

# 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)

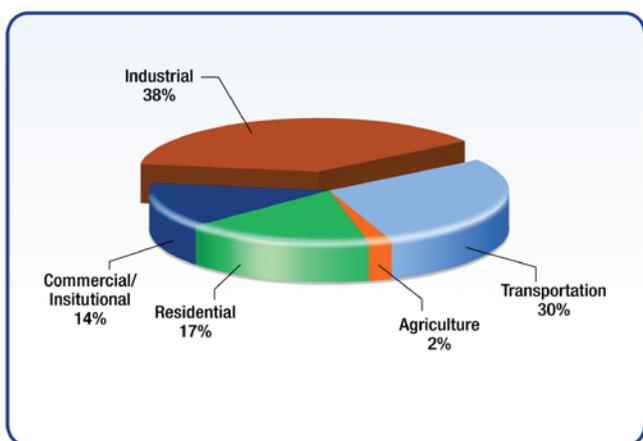
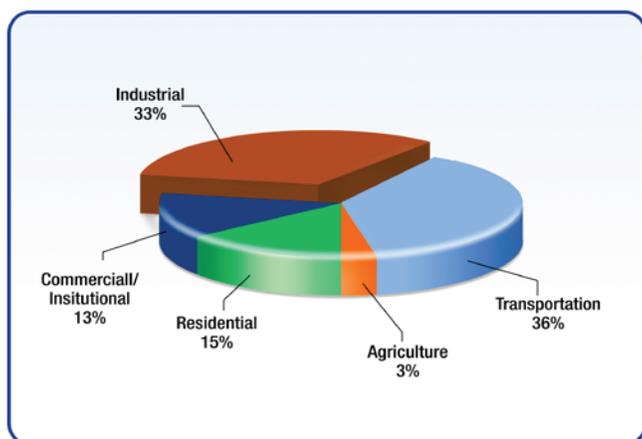


Figure 5.2 GHG emissions by sector, 2005 (percent)



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)

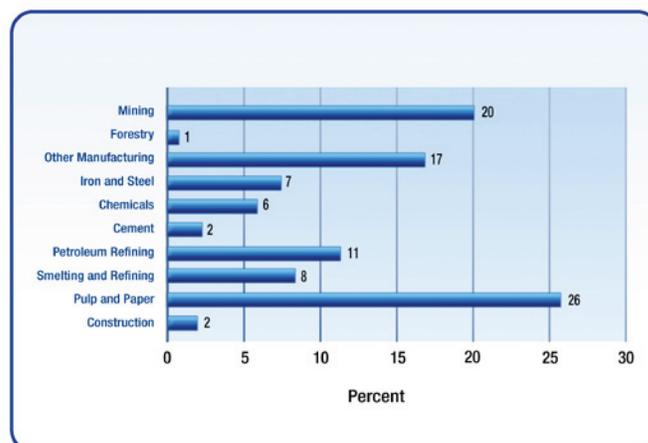
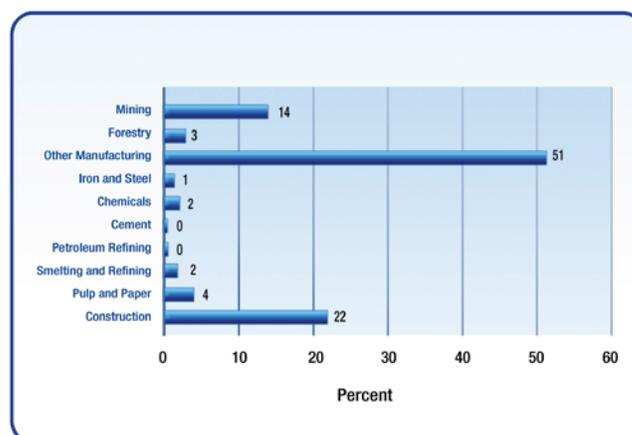


Figure 5.4 Distribution of activity by industry, 2005 (percent)



## 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.

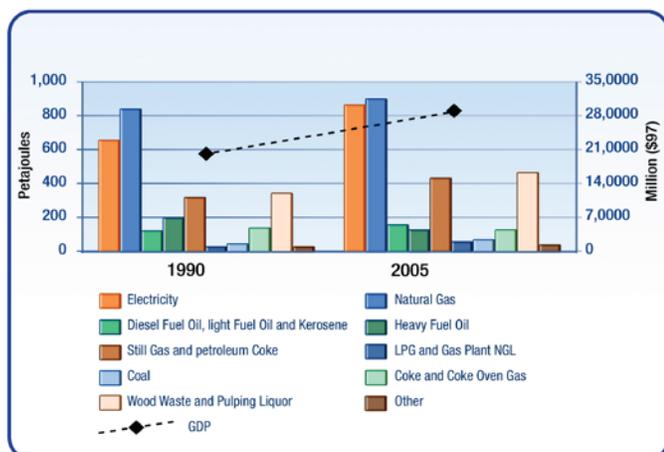
The type of energy used varies greatly depending on the industries in which it is used. Although electricity is used in virtually the entire sector, it is the pulp and paper and the smelting and refining industries that require the most electricity. Combined, these two industries account for more than 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.<sup>7</sup>

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.

