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Industrial Consumption of Energy (ICE) Survey
**SUMMARY REPORT OF
ENERGY USE IN THE CANADIAN
MANUFACTURING SECTOR**
1995-2005



March 2008



Canada 

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Industrial Consumption of Energy (ICE) Survey - Summary Report of Energy Use in the Canadian Manufacturing Sector, 1995-2005

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Every year, Statistics Canada conducts the *Industrial Consumption of Energy (ICE)* survey, which collects energy use data from establishments in Canada's Manufacturing sector.

The ICE survey was previously sponsored by climate change initiatives of the Government of Canada, and is currently sponsored by the Office of Energy Efficiency (OEE) of Natural Resources Canada (NRCan). The survey helps to fulfill part of the OEE's mandate to strengthen and expand Canada's commitment to energy conservation and energy efficiency.

The survey data will contribute to the knowledge of energy consumption in the Manufacturing sector. The data will also enable NRCan to develop and refine its programs that are designed to support industry in achieving greater energy efficiency and in reducing greenhouse gas emissions. For example, the ecoENERGY for Industry program aims to accelerate energy-saving investments and the exchange of information on best practices.

This summary report presents the results of the 1995–2005* ICE survey to show how and where the Canadian Manufacturing sector uses energy. Additional information gives readers some context with which to interpret the energy use data. As this information is based on a combination of several publicly available resources, some of it may differ from that of other publications.

This report was prepared by Amélie Giroux, of the Demand Policy and Analysis Division of the OEE.¹ An electronic version of the publication is available on the OEE Web site at oee.nrcan.gc.ca/statistics.

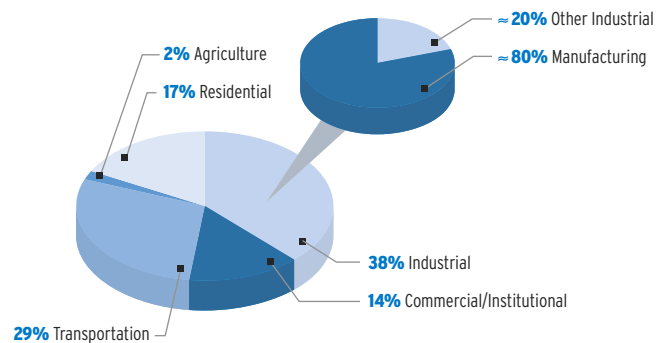
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Office of Energy Efficiency
Natural Resources Canada
580 Booth Street, 18th Floor
Ottawa ON K1A 0E4
E-mail: euc.cec@nrcan.gc.ca
Web site: oee.nrcan.gc.ca

Due to rounding, the numbers in this summary report may not add up to the totals shown in the tables (or to 100%, where applicable).

Canada's secondary energy consumption² in 2004 was divided among five sectors, according to the *Energy Use Data Handbook, 1990 and 1998 to 2004*, published by the OEE in 2006. See Figure 1.1 (circle on the left).

Figure 1.1 Canada's secondary energy use in 2004



In 2004, the industrial sector represented 38% of Canada's secondary energy consumption (referred to as "energy consumption" for the remainder of this report).

Figure 1.1 (circle on the right) shows that the Manufacturing sector, which is the universe represented by the ICE survey, used

- approximately 80% of the energy consumed by the industrial sector
- approximately 30% of the energy consumed in Canada

* The 2005 data are subject to revision. Contact the Office of Energy Efficiency for any revised figures.

1 Indrani Hulan supervised the project and David McNabb provided project leadership.

2 The term "secondary energy consumption" refers to the energy used by final consumers for residential, agricultural, commercial, industrial and transportation purposes.



Industrial energy data: sources and publications

The Government of Canada, and Natural Resources Canada (NRCan), in particular, have worked with Canadian industry for more than 30 years to promote energy efficiency in industrial practices. To monitor energy efficiency in the industrial sector, it is important to have access to data on industry's energy consumption.

NRCan works with a wide variety of data collection initiatives designed to gather data on energy use in different sectors of the Canadian economy, including the following:

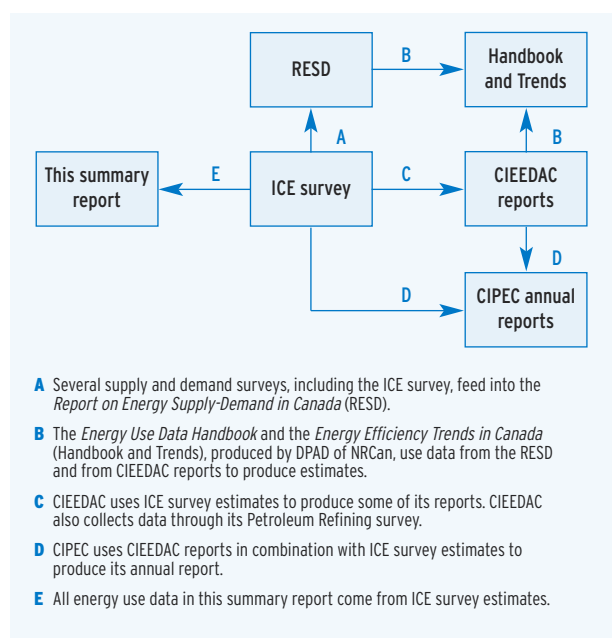
- *Industrial Consumption of Energy* (ICE) survey
- *Report on Energy Supply-Demand in Canada* (RESD)

This summary report focuses on the energy data collected by the ICE survey. Other publications that provide industrial energy consumption data are produced by

- Canadian Industry Program for Energy Conservation (CIPEC)
- Canadian Industrial Energy End-Use Data and Analysis Centre (CIEEDAC)
- Demand and Policy Analysis Division (DPAD) of NRCan

Figure 2.1 illustrates the links between the industrial data sources and publications, which are explained in the following sections. These explanations include a brief description, the methodology used to collect data and the definition of the “industrial” sector. Note that the definition of the Canadian industrial sector can differ among the data sources. Therefore, discretion should be used when comparing data from these sources.

Figure 2.1 Links between industrial data sources and publications



2.1 Data sources

2.1.1 Industrial Consumption of Energy survey

The ICE survey collects information on energy consumption from establishments in the Manufacturing sector in Canada. Statistics Canada (SC) has conducted the ICE survey since 1977.

The ICE survey was established as a quarterly survey, but in 1995, an annual component was added so that energy consumption estimates could be produced at a national level.

The ICE data from 1995 to 2000 were collected according to the Standard Industrial Classification (SIC) system and were converted to the North American Industry Classification System (NAICS)³ as part of a backcast in 2001. As well, some industries were added in 2001. In 2003, the quarterly component of the survey was cancelled. Currently, all data are collected on an annual basis. Recently, the ICE data dating back to 1995 were revised to update the electricity consumption estimates.

The methodology used to conduct the ICE survey is provided in Appendix C.

The energy data presented in this publication come from the ICE survey estimates for 1995 to 2005. The ICE survey estimates are based on the NAICS and include all 21 subsectors of the Manufacturing sector (NAICS 31-33). Information is collected at various levels of classification. For a list of all industries covered by the ICE survey, see Appendix A.

Information collected through the ICE survey contributes to the estimates of manufacturing energy demand in the RESD and to the production of CIPEC and CIEEDAC reports.

2.1.2 Report on Energy Supply-Demand in Canada

The *Report on Energy Supply-Demand in Canada* (RESD), which is produced by SC, is the official report on the energy supply and demand balance in Canada. The report presents data on energy consumption, production, trade and conversion by sector and by province.

The RESD began in 1976 as a quarterly report and became an annual report in 2004. Over time, the RESD expanded to include more variables. A total of 13 supply and demand surveys provide information for the RESD, and an input/output energy model is used to produce the estimates.

The RESD is a key source of information used by NRCan and Environment Canada to assess the progress of improvements in energy efficiency and to fulfill international reporting commitments. NRCan also uses data from the RESD to monitor and analyse trends in energy use and efficiency in the Canadian economy, and to run national forecasting models of energy use and related emissions.

The Canadian industrial sector, as defined by the RESD, comprises all Manufacturing industries, mining and oil and gas extraction establishments,⁴ forestry and construction. See Appendix A for a list of industries included in the RESD industrial sector. Note that the list differs slightly from the list of industries included in the ICE survey.

Until 1995, most of the RESD data for the Manufacturing sector were estimated from disposition survey sources. With the expansion of the ICE survey over the years, the RESD Manufacturing data was based increasingly on estimates from this survey.

2.2 Publications

2.2.1 Canadian Industry Program for Energy Conservation

The Canadian Industry Program for Energy Conservation (CIPEC) was created in 1975 as a voluntary partnership between the Government of Canada and industry to improve Canada's industrial energy efficiency. NRCan manages the program.

Since its creation, CIPEC has helped companies cut costs and increase profits by providing tools, support and a policy framework to improve energy efficiency. CIPEC brings together industry associations and companies that represent more than 98% of all industrial energy use in Canada.

CIPEC sectors represent over 98% of Canadian industrial secondary energy use. Because of their continued efforts, they improved their energy intensity by 9.1% between 1990 and 2004, or an average of 0.7% per year. Improved energy management enabled Canadian industry to avoid approximately \$3.1 billion in energy costs in 2004.¹

CIPEC publishes an annual report that outlines the energy efficiency accomplishments of Canadian industry. The report features "success stories" of Canadian industrial companies to illustrate how they improved their energy efficiency.

The CIPEC annual report also profiles 29 industrial task forces by noting their energy intensity improvements, targets and challenges. These task forces are listed in Appendix A. Note that the definitions of the Canadian industrial sector differ in the CIPEC report and the ICE survey. Some subsectors and industrial task forces are comparable, however, because they are defined with the same NAICS codes.

To monitor progress of the Canadian industrial sector's energy efficiency, CIPEC relies on ICE data, industrial associations and the activities of CIEEDAC.

Information on CIPEC, including CIPEC annual reports, is available at oee.nrcan.gc.ca/industrial/cipec.cfm.

³ See Appendix A for more information on NAICS.

⁴ "Mining and oil and gas extraction establishments" include those that are engaged primarily in extracting naturally occurring minerals.

2.2.2 Canadian Industrial Energy End-Use Data and Analysis Centre

NRCan sponsors three Data and Analysis Centres to improve the accessibility and comparability of existing data on energy consumption in Canada:

- Canadian Industrial Energy End-Use Data and Analysis Centre (CIEEDAC)
- Centre for Data and Analysis in Transportation (CDAT)
- Canadian Building Energy End-Use Data and Analysis Centre (CBEEDAC)

Established in 1993, CIEEDAC plays an important role in industrial energy data management and analysis in Canada. With the aim of remaining competitive and meeting environmental obligations, industries rely on CIEEDAC to obtain information on their energy consumption.

Since its creation, CIEEDAC has published annual analysis reports on energy consumption in Canadian industry. It has divided the Canadian industry sector into two sectors: Mining and Manufacturing.

The industries included in the CIEEDAC Manufacturing sector are the same as those included in the ICE survey. However, CIEEDAC publications also have aggregations of some industries. Since 2003, CIEEDAC has included information on the Electricity Supply and Construction subsectors in its reports. See Appendix A for a list of all industries included in the industrial sector, as defined by CIEEDAC.

The primary sources of data used for CIEEDAC activities come from SC⁵ and industrial associations. CIEEDAC also collects data from its Petroleum Refining survey.

CIEEDAC reports present data and trends in energy consumption, production and energy intensity for industrial sectors in Canada. Governments use information from publicly available CIEEDAC reports to support their programs and other activities. For example, CIPEC uses certain reports to do its own analysis and publications. The *Energy Use Data Handbook* also relies, in part, on data published by CIEEDAC.

Information on CIEEDAC and various reports are available at www.cieedac.sfu.ca.

2.2.3 Demand and Policy Analysis Division of NRCan

The Demand and Policy Analysis Division (DPAD)⁶ of NRCan publishes a variety of reports on energy use in Canada. For the 2005 reference year, DPAD published two summaries outlining energy use in the industrial sector – this summary report and DPAD’s online *Comprehensive Energy Use Database*.

The *Energy Use Data Handbook* (the Handbook) is produced annually. The fifth edition of the Handbook, *Energy Use Data Handbook, 1990 and 1998 to 2004*, was published in August 2006.

The main objective of the Handbook is to provide a statistical overview of Canada’s five sectoral energy markets at an aggregate level: Residential, Commercial/Institutional, Industrial, Transportation and Electricity Generation. The Handbook defines the Canadian Industrial sector as including all Manufacturing industries, all Mining activities, Forestry and Construction.

See Appendix A for a list of industries included in the Handbook’s definition of the industrial sector. Note that the manufacturing industries included in the Handbook’s industrial sector differ slightly from those encompassed by the ICE survey.

The aggregate energy use data presented in the Handbook for the industrial sector are taken from the RESD, and the disaggregated data come from the CIEEDAC database, which is based on ICE data.⁷ In addition to energy use data, the Handbook provides data on greenhouse gas (GHG) emissions and information on major activities and indicators that influence energy use.

Along with the Handbook, DPAD produces *Energy Efficiency Trends in Canada* (the Trends). The eleventh edition, *Energy Efficiency Trends in Canada, 1990 to 2004*, was published in August 2006. This publication assesses factors influencing changes in energy use and related changes in GHG emissions. The publication covers the same five sectors as the Handbook and uses the same definition for the Industrial sector.

The Energy Use Data Handbook, 1990 and 1998 to 2004 is on the OEE Web site at oee.nrcan.gc.ca/Publications/statistics/handbook06/.

Energy Efficiency Trends in Canada, 1990 to 2004 is on the OEE Web site at oee.nrcan.gc.ca/Publications/statistics/trends06/.

The Comprehensive Energy Use Database is on the OEE Web site at oee.nrcan.gc.ca/tables06/.

⁵ The ICE survey from SC contributes to the CIEEDAC database for the Manufacturing sector.

⁶ DPAD is a division of the OEE.

⁷ Disaggregated energy use data are calibrated to match the aggregated RESD energy use estimates.

2.3 Comparison of energy data in the various publications

Table 2.3.1 presents a comparison of 2004 data on the energy consumed in the Canadian Industrial sector found in the ICE survey (thus in this summary report) with data in the RESD (Table 1A Primary and Secondary Energy)⁸ and in the *Energy Use Data Handbook, 1990 and 1998 to 2004* (the Handbook).

Table 2.3.1 Comparison of 2004 data in the Canadian Industrial sector, found in ICE, RESD and the Handbook

Energy consumed in 2004 (petajoules)			
Sector	ICE	RESD	Handbook
Manufacturing	2614.70	1806.50	2559.33
Construction	–	59.87	59.87
Forestry	–	22.72	22.72
Mining	–	455.11	635.56
Industrial	–	2344.45	3277.48
Commentary	<p>The ICE survey presents data only for the Manufacturing sector. Although all three data sources encompass the same industries in their definition of the Manufacturing sector (NAICS 31-33), the estimates of manufacturing energy use are different. Some energy sources are not included in the RESD's estimate of manufacturing energy consumption, but are included in the ICE survey and the Handbook. For example, wood and spent pulping liquor consumption, as well as the consumption of petroleum products by petroleum product producers (own-consumption), are not included in the RESD's estimate of manufacturing energy demand. Instead, they appear in separate tables. This explains, in part, why the estimates of energy use in the Manufacturing sector presented in the ICE survey and the Handbook are higher than those in the RESD.</p> <p>Both the RESD and the Handbook publish energy use data for the Manufacturing, Construction, Forestry and Mining sectors. They also publish data for the Industrial sector, which is the sum of the four sectors mentioned above. Because the RESD estimate of manufacturing energy use does not include every energy source consumed in the Industrial sector, data in the Handbook are higher than in the RESD for the Manufacturing, Mining and consequently, the Total Industrial sectors, because these additional energy sources are included. However, data in the Handbook are calibrated to match the RESD energy use data (on an aggregate basis). The Construction and Forestry numbers are the same in the two publications, but the manufacturing number is different because it reflects both the additional fuels, mentioned above, and the overall calibration to the RESD.</p> <p>A table providing a reconciliation of the energy use estimates from the Handbook and the RESD is in Appendix A of the Handbook. Note that industrial energy use data for the RESD in the reconciliation table vary slightly from the data presented in Table 2.3.1 of this summary report. This is because the Handbook was published in 2006, when only the preliminary version of the 2004 RESD data had been released. The 2004 RESD data has since been revised, and Table 2.3.1 includes these revised data, which were published in 2007.</p>		

8 As there is no primary energy use data for the Industrial sector in this table, the numbers presented in Table 2.3.1 are only for secondary energy use.

3

Factors that can influence manufacturing energy consumption

Several factors influence energy demand in the Canadian Manufacturing sector. These factors can work alone or in combination with others to increase or decrease the energy demand. It is difficult to attribute the observed changes in manufacturing energy consumption to individual factors.

Therefore, this section presents a list and short description of some of the factors that can affect energy consumption in the Manufacturing sector.

3.1 Activity

The energy consumption in the Manufacturing sector is influenced by its activity. For the Manufacturing sector, activity is often represented by indicators, such as Gross Domestic Product (GDP), Gross Output (GO) and physical outputs.⁹ Activity is used as a measure of the production of manufacturing industries.

If the production (activity) of an industry increases and everything else is left unchanged, its energy consumption increases. Many factors can affect the production of an industry, including changes in consumer demand, and the prices of input (including energy prices), exports and technologies. In turn, the resulting changes in production can affect energy consumption.

The Energy Use Data Handbook, 1990 and 1998 to 2004 at oee.nrcan.gc.ca/Publications/statistics/handbook06/ presents additional information on activity in the Manufacturing sector.

3.2 Exchange rate

The exchange rate of the Canadian dollar has an impact on the economy and can affect the energy consumption of the Manufacturing sector in different ways:

- The prices of internationally traded energy sources are directly influenced by the exchange rate. For example, crude oil, which is quoted in United States (U.S.) dollars, is more expensive for Canadian industries to buy when the Canadian dollar is devalued compared to the U.S. dollar. As will be discussed in Section 3.3, the prices of energy sources have an impact on their use.
- The exchange rate also affects the purchase of foreign machines and technologies because the rate causes their prices to vary. For example, an evaluated dollar would be favourable for the purchase of a specific energy-saving technology from another country.
- The exchange rate influences production through its influence on exports. The more the Canadian dollar is devalued compared with the currency of other countries, the more attractive it is for other countries to import Canadian products. Exports from the Canadian Manufacturing sector can have an impact on its production, and thus on its energy consumption.

3.3 Prices of energy

In recent years, the world demand for energy has greatly increased, due in part to the growth of Asian economies, resulting in increasing energy prices. The prices of different energy sources can have an influence on their use. In response to higher energy prices, industries can introduce more efficient equipment or practices to reduce their energy consumption, or they may be encouraged to move toward less expensive energy sources, which may be more or less efficient than their former energy source.

⁹ See the Glossary in Appendix D for a definition of GDP and GO.

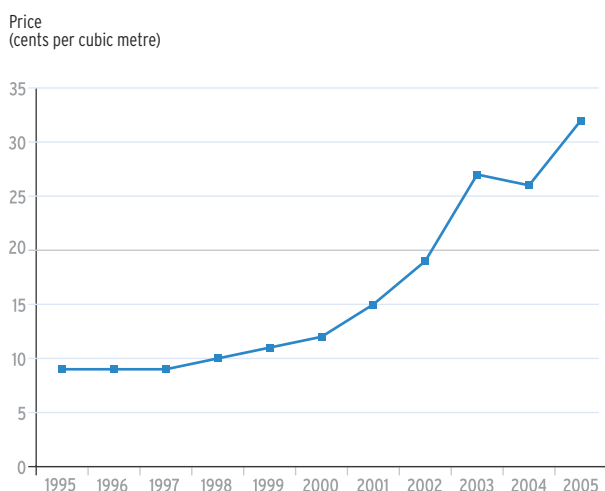
The Pulp and Paper Mills industry is gradually substituting some fossil fuels with biomass. In addition to becoming more energy self-sufficient, this allows the industry to avoid soaring fossil-fuel prices. According to the Forest Products Association of Canada, “almost 60% of the pulp and paper sector’s energy is self-generated using biomass and small hydro.”ⁱⁱ

Fossil-fuel prices have been particularly affected in recent years. Because natural gas was the fossil fuel used most often by the Manufacturing sector in 2005, particular attention is given to its fuel price variations in the following text.

Figure 3.3.1 shows the progression of natural gas prices since 1995 in the Canadian Industrial sector. A sharp increase has occurred since 2000. According to the Natural Gas Division of Natural Resources Canada (NRCan), many factors contributed to increased natural gas prices.ⁱⁱⁱ Among them, the steady demand growth and slow supply growth have played important roles.

High crude oil prices may also have had an impact because the prices of the two fuels influence each other, due to the possibility of fuel substitution in some applications. Natural gas prices reached a record high level in 2005, due, in part, to hurricane Katrina and other hurricanes that caused losses of natural gas supplies.

