[6] Among the sectors presented in this document, the commercial/institutional sector has the most significant data limitations. Readers should keep this in mind while reviewing this chapter.

Figure 4.4 Commercial/institutional floor space by activity type, 2005 (percent)

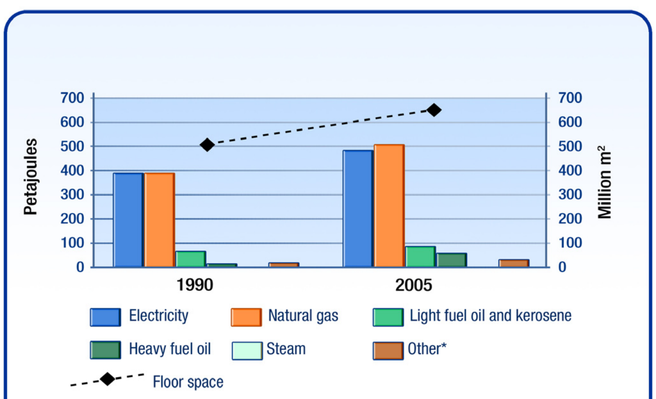


Trends – Commercial/Institutional energy use and GHG emissions

Between 1990 and 2005, the commercial/institutional sector was the second fastest growing sector with respect to energy use (transportation was first), but was the fastest growing sector with respect to GHG emissions.

From 1990 to 2005, total commercial/institutional energy use increased 33 percent, from 867 PJ to 1153 PJ, including street lighting. At the same time, GDP for the commercial/institutional sector grew 57 percent and the floor space grew 28 percent.

Figure 4.5 Commercial energy use by fuel type and floor space, 1990-2005



* Other includes coal and propane.

The GHG emissions associated increased 37 percent over the same period. The increase in the use of more GHG-intensive fuels, such as heavy oil and light fuel oil, explains why GHG emissions grew at a faster pace than energy use.

Natural gas and electricity are the main energy sources for the commercial/institutional sector, accounting for 86 percent of total energy use. There was a rapid growth in the use of heavy fuel oil (228 percent), light fuel oil and kerosene (77 percent) since 1999.

The reason for these increases is still unknown and may be due, in part, to the fact that these fuel types are erroneously attributed to the commercial sector. Fuel marketers included in the commercial/institutional sector are buying petroleum products from refineries and then reselling the fuel to other sectors (e.g. industrial, transportation). NRCan is working with Statistics Canada (SC) to determine the possible reasons for these anomalies in order to improve the quality of the commercial/institutional data reported.

The proliferation of auxiliary equipment such as computers, faxes and printers added to energy use in Canada since 1990.

As shown in Figure 4.6, of the seven end-uses, space heating and cooling, water heating and auxiliary equipment have contributed to commercial energy growth. This growth is consistent with an overall increase in commercial/institutional floor space in Canada.

Space heating continues to be the primary end-use in the sector. Energy use for space heating increased 24 percent between 1990 and 2005. Two other end-uses have large increases in energy requirement: auxiliary equipment, resulting from increasing computerization of work spaces, and space cooling, resulting from a higher cooling rate of commercial/institutional buildings.

Figure 4.6 Commercial energy use by end-use, 1990 and 2005

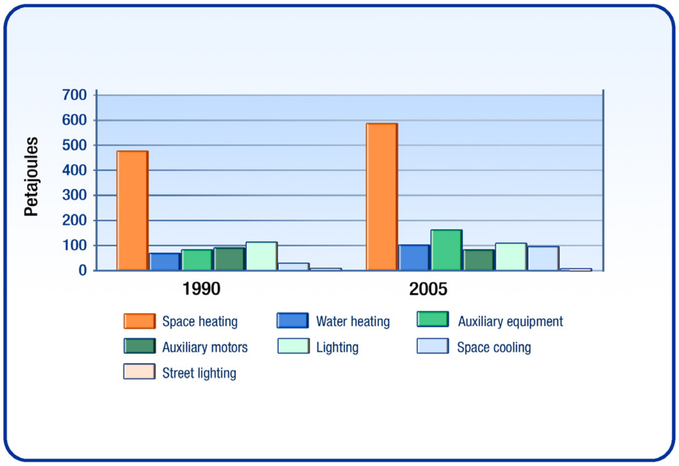
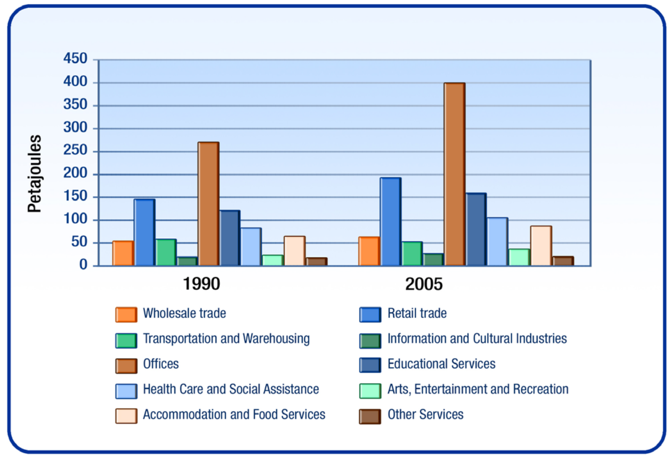


Figure 4.7 Commercial energy use by activity type, 1990 and 2005



The increase in office activities drove most of the increased demand for energy in Canada's commercial sector.

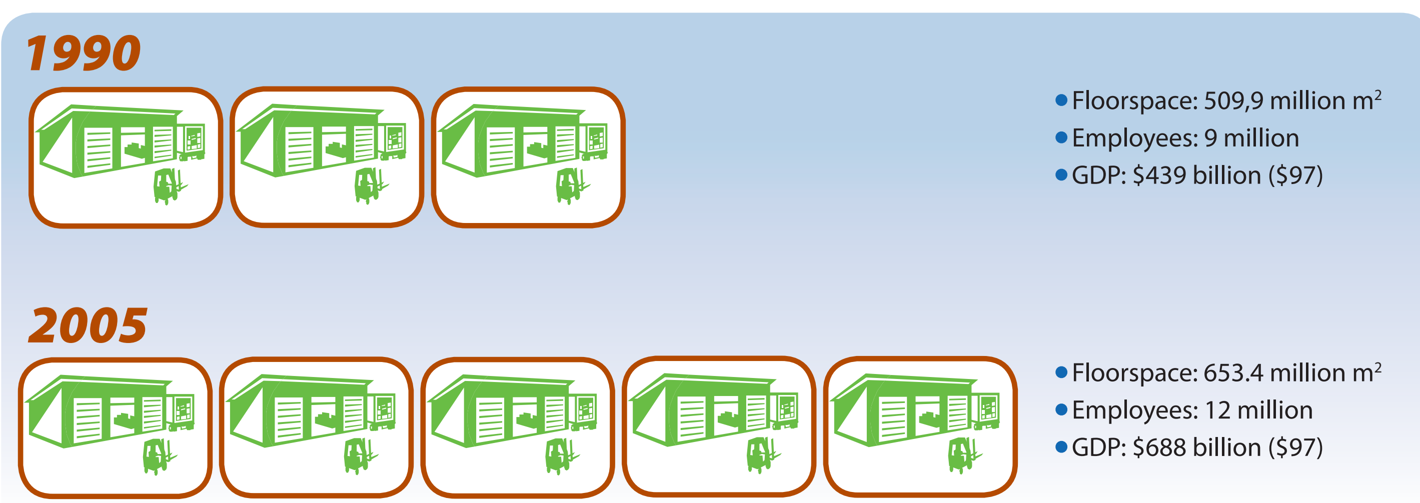
As shown in Figure 4.7, the office subsector accounted for the largest share of energy use in 2005 (35 percent). Retail trade (17 percent) and education services (14 percent) were the next largest users. Offices also had the largest increase in energy consumption, using 129.5 PJ more energy in 2005 than in 1990, followed by retail trade (46.8 PJ increase).

Twelve million people worked in Canada's commercial sector in 2005.

Several indicators can help describe the growth of energy use in the commercial sector, including the number of employees, floor space and GDP. Figure 4.8 shows that floor space increased 33 percent from 1990 and the number of employees in this sector increased 28 percent.

While some gains in energy efficiency were made in terms of overall floor space per employee, this was offset by an increase in energy requirements for auxiliary equipment. Not only was there an overall increase in computerization of the work environment in the commercial/institutional sector during this period but the actual number of devices required increased with employment.

Figure 4.8 Commercial energy indicators, 1990 and 2005



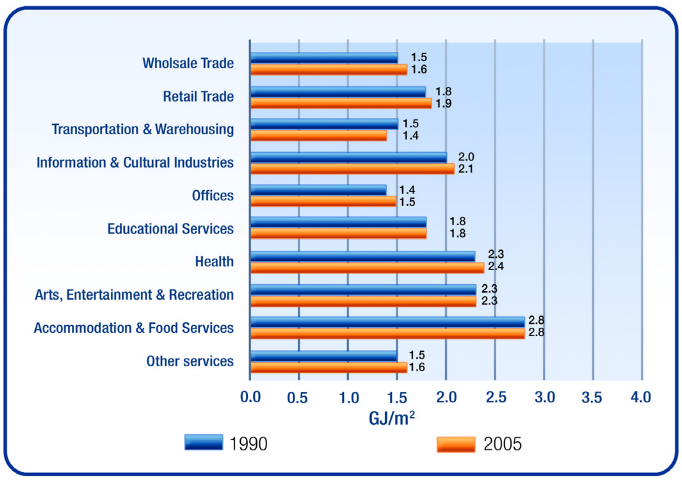
Commercial/Institutional energy intensity and efficiency

Energy intensity

Accommodation and Food Services is the most energy-intensive commercial/institutional activity.

In the commercial/institutional sector, energy intensity refers to the amount of energy used per unit of floor space (GJ/m²).

Figure 4.9 Commercial/institutional energy intensity by activity type, 1990 and 2005



Accommodation and Food Services consumed 2.8 GJ/m² in 2005, followed closely by Health Care and Social Assistance, which consumed 2.4 GJ/m². Combined, energy intensity of these two activities increased 3 percent between 1990 and 2005.

The rise in intensity may be attributable to an increase in energy-intensive activities (restaurants, laundry) and services (extensive hours of operation), as well as the addition of electronic equipment that has high energy requirements (such as medical scanners).

The commercial and institutional sector as a whole experienced a small increase in energy intensity of 4 percent in terms of energy consumed per unit of floor space (GJ/m²). But the sector improved its energy intensity by 15 percent when measured against economic activity (PJ/$97).