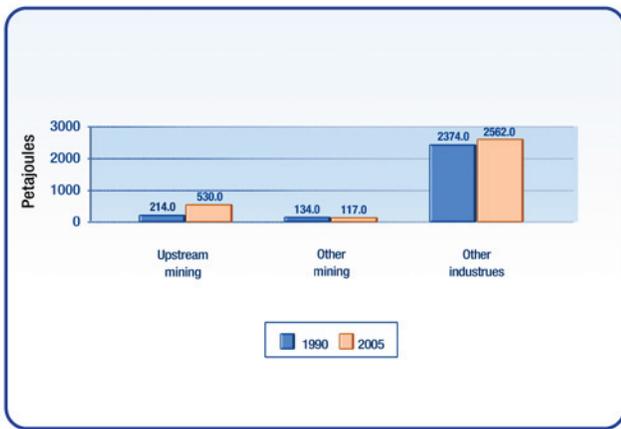
Growth in the mining sector was mainly driven by the upstream mining component, which includes oil sands mining operations. Since the late 1990s, production from non-conventional resources (oil sands) increased. Driven by technological advances, which have lowered production costs, and by additional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

<sup>7</sup> 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<sup>3</sup>/day). It reached 68 000 m<sup>3</sup>/day by 1996 and climbed to 175 000 m<sup>3</sup>/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



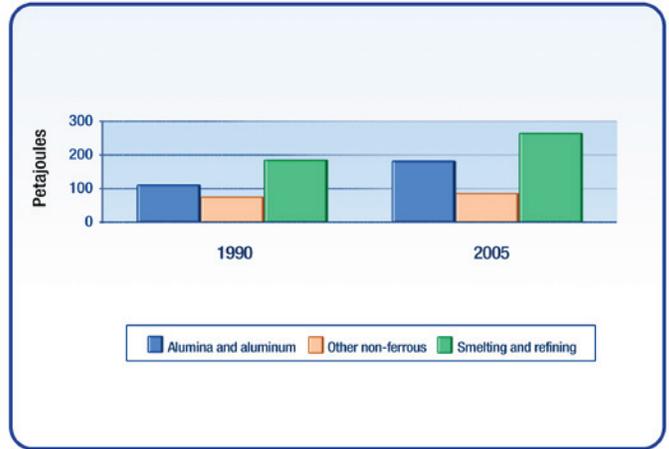
### Trends – Smelting and refining energy use and GHG emissions