Figure 3.3.1 Natural gas prices in the Canadian industrial sector (1995-2005) (unit price excluding taxes)^{iv}



Soaring natural gas prices have greatly affected some manufacturing industries, including the Chemical Fertilizer Manufacturing industry, which uses natural gas as one of its significant energy sources and also as a major feedstock.¹⁰

3.4 Industry actions

For various reasons, industries may have decided to change their energy use. Among possible motivators, industries may have considered the following:

- the possibility of lowering their production costs
- the need to remain competitive
- the ability to face the rise of energy prices
- the desire to use less energy or a cleaner source of energy

3.5 Changes to the composition of industries

According to the North American Industry Classification System (NAICS) definition, “an establishment is classified to an industry when its principal activity¹¹ meets the definition for that industry.” This implies that if the principal activity of an establishment changes, its energy consumption will be included in a new industry NAICS code. Changes in energy consumption of an industry may be caused, in part, by establishments moving in or out of this industry (as defined by the NAICS code) because of a change of the principal activity.

Also, establishment closures or openings affect the energy consumption of specific industries. A partial shutdown of an establishment – for example, because of a strike – will reduce the establishment’s contribution to the estimates of that subsector’s energy consumption.

3.6 Natural Resources Canada programs

Several governmental and non-governmental programs promote energy efficiency in the industrial sector. The programs may affect the energy consumed by the Manufacturing sector because they encourage industrial processes that are more energy efficient. Over the years, NRCan has been responsible for a variety of industrial programs that

- aim to improve Canada’s industrial energy efficiency
- encourage the design and construction of new energy-efficient industrial facilities
- provide information to assist industrial establishments in selecting and purchasing energy-efficient products

For more information about the industrial programs at NRCan, visit oee.nrcan.gc.ca and follow the links to industrial programs.

¹⁰ In this context, the term “feedstock” refers to the consumption of energy in the manufacturing process as a raw material used in the production of another product (that is, the energy is not consumed as fuel).

¹¹ In this context, the term “activity” refers to the type of goods or services produced, or the production process used by an establishment.

4

Manufacturing energy consumption (ICE data)

The Industrial Consumption of Energy (ICE) survey collects energy use data from establishments that have a North American Industry Classification System (NAICS) code of between 311000 and 339000. These establishments, which comprise the Manufacturing sector, according to this summary report, primarily transform materials or substances into new products.

The energy consumption for the entire Manufacturing sector, as estimated by the ICE survey, is presented in Section 4.1. The energy consumption data of the six subsectors that consume the most significant portion of the total energy are presented next, followed by energy consumption data for the remaining subsectors.

4.1 Total energy consumption of the Manufacturing sector

Overview of the Manufacturing sector in Canada

With a Gross Domestic Product (GDP) of \$175 billion,¹² the activities of the Canadian Manufacturing sector accounted for 16% of the GDP in the Canadian economy in 2005.^v

In 2004, there were 1.75 million employees in the Manufacturing sector, of whom 76% were production workers.^{vi}

In 2005, 84% of the exports of the Manufacturing sector were destined for the United States. The next three most significant importers were Japan, the United Kingdom and China, with 2% of total Canadian Manufacturing exports each.^{vii}

¹² In this summary report, GDP is reported in chained 1997 dollars.

Manufacturing energy consumption in 2005 and trends

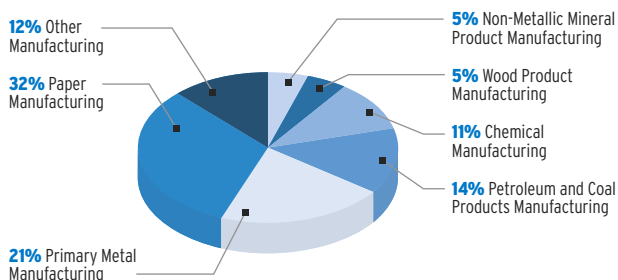
The Manufacturing sector consumed 2526.17 petajoules (PJ) of energy in 2005, according to ICE estimates. Assuming each household uses 115 gigajoules (GJ) annually,^{viii} 1 PJ is approximately equal to the amount of energy consumed by 8700 households in one year. Therefore, in 2005, the Manufacturing sector's energy consumption was approximately the amount consumed by 22 million households in one year (nearly twice the number of households in Canada).

According to the ICE data, the following six subsectors are the highest consumers of energy in the Manufacturing sector:

- Paper Manufacturing (322)¹³
- Primary Metal Manufacturing (331)
- Petroleum and Coal Products Manufacturing (324)
- Chemical Manufacturing (325)
- Wood Product Manufacturing (321)
- Non-Metallic Mineral Product Manufacturing (327)

Figure 4.1.1 shows that these six subsectors accounted for 88% of the energy use in Canada's Manufacturing sector in 2005. The energy consumption and activities of these subsectors are discussed in detail in the next sections.

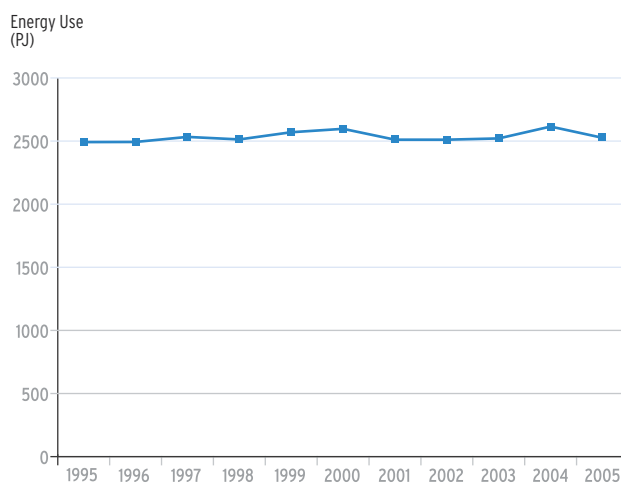
Figure 4.1.1 Share of energy use in the Manufacturing sector (2005)



The other subsectors, which were responsible for the remaining 12% of manufacturing energy consumption in 2005, are analysed as a group named "Other Manufacturing" subsector.

Figure 4.1.2 shows the trend of the annual energy consumption of the Manufacturing sector between 1995 and 2005.

Figure 4.1.2 Total energy use in the Manufacturing sector (1995-2005)

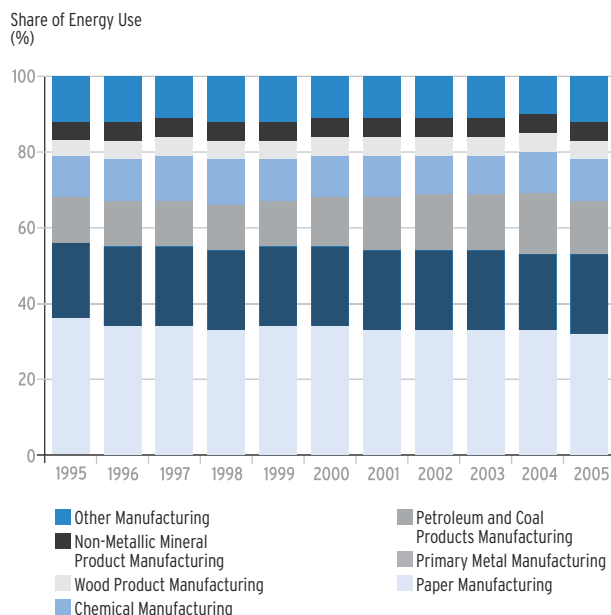


The energy consumption of the Manufacturing sector increased slightly between 1995 and 1997, and then dropped in 1998. Between 1998 and 2000, the consumption of energy increased and dropped again in 2001. The energy consumption increased between 2002 and 2004, but decreased noticeably (-3.4%) in 2005.

The energy consumed by the Manufacturing sector between 1995 and 2005 increased by 1.4%.

The industry shares of energy consumption, shown in Figure 4.1.3, show the consumption of the seven subsectors (including Other Manufacturing) between 1995 and 2005.

Figure 4.1.3 Share of energy use in the Manufacturing sector (1995-2005)



¹³ The subsectors are presented with their three-digit NAICS code in parentheses. Industry groups, industries and national industries are also presented with their NAICS code, but at the six-digit level, and they are referred to as industries in this summary report.

The following observations can be made from these energy shares:

- The Paper Manufacturing subsector share was 36% in 1995, and since has remained between 32% and 34%.
- The Primary Metal Manufacturing share remained between 20% and 21%.
- The shares of the Petroleum and Coal Products Manufacturing subsector increased from 12% to 16% between 1995 and 2004, and then decreased to 14% in 2005.
- The Chemical Manufacturing subsector peaked slightly in 1997 and 1998, with a share of 12%.
- Since 1996, the Wood Product Manufacturing subsector's share has been 5%.
- The Non-Metallic Mineral Product Manufacturing subsector share was fairly constant at 5%.
- The shares of the Other Manufacturing subsector were between 11% and 12%.

Manufacturing energy consumption by source in 2005 and trends

The Manufacturing sector consumed several types of energy in 2005. See Figure 4.1.4 and Table 4.1.1.

Figure 4.1.4 Share of energy use in the Manufacturing sector (2005)

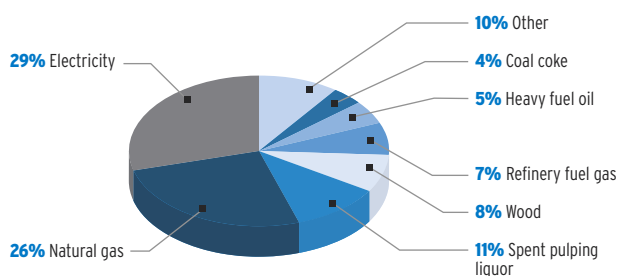


Table 4.1.1 Energy use in the Manufacturing sector (2005)

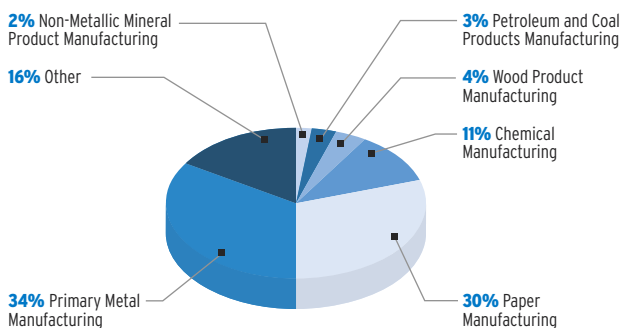
Type of Energy	Energy Use (PJ)
Coal	50.29
Coal coke	92.15
Coke oven gas	29.55
Electricity	723.78
Heavy fuel oil	126.04
Middle distillates	20.60
Natural gas	662.99
Petroleum coke and coke from catalytic cracking catalyst	84.47
Propane	8.24
Refinery fuel gas	186.41
Spent pulping liquor	283.72
Steam	48.76
Wood	209.18
Total	2526.17

Electricity

Electricity was the most consumed energy source in 2005. The consumption was 723.78 PJ, which is 29% of the energy consumed in the Manufacturing sector.

Every subsector in the Manufacturing sector used electricity between 1995 and 2005. Figure 4.1.5 shows that the Primary Metal Manufacturing and Paper Manufacturing subsectors consumed, respectively, 34% and 30% of the total manufacturing electricity consumption in 2005. The Chemical Manufacturing subsector consumed 11% of the electricity in that year.

Figure 4.1.5 Share of electricity use in the Manufacturing sector (2005)

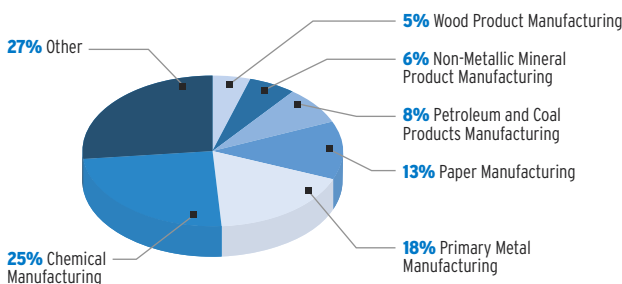


Natural gas

Natural gas consumption reached 662.99 PJ in 2005, making it the second-highest energy source consumed in the Manufacturing sector, with 26% of the total consumption.

Natural gas was also consumed by every subsector between 1995 and 2005. In 2005, Chemical Manufacturing, Primary Metal Manufacturing and Paper Manufacturing subsectors were responsible for 25%, 18% and 13%, respectively, of the natural gas consumption in the Manufacturing sector. See Figure 4.1.6.

Figure 4.1.6 Share of natural gas use in the Manufacturing sector (2005)



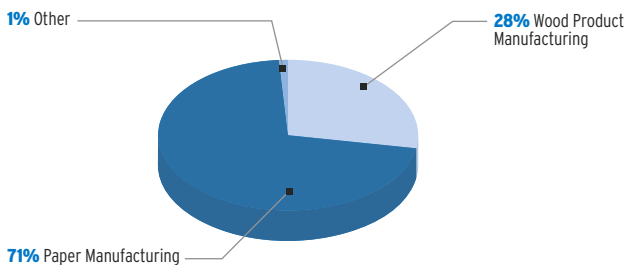
Spent pulping liquor

Since 1995, only the Paper Manufacturing subsector has consumed spent pulping liquor. See Section 4.2 for more details. In 2005, 283.72 PJ of spent pulping liquor was consumed, making it the third-highest consumed source of energy in the Manufacturing sector, representing 11% of its energy consumption.

Wood

The Manufacturing sector used 209.18 PJ of wood in 2005, which represented 8% of its energy use. Figure 4.1.7 shows that wood was used mostly by the Paper Manufacturing subsector (71%) and the Wood Product Manufacturing subsector (28%) in 2005.

Figure 4.1.7 Share of wood use in the Manufacturing sector (2005)



Refinery fuel gas

Only the Petroleum and Coal Products Manufacturing (324) subsectors used refinery fuel gas in 2005, for a total of 7% (186.41 PJ) of the total energy consumed by the Manufacturing sector.

Other energy sources

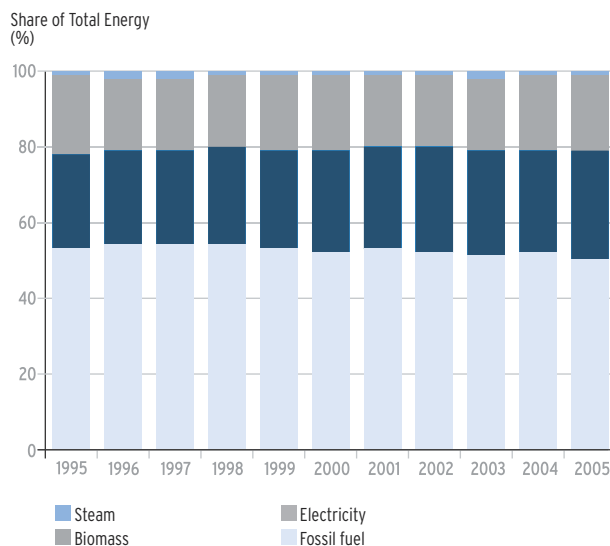
The remaining energy sources, which together accounted for 19% of the total Manufacturing sector's energy consumption in 2005, are

- coal
- coal coke
- coke from catalytic cracking catalyst
- coke oven gas
- heavy fuel oil
- middle distillates
- petroleum coke
- propane
- steam

Some of these energy sources are discussed in greater detail in this summary report. Note that, for confidentiality, the estimates of the energy consumed for coke from catalytic cracking catalyst and petroleum coke were combined.

Figure 4.1.8 presents the relative energy shares of fossil fuel,¹⁴ electricity, biomass¹⁵ and steam in the Manufacturing sector between 1995 and 2005. The figure shows that half of the energy use in 2005 was fossil fuel, 29% was electricity and 20% was biomass.

Figure 4.1.8 Share of energy in the Manufacturing sector (1995-2005)



¹⁴ "Fossil fuel" includes coal, coal coke, coke from catalytic cracking catalyst, coke oven gas, heavy fuel oil, middle distillates, natural gas, petroleum coke, propane and refinery fuel gas.

¹⁵ "Biomass" includes spent pulping liquor and wood.

Fossil fuel remained the most used fuel between 1995 and 2005, but it reached its lowest level in 2005 (50%), whereas electricity reached its highest level (29%). Biomass reached a peak in 1995 (21%) and then stayed relatively constant (between 19% and 20%).

4.2 Paper Manufacturing

Overview of the Paper Manufacturing (322) subsector in Canada

With a GDP of \$11.7 billion, the Paper Manufacturing subsector was responsible for 7% of the total GDP in the Manufacturing sector in 2005.^{ix}

The Paper Manufacturing subsector employed 86 600 workers in 2004, of whom 79% were production workers.^x

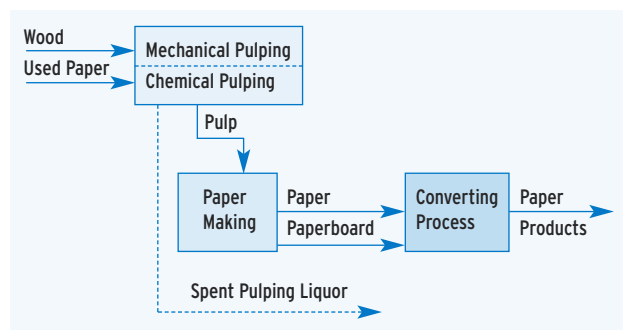
Among the exports of the Paper Manufacturing subsector, 74% were destined for the United States and 4% for China in 2005.^{xi}

Canada was the world's largest producer of newsprint and also the largest supplier of the world market pulp in 2005.^{xii}

Industries in the Paper Manufacturing subsector

Establishments in the Paper Manufacturing (322) subsector make pulp, paper and paper products. The manufacturing of these three products requires linked processes. See Figure 4.2.1.¹⁶

Figure 4.2.1 Pulp, paper and paper products manufacturing processes



Wood is made primarily from cellulose fibres, which are held together by lignin, the second-most abundant constituent of wood.

Pulp Mills

The manufacture of pulp involves the separation of wood cellulose fibres by mechanical or chemical action. The Pulp Mills (322110) industry comprises establishments that manufacture pulp but do not make it into paper. The industry also includes establishments that remove printing ink and impurities from waste paper to process the paper into pulp.

The pulp produced in this industry is sold or transferred to separate paper-making establishments. The Pulp Mills industry can be separated into the Mechanical Pulp Mills (322111)¹⁷ and the Chemical Pulp Mills (322112) industries.

The pulping process can be performed using mechanical, semichemical or chemical methods. Some differences among the three methods are outlined below.

The chemical pulping process cooks wood with various chemicals, usually under pressure. This process separates the wood into cellulose fibres by removing the lignin (the substance in wood that binds the fibres together). A common chemical pulping process is called the "Kraft process," and chemical pulp from this process is referred to as "Kraft pulp." In the Kraft process, pulping liquor¹⁸ is used to dissolve the lignin.

¹⁶ Note that the illustrated manufacturing processes are simplified. They do not describe details of the manufacturing processes, but give only a general idea of each sector's main activity.

¹⁷ "Mechanical Pulp Mill (322111) industry" includes semi-chemical pulping methods.

¹⁸ Pulping liquor is a substance primarily made up of lignin and other wood constituents and chemicals that are by-products of the manufacture of chemical pulp.

The spent liquor, now called “spent pulping liquor,” is then removed from the pulp. This substance, primarily made up of lignin, other wood constituents and chemicals, can be used as a fuel. For example, it can be burned in a boiler to produce steam for manufacturing processes or it can be used to produce electricity through thermal generation.

The mechanical pulping process separates the fibres physically by grinding wood, but does not remove the lignin.

Because the lignin is not removed, mechanical pulping processes use more of the tree, so fewer trees are required to produce the same amount of paper than with chemical pulping processes. However, the paper produced from pulp containing lignin (such as newsprint) turns yellow when exposed to light.

The semichemical pulping process is a combination of chemical and mechanical pulping processes. The wood is first partially cooked with chemicals and then physically processed using a mechanical method to separate the wood fibres.

Paper Mills and Paperboard Mills

The manufacture of paper involves removing the liquid from the pulp fibres and pressing or forming them into a sheet. The kind of paper or paperboard that is manufactured is determined by the fibre used in the pulping process and the type of pulping method.

Any establishment that makes paper or paperboard (regardless of whether they also manufacture pulp) is classified in the Paper Mills (322120) industry or Paperboard Mills (322130) industry. The Paper Mills (322120) industry is divided into two categories: the Paper Mills (except newsprint) (322121) industry and the Newsprint Mills (322122) industry.

Converted Paper Product Manufacturing

Paper products (such as paperboard containers and paper bags) can be produced from paper and paperboard. Establishments that make paper products from paper and paperboard that they purchased from the Converted Paper Product Manufacturing (322200) industry.

“In 2004, the Canadian industry recovered approximately 46% of the paper and paperboard consumed in Canada and transformed it into new paper and paperboard products.” In 1995, this recovery rate was 41%, whereas it was only 20% in 1980.^{xiii}

Paper Manufacturing energy consumption in 2005 and trends

The 2005 ICE survey estimates that the Paper Manufacturing subsector consumed 800.07 PJ of energy, corresponding to 32% of the Manufacturing energy consumption, and making it the largest energy consumer in Canada’s Manufacturing sector.