Energy efficiency

Energy efficiency improvements in Canada resulted in an energy savings of $1.6 billion in the commercial/institutional sector since 1990.

Energy efficiency improvements in the commercial/institutional sector are very similar to those in the residential sector. They include changes to the thermal envelope of buildings (insulation, windows etc.) and increased efficiency of various energy consuming items in commercial/institutional buildings such as furnaces, auxiliary equipment and lighting. The estimated energy efficiency improvements have resulted in a 75.4 PJ energy savings for this sector between 1990 and 2005

Figure 4.10 Commercial/institutional energy use, with or without energy efficiency improvements, 1990-2005

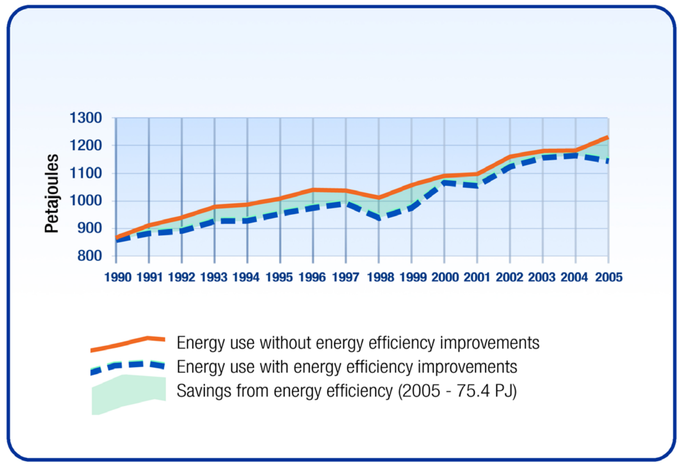


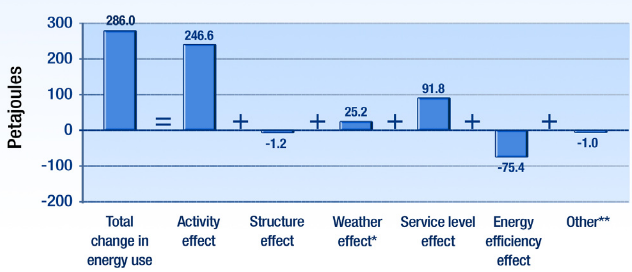
Figure 4.11 illustrates the influence that various factors had on the change in commercial/institutional sector energy use between 1990 and 2005. These effects are the

- **activity effect –** An increase in floor space increased energy use 28 percent (246.6 PJ) and led to an increase of 14.0 Mt in GHG-related emissions.
- **structural effect –** The effect of structure changes in the sector (the mix of activity types) was small – a decrease of 1.2 PJ in energy use and 0.1 Mt in GHG-related emissions.
- **weather effect –** The winter of 2005 was similar to the winter of 1990, but the summer was warmer. The net result was a 25.2 PJ increase in energy demand in the commercial/institutional sector for space conditioning. GHG-related emissions rose by 1.4 Mt.

- **service level effect –** An increase in space cooling and in the service level of auxiliary equipment, which is the penetration rates of office equipment, (e.g. computers, fax machines and photocopiers), led to a 91.8 PJ increase in energy use and a 5.2 Mt increase in GHG-related emissions.

- **energy efficiency effect –** Improvements in the energy efficiency of the commercial/institutional sector saved 75.4 PJ of energy and 4.3 Mt of related emissions.

Figure 4.11 Impact of activity, structure, weather, service levels and energy efficiency on the change in commercial/institutional energy use, 1990-2005



* The service level effect refers to the increased use of auxiliary equipment and office equipment.

* * Other refers to street lighting, which is included in total energy use but excluded from the factorization results.

Chapter 5: Industrial sector

Overview – Industrial energy use and GHG emissions

The industrial sector used the most energy of any sector in Canada but had fewer GHG emissions than the transportation sector.

The industrial sector includes all manufacturing, mining, forestry and construction activities. In 2005 alone, these industries spent $36.2 billion for energy. Total energy use by industry accounted for 38 percent of the total energy use and 33 percent of end-use GHG emissions. Using more diverse energy sources, such as less GHG-intensive biomass, explains the relatively smaller share of GHG emissions associated with the industrial sector compared to its share of energy.

Figure 5.1 Energy use by sector, 2005 (percent)

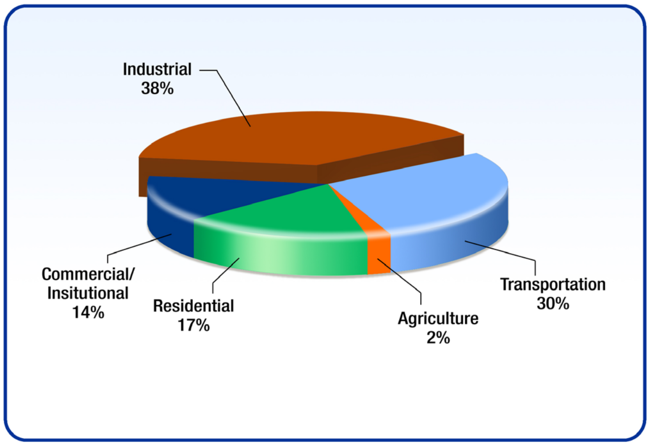
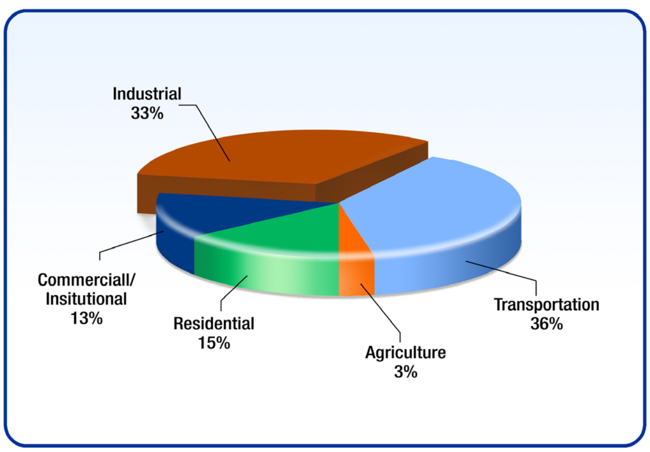


Figure 5.2 GHG emissions by sector, 2005 (percent)



The level of economic activity in an industry is not necessarily proportional to energy use.

In 2005, the industrial sector's share of GDP accounted for 27 percent of the Canadian total (excluding agriculture). The main contributor to industrial GDP was the other manufacturing industry, which includes a variety of activities such as food and beverage, textile, computer and electronic industries. Construction and mining were the only two other industries that contributed more than 10 percent to the industrial sector's GDP (see Figure 5.4).

Although GDP is an indicator of economic activity, a notable characteristic of the industrial sector is that the industry with the highest activity level does not necessarily use the most energy. For example, in Figure 5.4, the pulp and paper industry is responsible for 4 percent of economic activity but 26 percent of industrial energy use. In contrast, an industry such as construction is responsible for 22 percent of the economy but only 2 percent of industrial energy use (see Figure 5.4).

Figure 5.3 Distribution of energy use by industry, 2005 (percent)

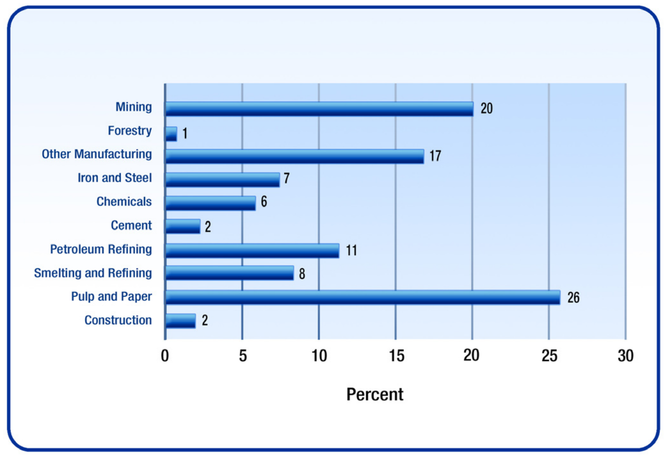
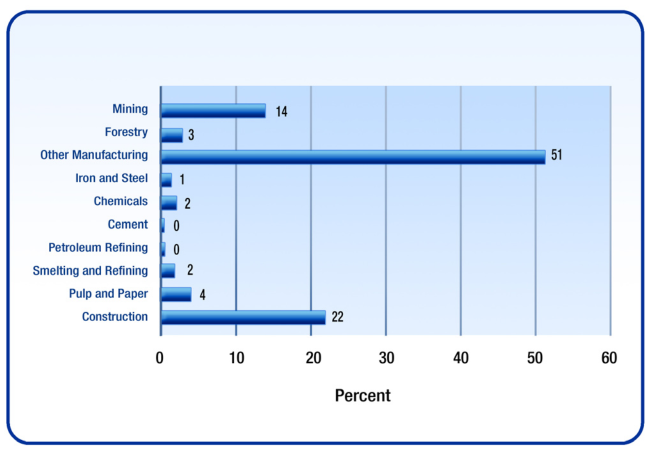


Figure 5.4 Distribution of activity by industry, 2005 (percent)



Variation of fuel use by industry

In the industrial sector, energy is used primarily to produce heat, to generate steam or as a source of motive power. For example, coal is one of the types of energy used by the cement industry to heat cement kilns. Many other industries use natural gas to fuel boilers for steam generation and electricity to power motors for pumps and fans.

Natural gas and electricity were the main fuels used in the industrial sector in 2005, meeting 28 percent and 27 percent, respectively, of the energy needs of the sector. Wood waste and pulping liquor (14 percent) and still gas and petroleum coke (14 percent) were the other most commonly used fuel types.

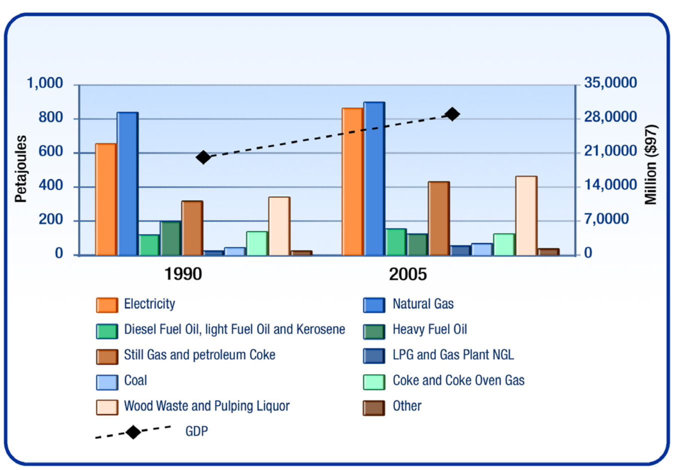
The type of energy used varies greatly depending on the industries in which it is used. Although electricity is used in virtually the entire sector, it is the pulp and paper and the smelting and refining industries that require the most electricity. Combined, these two industries account for more than 51 percent of the sector's electricity use.