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

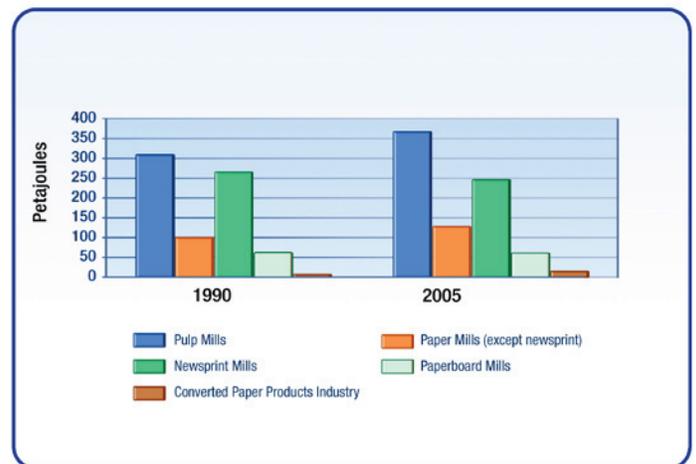


### Trends – Pulp and paper energy use and GHG emissions

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

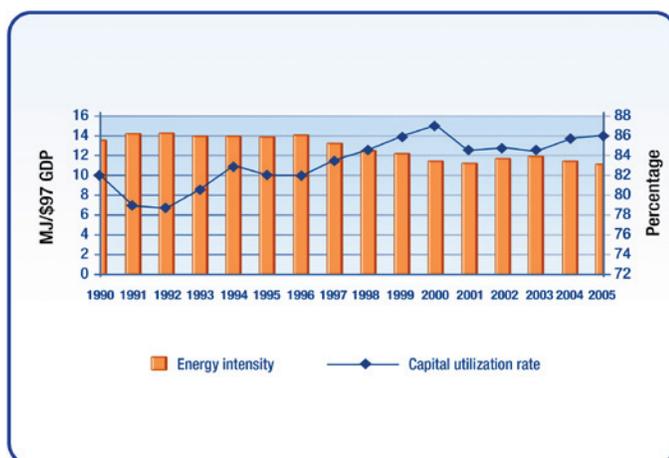
This industry represented 13 percent of the other manufacturing subsector's energy use, with 69.5 PJ. Its average annual increase is 0.8 percent.

## 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

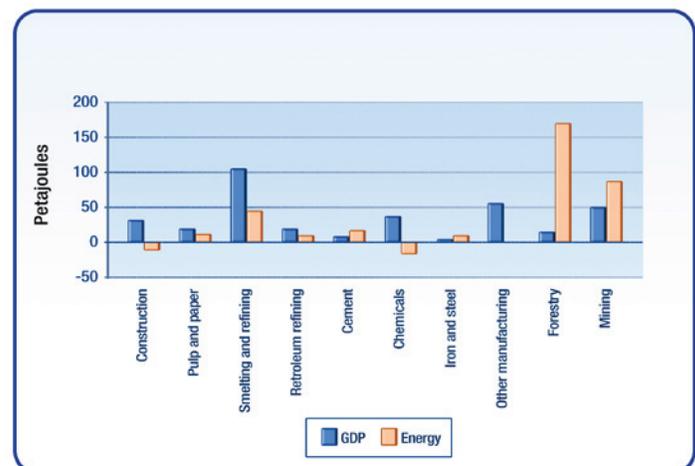


Energy efficiency improvements in the form of more efficient capital and management practices are important factors. Another key variable closely linked to energy intensity is the capacity utilization rate. This rate is calculated by dividing the actual production level for an establishment (measured 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<sup>8</sup> 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



<sup>8</sup> 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 efficiency improvements, 1990-2005

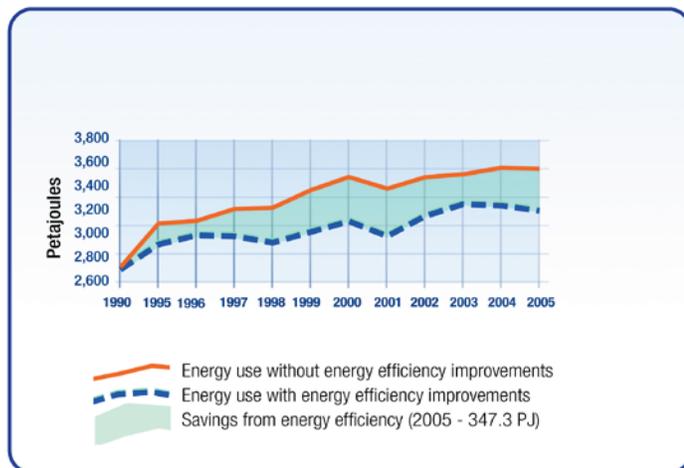


Figure 5.12 Impact of activity, structure, and energy effects on the change in industrial energy use, 1990-2005

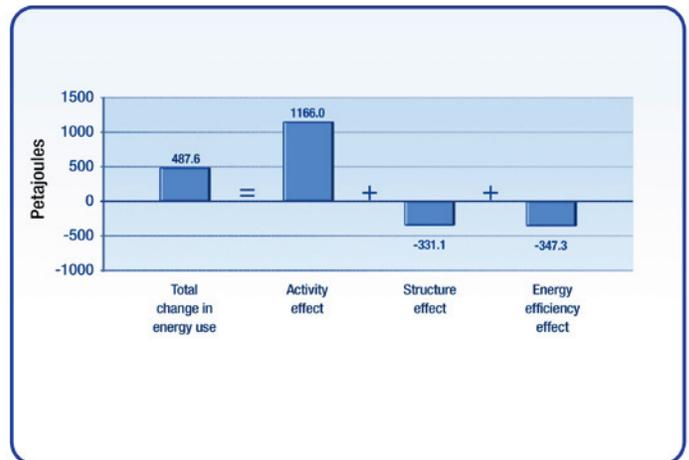


Figure 5.12 illustrates the influence that various factors had on the change in industrial energy use between 1990 and 2005. These effects are the

- **activity effect** – The mix of GDP, Gross Output (GO) and production units increased the energy use 43 percent or 1 166.0 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.