Figure 4.2.2 and Table 4.2.1 show that the greater part of the energy used in paper manufacturing is in the pulping process. The pulping process used 46% (364.37 PJ) of the energy consumed by the Paper Manufacturing subsector in 2005. However, because establishments that make paper and paperboard, in addition to manufacturing pulp, are not included in the estimate of energy consumption for the Pulp Mills industry, this share may be even higher than 46%.

Figure 4.2.2 Share of energy use in the Paper Manufacturing subsector (2005)

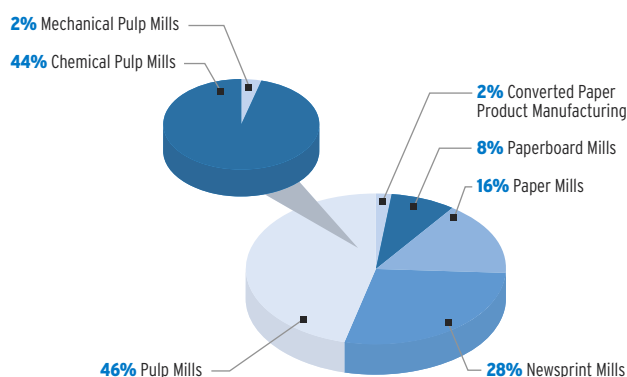


Table 4.2.1 Energy use in the Paper Manufacturing subsector (2005)

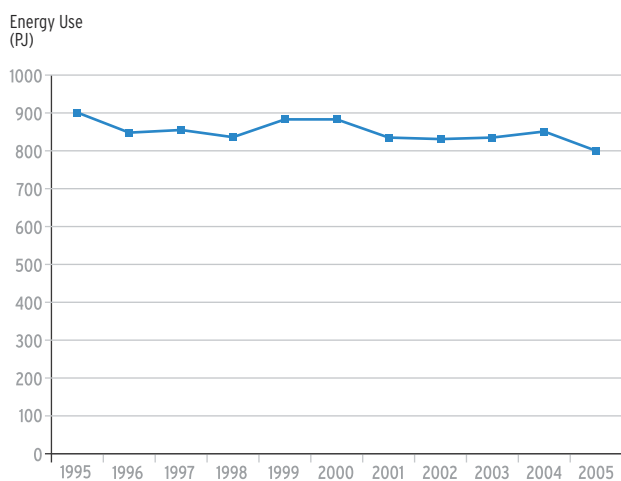
Industry	Energy Use (PJ)
Mechanical Pulp Mills (322111)	13.19
Chemical Pulp Mills (322112)	351.18
Paper Mills (322121)	124.11
Newsprint Mills (322122)	226.56
Paperboard Mills (322130)	66.91
Converted Paper Product Manufacturing (322200)	18.12
Paper Manufacturing (322)	800.07

The majority of energy used by the Pulp Mills industry was for the Chemical Pulp Mills industry (351.18 PJ), and the rest was for the Mechanical Pulp Mills industry (13.19 PJ). The second-highest energy consumer in the Paper Manufacturing subsector in 2005 was the Newsprint Mills industry, with 28% (226.56 PJ) of the subsector's energy consumption.

The Paper Mills industry was third, with 16% (124.11 PJ) of the energy consumption. The remaining 10% of the energy consumption was divided between the Paperboard Mills industry, with 8% (66.91 PJ) and Converted Paper Mills industry, with 2% (18.12 PJ).

Figure 4.2.3 shows the trend in energy consumption of the Paper Manufacturing subsector between 1995 and 2005, which varied between 800.07 PJ and 901.08 PJ.

Figure 4.2.3 Total energy use in the Paper Manufacturing subsector (2005)



Paper Manufacturing energy consumption by source in 2005 and trends

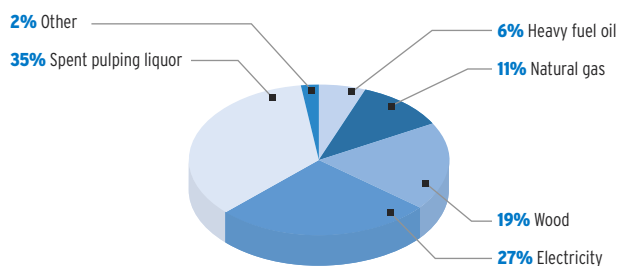
Table 4.2.2 and Figure 4.2.4 show the energy consumption by energy source for the Paper Manufacturing subsector in 2005.

Table 4.2.2 Energy use in the Paper Manufacturing subsector (2005)

Type of Energy	Energy Use (PJ)
Coal	x
Electricity	214.74
Heavy fuel oil	49.97
Middle distillates	1.88
Natural gas	84.04
Propane	x
Spent pulping liquor	283.72
Steam	14.72
Wood	149.11
Total	800.07
Confidential	1.90

x = confidential data

Figure 4.2.4 Share of energy use in the Paper Manufacturing subsector (2005)



The Paper Manufacturing subsector is the only producer and consumer of spent pulping liquor. This source of energy was significant for this subsector in 2005 because it represented 35% of the total energy consumption, or 283.72 PJ.

Electricity use accounted for 27% of energy use in the Paper Manufacturing subsector in 2005. The next largest energy sources used were wood (19%), natural gas (11%), heavy fuel oil (6%) and other energy sources¹⁹ (2%).

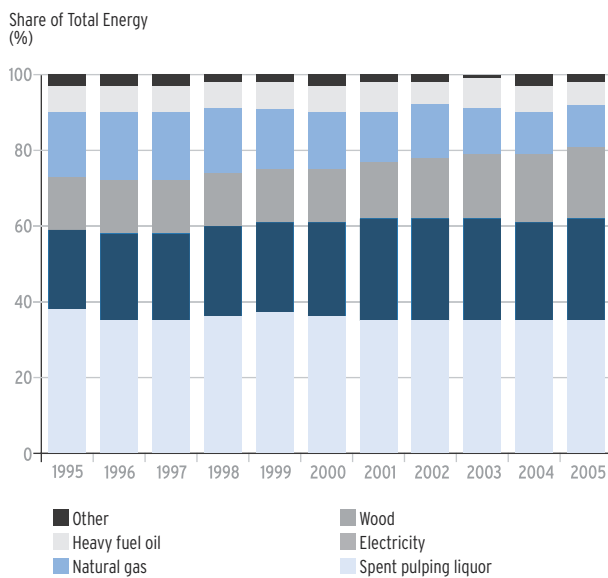
The Pulp, Paper and Paperboard Mills (322100)²⁰ industry is Canada's leading industrial user of renewable energy, with biomass and small hydro power making up 60% of the industry's energy consumption.^{xiii}

¹⁹ The energy sources included in "Other" are coal, middle distillates, propane and steam.

²⁰ "Pulp, Paper and Paperboard Mills (322100) industry" includes the Pulp Mills (322110) industry, the Paper Mills (322120) industry and the Paperboard Mills (322130) industry.

The energy source shares indicate the relative consumption of the energy sources used in the Paper Manufacturing subsector between 1995 and 2005. See Figure 4.2.5.

Figure 4.2.5 Share of energy sources used in the Paper Manufacturing subsector (1995-2005)



The relative energy consumption of natural gas decreased, reaching 11% in 2005, and the wood share has increased steadily from 14% to 19% since 1995. The electricity share increased, from 21% in 1995 to 27% in 2005. The spent pulping liquor share was highest in 1995, and then dropped in 1996. Between 1996 and 1999, the share of spent pulping liquor increased. Since then, the share decreased to 35% and has been steady since 2001.

Because the Chemical Pulp Mills and Newsprint Mills industries account for a significant portion of the Paper Manufacturing subsector's energy use, their energy consumption is discussed in detail in the following sections.

Chemical Pulp Mills

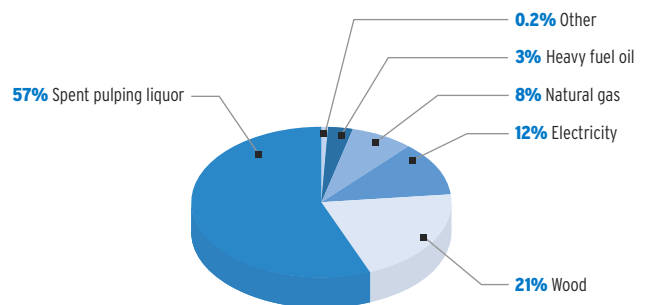
In 2005, spent pulping liquor was responsible for 57% (198.49 PJ) of the energy consumed by the Chemical Pulp Mills industry. See Table 4.2.3 and Figure 4.2.6.

Table 4.2.3 Energy use in the Chemical Pulp Mills industry (2005)

Type of Energy	Energy Use (PJ)
Electricity	41.24
Heavy fuel oil	10.96
Middle distillates	0.62
Natural gas	27.01
Propane	x
Spent pulping liquor	198.49
Steam	x
Wood	72.71
Total	351.18
Confidential	0.14

x = confidential data

Figure 4.2.6 Share of energy use in the Chemical Pulp Mills industry (2005)



Wood, electricity, natural gas and heavy fuel oil represented 21%, 12%, 8% and 3%, respectively, of the energy consumed by this industry in 2005. Middle distillates, propane and steam, which make up an "Other" category, were also used in 2005, but in smaller quantities.

Figure 4.2.7 shows that between 1995 and 2005, the relative shares of energy consumed by the Chemical Pulp Mills industry were almost unchanged. Spent pulping liquor shares varied between 55% and 59%, wood shares varied between 16% and 21%, electricity shares varied between 9% and 12% and natural gas shares varied between 8% and 12%.

Figure 4.2.8 shows that the total energy used by the Chemical Pulp Mills industry was constant (approximately 350 PJ), except in 1995, when it was 382.49 PJ.

Figure 4.2.7 Share of energy use in Chemical Pulp Mills (1995-2005)

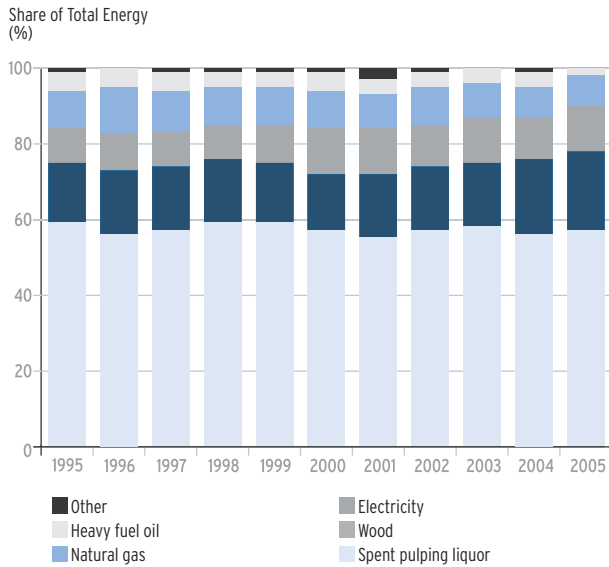
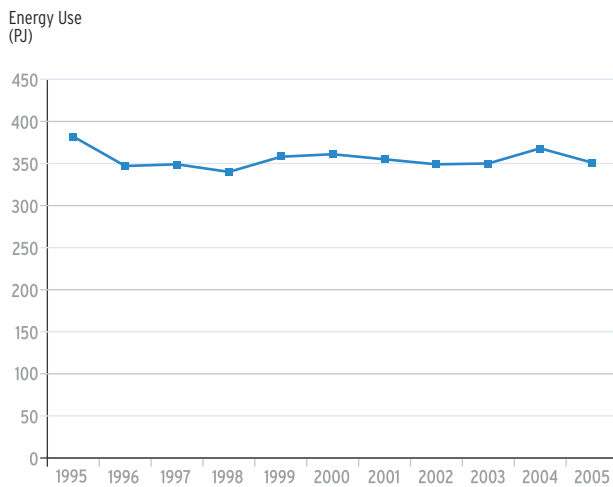


Figure 4.2.8 Total energy use in Chemical Pulp Mills (1995-2005)



Newsprint Mills

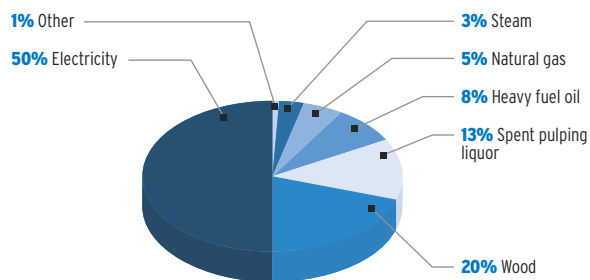
Table 4.2.4 and Figure 4.2.9 show that electricity was responsible for most of the total energy used by the Newsprint Mills industry in 2005, at 50% (113.38 PJ) of the energy consumed.

Table 4.2.4 Energy use in the Newsprint Mills industry (2005)

Type of Energy	Energy Use (PJ)
Coal	x
Electricity	113.38
Heavy fuel oil	18.72
Middle distillates	x
Natural gas	12.22
Propane	0.11
Spent pulping liquor	28.45
Steam	7.85
Wood	44.19
Total	226.56
Confidential	1.65

x = confidential data

Figure 4.2.9 Share of energy use in the Newsprint Mills industry (2005)

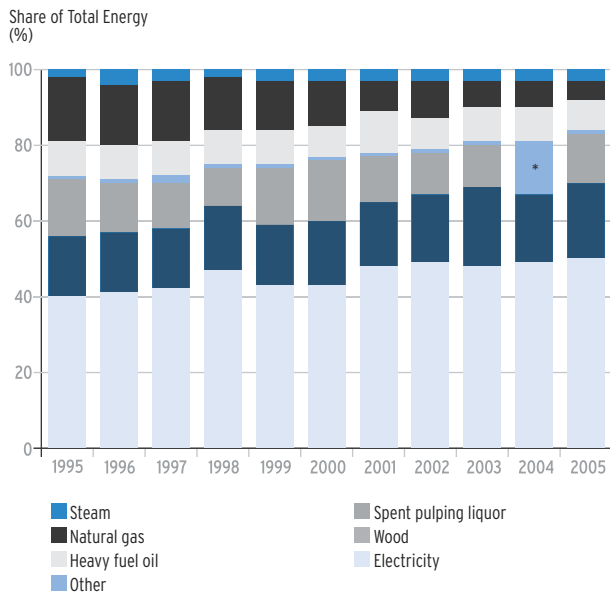


Wood, spent pulping liquor, heavy fuel oil, natural gas and steam represented 20%, 13%, 8%, 5% and 3%, respectively, of this industry's energy consumption. Propane, coal and middle distillates were also used in 2005, and they have been combined in an "Other" category.

The spent pulping liquor energy share for 2004 is confidential, so it has been combined with the Other category for that year in Figure 4.2.10. This figure shows the relative shares of energy consumed by the Newsprint Mills industry. Electricity shares went from 40% to 50% between 1995 and 2005. Wood shares ranged between 16% and 21%, spent pulping liquor shares ranged between 10% and 16% and heavy fuel oil shares ranged between 8% and 11%. The shares of natural gas dropped from 17% in 1995 to 5% in 2005.

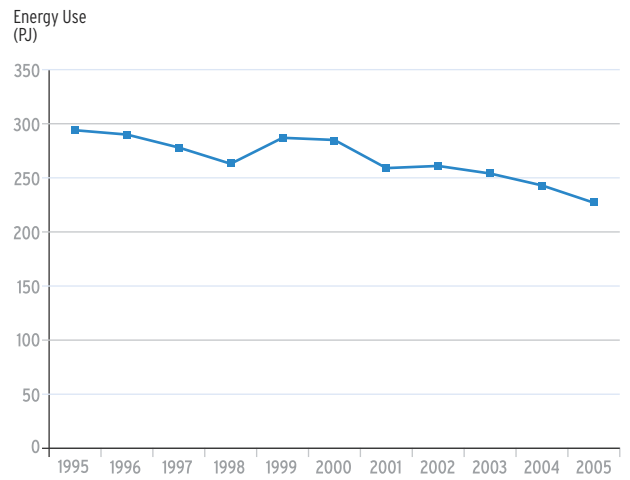
Figure 4.2.11 shows that the total energy used by the Newsprint Mills industry decreased from 294.36 PJ to 226.56 PJ (23%) between 1995 and 2005.

Figure 4.2.10 Share of energy use in the Newsprint Mills industry (1995-2005)



*Combined data

Figure 4.2.11 Total energy use in the Newsprint Mills industry (1995-2005)



4.3 Primary Metal Manufacturing

Overview of the Primary Metal Manufacturing (331) subsector in Canada

With a GDP of \$12 billion, the Primary Metal Manufacturing subsector was responsible for 7% of the total GDP in the Manufacturing sector in 2005.^{xiv}

The Primary Metal Manufacturing subsector employed 75 065 workers in 2004, of whom 80% were production workers.^{xv}

Among the exports of the Primary Metal Manufacturing subsector, 77% were destined for the United States and 5% for Norway in 2005.^{xvi}

In 2005, Canada ranked third among the world's aluminum-producing countries.^{xvii}

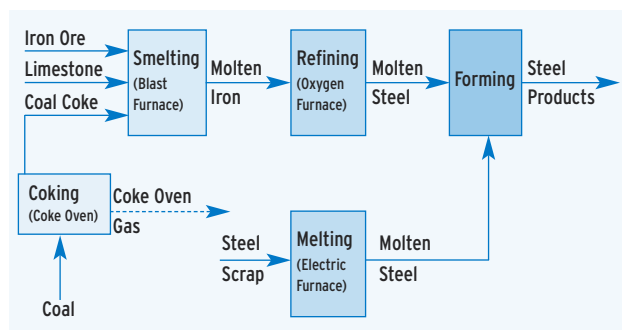
Industries in the Primary Metal Manufacturing subsector

The Primary Metal Manufacturing (331) subsector includes establishments that perform smelting and refining of ferrous metals (those that contain iron, including iron-containing alloys, such as steel) and non-ferrous metals (which are metals that do not contain iron, such as aluminum and copper). Smelting refers to the “heat treatment of an ore to separate the metallic portion.” Refining is “a separation process whereby undesirable components are removed ... to give a concentrated and purified product.”^{xviii}

Iron and Steel Mills and Ferro-Alloy Manufacturing

The Iron and Steel Mills and Ferro-Alloy Manufacturing (331100) industry comprises establishments producing iron and steel. Figure 4.3.1 shows the manufacturing process of iron and steel.

Figure 4.3.1 The iron and steel manufacturing process



A method commonly used for producing iron consists of reducing iron ore in a blast furnace. Iron ore, coal coke²¹ and flux²² (usually limestone) are smelted together to produce pig iron (molten iron). The pig iron can be used to produce basic iron shapes or can be converted into steel.

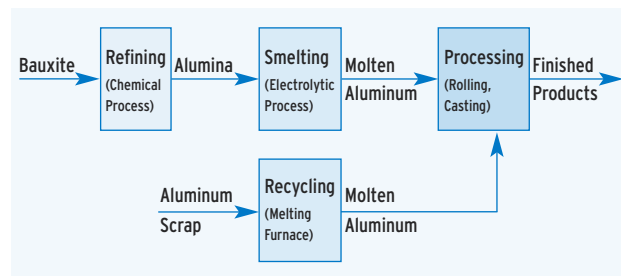
The refining process most commonly used to make steel from iron, which is called the “basic oxygen process,” uses oxygen to remove the carbon from pig iron through combustion, and thereby produce steel. Steel can also be produced by melting scrap (by-products of steel manufacturing and other material containing steel) in an electric furnace. The electric-arc furnace is the most used electric furnace. The molten steel is then shaped into various products.

This industry also includes establishments that produce ferro-alloys.²³

Primary Production of Alumina and Aluminum

Establishments in the Primary Production of Alumina and Aluminum (331313) industry extract alumina, which is a compound of aluminum and oxygen, from bauxite²⁴ to produce aluminum. The alumina and aluminum manufacturing process is illustrated in Figure 4.3.2.

Figure 4.3.2 Alumina and aluminum manufacturing process



²¹ The coal coke used in the blast furnaces can be made onsite by converting coal to coal coke in a coke oven. This process produces coke oven gas that is then used as an energy source by establishments.

²² Flux is “a substance that promotes the fusing of minerals or metals or prevents the formation of oxides.”^{xviii}

²³ Ferro-alloy is “an alloy of iron with some element other than carbon used as a vehicle for introducing such an element into steel during its manufacture.”^{xviii}

²⁴ Bauxite is “a natural aggregate of aluminum-bearing minerals.”^{xviii}

Through a chemical process, alumina is extracted from bauxite. The alumina is then used to produce aluminum by an electrolytic process. Aluminum can also be produced by melting aluminum scrap (by-products of aluminum manufacturing and other material containing aluminum) in a furnace.

The Primary Production of Alumina and Aluminum (331313) industry also includes establishments engaged in secondary activities, such as rolling or casting of aluminum that was produced in the same establishment. Rolling is a process for producing sheets or strips of aluminum. In casting, molten aluminum is poured into moulds. Other techniques can also be used.

Non-Ferrous Metal Smelting and Refining

The Non-Ferrous Metal Smelting and Refining (331410) industry smelts non-ferrous metals (such as cobalt, copper, gold and nickel) from ores and refines them. Aluminum processing is not included in this industry.