Wood waste and pulping liquor are primarily used in the pulp and paper industry because they are recycled materials produced by only this industry. However, some of the electricity produced from these materials is sold to other industries.

Trends – Industrial energy use and GHG emissions

From 1990 to 2005, industrial energy use increased 18 percent, from 2722 PJ to 3209 PJ. The associated end-use GHG increased 16 percent, from 142 Mt to 164 Mt. GDP increased 44 percent from $200 billion ($97) in 1990 to $288 billion ($97) in 2005.

Figure 5.5 Industrial energy use by fuel type and GDP, 1990 and 2005



Generally, fuel shares remained relatively constant between 1990 and 2005. Fuel consumption for all fuel types increased during this period. The exceptions were heavy fuel oil (HFO), which experienced a 37 percent decrease, and coke and coke oven gas, which decreased 6 percent.

One reason for the decline in use of HFO was that the pulp and paper industry, the largest user of HFO, adopted alternate forms of fuels such as pulping liquor. Fuel switching was facilitated by the use of interruptible contracts, with energy suppliers allowing the industry to react to changes in relative prices of fuels.

Forestry, mining, smelting and refining, cement, and pulp and paper have all experienced large growth in energy use since 1990. However, forestry and cement consume proportionally less energy than the other three sectors (mining, smelting and refining, and pulp and paper). "Trends – Mining energy use and GHG emissions" describes in greater detail the trends for these three main contributors to energy demand in the industrial sector. Given the relative size of the other manufacturing subsector, further details will also be provided.

Trends – Mining energy use and GHG emissions

The mining industry comprises industries engaged in oil and gas extraction, coal mining, metal ore mining, non-metallic mineral mining, and quarrying and support activities for mining and oil and gas extraction. [7]

Activity in the oil sands was the main driver in the increase in energy demand from the mining industries.

Since 1990, the mining industry's energy consumption grew 86 percent and its associated end-use emissions grew 79 percent.

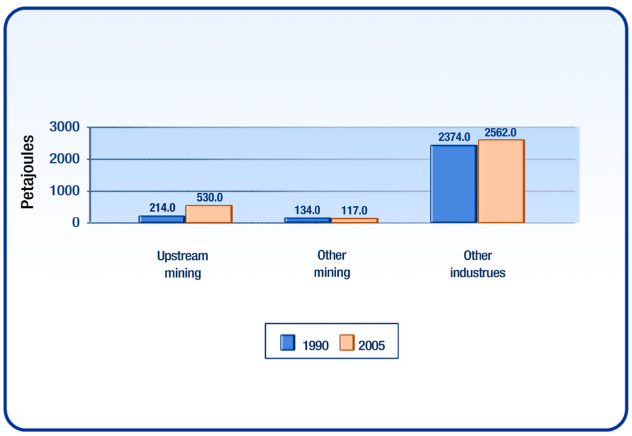
Growth in the mining sector was mainly driven by the upstream mining component, which includes oil sands mining operations. Since the late 1990s, production from non-conventional resources (oil sands) increased. Driven by technological advances, which have lowered production costs, and by additional revenue from higher crude oil prices, investment in oil sands projects has become much more attractive.

[7] NAICS code 21 excluding 213118, 213119 and part of 212326.

The production of bitumen and synthetic crude oil in 1985 was 35 000 cubic metres per day (m^3/day). It reached 68 000 m^3/day by 1996 and climbed to 175 000 m^3/day by 2005. This rise is the principal factor explaining the increase of 148 percent in the energy used by the upstream mining industry since 1990.

Energy use is also reflected in the economic activity of the sector. The GDP of the mining industry increased 48 percent over the 1990–2005 period, from $26.9 billion ($97) to $39.8 billion ($97), compared to a 44 percent increase for the entire industrial sector. Again, upstream mining was the biggest contributor, representing $31 billion ($97) of Canada's GDP in 2005.

Figure 5.6 Industrial energy use by selected industry, 1990 and 2005



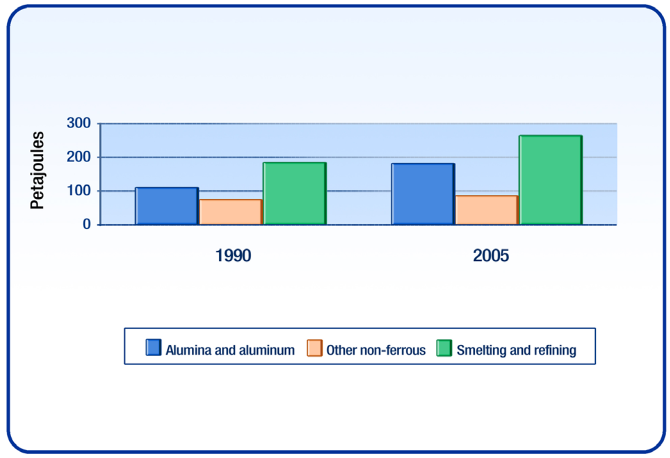
Trends – Smelting and refining energy use and GHG emissions

The smelting and refining industries are primarily engaged in the production of aluminum, nickel, copper, zinc, lead and magnesium.

The smelting and refining subsector is the third-largest contributor to growth in energy demand. This was mainly driven by economic growth, as the GDP increased from $2.5 billion ($97) in 1990 to $5.1 billion ($97) in 2005 – a 104 percent increase. During the same period, associated GHG emissions increased 48 percent.

The primary production of alumina and aluminum was responsible for most of the 64 percent growth in energy use in this subsector since 1990. This increase is consistent with the growth in the production of aluminum, which grew 85 percent between 1990 and 2005.

Figure 5.7 Smelting and refining energy use by selected industry, 1990 and 2005

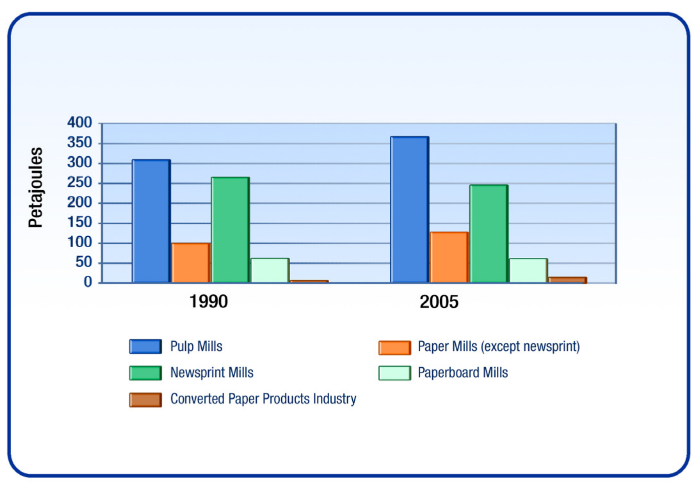


Trends – Pulp and paper energy use and GHG emissions

The pulp and paper industries are primarily engaged in the manufacturing of pulp, paper and paper products. The pulp and paper industry is the only industry using biomass as a source of energy.

Pulp and paper production, the most energy-consuming industrial activity with a 26 percent share of sectoral energy used, increased its energy use by 10 percent since 1990. Pulp and paper mill output increased 51 percent and 73 percent, respectively, since 1990.

Figure 5.8 Energy consumption by subsector of pulp and paper industry, 1990 and 2005



Trends – Other manufacturing energy use and GHG emissions

Other manufacturing is a residual category of manufacturing industries not classified elsewhere in the industrial sector definition we use in this analysis. This category includes many industries, such as wood products, food and beverage, and motor vehicle manufacturing.

The biggest energy consumer in the other manufacturing category is the wood products industry. These establishments are engaged in

- sawing logs into lumber and similar products, or preserving these products
- making products that improve the natural characteristics of wood, for example, by making veneers, plywood, reconstituted wood panel products or engineered wood assemblies
- making a diverse range of wood products such as millwork

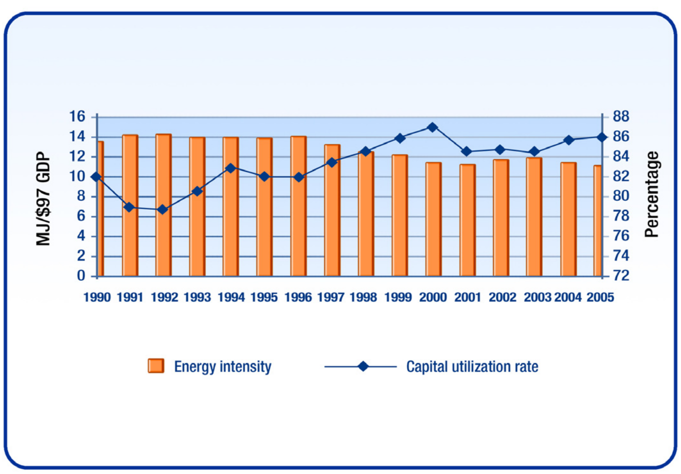
This industry represented 13 percent of the other manufacturing subsector's energy use, with 69.5 PJ. Its average annual increase is 0.8 percent.

Industrial energy intensity and efficiency

Energy intensity

Several factors influenced the trends in energy use and energy intensity. Since 1990, energy intensity decreased at an average rate of 1.3 percent per year, from 13.6 MJ/$97 – GDP in 1990 to 11.2 MJ/$97 – GDP in 2005.

Figure 5.9 Capacity utilization and energy intensity per year

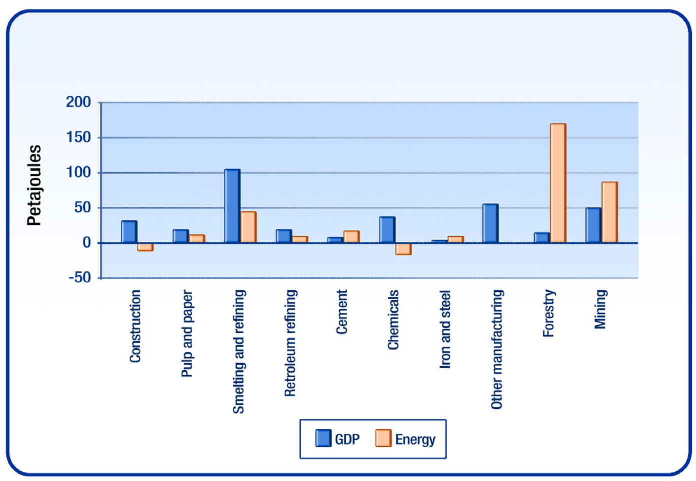


Energy efficiency improvements in the form of more efficient capital and management practices are important factors. Another key variable closely linked to energy intensity is the capacity utilization rate. This rate is calculated by dividing the actual production level for an establishment (measured in dollars or units) by the establishment's maximum production level under normal conditions. Since 1990, capacity utilization increased by 5 percent; this means that industries are getting closer to their optimum production level, and thus becoming more efficient.