Foundries

Establishments that produce castings by pouring molten metal into moulds or dies form the Foundries (331500) industry. This industry can be divided into the Ferrous Metal Foundries (331510) industry and the Non-Ferrous Metal Foundries (331520) industry. Ferrous Metal Foundries can be divided further into Iron Foundries (331511) and Steel Foundries (331514).

The following industries are included in the Primary Metal Manufacturing (331) subsector, but are not discussed in detail:

- Iron and Steel Pipes and Tubes Manufacturing from Purchased Steel (331210)
- Rolling and Drawing of Purchased Steel (331220)
- Aluminum Rolling, Drawing, Extruding and Alloying (331317)
- Copper Rolling, Drawing, Extruding and Alloying (331420)
- Non-Ferrous Metal (except Copper and Aluminum) Rolling, Drawing, Extruding and Alloying (331490)

Primary Metal Manufacturing energy consumption in 2005 and trends

With 529.16 PJ of energy consumed in 2005, the Primary Metal Manufacturing subsector was the second-largest consumer of energy in the Manufacturing sector in Canada.

The energy used in the Iron and Steel Mills and Ferro-Alloy Manufacturing industry, 237.97 PJ in 2005, represented 45% of the energy consumption in the Primary Metal Manufacturing subsector. See Figure 4.3.3 and Table 4.3.1.

Figure 4.3.3 Share of energy use in the Primary Metal Manufacturing subsector (2005)

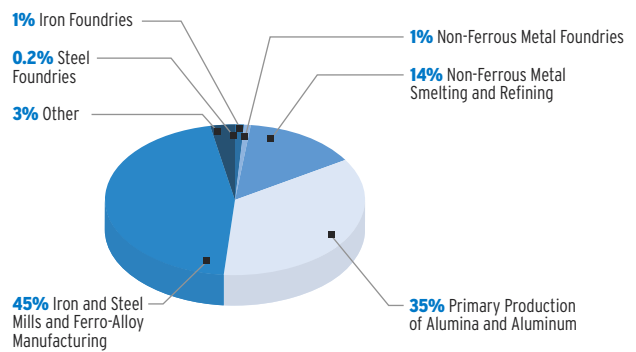


Table 4.3.1 Energy use in the Primary Metal Manufacturing subsector (2005)

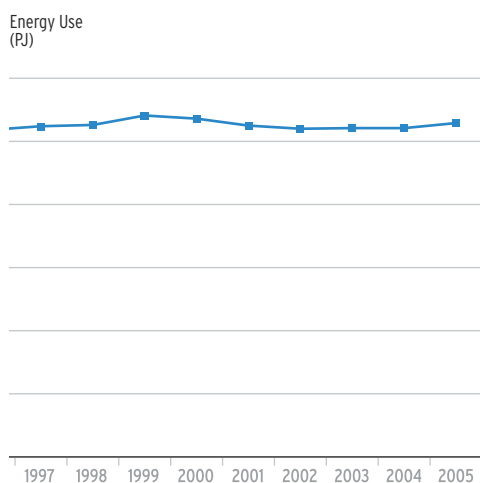
Industry	Energy Use (PJ)
Iron and Steel Mills and Ferro-Alloy Manufacturing (331100)	237.97
Primary Production of Alumina and Aluminum (331313)	184.81
Non-ferrous Metal Smelting and Refining (331410)	75.22
Iron Foundries (331511)	5.81
Steel Foundries (331514)	1.06
Non-Ferrous Metal Foundries (331520)	6.08
Other	18.21
Primary Metal Manufacturing (331)	529.16

The Primary Production of Alumina and Aluminum industry was responsible for 35% (184.81 PJ) of the Primary Metal Manufacturing subsector energy use in 2005. The Non-Ferrous Metal Smelting and Refining, and the Foundries²⁵ industries consumed 14% (75.22 PJ) and 2% (12.95 PJ), respectively, of the Primary Metal Manufacturing subsector's energy consumption.

The total energy consumed by the Primary Metal Manufacturing subsector between 1995 and 2005 is shown in Figure 4.3.4.

25 "Foundries (331500) industry" includes the Iron Foundries (331511), Steel Foundries (331514) and Non-Ferrous Metal Foundries (331520) industries.

Figure 4.3.4 Total energy use in the Primary Metal Manufacturing subsector (1995–2005)



Between 1995 and 2005, the energy consumption of the Primary Metal Manufacturing subsector remained relatively stable. The lowest amount of energy, 503.79 PJ, was used in 1995, and the highest amount, 540.50 PJ, was used in 1999.

Primary Metal Manufacturing energy consumption by source in 2005 and trends

The industries in the Primary Metal Manufacturing subsector use different energy sources, depending on their processes. For example, the Iron and Steel Mills and Ferro-Alloy Manufacturing industry uses coal coke and coke oven gas in large quantities, whereas the Primary Production of Alumina and Aluminum industry does not use those energy sources. Because the energy consumption of these two industries accounts for a significant portion of the subsector's total energy use (more than 80%), they are discussed in detail in the following section.

Iron and Steel Mills and Ferro-Alloy Manufacturing

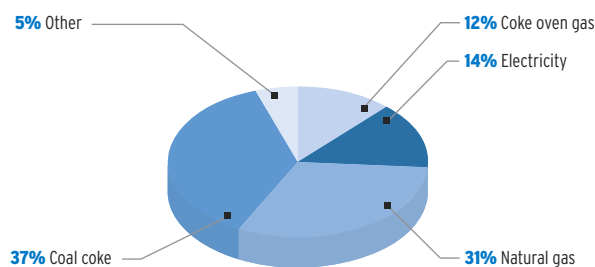
Table 4.3.2 and Figure 4.3.5 show the energy consumption of the Iron and Steel Mills and Ferro-Alloy Manufacturing industry for 2005 by source.

Table 4.3.2 Energy use in the Iron and Steel Mills and Ferro-Alloy Manufacturing industry (2005)

Type of Energy	Energy Use (PJ)
Coal	x
Coal coke	89.06
Coke oven gas	29.55
Electricity	32.48
Heavy fuel oil	x
Middle distillates	0.83
Natural gas	74.32
Petroleum coke and coke from catalytic cracking catalyst	x
Propane	0.05
Steam	x
Wood	x
Total	237.97
Confidential	11.68

x = confidential data

Figure 4.3.5 Share of energy use in the Iron and Steel Mills and Ferro-Alloy Manufacturing industry (2005)



As stated above, smelting of iron ore requires coal coke, which is produced by heating coal in a coke oven. This process also generates coke oven gas, which is also used as an energy source. The Iron and Steel Mills and Ferro-Alloy Manufacturing industry is, therefore, the primary user of these energy sources.

In 2005, the industry consumed 89.06 PJ of coal coke, which is 97% of the total consumption of coal coke by the Manufacturing sector. With respect to the total energy consumed by the Iron and Steel Mills and Ferro-Alloy Manufacturing industry, coal coke accounted for 37%. Because much of the coal entering the coking process is used for a non-energy use (that is, it is not burned as fuel, but used as a material in the process), it is not included in the energy data provided in this document. Only coal used as an energy source is included.

In the Manufacturing sector, coke oven gas was consumed only by the Iron and Steel Mills and Ferro-Alloy Manufacturing industry in 2005, and accounted for 12% of the industry's energy consumption. With a share of 31%, natural gas is also an important energy source for the manufacturing of iron and steel. Electricity and other energy sources – that is coal, heavy fuel oil, middle distillates, petroleum coke and coke from catalytic cracking catalyst, propane, steam and wood – represented 14% and 5%, respectively, of the industry's energy use in 2005.

The share of coal coke in this industry's energy consumption peaked in 2001 at 42%, whereas the natural gas share was at its lowest level, at 28%. See Figure 4.3.6.

Figure 4.3.6 Share of energy use in the Iron and Steel Mills and Ferro-Alloy Manufacturing industry (1995-2005)

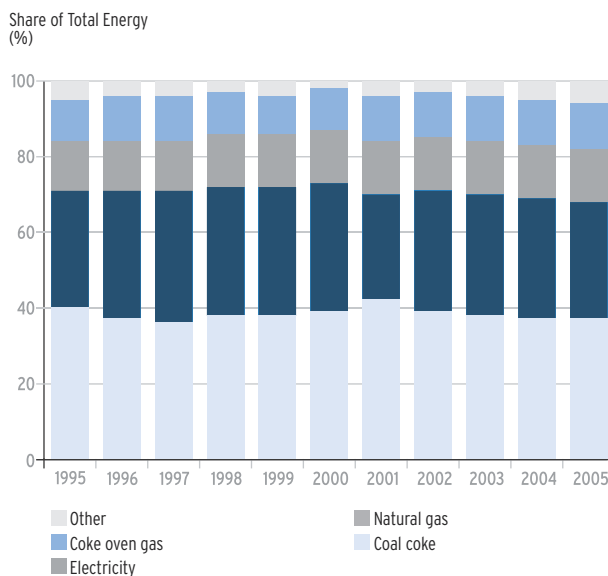


Figure 4.3.7 Total energy use in the Iron and Steel Mills and Ferro-Alloy Manufacturing industry (1995-2005)

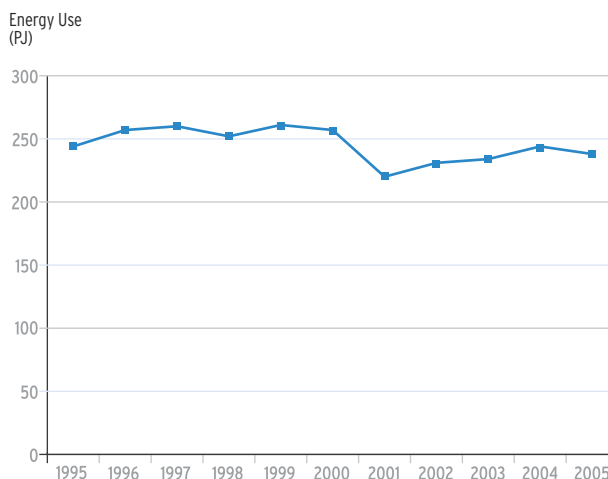


Figure 4.3.7 shows that from 2000 to 2001, the energy consumption of the Iron and Steel Mills and Ferro-Alloy Manufacturing industry dropped by 36.92 PJ, a decrease of 14%.

Primary Production of Alumina and Aluminum

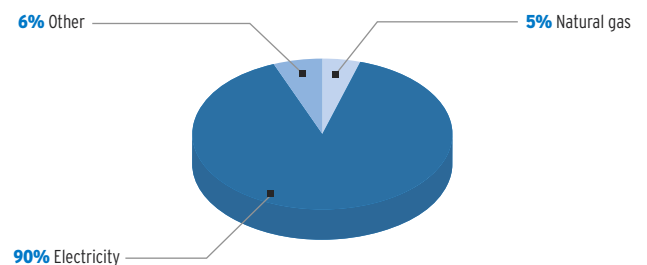
The Primary Production of Alumina and Aluminum industry consumed mainly electricity in 2005. See Table 4.3.3 and Figure 4.3.8.

Table 4.3.3 Energy use in the Primary Production of Alumina and Aluminum industry (2005)

Type of Energy	Energy Use (PJ)
Electricity	165.85
Heavy fuel oil	x
Middle distillates	x
Natural gas	8.75
Propane	x
Total	184.81
Confidential	10.21

x = confidential data

Figure 4.3.8 Share of energy use in the Primary Production of Alumina and Aluminum industry (2005)



The electrolytic process that produces aluminum from alumina requires a lot of electricity. Approximately 54 GJ of electricity are required to produce 1 tonne of aluminum.²⁶ With a consumption of 165.85 PJ, electricity accounted for 90% of energy consumed in the Primary Production of Alumina and Aluminum industry in 2005. The remaining 11% of the energy consumption was divided between natural gas, with 5%, and other energy sources – that is, heavy fuel oil, middle distillates and propane – which, together, accounted for 6%.

²⁶ An average of 15 kWh (0.054GJ) is needed to produce 1 kg of aluminum.^{xix}

Although energy costs to produce aluminum are significant, up to 95% of the power required to produce the metal can be saved by recycling aluminum instead of producing it from alumina. Recycling 1 kilogram (kg) of aluminum can save 8 kg of bauxite, 4 kg of chemical products and 15 kilowatt hours (kWh) (0.054GJ) of electrical power.^{xix}

The shares of electricity and natural gas in the total energy consumption of this industry remained approximately the same between 1995 and 2005. See Figure 4.3.9. The energy share of electricity varied between 89% and 92%, whereas the energy share of natural gas varied between 5% and 8% over this period.

The trend of energy consumption for the years 1995 to 2005 is shown in Figure 4.3.10. Total energy use increased by 29% during those years.

Figure 4.3.9 Share of energy use in the Primary Production of Alumina and Aluminum industry (1995-2005)

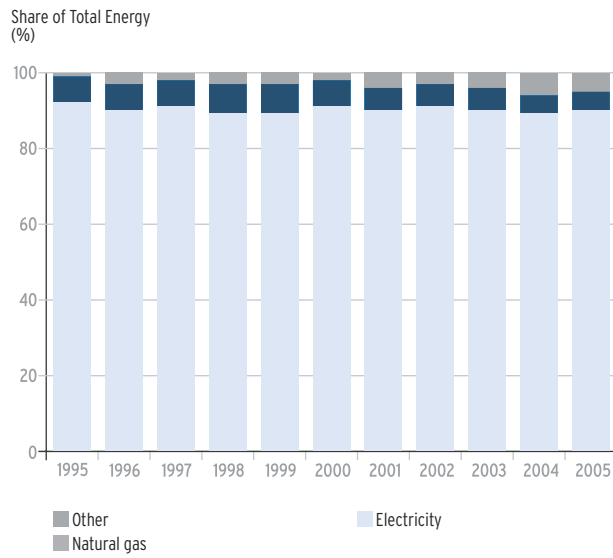
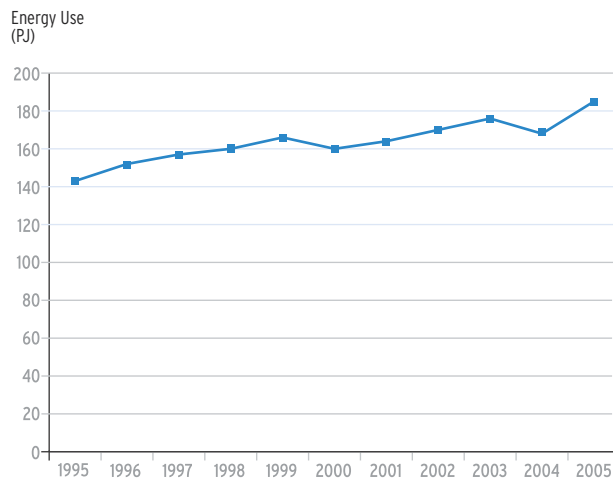


Figure 4.3.10 Total energy use in the Primary Production of Alumina and Aluminum industry (1995-2005)



4.4 Petroleum and Coal Products Manufacturing

Overview of the Petroleum and Coal Products Manufacturing (324) subsector in Canada

With a GDP of \$2.0 billion, the Petroleum and Coal Products Manufacturing subsector was responsible for 1% of the total GDP in the Manufacturing sector in 2005.^{xx}

The Petroleum and Coal Products Manufacturing subsector employed 11 227 workers in 2004, of whom 67% were production workers.^{xxi}

Among the exports of the Petroleum and Coal Products Manufacturing subsector, 95% were destined for the United States in 2005.^{xxii}

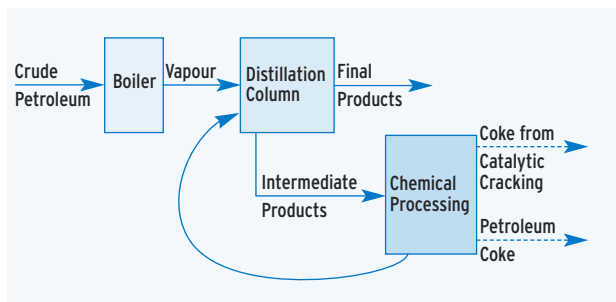
Industries in the Petroleum and Coal Products Manufacturing subsector

Establishments in the Petroleum and Coal Products Manufacturing (324) subsector transform crude petroleum and coal into usable products, such as gasoline or various types of oil.²⁷

Petroleum Refineries

The Petroleum Refineries (324110) industry represents the main industry of the subsector. The petroleum refining process separates various hydrocarbons²⁸ contained in the crude petroleum to produce many products, such as gasoline, diesel fuel oil, light and heavy fuel oils and asphalt. A high-level overview of the steps in the petroleum refining process is shown in Figure 4.4.1.

Figure 4.4.1 Petroleum refining process



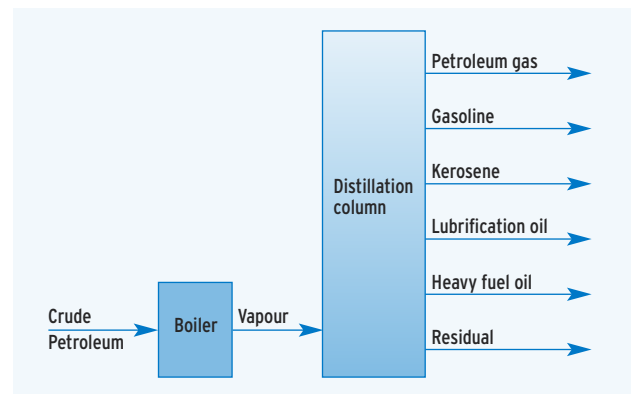
The various types of hydrocarbons contained in crude petroleum must be separated to produce usable products. Each type of hydrocarbon has a different boiling point.²⁹ Therefore, they can be separated by a distillation process.

The distillation process in petroleum refining

In the first step, the crude petroleum is boiled and the vapour that is formed goes into a distillation column. The temperature is very high at the bottom of the column and cools as it reaches the top of the column. By going through the distillation column, hydrocarbons contained in the vapour condense and form a liquid when they reach a height where the temperature is equal to their boiling point.³⁰ The liquid products are collected separately. Some gases are collected at the top of the distillation column, and the residual is collected in solid form at the bottom of the distillation column.

Figure 4.4.2 illustrates the basic distillation process. Note that for demonstration purposes, only some of the products that can result from the distillation process are included in this figure.

Figure 4.4.2 Distillation process in petroleum refining



27 The ICE survey collected energy data for only the Petroleum Refineries (324110) industry in the Petroleum and Coal Products Manufacturing (324) subsector.

28 Hydrocarbons are molecules composed of hydrogen and carbon atoms. For example, methane (CH₄) is a hydrocarbon with one carbon atom and four hydrogen atoms.

29 The boiling point is the temperature at which a liquid changes its state to a vapour (gas).

30 The hydrocarbons with low boiling points will condense at higher points in the distillation column, and those with high boiling points will condense in lower locations.

Following the distillation process, many of the products from the distillation column are chemically processed and eventually changed into different petroleum products (the hydrocarbons are converted into other hydrocarbons).

Conversion processes in petroleum refining

The catalytic cracking process separates hydrocarbons into smaller ones by using a catalyst to speed up the cracking (or breaking) process. In addition to the simpler hydrocarbon molecules that are formed, this process produces a by-product called coke from catalytic cracking catalyst. The coke obtained is used as an energy source in the Petroleum Refineries industry.

A thermal cracking process can also be used to break large hydrocarbons into smaller ones. Heavier products from the distillation process can be refined with this method, which consists of cooking hydrocarbons at high temperatures to break them. Smaller hydrocarbons and petroleum coke are produced. Petroleum coke is used as an energy source by a few industries, especially the Petroleum Refineries industry.

Other conversion methods exist, such as combining smaller hydrocarbons to make larger ones, or rearranging them to form the required hydrocarbons.

After they undergo chemical processing, the various hydrocarbons go through another distillation process to be separated. The hydrocarbons are sold or used directly in the Petroleum Refineries industry.

Other industries that are included in the Petroleum and Coal Products Manufacturing (324) subsector, but are not discussed in detail in this report, include the following:

- Asphalt Paving, Roofing and Saturated Materials Manufacturing (324120)
- Other Petroleum and Coal Products Manufacturing (324190)

Petroleum and Coal Products Manufacturing energy consumption in 2005 and trends

A total of 358.02 PJ of energy was consumed by the Petroleum and Coal Products Manufacturing subsector in 2005, making it the third-largest energy consumer in the Manufacturing sector in Canada.

The Petroleum Refineries subsector used most of the energy in this subsector, with 95% (338.45 PJ) of the energy consumption in 2005. See Figure 4.4.3 and Table 4.4.1.