At the aggregate industry level, 6 of the 10 industries reduced their energy intensity[8] over the 1990 to 2005 period. Four industries experienced an increase: mining, iron and steel, cement, and forestry. The biggest increase in energy intensity was in forestry, with a 139 percent increase. The main factor contributing to this increase is the use of diesel fuel oil (partially used for hauling). In the mining sector, the move toward unconventional crude oil production contributed to the increase in the energy intensity.

Gains in energy efficiency and a shift toward less energy-intensive activities were contributing factors to the subsectors that decreased their energy. In 2005, the share of industries that used more than 6 MJ per dollar of GDP represented 24 percent of total industrial GDP. This number is down from 42 percent in 1990.

Figure 5.10 GDP and energy use increase, 1990-2005



[8] MJ/($97) – GDP

Energy efficiency

Since 1990, energy efficiency in the industrial sector improved 13 percent. In 2005 alone, Canadian industry saved $3.9 billion in energy costs and 347.3 PJ of energy. The improvement in energy efficiency was largely the result of improvements in energy intensity. The energy savings due to the energy efficiency improvements made by some industries were offset by increases in consumption by the upstream mining, fertilizer and forestry subsectors.

Figure 5.11 Industrial energy use, with or without energy effiency improvements, 1990-2005

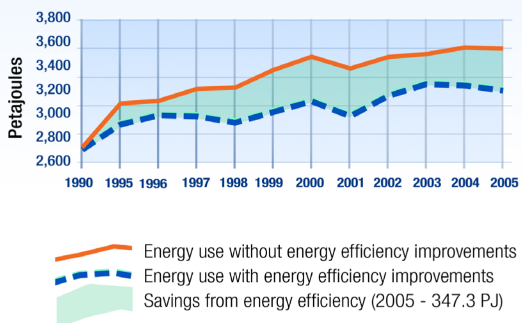


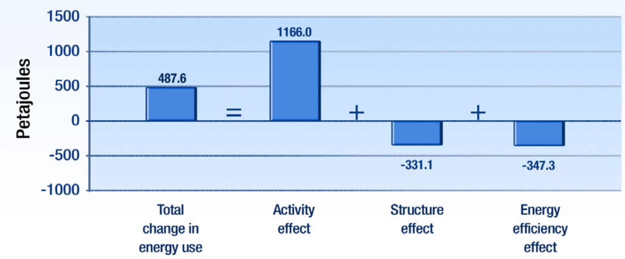
Figure 5.12 illustrates the influence that various factors had on the change in industrial energy use between 1990 and 2005. These effects are the

- **activity effect –** The mix of GDP, Gross Output (GO) and production units increased the energy use 43 percent or 1166.0 PJ.

- **structure effect –** The 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 by 331.1 PJ. Note that industries consuming more than 6 MJ per dollar of GDP (e.g. pulp and paper, petroleum refining, upstream mining) represented 42 percent of industrial GDP in 1990. However, they accounted for only 24 percent in 2005.

- **energy efficiency effect –** Improvements in the energy efficiency of the industrial sector avoided 347.3 PJ of energy use.

Figure 5.12 Impact of activity, structure, and energy effects on the change in industrial energy use, 1990-2005



Chapter 6: Transportation sector

Overview – Transportation energy use and GHG emissions

Transportation is second to the industrial sector in terms of energy use, but accounted for the largest share of end-use GHGs in 2005.

The transportation sector is a diverse sector that includes several modes: road, air, rail and marine transport. Canadians use these modes to move both passengers and freight. This chapter describes the energy consumed for these two groups.

In 2005, Canadians (people and companies) spent $60.8 billion on transportation fuels, the most of any sector in Canada and $24.6 billion more than was spent in the industrial sector. The reason for this high level of spending is the notably higher cost of transportation fuels compared to the fuels used in other sectors.

Also, the transportation sector used the second largest amount of energy in Canada at 30 percent of the total, and produced the largest portion of end-use GHG emissions (36 percent). Transportation produces a larger share of the GHG emissions because the main fuels used by the sector are more GHG intensive compared with other areas of the economy.

Figure 6.1 Energy use by sector, 2005 (percent)

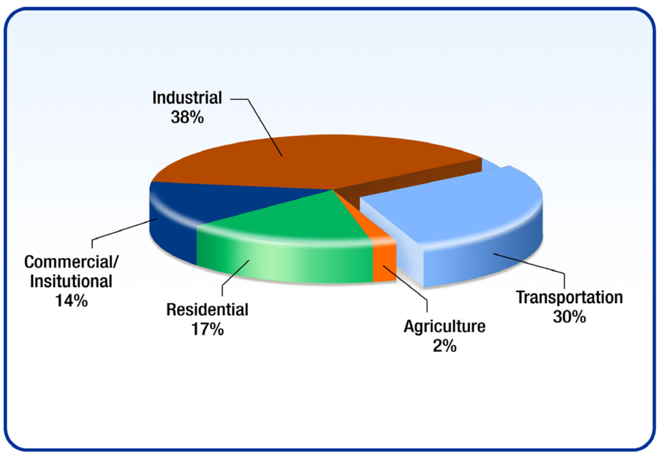
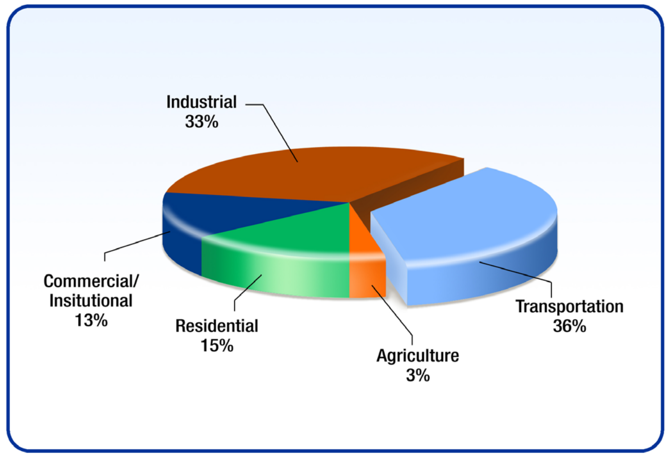
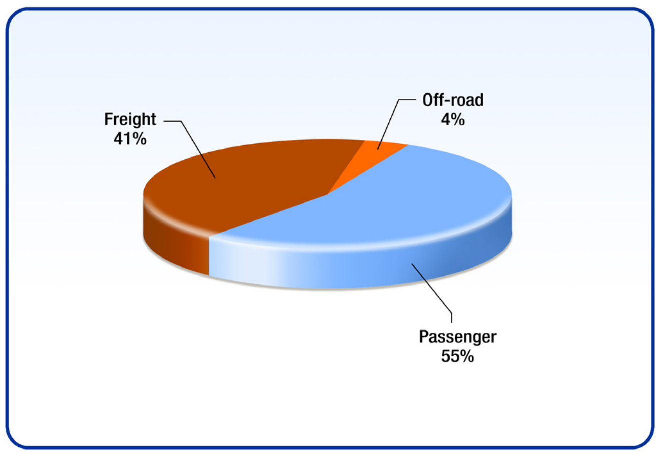


Figure 6.2 GHG emissions by sector, 2005 (percent)



In the transportation sector, passenger modes consumed 55 percent of total energy use, while the freight subsector used 41 percent and off-road vehicles used the remaining 4 percent. Off-road vehicles include such items as snowmobiles and lawnmowers. Off-road transportation is not analysed in this report because little data is available for these items, and they consume only a small portion of the overall transportation energy use.

Figure 6.3 Energy use by subsector, 2005 (percent)



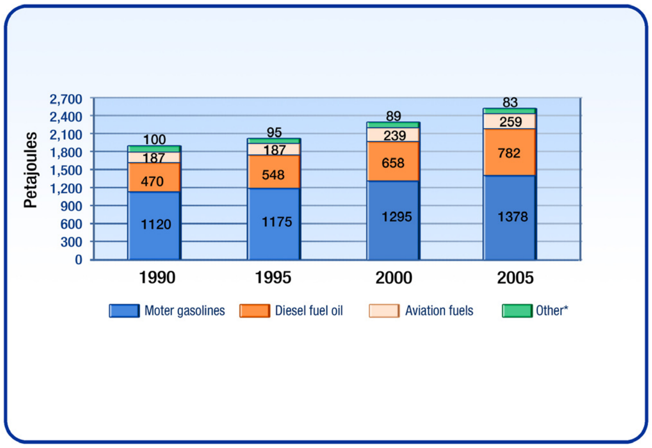
Trends – Transportation energy use and GHG emissions

Growth in freight transport drove energy demand in the transportation sector.

Between 1990 and 2005, total transportation energy use increased 33 percent from 1878 PJ to 2502 PJ and the associated GHGs increased 32 percent from 134.7 Mt to 177.5 Mt.

Freight was the fastest growing subsector, accounting for 63 percent of the change in total transportation energy use. Heavy trucks, which have been growing in popularity for moving goods but are more energy intensive than other modes, explain 78 percent of this increase in freight energy use.

Figure 6.4 Transportation sector energy use by energy source, selected years



Growth in freight transportation contributed to a 66 percent increase in the demand for diesel fuel.

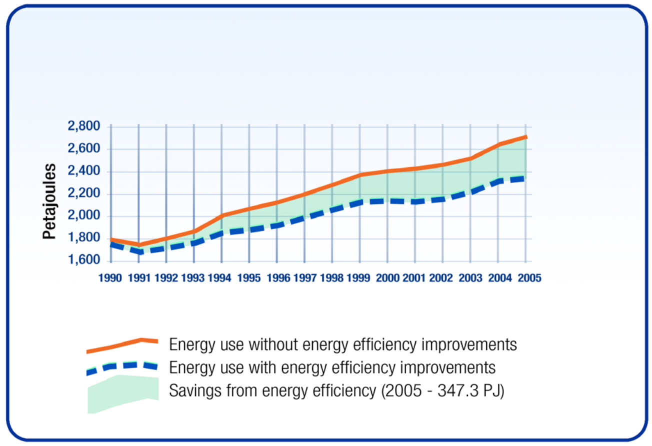
Motor gasoline and diesel fuel oil are the main fuels used in the transportation sector, accounting for 86 percent of the total. In order of use, aviation turbo fuel, heavy fuel oil, propane, electricity, aviation gasoline and natural gas are the remaining fuels that are used for transport. The overall use of diesel fuel increased more than any other fuel because of the large increase in freight activity. However, total diesel use is still less than motor gasoline use. Aviation gasoline and propane are the only fuels whose use decreased over the period.

Transportation energy efficiency

Energy efficiency improvements in transportation resulted in an energy saving of 352.4 PJ in 2005 or $8.5 billion for Canada.

Between 1990 and 2005, energy efficiency in the transportation sector improved 19 percent, leading to a savings of $8.5 billion and 352.4 PJ of energy. These savings were largely a result of improvements in the energy efficiency of heavy trucks and passenger light-duty vehicles. Small savings at the level of individual vehicle types in these modes can have a large impact on the total because these two types of vehicles comprise the majority of transportation use.

Figure 6.5 Transportation energy use, with or without energy efficiency improvements, 1990-2005



Trends – Passenger transportation energy use and GHG emissions

Light-duty vehicles (small cars, large cars, light trucks and motorcycles) represent the main types of transportation used by Canadians for passenger transportation. Air, bus and rail modes are also used, but to a lesser extent.

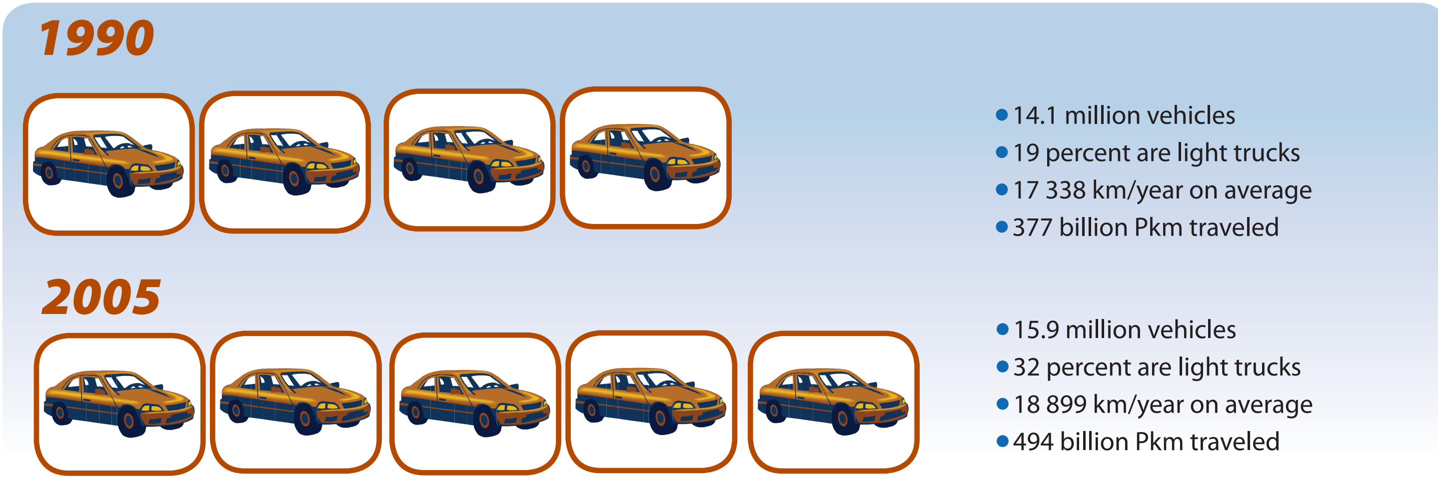
For the passenger transportation subsector, energy use is related to passenger-kilometres (Pkm). A Pkm is calculated by multiplying the number of passengers carried by the distance traveled. Therefore, two passengers traveling in a car for 10 km equals 20 Pkm. As the number of Pkm increases, a rise in energy use often occurs, unless energy efficiency improvements have taken place.

More vehicles on the road are driving longer distances, on average.

Energy use in passenger transportation increased 16 percent from 1188 PJ to 1376 PJ between 1990 and 2005. The associated GHG emission increase was 14 percent from 84.6 Mt to 96.2 Mt. During the same period, Canada experienced a 24 percent increase in registered drivers,[9] a 13 percent increase in the number of light-duty vehicles registered, and a 9 percent increase in the average passenger distance driven.

[9] Transport Canada, Canadian Motor Vehicle Traffic Collision Statistics: 2005, Ottawa, December 2006 (Cat. T45-3/2005).

Figure 6.6 Passenger transportation energy indicators, 1990–2005



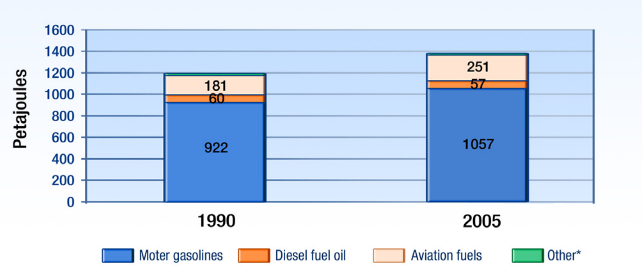
Personal vehicles are the main form of passenger transportation in Canada. Consequently, the increase in the number of drivers, the number of vehicles and the distance that vehicles are driven heavily influenced the total Pkm traveled. As a result, overall Pkm increased 34 percent during the period. However, energy use rose by only 16 percent. The difference in these two values can be attributed to changes in the types of vehicles used for passenger transportation and improvements in energy efficiency.

The mix of fuels for passenger transport remained relatively constant. Motor gasoline is the main source of energy, representing 77 percent of the fuel mix in 2005, followed by aviation turbo fuel and diesel fuel.

More Canadians drive minivans and SUVs.

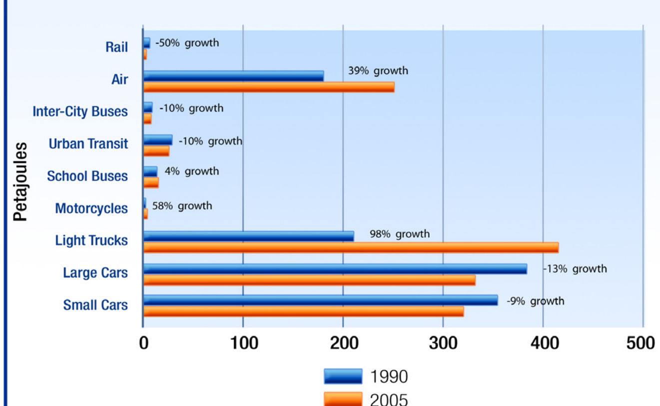
The choices that Canadians make to meet their transportation needs contribute to the growth in energy use. More Canadians bought minivans and sport utility vehicles (SUVs /light trucks) instead of cars, which are often more fuel efficient. In 2005, 38 percent of all new passenger vehicle sales were light trucks. This change led to a large increase and shift in passenger transportation energy use toward light trucks and away from cars. Between 1990 and 2005, light truck energy use increased more quickly than any other passenger transportation mode, rising 98 percent.

Figure 6.7 Passenger transportation energy use by fuel type, 1990 and 2005



* Aviation fuels include aviation turbo fuel and aviation gasoline.
** Other includes electricity, natural gas, heavy fuel oil and propane.

Figure 6.8 Passenger transportation energy use by mode, 1990 and 2005



Air transport is rising in popularity.

Canadians increased their use of planes. The popularity of air transportation lead to a increase of 65 percent in aviation Pkm over the period. This increase in activity is a result of both more flights and more passengers per plane compared to 1990. Therefore, this rise of 65 percent in Pkm caused a 39 percent increase in energy use since 1990.

Shared public transit is on the decline.

While road and aviation transportation activity increased, use of shared passenger transit such as trains, buses and tramways decreased since 1990. The most significant decreases were in passenger rail travel (17 percent) and intercity bus travel (8 percent). Urban transit also decreased (5 percent) in Pkm since 1990.

Passenger transportation energy intensity and efficiency

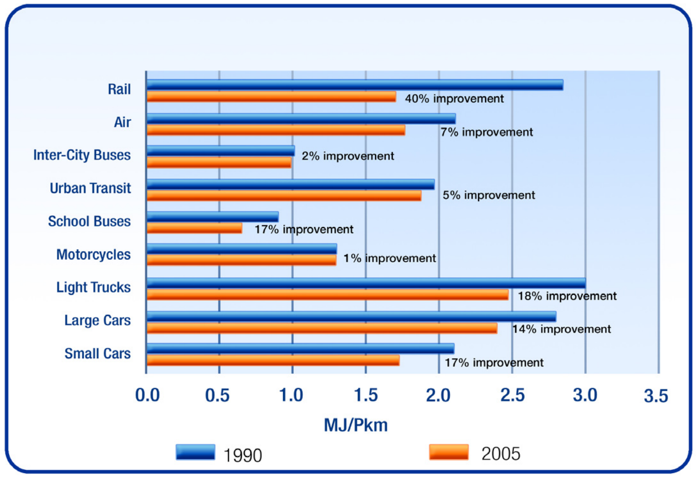
Energy intensity

Passenger transportation energy intensity, defined as the amount of energy required to move one person over 1 km, improved from year to year. Between 1990 and 2005, energy intensity improved 13 percent from 2.4 megajoules (MJ) per Pkm traveled to 2.1 MJ per Pkm. An improvement in vehicle fuel efficiency is the main reason for this change.

In the period, the average fuel efficiency improved for all types of on-road vehicles except motorcycles. Average fuel efficiency is measured by litres used per 100 kilometres (L/100km).

As expected, light trucks have a higher energy intensity level than passenger cars because they also have a higher rate of fuel consumption. This higher energy intensity, combined with the increase in popularity of light trucks, increased passenger energy use.