Figure 4.4.3 Share of energy use in the Petroleum and Coal Products Manufacturing subsector (2005)

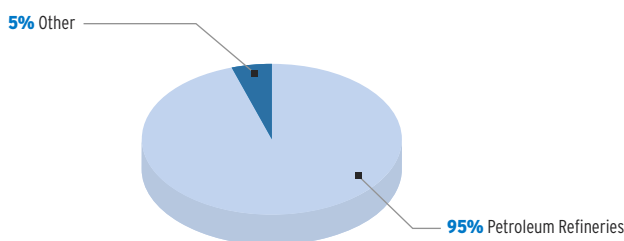


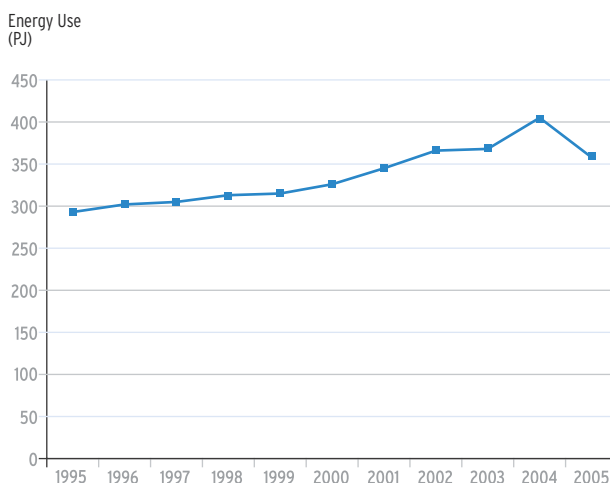
Table 4.4.1 Energy use in the Petroleum and Coal Products Manufacturing subsector (2005)

Industry	Energy Use (PJ)
Petroleum Refineries (324110)	338.45
Other	19.56
Petroleum and Coal Products Manufacturing (324)	358.02

All other industries included in the Petroleum and Coal Products Manufacturing subsector comprise an “Other” category, which used 5% (19.56 PJ) of the subsector’s energy consumption.

Figure 4.4.4 shows the energy consumption in the Petroleum and Coal Products Manufacturing subsector between 1995 and 2005.

Figure 4.4.4 Total energy use in the Petroleum and Coal Products Manufacturing subsector (1995-2005)



Between 1995 and 2004, total energy consumption increased by 38%, rising from 292.95 PJ to 405.49 PJ. A decrease of 12% occurred between 2004 and 2005.

Because the greatest share of energy use in the Petroleum and Coal Products Manufacturing subsector is due to the Petroleum Refineries industry, an analysis of the energy consumption data will be provided only for that industry as it greatly influences the subsector's energy consumption.

Petroleum Refineries energy consumption by source in 2005 and trends

The Petroleum Refineries industry relies primarily on refinery fuel gas as its energy source. See Figure 4.4.5. Table 4.4.2 confirms that 183.59 PJ of energy or 54% of that industry's energy consumption was provided by refinery fuel gas in 2005.

Figure 4.4.5 Share of energy use in the Petroleum Refineries industry (2005)

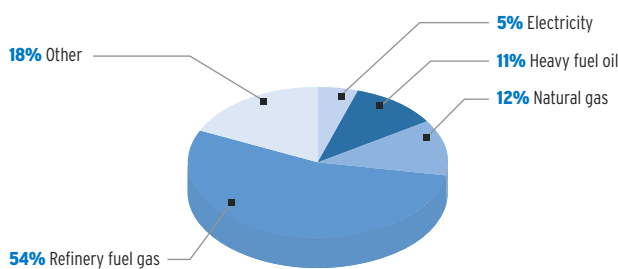


Table 4.4.2 Energy use in the Petroleum Refineries industry (2005)

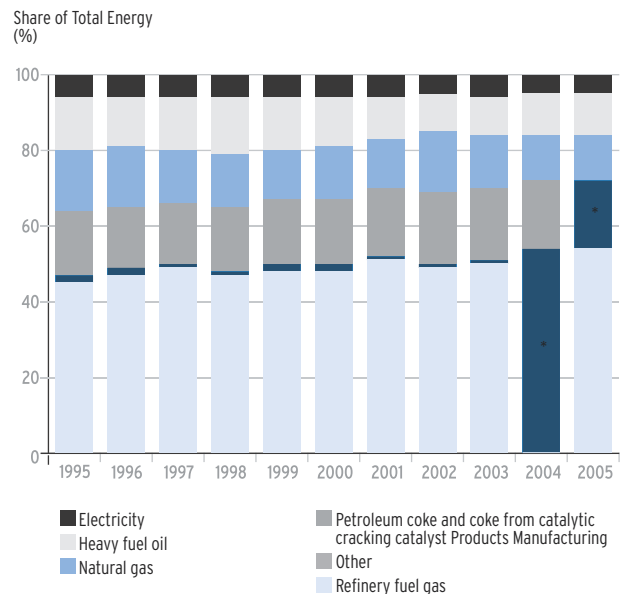
Type of Energy	Energy Use (PJ)
Electricity	17.92
Heavy fuel oil	36.24
Middle distillates	x
Natural gas	40.62
Petroleum coke and coke from catalytic cracking catalyst	x
Propane	0.60
Refinery fuel gas	183.59
Steam	x
Total	338.45
Confidential	59.48

x = confidential data

Like refinery fuel oil, petroleum coke and coke from catalytic cracking catalyst are by-products of the Petroleum Refineries industry. Their consumption for 2005 is confidential, but in 2004, they represented 18% of the industry energy use when combined. The remaining energy consumption in 2005 was divided among natural gas (12%), heavy fuel oil (11%), electricity (5%), middle distillates, propane and steam.

Figure 4.4.6 shows that the share of energy consumption by energy type for the Petroleum Refineries industry underwent changes between 1995 and 2005. The share of refinery fuel gas is confidential for 2004, so it was combined with the "Other" category comprised of middle distillates, propane and steam. For 2005, since the share of petroleum coke and coke from catalytic cracking catalyst is confidential, it was combined with the Other category in the figure.

Figure 4.4.6 Share of energy use in the Petroleum Refineries industry (1995-2005)



*Combined data

The relative consumption of refinery fuel gas increased from 45% to 54% between 1995 and 2005. Conversely, the relative consumption of natural gas decreased from 16% to 12% over the same period. The share of heavy fuel oil was 14% in 1995 and 11% in 2005. The share of petroleum coke and coke from catalytic cracking varied between 16% and 19% over the study period.

4.5 Chemical Manufacturing

Overview of the Chemical Manufacturing (325) subsector in Canada

With a GDP of \$17.2 billion, the Chemical Manufacturing subsector was responsible for 10% of the total GDP in the Manufacturing sector in 2005.^{xxiii}

The Chemical Manufacturing subsector employed 84 534 workers in 2004, of whom 58% were production workers.^{xxiv}

Among the exports of the Chemical Manufacturing subsector, 80% were destined for the United States and 5% for China in 2005.^{xxv}

Industries in the Chemical Manufacturing subsector

Establishments in the Chemical Manufacturing (325) subsector manufacture chemicals and chemical products. The chemicals produced are used by other industries and sectors and in commercial products. This subsector is varied and includes too many industries to describe each one in detail. Therefore, only the biggest energy consumers are described below.

Petrochemical Manufacturing

Establishments in the Petrochemical Manufacturing (325110) industry are primarily involved in making petrochemicals. Examples include benzene (which is used in the manufacturing of other products, such as polystyrene, nylon and dyes) and ethylene (which is used to produce plastics and resins, for example). Petrochemicals are chemicals derived from petroleum or natural gas.

All Other Basic Inorganic Chemical Manufacturing

The All Other Basic Inorganic Chemical Manufacturing (325189) industry comprises establishments that manufacture inorganic chemicals and are not classified to any other industry. Examples of inorganic chemicals include ammonium chloride (which is used for the manufacture of dry-cell batteries and quarrying explosives) and sulphur (which is used in the form of sulphuric acid in the production of iron and steel).

Other Basic Organic Chemical Manufacturing

The Other Basic Organic Chemical Manufacturing (325190) industry comprises establishments that manufacture basic organic chemicals and that are not classified in any other industry. Examples of organic chemicals include synthetic sweeteners (sweetening agents) and rosin (which is made by distillation of pine gum or pine wood).

Resin and Synthetic Rubber Manufacturing

Establishments in the Resin and Synthetic Rubber Manufacturing (325210) industry manufacture synthetic resins (“a man-made polymer resulting from a chemical reaction between two (or more) substances”^{xxvi}) that can be used in products such as varnishes), plastics materials and synthetic rubber from basic organic chemicals.

Chemical Fertilizer Manufacturing

The Chemical Fertilizer (except Potash) Manufacturing (325313) industry includes establishments that manufacture fertilizers. Fertilizers help plant growth by providing additional nutrients.

Many other industries comprise the Chemical Manufacturing (325) subsector, but are not discussed in detail because they do not represent significant energy consumption in this subsector. They include the following:

- Industrial Gas Manufacturing (325120)
- Synthetic Dye and Pigment Manufacturing (325130)
- Alkali and Chlorine Manufacturing (325181)
- Artificial and Synthetic Fibres and Filaments Manufacturing (325220)
- Mixed Fertilizer Manufacturing (325314)
- Pesticide and Other Agricultural Chemical Manufacturing (325320)
- Pharmaceutical and Medicine Manufacturing (325410)
- Paint and Coating Manufacturing (325510)
- Adhesive Manufacturing (325520)
- Soap and Cleaning Compound Manufacturing (325610)
- Printing Ink Manufacturing (325910)
- Explosives Manufacturing (325920)
- Custom Compounding of Purchased Resins (325991)
- All Other Miscellaneous Chemical Product Manufacturing (325999)

Chemical Manufacturing energy consumption in 2005 and trends

The Chemical Manufacturing subsector consumed 272.83 PJ of energy in 2005, making it the fourth-largest consumer of energy in Canada's Manufacturing sector.

Figure 4.5.1 and Table 4.5.1 show that with 63.47 PJ of energy consumed in 2005, the Petrochemical Manufacturing industry was responsible for 23% of this subsector's energy consumption, whereas 20% (54.65 PJ) was attributable to the Chemical Fertilizer (except Potash) Manufacturing industry.

Figure 4.5.1 Share of energy use in the Chemical Manufacturing industry (2005)

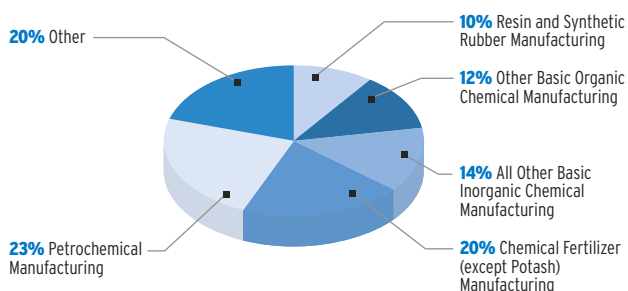


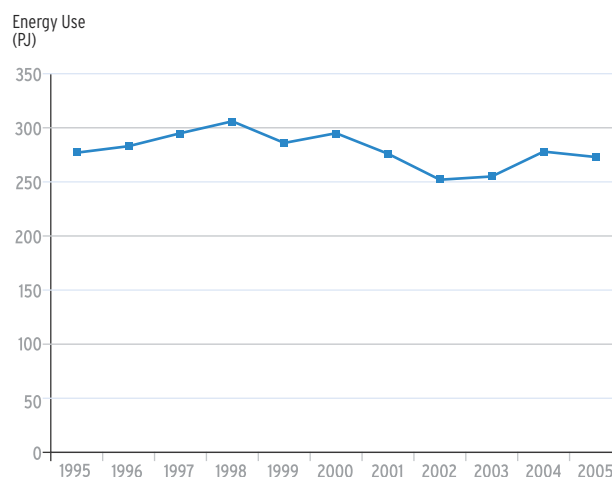
Table 4.5.1 Energy use in the Chemical Manufacturing industry (2005)

Industry	Energy Use (PJ)
Petrochemical Manufacturing (325110)	63.47
All Other Basic Inorganic Chemical Manufacturing (325189)	37.91
Other Basic Organic Chemical Manufacturing (325190)	33.79
Resin and Synthetic Rubber Manufacturing (325210)	28.19
Chemical Fertilizer (except Potash) Manufacturing (325313)	54.65
Other	54.81
Chemical Manufacturing (325)	272.83

The remaining 56% of energy consumption was divided between the All Other Basic Inorganic Chemical Manufacturing industry, with 14% (37.91 PJ), the Other Basic Organic Chemical Manufacturing industry, with 12% (33.79 PJ), the Resin and Synthetic Rubber Manufacturing (325210) industry, with 10% (28.19 PJ), and other industries, with 20% (54.81 PJ).

Some interesting trends are shown in Figure 4.5.2, which depicts the subsector's energy consumption between 1995 and 2005.

Figure 4.5.2 Total energy use in the Chemical Manufacturing subsector (1995-2005)



Total energy consumption reached its lowest point at 252.06 PJ in 2002 and its highest point at 306.20 PJ in 1998. Moreover, a decrease of 2% in energy use occurred between 1995 and 2005.

Chemical Manufacturing energy consumption by source in 2005 and trends

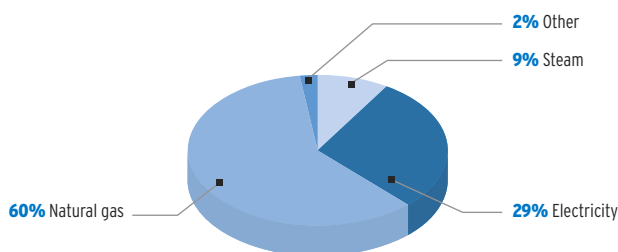
The Chemical Manufacturing subsector relies primarily on the use of natural gas. See Table 4.5.2 and Figure 4.5.3. In fact, 60% (162.48 PJ) of this subsector's energy consumption was that of natural gas in 2005.

Table 4.5.2 Energy use in the Chemical Manufacturing industry (2005)

Type of Energy	Energy Use (PJ)
Electricity	80.42
Heavy fuel oil	3.20
Middle distillates	0.63
Natural gas	162.48
Petroleum coke and coke from catalytic cracking catalyst	x
Propane	0.24
Steam	24.63
Wood	x
Total	272.83
Confidential	1.24

x = confidential data

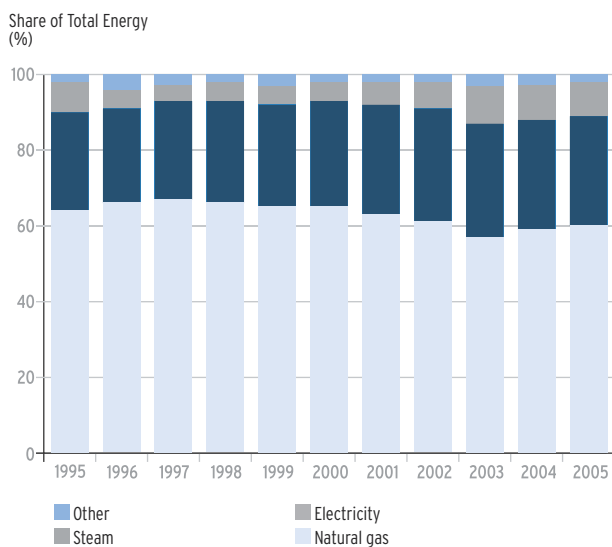
Figure 4.5.3 Shares of energy use in the Chemical Manufacturing industry (2005)



Following natural gas, the most used energy source in the subsector was electricity, which represents 29% of the total energy consumption. With a share of 9% of the subsector's energy consumption, steam also played a significant role as an energy source. Many other energy sources were consumed (heavy fuel oil, propane, middle distillates, coke from catalytic cracking catalyst and wood), but these other energy sources provided only 2% of the total energy consumed in 2005.

Figure 4.5.4 shows the share of each energy source used by the Chemical Manufacturing (325) subsector between 1995 and 2005.

Figure 4.5.4 Share of energy use in the Chemical Manufacturing industry (1995-2005)



Between 1995 and 2005, of total energy consumption, the share of natural gas varied between 57% and 67%. The share went from 67% in 1997 to 60% in 2005. At the same time, the share of electricity increased from 26% to 29%, and the share of steam increased from 4% to 9%.

Because the Petrochemical Manufacturing and Chemical Fertilizer (except Potash) Manufacturing industries accounted for a significant portion of the Chemical Manufacturing subsector's energy use, they are discussed in detail in the following sections.

Petrochemical Manufacturing

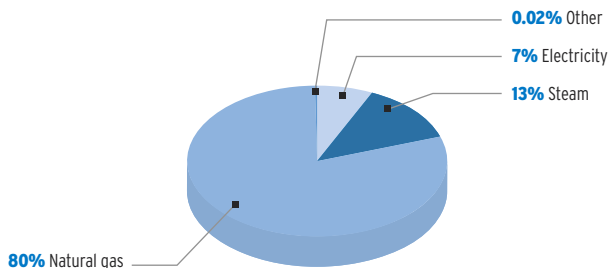
Natural gas supplied 80% (50.72 PJ), which was most of the energy used by the Petrochemical Manufacturing industry in 2005. See Table 4.5.3 and Figure 4.5.5.

Table 4.5.3 Energy use in the Petrochemical Manufacturing industry (2005)

Type of Energy	Energy Use (PJ)
Electricity	4.50
Middle distillates	x
Natural gas	50.72
Propane	x
Steam	8.25
Total	63.47
Confidential	0.01

x = confidential data

Figure 4.5.5 Share of energy use in the Petrochemical Manufacturing industry (2005)

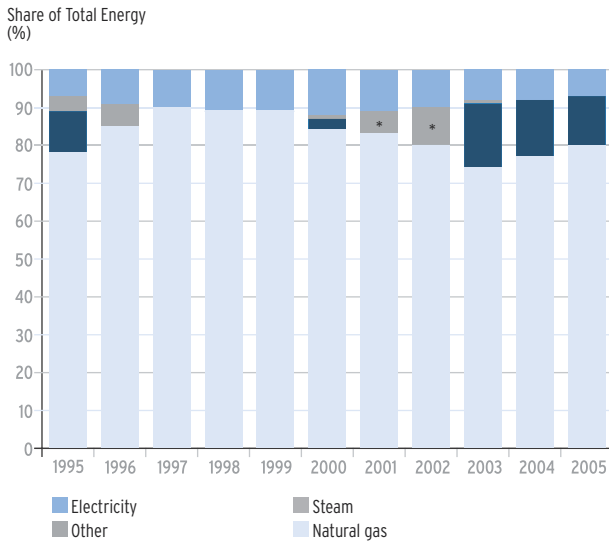


Steam and electricity also contributed to the energy used by the industry, with 13% and 7% of energy shares, respectively.

Over the years, the shares of energy consumption have changed. See Figure 4.5.6. Between 1995 and 1997, the share of natural gas increased from 78% to 90%. Between 1997 and 2003, this share decreased to 74% and finally increased to reach 80% in 2005.

The share of electricity remained relatively stable, between 7% and 12%, during this period. Interestingly, no steam was used between 1996 and 1999. However, since then, the share of steam rose to 17%. The steam shares are confidential for 2001 and 2002, and were combined with middle distillates and propane, which make up the "Other" category for those years.

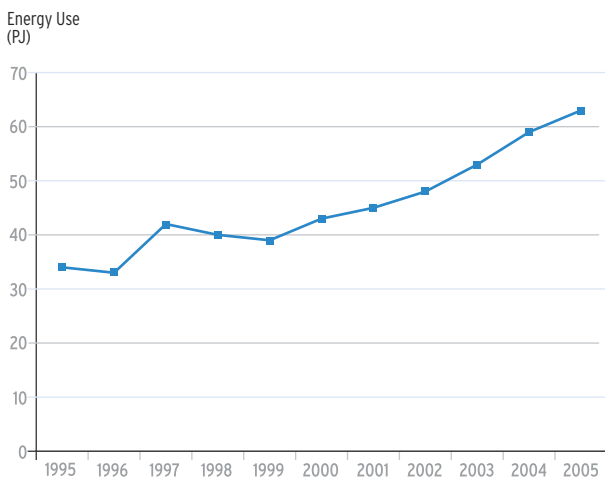
Figure 4.5.6 Share of energy use in the Petrochemical Manufacturing industry (1995-2005)



*Combined data

The total energy used by the Petrochemical Manufacturing industry dramatically increased between 1999 and 2005. See Figure 4.5.7. Between 1995 and 2005, the total consumption of energy increased 85%, from 34.22 PJ to 63.47 PJ.

Figure 4.5.7 Total energy use in the Petrochemical Manufacturing industry (1995-2005)



Chemical Fertilizer (except Potash) Manufacturing

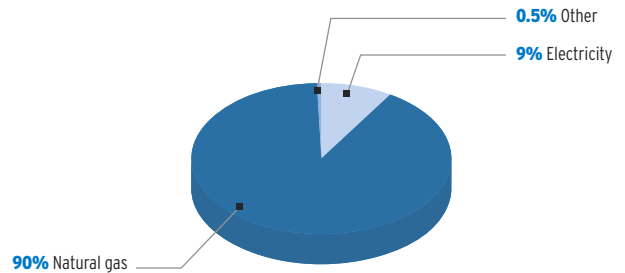
Most of the energy consumption of the Chemical Fertilizer (except Potash) Manufacturing industry, 90% (49.32 PJ), was provided by natural gas in 2005. See Table 4.5.4 and Figure 4.5.8.