Figure 6.9 Passenger transportation energy intensity by mode, 1990 and 2005

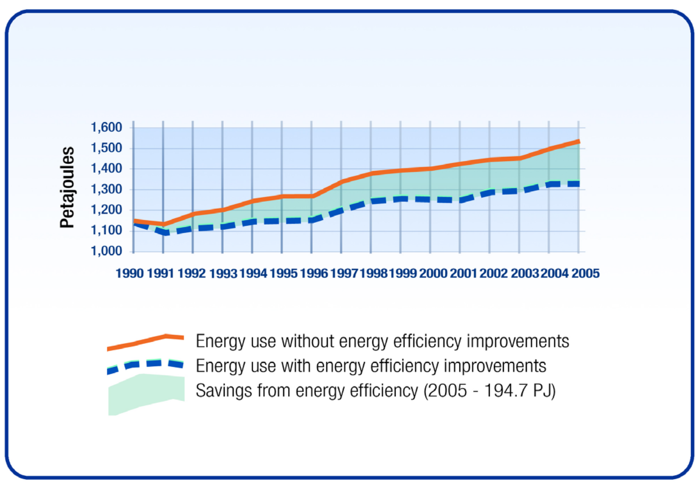


Energy Efficiency

Energy efficiency improvements in passenger transportation caused an energy savings of 194.7 PJ or $4.8 billion in the transportation sector.

The amount of energy used for passenger travel increased 16 percent, rising from 1188 PJ in 1990 to 1376 PJ in 2005. Also, energy-related GHG emissions increased 14 percent, from 84.6 Mt to 96.2 Mt.[10] Without energy efficiency improvements, energy use would have increased 34 percent between 1990 and 2005, instead of the 16 percent.

Figure 6.10 Passenger transportation energy use, with or without energy efficiency improvements, 1990-2005



[10] Electricity accounts for only 0.3 percent of total passenger transportation energy use and is used, for the most part, for urban transit.

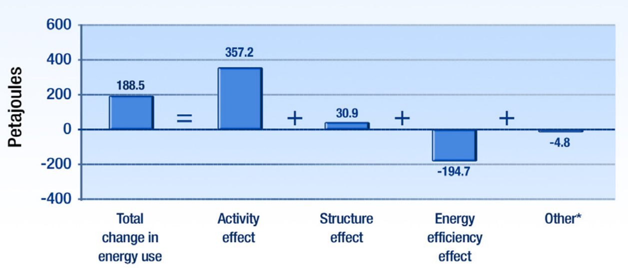
Figure 6.11 illustrates the influence that various factors had on the change in passenger transportation energy use between 1990 and 2005. These effects are the

- **activity effect** – The activity effect (i.e. Pkm travelled) increased energy use by 30 percent or 357.2 PJ and a corresponding 25.0 Mt increase in GHG-related emissions. Light truck and air transportation led the growth in Pkm (and therefore, activity effect), with respective increases of 141 percent and 65 percent.

- **structure effect** – Changes to the mix of transportation modes, or the relative share of Pkm travelled by air, rail and road, are used to measure changes in structure. The popularity of minivans and SUVs increased the activity share of light trucks compared to other modes, contributing to a 30.9 PJ increase in energy consumption and a 2.2 Mt increase in GHG emissions.

- **energy efficiency effect** – Improvements in the energy efficiency of passenger transportation saved 194.7 PJ of energy and 13.6 Mt of related GHG emissions. Despite the increasing popularity of larger and heavier light-duty vehicles with greater horsepower, the light-duty vehicle segment (cars, light trucks and motorcycles) of passenger transportation helped save 172.5 PJ of energy.

Figure 6.11 Impacts of activity, structure, and energy efficiency effects on the change in passenger transportation energy use, 1990-2005



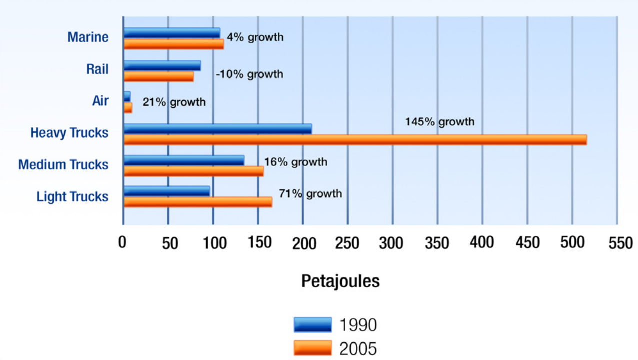
* Other refers to non-commercial airline aviation, which is included in the Total change in energy use value depicted above, but is excluded from the factorization analysis.

Trends – Freight transportation energy use and GHG emissions

The freight subsector in Canada includes four modes: trucking, air, marine and rail. The trucking mode is divided into three truck types: light, medium and heavy. Energy use for freight transportation is related to tonne-kilometres (Tkm). One tonne-kilometre represents the movement of one tonne of goods across one kilometre.

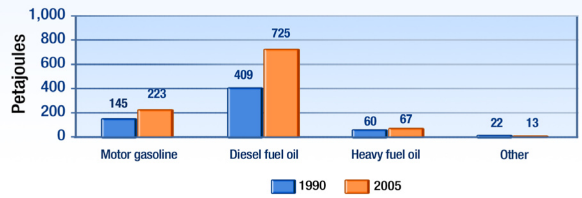
Freight energy use increased 61 percent from 636.9 PJ in 1990 to 1028.3 PJ in 2005. As a result, energy-related GHGs produced by freight transportation increased 61 percent, from 46.4 Mt in 1990 to 74.5 Mt in 2005. Energy use increased for all modes of freight transportation except rail, which experienced a decline of 10 percent. Heavy and light trucks experienced the largest increase in energy use, with the majority of energy consumed for freight transportation.

Figure 6.12 Freight transportation energy use by mode, 1990 and 2005



The mix of fuels used in the freight subsector remained relatively constant between 1990 and 2005. Diesel fuel oil continues to be the main source of energy, comprising over 71 percent of the fuel consumed for freight transportation.

Figure 6.13 Freight transportation energy use by fuel type, 1990 and 2005



* Other includes aviation turbo fuel, aviation gasoline, natural gas and propane.

Just-in-time delivery pushes the demand for heavy-truck transportation.

Maintaining a just-in-time inventory system requires just-in-time delivery. The system uses a relatively small warehouse space for inventory and instead relies on orders arriving to the company just as they are required for production. This change in the inventory system had a major impact on energy use in the freight subsector.

Using transportation vehicles as virtual warehouses requires a very efficient and on-time transportation system. This need is often met by means of heavy trucks. As a result, heavy truck use for freight transportation increased significantly over the period.

Between 1990 and 2005, the number of heavy trucks increased 13 percent and the average distance traveled increased 26 percent, to reach 89 332 km/year. However, heavy trucks are not only traveling longer distances; they are also carrying more freight as the number of trailers they pull increases. These factors are having a major impact on the tonne-kilometres and the energy use that heavy trucks are contributing to the freight subsector.

Rail remains the main mode to move goods in Canada.

Even with this significant growth in the trucking industry, rail still moves the largest amount of freight in terms of tonne-kilometres at 355.7 billion Tkm. This amount is 43 percent higher than in 1990. Marine followed rail with 241.4 billion Tkm traveled, which is 27 percent more than in 1990.

However, both of these increases are overshadowed by the 190 percent growth in tonne-kilometres of heavy trucks; which is close to the marine's share of total activity.

Figure 6.15 Freight transportation energy use versus activity by mode, 2005

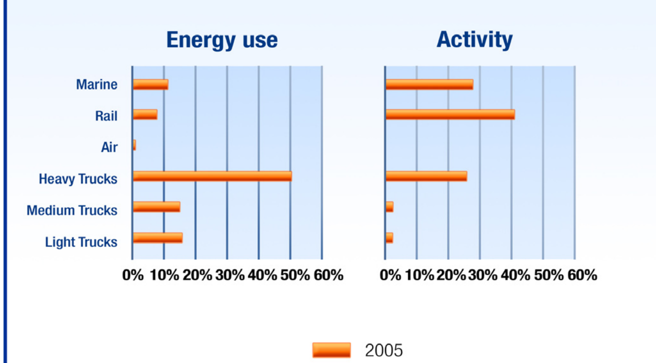
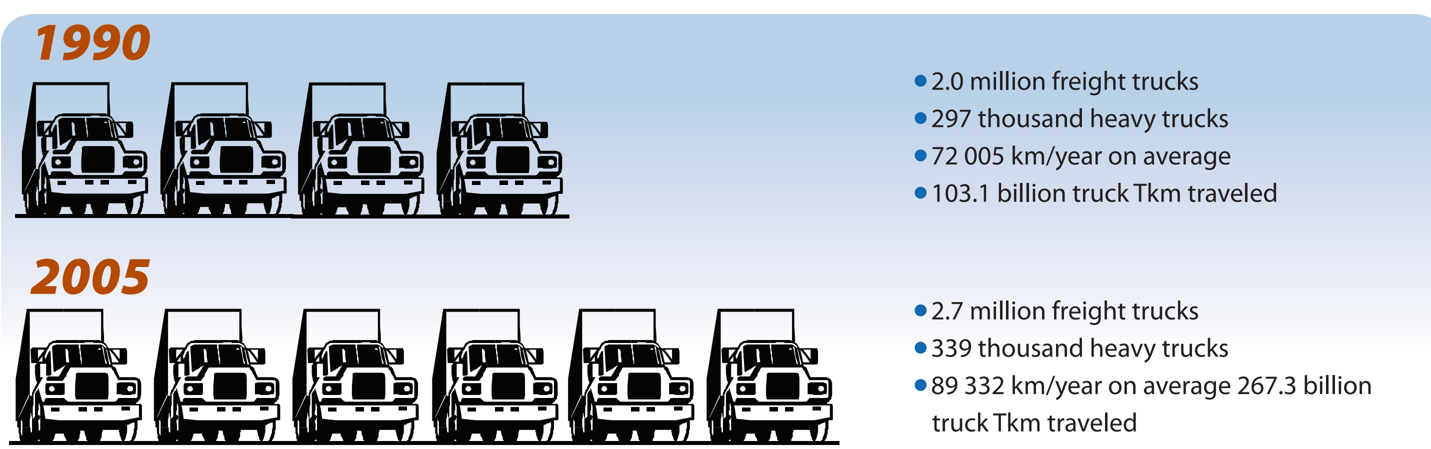


Figure 6.14 Freight transportation energy indicators, 1990–2005



Since 1990, all modes of freight transportation became more efficient in terms of energy use relative to tonne-kilometres moved. Figure 6.15 shows that the relative efficiency of rail and marine is greater than trucks at moving goods. However, over the period, trucks increased in efficiency because their on-road average fuel consumption improved.

Freight transportation energy efficiency

Energy efficiency improvements in freight transportation resulted in an energy savings of 157.7 PJ in 2005 or $3.7 billion in the transportation sector.

Between 1990 and 2005, energy use by freight transportation increased 61 percent, from 636.9 PJ to 1028.3 PJ. Without energy efficiency improvements, energy use would have increased 86 percent – 15 percent more than what was observed in 2005.

Figure 6.16 Freight transportation energy use, with or without energy efficiency improvements, 1990-2005

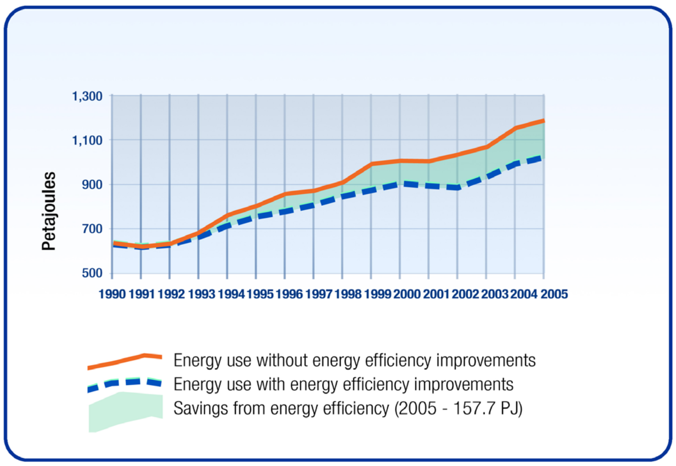
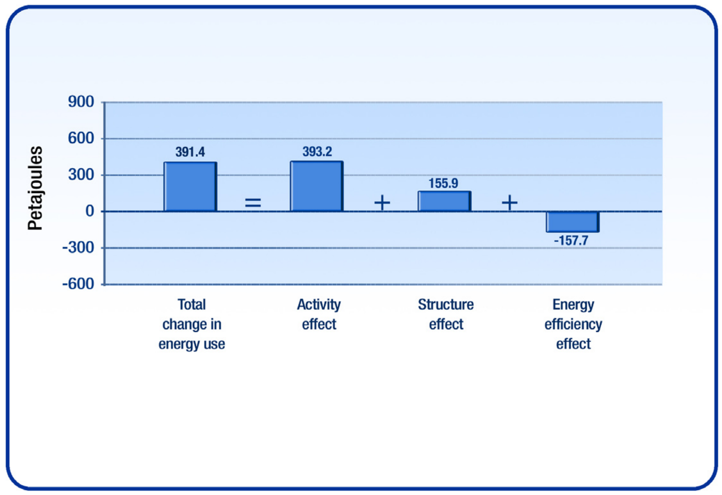


Figure 6.17 illustrates the influence that various factors had on the change in freight transportation energy use between 1990 and 2005. These effects are the

- **activity effect –** The activity effect (i.e. Tkm moved) increased energy use 62 percent or 393.2 PJ and caused a corresponding 28.5 Mt increase in GHG-related emissions. This increase was caused by free trade and the deregulation of the trucking and rail industries.
- **structure effect –** Changes in the structure of freight transportation (shifts in activity between modes) were due to growth in international trade and customer requirements for just-in-time delivery. The shift between modes was the increase in the share of freight moved by heavy trucks relative to other modes. Because trucks are more energy intensive per tonne-kilometre than other modes, the sector used an additional 155.9 PJ of energy and emitted 11.3 Mt more GHGs.
- **energy efficiency effect –** Improvements in the energy efficiency of freight transportation saved 157.7 PJ of energy and 11.4 Mt of GHGs. Improvements in heavy trucks were a large contributor, saving about 52.9 PJ.

Figure 6.17 Impact of activity, structure, and energy efficiency on the change in freight transportation energy use, 1990-2005



Appendices

Appendix A: Reconciliation of data

Figure A.1 Reconciliation of data with the RESD – 2005

	RESD data (PJ)	Wood (PJ)	Diesel (PJ)	Aviation fuels (PJ)	Motor gasoline (PJ)	Pipeline (PJ)	Wood waste and pulping liquor (PJ)	Waste (cement industry) (PJ)	Producer consumption (PJ)	OEE (PJ)
Residential	1,296	106								1 402
Commercial/ institutional	1,477		-216	-34	-73					1,153
Industrial	2,283						462	4	459	3,209
Transportation	2,389		216	34	73	-211				2,502
Agriculture	209									209
Final demand	**7,653**	**106**	**0**	**0**	**0**	**-211**	**462**	**4**	**459**	**8,475**
Non-energy use	982									982
Producer consumption	1,355					211			-459	1,106
Net supply	**9,990**	**106**	**0**	**0**	**0**	**0**	**462**	**4**	**0**	**10,563**
Electricity, steam and coal/coke input fuels[1]	4,138									4,138
Electricity, steam and coal/coke production[2]	-2,333									-2,333
Total primary	**11,795**	**106**	**0**	**0**	**0**	**0**	**462**	**4**	**0**	**12,369**

[1] Electricity, steam and coal/coke input fuels represents the amount of input energy from source fuels (coal, uranium, etc.) that are transformed to electricity, steam, coke and coke gas.

[2] Electricity, steam and coal/coke production represents the amount of electricity, steam, coke and coke gas produced. The difference between these items is referred to as conversion losses.

Residential: Base data taken from RESD (Table 1A, line 44) plus residential wood use (estimated from NRCan's residential end-use model).

Commercial/institutional: Base data taken from RESD (Table 1A, line 45 plus line 46) less commercial and public administration motor gasoline, diesel, aviation gasoline and aviation turbo fuel (Table 1B, motor gasoline, diesel, aviation gasoline and aviation turbo fuel columns, line 45 plus line 46).

Industrial: Base data taken from RESD (Table 1A, line 31) plus solid wood waste and spent pulping liquor (Table 20) less wood waste and spent pulping liquor used for electricity generation (Table 18) multiplied by a conversion factor, plus producer consumption by refining and mining industries of still gas, diesel, heavy fuel oil, light fuel oil, kerosene, petroleum coke and refinery LPG (Table 1B, still gas, diesel, heavy fuel oil, light fuel oil, kerosene, petroleum coke and refinery LPG columns, line 16), plus waste fuels from the cement industry (Canadian Industrial Energy End-Use Data and Analysis Centre).

Transportation: Base data taken from RESD (Table 1A, line 42) less pipeline fuels (Table 1A, line 39) plus commercial and public administration motor gasoline, diesel, aviation gasoline and aviation turbo fuel (Table 1B, motor gasoline, diesel, aviation gasoline and aviation turbo fuel columns, line 45 plus line 46).

Agriculture: Base data taken from RESD (Table 1A, line 43).

Appendix B: Glossary of terms

Activity: This term characterizes major drivers of energy use in a sector (e.g. floor space area in the commercial/institutional sector).

AECO-C hub: A hub is a market centre where several pipelines interconnect and where many buyers and sellers trade gas, thereby creating a liquid pricing point. The AECO-C hub is the main pricing point for Alberta natural gas and represents the major pricing point for Canadian gas. Prices are determined through the spot market, which includes all transactions for sales of 30 days or less, but it typically refers to a 30-day sale.

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.

Apartment: This type of dwelling includes dwelling units in apartment blocks or apartment hotels; units in duplexes or triplexes where the division between dwelling units is horizontal; suites in structurally converted houses; living quarters located above or in the rear of stores, restaurants, garages or other business premises; caretakers' quarters in schools, churches, warehouses, etc.; and private quarters for employees in hospitals or other types of institutions.

Appliance: This term is for energy-consuming equipment used in the home for purposes other than air conditioning, centralized water heating and lighting. Appliances include cooking appliances (gas stoves and ovens, electric stoves and ovens and microwave ovens) as well as refrigerators, freezers, clothes washers and dishwashers. Other appliances include devices such as televisions, video cassette recorders, digital video disc players, radios, computers and set top boxes.

Auxiliary equipment: With the exception of auxiliary motors (see Auxiliary motors), 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.

Auxiliary motors: This term refers to devices used to transform electric power into mechanical energy to provide a service, such as pumps, ventilators, compressors and conveyors.

Annual fuel utilization efficiency (AFUE): The AFUE refers to the amount of energy supplied to a natural gas or oil furnace compared with the amount of energy delivered to the home in the form of heat. For example, a furnace that has a 90 percent AFUE will lose 10 percent of the energy it is supplied (conversion loss) and will deliver 90 percent of the energy supplied in the form of heat to the dwelling.

Biomass: 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 that consists of primarily 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 it is burned in a boiler or produce electricity through thermal generation.

Bitumen: Bitumen is a dense type of petroleum that is often mixed with sand, clay and water in its natural state. Because it is too thick to flow, it is not usually recoverable at commercial rates through a well (see Oil sands, Unconventional crude oil).

Capacity utilization rate: The rate of capacity use is a measure of the intensity with which industries use their production capacity. The rate is the ratio of an industry's actual output to its estimated potential output.

Carbon dioxide (CO_2): This compound of carbon and oxygen is formed when 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).

Compact fluorescent lamp (CFL), also known as compact fluorescent light bulb: A compact fluorescent bulb is a smaller version of a fluorescent lamp. These bulbs use 67 to 75 percent less energy but provide comparable lighting to that which is supplied by an incandescent bulb.

Commercial/institutional sector: 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 the North American Industry Classification System. 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.

Conventional crude oil: This is a liquid form of petroleum that can be economically produced through a well by using normal production practices and without further processing or dilution.

Cooling degree-day (CDD): The cooling degree-day is a measure of how hot a location was over a period, relative to a base temperature. In this publication, the base temperature is 18°C and the period is one year. If the daily average temperature exceeds the base temperature, the number of cooling degree-days for that day is the difference between the two temperatures. However, if the daily average is equal to or less than the base temperature, the number of cooling degree-days for that day is zero. The number of cooling degree-days for a longer period is the sum of the daily cooling degree-days for the days in that period.

Cooling degree-day index: This index is a measure of how relatively hot (or cold) a summer was compared with the cooling degree-day (CDD) average. When the CDD index is above (below) 1, the observed temperature is warmer (colder) than normal. The CDD normal represents a weighted average of the 1951 to 1980 CDDs observed in a number of weather stations across Canada.

Dwelling: A dwelling is a structurally separate set of living premises with a private entrance from outside the building or from a common hallway or stairway inside. A private dwelling is one in which one person, a family or other small group of individuals may reside, such as a single house or apartment.

Electricity conversion loss: This term refers to the energy lost during the conversion from primary energy (petroleum, natural gas, coal, hydro, uranium and biomass) to electrical energy. Losses occur during generation, transmission and distribution of electricity and include plant and unaccounted for uses.

End-use: An end-use is any specific activity that requires energy (e.g. lighting, space heating, water heating and manufacturing processes).

Energy efficiency: This term refers to how effectively energy is being used for a particular 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: Energy intensity is the amount of energy use per unit of activity. Examples of activity measures in this publication are households, floor space, passenger-kilometres, tonne-kilometres, physical units of production and constant dollar value of gross domestic product (also see Activity).