Table 4.5.4 Energy use in the Chemical Fertilizer (except Potash) Manufacturing industry (2005)

Type of Energy	Energy Use (PJ)
Electricity	5.09
Heavy fuel oil	x
Middle distillates	0.02
Natural gas	49.32
Propane	0.003
Steam	x
Total	54.65
Confidential	0.23

x = confidential data

Figure 4.5.8 Share of energy use in the Chemical Fertilizer (except Potash) Manufacturing industry (2005)



The remaining energy use was provided by electricity and other energy sources (heavy fuel oil, middle distillates, propane and steam), with 9% and 0.5%, respectively, of energy shares.

Figure 4.5.9 shows that the shares of natural gas and electricity in the industry's energy use have not changed much over the period of study. In fact, between 1995 and 2005, the natural gas share varied between 89% and 92%, whereas the electricity share varied between 8% and 10%. The shares of other energy sources remained under 1%.

Total energy consumption in the Chemical Fertilizer Manufacturing industry increased between 1996 and 2000. See Figure 4.5.10. A decrease occurred between 2000 and 2002, followed by an increase between 2002 and 2004. Energy use decreased between 2004 and 2005 to reach almost the same level as in 1995. In fact, a decrease of 2% (1.32 PJ) occurred between 1995 and 2005.

Figure 4.5.9 Share of energy use in the Chemical Fertilizer (except Potash) Manufacturing industry (1995-2005)

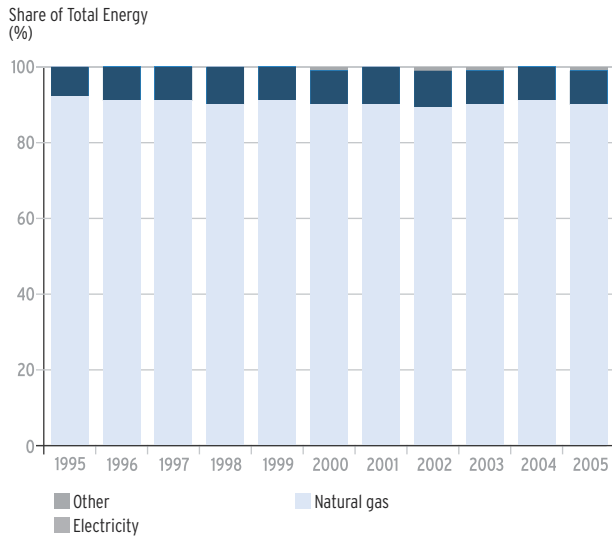
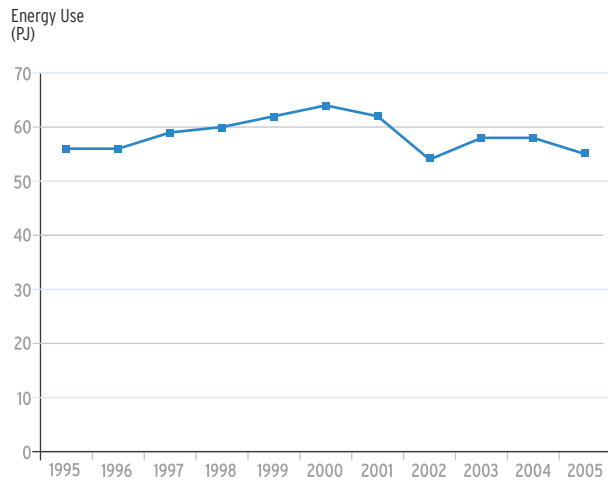


Figure 4.5.10 Total energy use in the Chemical Fertilizer (except Potash) Manufacturing industry (1995-2005)



4.6 Wood Product Manufacturing

Overview of the Wood Product Manufacturing (321) subsector in Canada

With a GDP of \$13.5 billion, the Wood Product Manufacturing subsector was responsible for 8% of the total GDP in the Manufacturing sector in 2005.^{xxvii}

The Wood Product Manufacturing subsector employed 123 449 workers in 2004, of whom 85% were production workers.^{xxviii}

Among the exports of the Wood Product Manufacturing subsector, 89% were destined for the United States and 6% for Japan in 2005.^{xxix}

Industries in the Wood Product Manufacturing subsector

Establishments in the Wood Product Manufacturing (321) subsector manufacture products from wood. The subsector includes establishments that saw logs into wood products, such as particle board and fibreboard, and preserve wood.

Sawmills (except Shingle and Shake Mills)

Establishments in the Sawmills (321111) industry saw logs and bolts (short logs) into boards, dimension lumber (lumber that is cut to a standardized width and depth) and other similar products.

Shingle and Shake Mills

The Shingle and Shake Mills (321112) industry includes establishments that produce shingles (“thin rectangular piece of wood [...] used like tiles for roofing and weatherboarding”^{xxx}) by sawing blocks of wood, and shakes (“a type of shingle usually hand-cleft from a bolt”^{xxx}) by splitting blocks of wood.

Wood Preservation

Establishments in the Wood Preservation (321114) industry treat wood products that are produced in other establishments with preservatives to prevent decay of wood and to protect the wood from insects and fire. The most commonly used preservation method is pressure treating, which forces chemicals (preservatives) into wood under high pressure.

Particle Board and Fibreboard Mills

The Particle Board and Fibreboard Mills (321216) industry comprises establishments that manufacture particle boards and fibreboards.

Particle board is a panel manufactured from wood particles (often residue from wood products manufacturing) bounded together under heat and pressure with an adhesive.

Fibreboard is a panel manufactured from wood fibres bounded together by lignin (a substance found in wood).

Several other industries are included in the Wood Product Manufacturing (321) subsector. However, they are not discussed in detail because ICE data are unavailable for them. They include the following:

- Hardwood Veneer and Plywood Mills (321211)
- Softwood Veneer and Plywood Mills (321212)
- Structural Wood Product Manufacturing (321215)
- Waferboard Mills (321217)
- Other Wood Product Manufacturing (321900)

Wood Product Manufacturing energy consumption in 2005 and trends

In 2005, the Wood Product Manufacturing subsector consumed 128.88 PJ of energy, making it the fifth-largest energy consumer in the Canadian Manufacturing sector.

Among the industries for which ICE data are available in the Wood Product Manufacturing subsector, the Sawmills industry was the largest energy consumer in 2005, with 38% (48.87 PJ) of the subsector’s energy use. See Figure 4.6.1 and Table 4.6.1.

Figure 4.6.1 Share of energy use in the Wood Product Manufacturing subsector (2005)

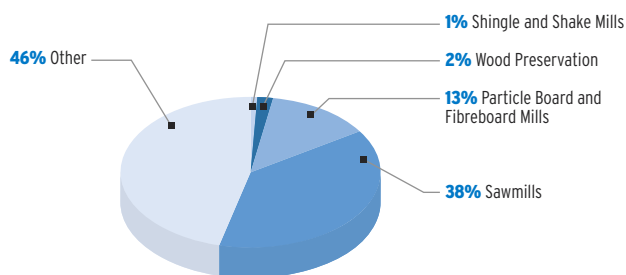


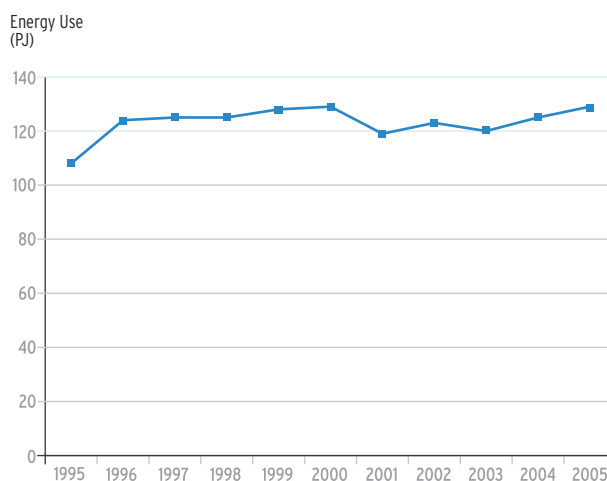
Table 4.6.1 Energy use in the Wood Product Manufacturing subsector (2005)

Industry	Energy Use (PJ)
Sawmills (321111)	48.87
Shingle and Shake Mills (321112)	0.84
Wood Preservation (321114)	2.11
Particle Board and Fibreboard Mills (321216)	17.24
Other	59.83
Wood Product Manufacturing (321)	128.88

The remaining 62% (80.01 PJ) of the subsector's energy consumption was divided among Particle Board and Fibreboard Mills (321216), with 13% (17.24 PJ), Wood Preservation (321114), with 2% (2.11 PJ), Shingle and Shake Mills (321112), with 1% (0.84 PJ), and other industries, with 46% (59.83 PJ).

The total energy consumption of the Wood Product Manufacturing subsector increased from 108.24 PJ to 129.43 PJ between 1995 and 2005, which represents an increase of 19%. See Figure 4.6.2.

Figure 4.6.2 Total energy use in the Wood Product Manufacturing subsector (1995-2005)



Wood Product Manufacturing energy consumption by source in 2005 and trends

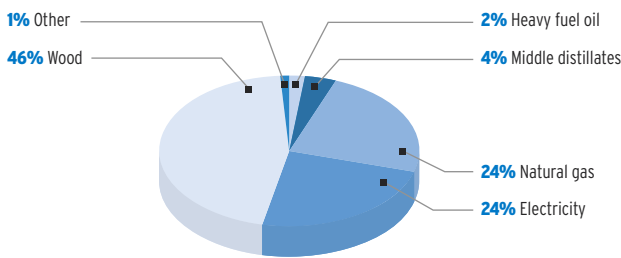
The Wood Product Manufacturing subsector consumed primarily wood as its energy source in 2005, with 46% (58.72 PJ) of its energy consumption. See Table 4.6.2 and Figure 4.6.3

Table 4.6.2 Energy use in the Wood Product Manufacturing subsector (2005)

Type of Energy	Energy Use (PJ)
Electricity	31.15
Heavy fuel oil	2.07
Middle distillates	5.60
Natural gas	30.36
Propane	x
Steam	x
Wood	58.72
Total	128.88
Confidential	0.98

x = confidential data

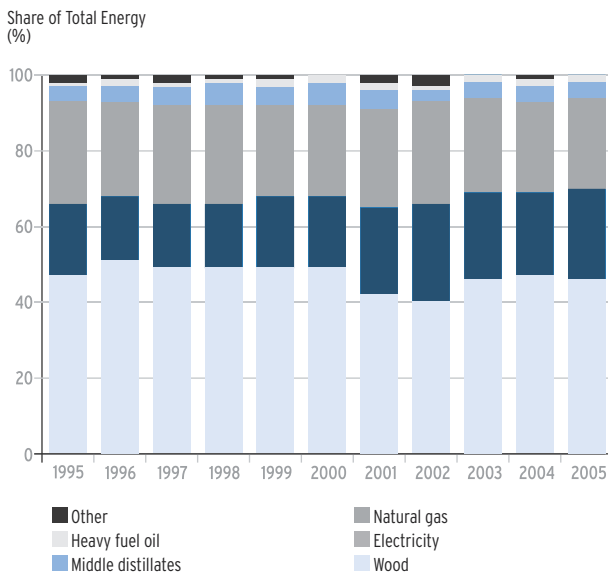
Figure 4.6.3 Share of energy use in the Wood Product Manufacturing subsector (2005)



Electricity and natural gas were, respectively, the second and third most-used energy sources, with 24% each of the subsector's energy consumption. The remaining 7% were divided among middle distillates (4%), heavy fuel oil (2%), propane and steam.

The share of each energy source used by the Wood Product Manufacturing subsector between 1995 and 2005 is shown in Figure 4.6.4.

Figure 4.6.4 Share of energy use in the Wood Product Manufacturing subsector (1995-2005)



The share of wood consumption in the total energy use was at its lowest in 2002, with 40%, and at its highest in 1996, with 51%. The share of electricity varied between 17% and 26%. The share of natural gas varied between 24% and 27%. The share of middle distillates varied between 3% and 6%.

The Sawmills industry is responsible for a significant amount of the Wood Product Manufacturing subsector's energy use. As such, the next section provides more detail on the energy consumption in that industry.

Sawmills

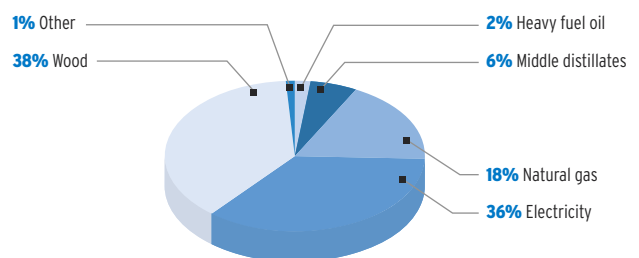
Wood and electricity were responsible for 38% (18.34PJ) and 36% (17.59 PJ), respectively, of the Sawmills industry's energy consumption in 2005. See Table 4.6.3 and Figure 4.6.5.

Table 4.6.3 Energy use in the Sawmills industry (2005)

Type of Energy	Energy Use (PJ)
Electricity	17.59
Heavy fuel oil	1.10
Middle distillates	2.76
Natural gas	8.77
Propane	x
Steam	x
Wood	18.34
Total	48.87
Confidential	0.31

x = confidential data

Figure 4.6.5 Share of energy use in the Sawmills industry (2005)



The remaining 27% of energy consumption was attributable to natural gas (18%), middle distillates (6%), heavy fuel oil (2%), propane and steam.

The shares of energy consumption varied significantly between 1995 and 2005. See Figure 4.6.6. The share of wood reached a high in 1999, with 47%, and a low in 1997 and 2002, with 34%. Since 2003, its energy share has been 38%. The share of electricity varied between 20% and 36%. The share of natural gas varied between 21% and 31%.

Figure 4.6.7 shows the total energy use in the Sawmills industry between 1995 and 2005. As indicated, total energy use was almost equal in 1995 and 2005 (47.74 PJ and 48.87 PJ, respectively). However, between those two years, total energy use varied greatly. A high was reached in 2000, with 63.19 PJ of energy consumed.

Figure 4.6.6 Share of energy use in the Sawmills industry (1995-2005)

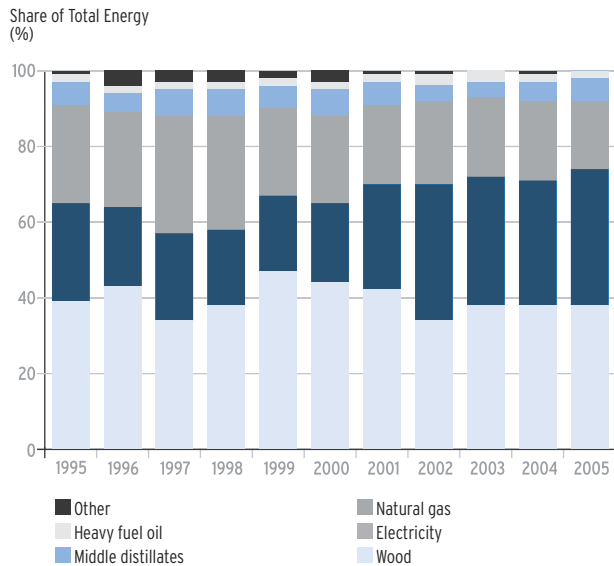
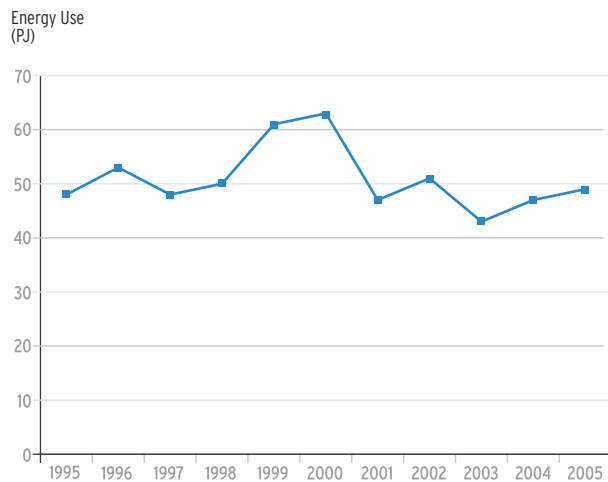


Figure 4.6.7 Total energy use in the Sawmills industry (1995-2005)



4.7 Non-Metallic Mineral Product Manufacturing

Overview of the Non-Metallic Mineral Product Manufacturing (327) subsector in Canada

With a GDP of \$5.1 billion, the Non-Metallic Mineral Product Manufacturing subsector was responsible for 3% of the total GDP in the Manufacturing sector in 2005.^{xxxii}

The Non-Metallic Mineral Product Manufacturing subsector employed 48 426 workers in 2005, of whom 78% were production workers.^{xxxiii}

Among the exports of the Non-Metallic Mineral Product Manufacturing subsector, 93% were destined for the United States in 2005.^{xxxiii}

Canada was the world's third-largest producer of gypsum in 2005.^{xxxiv}

Industries in the Non-Metallic Mineral Product Manufacturing subsector

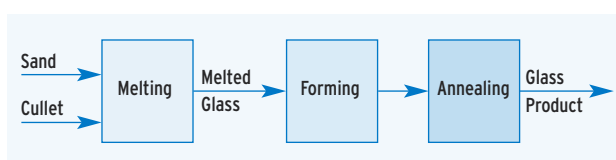
Establishments in the Non-Metallic Mineral Product Manufacturing (327) subsector transform non-metallic minerals (such as sand, gravel, stone and clay) into different products, such as glass, cement, concrete products, lime and gypsum.

Glass and Glass Product Manufacturing industry

The Glass and Glass Product Manufacturing (327200) industry manufactures glass and glass products. The establishments that make glass from sand and cullet (recycled glass) comprise the Glass Manufacturing (327214) industry. Those that re-melt, press, blow or otherwise shape purchased glass to produce glass products comprise the Glass Product Manufacturing from Purchased Glass (327215) industry.³¹

The glass manufacturing process begins with the melting of glass – made from silica sand and cullet – at high temperatures. Fluxes are added to lower the temperature at which the glass melts and to improve the chemical stability of the glass. The melted glass is then shaped by various processes. The molten glass can be moulded, rolled, blown or pressed, and is then slowly cooled (the annealing process). See Figure 4.7.1.

Figure 4.7.1 Glass and glass product manufacturing process

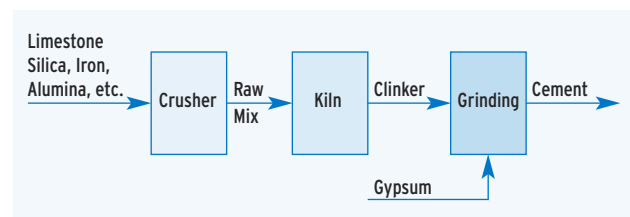


Cement Manufacturing

Establishments in the Cement Manufacturing (327310) industry are engaged primarily in the production of cement. Figure 4.7.2 shows the process of manufacturing Portland cement, the type that is most widely used.

To make cement, first, limestone is crushed. Other raw materials – such as silica, alumina and iron, which may also be crushed beforehand, depending on the size of the particles of the material – are combined with the crushed limestone to compose a raw mix. This raw mix is then carefully proportioned.

Figure 4.7.2 Cement manufacturing process



Next, the raw mix is processed at high temperatures in a rotating furnace or kiln, to produce an intermediate product called clinker. Cement is produced by grinding clinker to a fine powder and mixing it with gypsum and other additives.

Approximately 1.6 tonnes of raw material are required to produce 1 tonne of cement (85% limestone and 15% silica, alumina and iron, combined).^{xxxiii}

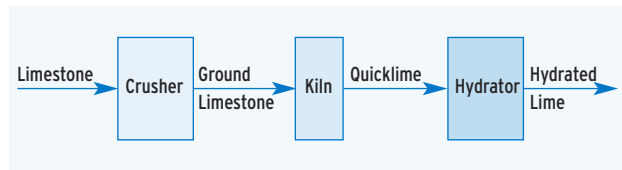
31 "Glass Product Manufacturing from Purchased Glass (327215) industry" also includes establishments that blow glass by hand.

Lime and Gypsum Product Manufacturing

Establishments in the Lime and Gypsum Product Manufacturing (327400) subsector manufacture lime and gypsum products, such as wallboard and plaster. This industry can be divided into two industries: Lime Manufacturing (327410) and Gypsum Product Manufacturing (327420).

Establishments in the Lime Manufacturing (327410) industry manufacture lime. The manufacturing processes of quicklime and hydrated lime are illustrated in Figure 4.7.3.

Figure 4.7.3 Lime manufacturing process



To produce quicklime, limestone³² is first crushed and screened. The crushed limestone is then burned in a kiln to release carbon dioxide. This process, which is called “calcination,” creates different types of quicklime, depending on the concentration of magnesium carbonate ($MgCO_3$) in the limestone. For example, high-calcium quicklime (CaO) is derived from limestone with high calcium and low magnesium content, and dolomitic quicklime ($CaOMgO$) is derived from limestone with high magnesium and calcium content.³³

Quicklime can be further processed by adding water to produce a dry powder called “hydrated lime.” The type of hydrated lime produced depends on the type of quicklime used and on the hydrating conditions employed.

Among many other applications, lime is used in steel manufacturing industries to remove impurities from the steel. In pulp manufacturing industries, lime can be used to produce cooking liquors.