Energy source: This term refers to any substance that supplies heat or power (e.g. petroleum, natural gas, coal, renewable energy and electricity).

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

Freight transportation: This subsector of the transportation sector includes the energy used by transportation modes that transport freight and whose activity is measured in tonne-kilometres. These modes include trucking, rail, marine and air.

Floor space (area): Floor space is 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.

Gigajoule (GJ): One gigajoule equals 1×10^9 joules (see Petajoule).

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 because 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). The most abundant greenhouse gas is CO_2, accounting for approximately 70 percent of total GHG emissions (see Carbon dioxide, Methane).

Greenhouse gas intensity: This intensity is the amount of greenhouse gases emitted per unit of energy used.

Gross domestic product (GDP): This measure is 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 GO is 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.

Heating degree-day (HDD): The HDD is a measure of how cold a location was over a period, relative to a base temperature. In this publication, the base temperature is 18°C and the period is one year. If the daily average temperature is below the base temperature, the number of heating degree-days for that day is the difference between the two temperatures. However, if the daily average temperature is equal to or higher than the base temperature, the number of heating degree-days for that day is zero. The number of heating degree-days for a longer period is the sum of the daily heating degree-days for the days in that period.

Heating degree-day index: This index is a measure of how relatively cold (or hot) a winter was when compared with the heating degree-day (HDD) average. When the HDD index is above (below) 1, the observed temperature is colder (warmer) than normal. The HDD normal represents a weighted average of the 1951 to 1980 HDDs observed in a number of weather stations across Canada.

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

High efficiency heating system: This classification indicates the efficiency of natural gas and oil furnaces. The high efficiency classification refers to a heating system that has an average annual fuel utilization efficiency (AFUE) of 90 percent or higher.

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

Housing stock: Housing stock is the number of physical dwellings, as opposed to the number of households, which refers to the number of occupied dwellings. Therefore, housing stock includes both occupied and unoccupied dwellings.

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

Joule: A joule is the international unit of measure for energy – the energy produced by the power of one watt flowing for a second. There are 3.6 million joules in one kilowatt hour (see Kilowatt hour).

Just-in-time inventory: This inventory system limits the required warehouse space by having orders arrive at the company only as they are required.

Kilowatt hour (kWh): This measurement is equivalent to 1000 watt hours. A kilowatt hour is the amount of electricity consumed by ten 100-watt bulbs burning for an hour. One kilowatt hour equals 3.6 million joules (see Watt).

Large car: A large car has a gross vehicle weight of 1182 kg (2601 lb) or more. The gross vehicle weight is the weight of the empty vehicle plus the maximum anticipated load weight.

Light-duty vehicle (LDV): This segment of passenger transportation vehicles includes small cars, large cars, motorcycles and light trucks.

Light truck: A light truck has a gross vehicle weight of up to 3855 kg (8500 lb). 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.

Lighting: The use of energy to light the interior and exterior of a dwelling.

Liquefied petroleum gases (LPG) and gas plant natural gas liquids (NGL): Propaneand 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.

Medium efficiency heating system: This classification indicates the efficiency of natural gas and oil furnaces. The medium efficiency classification refers to a heating system with an average annual fuel utilization efficiency (AFUE) between 78 and 89 percent.

Medium truck: A medium truck has a gross vehicle weight ranging from 3856 to 14 969 kg (8501 to 33 000 lb). The gross vehicle weight is the weight of the empty vehicle plus the maximum anticipated load weight.

Megajoule (MJ): One megajoule equals 1×10^6 joules (see Joule).

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

Minimum energy performance standards: These standards are established to ensure a minimum standard for appliances across Canada and ensure environmental concerns are met through reduced energy consumption and therefore reduced emissions.

Mobile home: A moveable dwelling designed and constructed to be transported by road on its own chassis to a site and placed on a temporary foundation (such as blocks, posts or a prepared pad). If required, it can be moved to a new location.

Model year: An annual period in which a national automotive industry organizes its operations and within which new models are announced. For example, if the model year is 2005, it begins September 1, 2004, and ends August 31, 2005.

Multifactor productivity: This is the ratio of output to unit of combined inputs (capital services and labour services).

Normal efficiency heating system: This classification indicates the efficiency of natural gas and oil furnaces. The normal efficiency classification refers to a heating system with an average annual fuel utilization efficiency (AFUE) of less than 78 percent.

North American Industry Classification System (NAICS): This classification system 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), was developed by the statistical agencies of Canada, Mexico and the United States.

Occupied dwelling: An occupied dwelling acts as a residence for a household, where the number of households will equal the number of occupied dwellings. Occupied dwellings may be occupied on a full-time or part-time basis.

Off-road transportation: Off-road transportation is a subsector of the transportation sector, which includes the energy used by off-road vehicles. These vehicles include items such as lawnmowers, snowmobiles and ATVs. Due to limitations in available data, this subsector is not analysed in detail.

Oil sands: The oil sands are a deposit of sand and other rock material saturated with bitumen, a type of crude oil (see Bitumen, Unconventional crude oil).

Passenger-kilometre (Pkm): This is an activity measure in the passenger transportation subsector that describes the transportation of one passenger across a distance of one kilometre.

Passenger transportation: This subsector of the transportation sector includes the energy used by transportation modes that transport passengers and whose activity is measured in passenger-kilometres. These modes include light-duty vehicles, buses and urban transit, passenger rail and passenger aviation.

Petajoule (PJ): One petajoule equals 1×10^{15} joules (see Joule).

Pulping liquor: This substance consists primarily of lignin, 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.

Residential sector: 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.

Sector: A sector is 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: This term characterizes the increased penetration of auxiliary equipment in commercial/ institutional buildings and the increased penetration of appliances and space cooling units in residential dwellings.

Single attached (dwelling): Each half of a semi-detached (double) house and each section of a row or terrace are defined as single attached dwellings. A single dwelling attached to a non-residential structure also belongs to this category.

Single detached (dwelling): This type of dwelling is commonly called a single house (i.e. a house containing one dwelling unit and completely separated on all sides from any other building or structure).

Small car: A small car has a gross vehicle weight of up to 1181 kg (2600 lb). The gross vehicle weight is the weight of the empty vehicle plus the maximum anticipated load weight.

Space cooling: This term refers to the 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: This term refers to the use of mechanical equipment to heat all or part of a building and includes the principal space heating system and any supplementary equipment.

Standard Industrial Classification (SIC): This classification system 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 compared to another is considered a structural change; in the electricity generation sector, a relative increase in production from one fuel process compared to another is considered a structural change.

Synthetic crude oil (SCO): This term refers to a mixture of hydrocarbons, similar to light crude oil, derived by upgrading bitumen from oil sands or conventional heavy crude oil.

Terajoule (TJ): One terajoule equals 1×10^{12} joules (see Joule).

Thermal envelope: Described as the shell of a dwelling, the thermal envelope protects the dwelling from the elements. The envelope consists of the basement walls and floor, the above-grade walls, the roof and the windows and doors. To maintain the indoor environment, the envelope must control the flow of heat, air and moisture between the inside and the outside of the dwelling.

Tonne-kilometre (Tkm): This term is an activity measure in the freight transportation subsector describing the transportation of one tonne across a distance of one kilometre.

Transportation sector: The transportation sector in Canada includes all modes of transportation required for the movement of passengers or freight. These modes include road, air, rail and marine transport. The transportation sector is divided into three subsectors: passenger, freight and off-road; however, only the passenger and freight subsectors are analysed in detail.

Unconventional crude oil: This term is for crude oil that is not classified as conventional crude oil (e.g. bitumen) (see Bitumen, Oil sands).

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

Vintage: This term means the year of origin or age of a unit of capital stock (e.g. a building or a car).

Waste fuel: This name is applied to any number of energy sources other than conventional fuels used in the cement industry. It includes materials such as tires, municipal waste and landfill off-gases.

Water heater: This term refers to an automatically controlled vessel designed for heating water and storing heated water.

Water heating: This term refers to 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 watt is a unit of power equal to one joule of energy per second. For example, a 40-watt light bulb uses 40 watts of electricity (see Kilowatt hour).

Wood waste: This term refers to a fuel that consists of bark, shavings, sawdust, low-grade lumber and lumber rejects from the operation of pulp mills, sawmills and plywood mills.

Appendix C: List of abbreviations

\$97	constant 1997 dollars
bbl.	barrel
ACM	*Annual Census of Mines*
CAFC	company average fuel consumption
CANSIM	Canadian Socio-Economic Information Management System
CBEEDAC	Canadian Building Energy End-Use Data and Analysis Centre
CEUM	commercial/institutional end-use model
CFL	compact fluorescent lamp, also known as compact fluorescent light bulb
CIEEDAC	Canadian Industrial End-Use Energy Data and Analysis Centre
CREEDAC	Canadian Residential Energy End-Use Data and Analysis Centre
CVIOC	*Canadian Vehicles in Operation Census*
CVS	*Canadian Vehicle Survey*
DVD	digital video disc or digital versatile disc
EC	Environment Canada
EER	energy efficiency ratio
GDP	gross domestic product
GHG	greenhouse gas
GJ	gigajoule = 1×10^9 joules
GO	gross output
GWh	gigawatt hour = 1×10^9 Wh
HFE	*Household Facilities and Equipment survey*
ICE	*Industrial Consumption of Energy survey*
IEUM	industrial end-use model
km	kilometre
kW	kilowatt
kWh	kilowatt hour = 1×10^3 Wh
L	litre
LDV	light-duty vehicle
LPG	liquefied petroleum gases
m^2	square metre
m^3	cubic metre
MJ	megajoule = 1×10^6 joules
Mt of CO_2e (Mt)	megatonne of carbon dioxide equivalent = 1×10^6 tonnes
NAICS	North American Industry Classification System
n.e.c.	not elsewhere classified
NGL	natural gas liquids
NRCan	Natural Resources Canada
OEE	Office of Energy Efficiency
PBS	Passenger Bus and Urban Transit Statistics
PJ	petajoule = 1×10^{15} joules
Pkm	passenger-kilometre
RESD	*Report on Energy Supply-Demand in Canada*
REUM	residential end-use model
SEER	seasonal energy efficiency ratio
SIC	standard industrial classification
SHEU	*Survey of Household Energy Use*
SHS	*Survey of Household Spending*
SC	Statistics Canada
TEUM	transportation end-use model
TIP	*Trucking Industry Profile*
TJ	terajoule = 1×10^{12} joules
Tkm	tonne-kilometre
UEC	unit energy consumption
VCR	videocassette recorder
VFEIS	*Vehicle Fuel Economy Information System*
W	watt
Wh	watt-hour

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

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