Establishments in the Gypsum Product Manufacturing (327420) subsector manufacture products composed of gypsum, such as gypsum building products, joint compounds and plaster.

Many other industries comprise the Non-Metallic Mineral Product Manufacturing (327) subsector, but are not discussed in detail because ICE data is unavailable for them. These include the following:

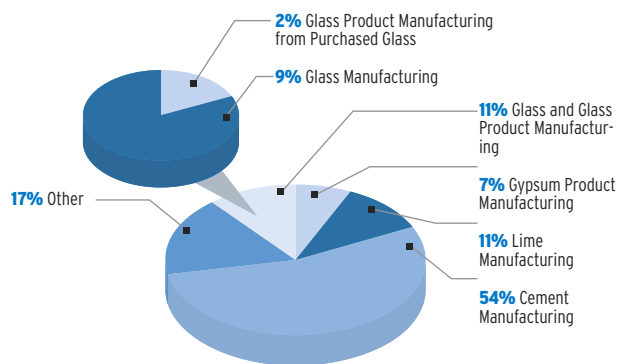
- Clay Product and Refractory Manufacturing (327100)
- Ready-Mix Concrete Manufacturing (327320)
- Concrete Pipe, Brick and Block Manufacturing (327330)
- Other Concrete Product Manufacturing (327390)
- Other Non-Metallic Mineral Product Manufacturing (327900)

Non-Metallic Mineral Product Manufacturing energy consumption in 2005 and trends

The Non-Metallic Mineral Product Manufacturing subsector was the sixth-largest consumer of energy in the Manufacturing sector in 2005, with a total of 124.49 PJ of energy consumed.

With a consumption of 66.62 PJ, 54% of the subsector’s energy consumption was attributable to the Cement Manufacturing industry in 2005, and 11% (14.17 PJ) was attributable to the Glass and Glass Product Manufacturing industry. See Figure 4.7.4 and Table 4.7.1.

Figure 4.7.4 Share of energy in the Non-Metallic Mineral Product Manufacturing subsector (2005)



³² Limestone is a mineral that contains mainly calcium carbonate ($CaCO_3$) or a mixture of $CaCO_3$ and $MgCO_3$.

³³ High-calcium quicklime contains less than 5% magnesium oxide (MgO); dolomitic quicklime contains between 35% and 45% MgO . A third type of quicklime, “magnesium quicklime,” contains between 5% and 35% MgO .

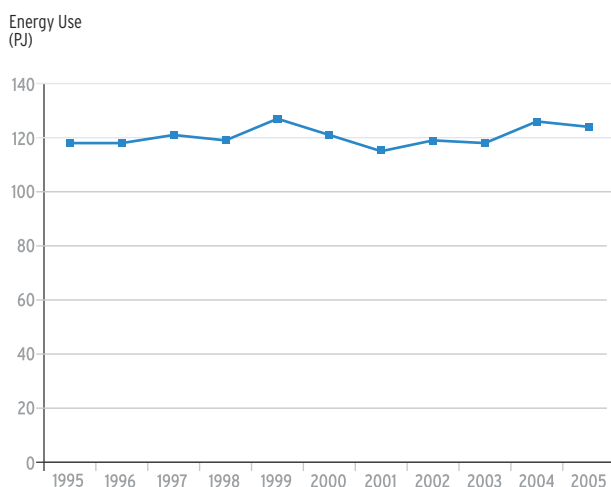
Table 4.7.1 Energy use in the Non-Metallic Mineral Product Manufacturing subsector (2005)

Industry	Energy Use (PJ)
Glass Manufacturing (327214)	11.76
Glass Product Manufacturing from Purchased Glass (327215)	2.41
Cement Manufacturing (327310)	66.62
Lime Manufacturing (327410)	13.82
Gypsum Product Manufacturing (327420)	8.80
Other	21.09
Non-Metallic Mineral Product Manufacturing (327)	124.49

The Gypsum Product Manufacturing (327420) industry was responsible for 7% (8.80 PJ) of the subsector's energy consumption. The remaining 28% (34.90 PJ) was consumed by the Lime Manufacturing industry (11%) and by other industries (17%).

Energy consumption in the subsector increased by 6% between 1995 and 2005. Energy consumption reached a high in 2004 with 126.54 PJ, and a low in 2001 with 115.20 PJ. See Figure 4.7.5.

Figure 4.7.5 Total energy use in the Non-Metallic Mineral Product Manufacturing subsector (1995-2005)



Non-Metallic Mineral Product Manufacturing energy consumption by source in 2005 and trends

The most widely consumed types of energy used in the Non-Metallic Mineral Product Manufacturing subsector were petroleum coke and coke from catalytic cracking catalyst (19%), natural gas (30%) and electricity (14%). Middle distillates and heavy fuel oil each represented 3% of the subsector's energy consumption. See Table 4.7.2 and Figure 4.7.6.

Table 4.7.2 Energy use in the Non-Metallic Mineral Product Manufacturing subsector (2005)

Type of Energy	Energy Use (PJ)
Coal	x
Coal coke	1.51
Electricity	16.99
Heavy fuel oil	3.92
Middle distillates	3.99
Natural gas	36.75
Petroleum coke and coke from catalytic cracking catalyst	23.91
Propane	0.46
Steam	x
Wood	x
Total	124.49
Confidential	36.98

x = confidential data

Figure 4.7.6 Share of energy use in the Non-Metallic Mineral Product Manufacturing subsector (2005)

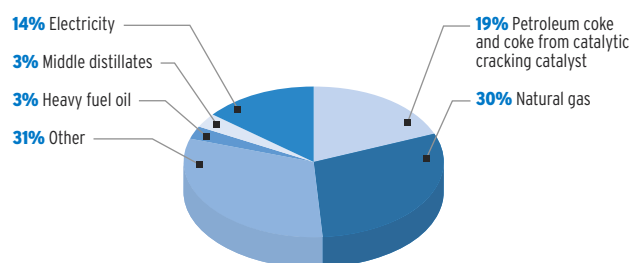
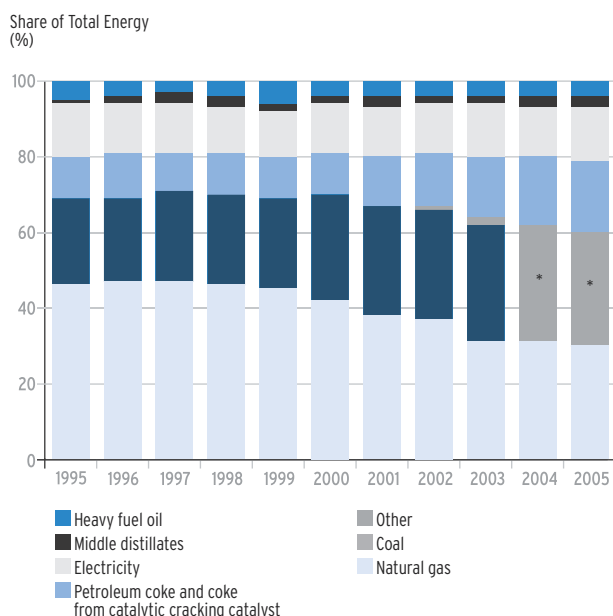


Figure 4.7.7 shows the share of each energy source in this subsector. Because data on coal consumption for 2004 and 2005 are confidential, these values have been combined with the "Other" category (comprised of coal coke, propane, steam and wood) to produce the figure.

Figure 4.7.7 Share of energy use in the Non-Metallic Mineral Product Manufacturing subsector (1995-2005)



*Combined data

The share of natural gas decreased between 1997 and 2003. Conversely, the shares of coal and petroleum coke and coke from catalytic cracking catalyst increased. The share of electricity remained relatively constant over this period, at approximately 12% to 13%.

The industries in the Non-Metallic Mineral Product Manufacturing subsector manufacture a variety of products that require several manufacturing processes. Therefore, the shares of energy use can vary widely between each industry in this subsector. Because the Cement Manufacturing industry accounts for the most significant portion of the subsector's energy consumption, this industry's energy use is discussed in detail in the following section.

Cement Manufacturing

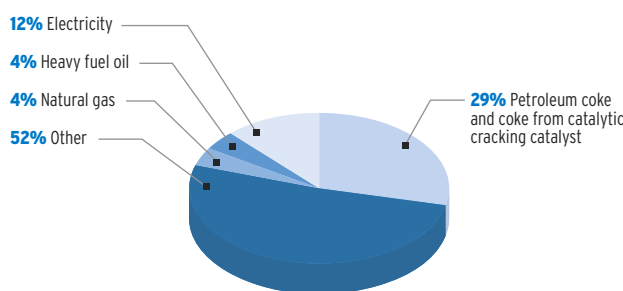
The Cement Manufacturing industry relies greatly on petroleum coke and coke from catalytic cracking catalyst as energy sources. In 2005, the combined share of petroleum coke and coke from catalytic cracking catalyst reached 29% (19.06 PJ) of this industry's energy consumption. See Table 4.7.3 and Figure 4.7.8.

Table 4.7.3 Energy use in the Cement Manufacturing industry (2005)

Type of Energy	Energy Use (PJ)
Coal	x
Coal coke	x
Electricity	7.84
Heavy fuel oil	2.81
Middle distillates	0.71
Natural gas	2.55
Petroleum coke and coke from catalytic cracking catalyst	19.06
Propane	0.01
Wood	x
Total	66.62
Confidential	33.64

x = confidential data

Figure 4.7.8 Share of energy use in the Cement Manufacturing industry (2005)



The next largest energy sources used in 2005 were electricity (12%), heavy fuel oil (4%) and natural gas (4%). Other energy sources (coal, coal coke, middle distillates, propane and wood) were responsible for 52% of the industry's energy consumption.

Some interesting trends are shown in Figure 4.7.9. Most of the energy used for the manufacture of cement was derived from coal between 1995 and 2003. The contribution of coal to the industry's energy use increased from 42% to 54% during this period. Because data for the consumption of coal for 2004 and 2005 are confidential, they have been combined with the "Other" category (comprised of coal coke, middle distillates, propane and wood) for those years to produce Figure 4.7.9.

Petroleum coke and coke from catalytic cracking catalyst were the second-highest energy source consumed between 1995 and 2003. The share of electricity remained between 11% and 13% for the period of 1995 to 2005, while the share of natural gas decreased from 25% to 4%. A drop in natural gas from 15% to 4% occurred between 2002 and 2003.

Figure 4.7.10 shows that the total energy consumption in the Cement Manufacturing industry increased 15% between 1995 and 2005.

Figure 4.7.9 Share of energy use in the Cement Manufacturing industry (1995-2005)

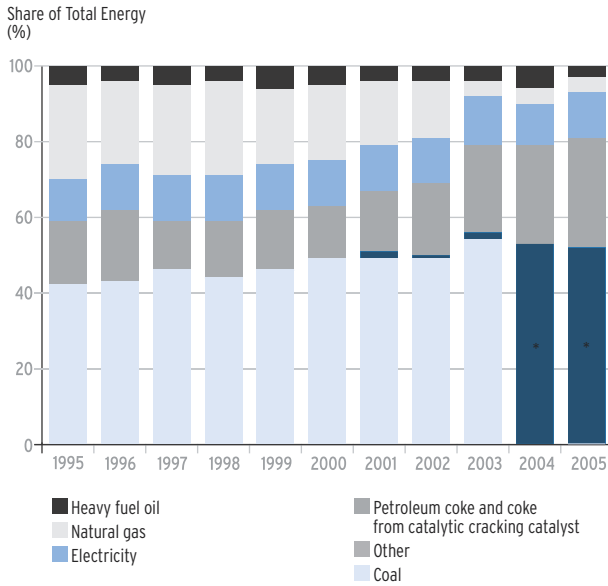
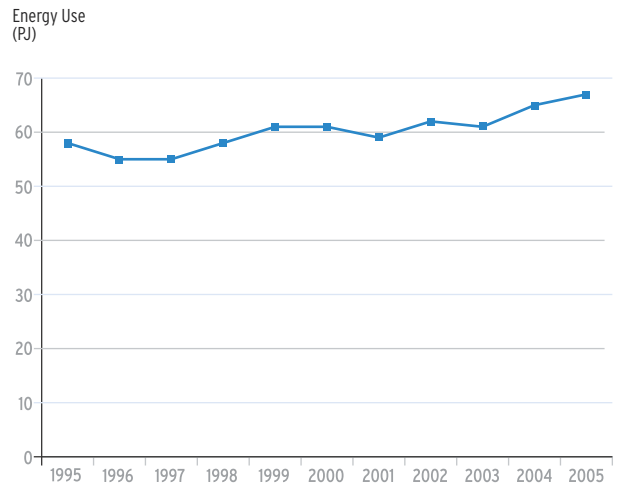


Figure 4.7.10 Total energy use in the Cement Manufacturing industry (1995-2005)



4.8 Other Manufacturing

Although Statistics Canada collects energy use data and provides estimates for each subsector included in the Manufacturing sector (NAICS 31 to 33) through the ICE survey, this summary report does not describe each subsector in detail.

The six subsectors presented previously in this summary report are the main energy-consuming subsectors of the Manufacturing sector and were described in some detail. However, to describe the entire sector's energy consumption as concisely as possible, all other subsectors have been combined into a residual category called the Other Manufacturing subsector.

In this summary report,³⁴ the Other Manufacturing subsector comprises the subsectors listed in Table 4.8.1. These include all other Manufacturing subsectors (NAICS 311 to 339) not already discussed in this report. The definitions of each subsector in the Manufacturing sector are given in Appendix B.

Table 4.8.1 Subsectors included in the Other Manufacturing subsector

311	Food Manufacturing
312	Beverage and Tobacco Product Manufacturing
313	Textile Mills
314	Textile Product Mills
315	Clothing Manufacturing
316	Leather and Allied Product Manufacturing
323	Printing and Related Support Activities
326	Plastics and Rubber Products Manufacturing
332	Fabricated Metal Product Manufacturing
333	Machinery Manufacturing
334	Computer and Electronic Product Manufacturing
335	Electrical Equipment, Appliance and Component Manufacturing
336	Transportation Equipment Manufacturing
337	Furniture and Related Product Manufacturing
339	Miscellaneous Manufacturing

A wide variety of processes are involved in the Other Manufacturing subsector, which are not discussed in this summary report. The following section provides only the energy consumption of this subsector.

Other Manufacturing energy consumption in 2005 and trends

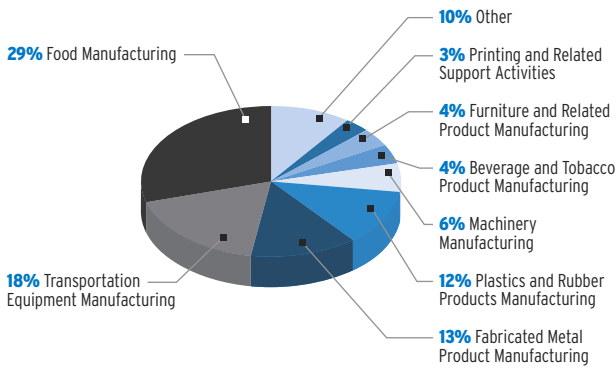
In 2005, 312.73 PJ of energy were consumed by the Other Manufacturing subsector. See Table 4.8.2. Figure 4.8.1 shows the energy shares of the subsectors included in the Other Manufacturing subsector.

Table 4.8.2 Energy use in the Other Manufacturing subsector (2005)

Subsector	Energy Use (PJ)
Food Manufacturing (311)	91.67
Beverage and Tobacco Product Manufacturing (312)	12.02
Textile Mills (313)	7.29
Textile Product Mills (314)	3.50
Clothing Manufacturing (315)	2.50
Leather and Allied Product Manufacturing (316)	0.37
Printing and Related Support Activities (323)	8.66
Plastics and Rubber Products Manufacturing (326)	39.09
Fabricated Metal Product Manufacturing (332)	41.98
Machinery Manufacturing (333)	17.53
Computer and Electronic Product Manufacturing (334)	5.56
Electrical Equipment, Appliance and Component Manufacturing (335)	7.18
Transportation Equipment Manufacturing (336)	57.52
Furniture and Related Product Manufacturing (337)	11.66
Miscellaneous Manufacturing (339)	6.21
Other Manufacturing	312.73

³⁴Note that the definition of "Other Manufacturing" can vary depending on the publication. Use discretion when comparing data from different data sources.

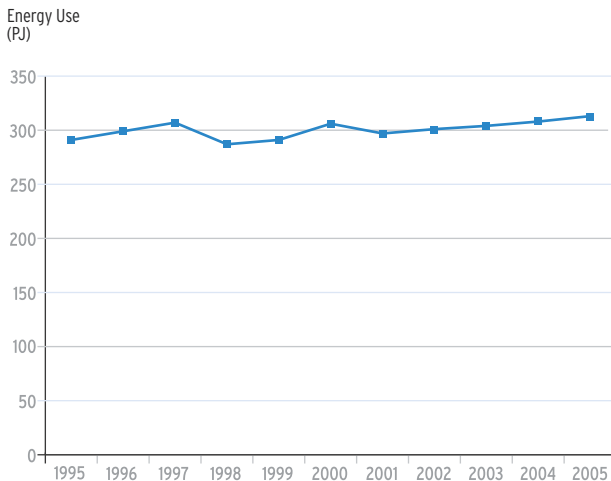
Figure 4.8.1 Share of energy in the Other Manufacturing subsector (2005)



Food Manufacturing, Transportation Equipment Manufacturing, Fabricated Metal Product Manufacturing, and Plastics and Rubber Products Manufacturing subsectors were responsible for 29% (91.67 PJ), 18% (57.52 PJ), 13% (41.98 PJ) and 12% (39.09 PJ), respectively, of the energy consumed in 2005. The remaining 27% (82.47 PJ) of energy consumed was divided among the Machinery Manufacturing, Beverage and Tobacco Product Manufacturing, Furniture and Related Product Manufacturing and other subsectors.

The total energy consumption in the Other Manufacturing subsector increased 8% between 1995 and 2005, from 290.52 PJ to 312.73 PJ. See Figure 4.8.2.

Figure 4.8.2 Total energy use in the Other Manufacturing subsector (1995-2005)



Other Manufacturing energy consumption by source in 2005 and trends

Table 4.8.3 and Figure 4.8.3 show that 57% (179.19 PJ) of the energy consumed by the Other Manufacturing subsector in 2005 was natural gas. Electricity was the second most widely used energy source (36%). Heavy fuel oil and middle distillates consumed 2% and 1%, respectively. The other energy sources (coal, propane, steam and wood) represented 3%.

Table 4.8.3 Energy use in the Other Manufacturing subsector (2005)

Type of Energy	Energy Use (PJ)
Coal	x
Electricity	112.84
Heavy fuel oil	7.68
Middle distillates	4.61
Natural gas	179.19
Propane	x
Steam	x
Wood	0.29
Total	312.73
Confidential	8.12

x = confidential data

Figure 4.8.3 Share of energy use in the Other Manufacturing subsector (2005)

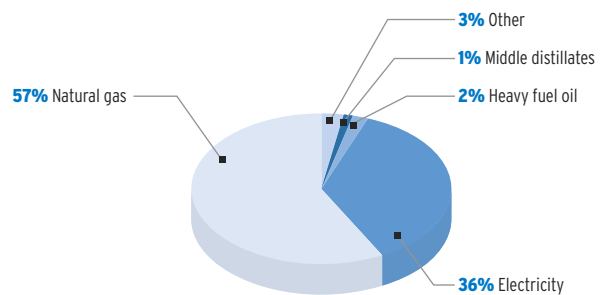
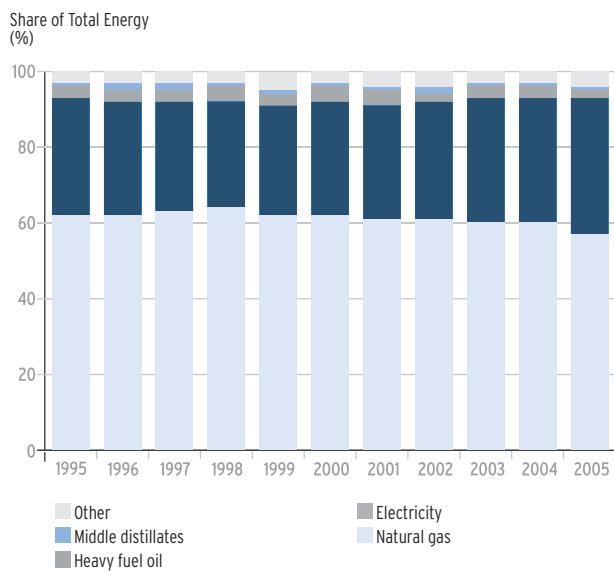


Figure 4.8.4 shows the shares of energy consumption by energy type for 1995 to 2005.

Figure 4.8.4 Share of energy use in the Other Manufacturing subsector (1995-2005)



The lowest energy share of natural gas was reached in 2005, with 57% of the subsector's energy consumption. Conversely, the share of electricity reached its highest level in 2005, with 36% of the energy consumed.

A Appendix: Industries included in data sources and publications

A.1 Industries included in the ICE survey

Table A.1 lists the industries included in the ICE survey. For most of these industries, Statistics Canada (SC) collected energy use data and provided energy use estimates for the period between 1995 and 2005. Industries that were added in 2001 are marked with an asterisk.

Table A.1 Industries included in the ICE survey

311 Food Manufacturing	
311400	Fruit and Vegetable Preserving and Specialty Food Manufacturing
311500	Dairy Product Manufacturing
311600	Meat Product Manufacturing
311700	Seafood Product Preparation and Packaging
311800	Bakeries and Tortilla Manufacturing
312 Beverage and Tobacco Product Manufacturing	
312100	Beverage Manufacturing
312120	Breweries
312200	Tobacco Manufacturing
313 Textile Mills	
314 Textile Product Mills	
315 Clothing Manufacturing	
316 Leather and Allied Product Manufacturing	
321 Wood Product Manufacturing	
321111	Sawmills (except Shingle and Shake Mills)
321112	Shingle and Shake Mills *
321114	Wood Preservation *
321216	Particle Board and Fibreboard Mills
322 Paper Manufacturing	
322111	Mechanical Pulp Mills
322112	Chemical Pulp Mills
322121	Paper (except Newsprint) Mills
322122	Newsprint Mills
322130	Paperboard Mills
322200	Converted Paper Product Manufacturing
323 Printing and Related Support Activities	
324 Petroleum and Coal Products Manufacturing	
324110	Petroleum Refineries

Table A.1 Industries included in the ICE survey (Continued)

325 Chemical Manufacturing	
325110	Petrochemical Manufacturing
325120	Industrial Gas Manufacturing
325130	Synthetic Dye and Pigment Manufacturing
325181	Alkali and Chlorine Manufacturing
325189	All Other Basic Inorganic Chemical Manufacturing
325190	Other Basic Organic Chemical Manufacturing
325210	Resin and Synthetic Rubber Manufacturing
325220	Artificial and Synthetic Fibres and Filaments Manufacturing *
325313	Chemical Fertilizer (except Potash) Manufacturing
325314	Mixed Fertilizer Manufacturing *
325320	Pesticide and Other Agricultural Chemical Manufacturing *
325400	Pharmaceutical and Medicine Manufacturing *
325500	Paint, Coating and Adhesive Manufacturing *
325600	Soap, Cleaning Compound and Toilet Preparation Manufacturing *
325900	Other Chemical Product Manufacturing *
326 Plastics and Rubber Products Manufacturing	
326100	Plastics Product Manufacturing
326193	Motor Vehicle Plastics Parts Manufacturing
326200	Rubber Product Manufacturing
327 Non-Metallic Mineral Product Manufacturing	
327214	Glass Manufacturing
327215	Glass Product Manufacturing from Purchased Glass *
327310	Cement Manufacturing
327410	Lime Manufacturing
327420	Gypsum Product Manufacturing *

* ICE estimates for this industry became available in 2001.

Table A.1 Industries included in the ICE survey (Continued)

331 Primary Metal Manufacturing	
331100	Iron and Steel Mills and Ferro-Alloy Manufacturing
331313	Primary Production of Alumina and Aluminum
331410	Non-Ferrous Metal (except Aluminum) Smelting and Refining
331511	Iron Foundries
331514	Steel Foundries *
331520	Non-Ferrous Metal Foundries *
332 Fabricated Metal Product Manufacturing	
332100	Forging and Stamping *
332200	Cutlery and Hand Tool Manufacturing *
332300	Architectural and Structural Metals Manufacturing *
332400	Boiler, Tank and Shipping Container Manufacturing *
332500	Hardware Manufacturing *
332600	Spring and Wire Product Manufacturing *
332700	Machine Shops, Turned Product, and Screw, Nut and Bolt Manufacturing *
332800	Coating, Engraving, Heat Treating and Allied Activities *
332900	Other Fabricated Metal Product Manufacturing *
333 Machinery Manufacturing	
334 Computer and Electronic Product Manufacturing	
335 Electrical Equipment, Appliance and Component Manufacturing	

Table A.1 Industries included in the ICE survey (Continued)

336 Transportation Equipment Manufacturing	
336110	Automobile and Light-Duty Motor Vehicle Manufacturing
336120	Heavy-Duty Truck Manufacturing
336310	Motor Vehicle Gasoline Engine and Engine Parts Manufacturing
336320	Motor Vehicle Electrical and Electronic Equipment Manufacturing
336330	Motor Vehicle Steering and Suspension Components Manufacturing
336340	Motor Vehicle Brake System Manufacturing
336350	Motor Vehicle Transmission and Power Train Parts Manufacturing
336360	Motor Vehicle Seating and Interior Trim Manufacturing
336370	Motor Vehicle Metal Stamping
336390	Other Motor Vehicle Parts Manufacturing
336400	Aerospace Product and Parts Manufacturing *
336500	Railroad Rolling Stock Manufacturing *
336600	Ship and Boat Building *
336900	Other Transportation Equipment Manufacturing *
337 Furniture and Related Product Manufacturing	
339 Miscellaneous Manufacturing	

* ICE estimates for this industry became available in 2001.

A.2 Industries included in the RESD

Industrial sector

Table A.2 lists the industries (and their associated North American Industry Classification System [NAICS] codes) encompassed by the Industrial sector in SC's Report on Energy Supply-Demand in Canada (RESD).

Table A.2 Industries included in the RESD Industrial sector

Industry	NAICS codes	
Manufacturing	Pulp and Paper	322111, 322112, 322122 and parts of 321216, 322121 and 322130
	Iron and Steel	331110, 331221 and 331514
	Smelting and Refining, Non-Ferrous	331313 and 331410
	Cement	327310
	Petroleum Refining	324110 and part of 324190
	Chemicals	325110, 325120, 325130, 325181, 325189, 325313 and parts of 325190, 325210, 325410 and 325610
	Other Manufacturing	All other Manufacturing industries (NAICS codes 311 to 339) not listed above
	Mining and Oil and Gas Extraction	21 excluding 213118, 213119 and part of 212326
	Forestry	113 and 1153
	Construction	23

A.3 Industries included in CIPEC annual reports

Table A.3 lists the industries (and their associated NAICS codes) included in the Canadian Industry Program for Energy Conservation (CIPEC) annual reports. These industries comprise CIPEC's Industrial Task Forces.

Table A.3 Industrial Task Forces included in CIPEC annual reports

Industrial Task Forces	NAICS Codes
Aluminum	331313
Brewery	312120
Cement	327310
Chemical	3251, 3252
Construction	230000
Dairy	311500
Electrical and Electronics	334335
Electricity Generation	22111
Fertilizer	325313
Food and Beverage	311000, 321200
Forestry	113
Foundry	331500
Lime	327410
Mining	212200
Oil Sands	211114
Petroleum Products	324110
Pipelines	486
Plastics	3261
Pulp and Paper	322100
Rubber	326200
Steel	331100
Textiles	313, 314
Transportation Equipment Manufacturing	336000
Upstream Oil and Gas	211113
Wood Products	321000
General Manufacturing 4 Task Forces based on region, including: Atlantic, Eastern, Central, and Western	316, 315, 337, 323, 332, 333, 3271, 3272, 32732, 32733, 32739, 32742, 3279, 339, 32522, 325314, 32532, 3254, 3255, 3256, 3259, 3122, 3222, 3261

A.4 Industries included in the CIEEDAC Industrial sector

Table A.4 lists the industries (and their associated NAICS codes) included in the Industrial sector, as defined by the Canadian Industrial Energy End-Use Data and Analysis Centre (CIEEDAC).

Table A.4 Industries included in the CIEEDAC Industrial sector

21	Mining, Oil and Gas Extraction
211000	Oil and Gas Extraction
212000	Mining (except Oil and Gas)
212200	Metal Ore Mining
212210	Iron Ore Mining
212220	Gold and Silver Ore Mining
212231	Lead-Zinc Ore Mining US
212232	Nickel-Copper Ore Mining CAN
212233	Copper-Zinc Ore Mining CAN
212291	Uranium Ore Mining US
212299	All Other Metal Ore Mining US
212300	Non-Metallic Mineral Mining and Quarrying
212310	Stone Mining and Quarrying
212320	Sand, Gravel, Clay, and Ceramic and Refractory Minerals Mining
212393	Salt Mining CAN
212394	Asbestos Mining CAN
212395	Gypsum Mining CAN
212396	Potash Mining CAN
212397	Peat Extraction CAN
212398	All Other Non-Metallic Mineral Mining and Quarrying CAN
221110	Electricity Power Generation
23	Construction
311	Food Manufacturing
311400	Fruit and Vegetable Preserving and Specialty Food Manufacturing
311500	Dairy Product Manufacturing
311600	Meat Product Manufacturing
311700	Seafood Product Preparation and Packaging
311800	Bakeries and Tortilla Manufacturing
312	Beverage and Tobacco Product Manufacturing
312100	Beverage Manufacturing
312120	Breweries
312200	Tobacco Manufacturing
313	Textile Mills
314	Textile Product Mills
315	Clothing Manufacturing
316	Leather and Allied Product Manufacturing

Table A.4 Industries included in the CIEEDAC Industrial sector (Continued)

321	Wood Product Manufacturing
321100	Sawmills and Wood Preservation
321111	Sawmills (except Shingle and Shake Mills)
321112	Shingle and Shake Mills
321114	Wood Preservation
321216	Particle Board and Fibreboard Mills
322	Paper Manufacturing
322100	Pulp, Paper and Paperboard Mills
322110	Pulp Mills
322111	Mechanical Pulp Mills
322112	Chemical Pulp Mills
322121	Paper (except Newsprint) Mills
322122	Newsprint Mills
322130	Paperboard Mills
322200	Converted Paper Product Manufacturing
323	Printing and Related Support Activities
324	Petroleum and Coal Products Manufacturing
324110	Petroleum Refineries
325	Chemical Manufacturing
325100	Basic Chemical Manufacturing
325110	Petrochemical Manufacturing
325120	Industrial Gas Manufacturing
325130	Synthetic Dye and Pigment Manufacturing
325180	Other Basic Inorganic Chemical Manufacturing
325181	Alkali and Chlorine Manufacturing
325189	All Other Basic Inorganic Chemical Manufacturing
325190	Other Basic Organic Chemical Manufacturing
325200	Resin, Synthetic Rubber, and Artificial and Synthetic Fibres and Filaments
325210	Resin and Synthetic Rubber Manufacturing
325220	Artificial and Synthetic Fibres and Filaments Manufacturing
325300	Pesticide, Fertilizer and Other Agricultural Chemical Manufacturing
325310	Fertilizer Manufacturing
325313	Chemical Fertilizer (except Potash) Manufacturing
325314	Mixed Fertilizer Manufacturing
325320	Pesticide and Other Agricultural Chemical Manufacturing
325400	Pharmaceutical and Medicine Manufacturing
325500	Paint, Coating and Adhesive Manufacturing
325600	Soap, Cleaning Compound and Toilet Preparation Manufacturing
325900	Other Chemical Product Manufacturing

Table A.4 Industries included in the CIEEDAC Industrial sector (Continued)

326 Plastics and Rubber Products Manufacturing	
326100	Plastics Product Manufacturing
326193	Motor Vehicle Plastics Parts Manufacturing
326200	Rubber Product Manufacturing
327 Non-Metallic Mineral Product Manufacturing	
327210	Glass and Glass Product Manufacturing
327214	Glass Manufacturing
327215	Glass Product Manufacturing from Purchased Glass
327310	Cement Manufacturing
327400	Lime and Gypsum Product Manufacturing
327410	Lime Manufacturing
327420	Gypsum Product Manufacturing
331 Primary Metal Manufacturing	
331100	Iron and Steel Mills and Ferro-Alloy Manufacturing
331313	Primary Production of Alumina and Aluminum
331410	Non-Ferrous Metal (except Aluminum) Smelting and Refining
331500	Foundries
331511	Iron Foundries
331514	Steel Foundries
331520	Non-Ferrous Metal Foundries
332 Fabricated Metal Product Manufacturing	
332100	Forging and Stamping
332200	Cutlery and Hand Tool Manufacturing
332300	Architectural and Structural Metals Manufacturing
332400	Boiler, Tank and Shipping Container Manufacturing
332500	Hardware Manufacturing
332600	Spring and Wire Product Manufacturing
332700	Machine Shops, Turned Product, and Screw, Nut and Bolt Manufacturing
332800	Coating, Engraving, Heat Treating and Allied Activities
332900	Other Fabricated Metal Product Manufacturing

Table A.4 Industries included in the CIEEDAC Industrial sector (Continued)

333 Machinery Manufacturing	
334 Computer and Electronic Product Manufacturing	
335 Electrical Equipment, Appliance and Component Manufacturing	
336 Transportation Equipment Manufacturing	
336100	Motor Vehicle Manufacturing
336110	Automobile and Light-Duty Motor Vehicle Manufacturing
336120	Heavy-Duty Truck Manufacturing
336300	Motor Vehicle Parts Manufacturing
336310	Motor Vehicle Gasoline Engine and Engine Parts Manufacturing
336320	Motor Vehicle Electrical and Electronic Equipment Manufacturing
336330	Motor Vehicle Steering and Suspension Components Manufacturing
336340	Motor Vehicle Brake System Manufacturing
336350	Motor Vehicle Transmission and Power Train Parts Manufacturing
336360	Motor Vehicle Seating and Interior Trim Manufacturing
336370	Motor Vehicle Metal Stamping
336390	Other Motor Vehicle Parts Manufacturing
336400	Aerospace Product and Parts Manufacturing
336500	Railroad Rolling Stock Manufacturing
336600	Ship and Boat Building
336900	Other Transportation Equipment Manufacturing
337 Furniture and Related Product Manufacturing	
339 Miscellaneous Manufacturing	

A.5 Industries included in the Industrial sector of the *Energy Use Data Handbook* and *Energy Efficiency Trends in Canada*

Table A.5 lists the industries (and their associated NAICS codes) included in the Industrial sector of the *Energy Use Data Handbook, 1990 and 1998 to 2004*, and *Energy Efficiency Trends in Canada, 1990 to 2004*. The Office of Energy Efficiency at Natural Resources Canada publishes both of these reports.

Table A.5 Industries included in the Industrial sector of the *Energy Use Data Handbook* and *Energy Efficiency Trends in Canada*

Industry	NAICS
Mining	
Gold and Silver Mines	21222
Copper, Nickel, Lead and Zinc Mines	21223
Iron Mines	21221
Other Metal Mines	21229
Potash Mines	212396
Salt Mines	212393
Other Non-Metal Mines	212392, 212394, 212395, 212397 and 212398
Upstream Mining	21 excluding the above, 213118, 213119 and part of 212326
Construction	
Construction	23
Forestry	
Forestry	113 and 1153
Pulp and Paper	
Pulp Mills	32211
Paper Mills (except newsprint)	322121
Newsprint Mills	322122
Paperboard Mills	32213
Converted Paper Products Industry	3222
Smelting and Refining	
Primary Production of Alumina and Aluminum	331313
Other Non-Ferrous Smelting and Refining	331410
Petroleum Refining	
Petroleum Refining	324110 and part of 324119
Cement	
Cement Industry	327310

Table A.5 Industries included in the Industrial sector of the *Energy Use Data Handbook* and *Energy Efficiency Trends in Canada* (Continued)

Chemicals	
Petrochemical Industry	32511
Industrial Gas Industry	32512
Other Basic Chemicals Industry	32513, 32518 and 32519
Fertilizer and Pesticide Industry	3253
Iron and Steel	
Iron and Steel Mills	331110, 331221 and 331514
Other Manufacturing	
Meat Products Industries	3116
Fruit and Vegetable Industries	3114
Bakery Products Industries	3118
Other Food Industries	311 excluding 3314, 3115, 3116 and 3118
Dairy Products Industry	3115
Beverage Industries	3121 excluding 31212
Breweries Industries	31212
Tobacco Products Industries	3122
Rubber Products Industries	3262
Plastic Products Industries	3261
Resin and Synthetic Rubber Industries	32521
Leather and Allied Products Industries	316
Textile Mills	313
Textile Products Mills	314
Clothing Industries	315
Wood Products Industries	321
Furniture and Related Products Industries	337
Printing and Related Support Activities	323
Fabricated Metal Products Industries	332
Machinery Industries	333
Motor Vehicle Industry	3361
Motor Vehicle Parts and Accessories Industries	3363
Computer and Electronic Products Industries	334
Electrical Equipment and Components Industries	335
Other Manufacturing	311 to 339 not listed above

B

Appendix: North American Industry Classification System

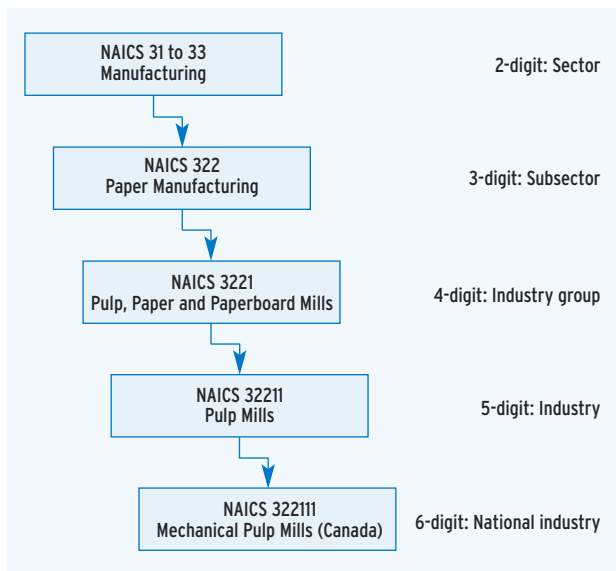
The North American Industry Classification System (NAICS) is an industry classification that provides common definitions of the industrial structure of Canada, Mexico and the United States. Developed jointly by the statistical agencies of the three countries, NAICS was adopted in 1997 and revised in 2002 to increase comparability among those countries and to add new industries.

The NAICS numbering system is a six-digit code, as follows:

- the first two digits designate the sector
- the third digit designates the subsector
- the fourth digit designates the industry group
- the fifth digit designates the industry
- the sixth digit can indicate another level of detail (to include additional detail, a country can create national industries and indicate that in the sixth digit)

Figure B.1 shows an example of the NAICS code designation.

Figure B.1 An example of NAICS code designation



The NAICS 2002 has 20 sectors, 103 subsectors, 328 industry groups, 728 industries and 928 national industries. Table B.1 lists the 20 sectors.

Table B.1 Sectors included in the NAICS 2002

Sector	NAICS
Agriculture, Forestry, Fishing and Hunting	11
Mining and Oil and Gas Extraction	21
Utilities	22
Construction	23
Manufacturing	31-33
Wholesale Trade	41
Retail Trade	44-45
Transportation and Warehousing	48-49
Information and Cultural Industries	51
Finance and Insurance	52
Real Estate and Rental and Leasing	53
Professional, Scientific and Technical Services	54
Management of Companies and Enterprises	55
Administrative and Support, Waste Management and Remediation Services	56
Educational Services	61
Health Care and Social Assistance	62
Arts, Entertainment and Recreation	71
Accommodation and Food Services	72
Other Services, except Public Administration	81
Public Administration	91

For a complete description of each sector, subsector and industry presented in this summary report, visit the NAICS section of the Statistics Canada Web site at www.statcan.ca/english/Subjects/Standard/naics/2002/naics02-menu.htm.

The 3-digit NAICS codes (subsectors) in the Manufacturing sector (311 to 339) are listed in the next section, along with their NAICS definitions.

311 Food Manufacturing

This subsector comprises establishments primarily engaged in producing food for human or animal consumption.

Exclusion(s): Establishments primarily engaged in:

- Manufacturing beverages or tobacco (312, Beverage and Tobacco Product Manufacturing)

312 Beverage and Tobacco Product Manufacturing

This subsector comprises establishments primarily engaged in Manufacturing beverages and tobacco products.

313 Textile Mills

This subsector comprises establishments primarily engaged in Manufacturing yarn or textile fabrics, or finishing yarn, textile fabrics or clothing. Establishments primarily engaged in Manufacturing both fabrics and textile products, except knitted clothing, are included.

Exclusion(s): Establishments primarily engaged in:

- Manufacturing textile products, except clothing, from purchased fabric (314, Textile Product Mills)
- Manufacturing clothing (315, Clothing Manufacturing)

314 Textile Product Mills

This subsector comprises establishments primarily engaged in Manufacturing textile products, except clothing.

Exclusion(s): Establishments primarily engaged in:

- Manufacturing yarn or textile fabrics, or finishing yarn or fabrics, or Manufacturing both fabrics and textile products (313, Textile Mills)
- Manufacturing clothing (315, Clothing Manufacturing)

315 Clothing Manufacturing

This subsector comprises establishments primarily engaged in Manufacturing clothing.

Exclusion(s): Establishments primarily engaged in:

- finishing clothing not made in the same establishment (313, Textile Mills)
- embroidering clothing not made in the same establishment (314, Textile Product Mills)
- printing on articles of clothing not made in the same establishment (323, Printing and Related Support Activities)
- Manufacturing safety clothing (339, Miscellaneous Manufacturing)

316 Leather and Allied Product Manufacturing

This subsector comprises establishments primarily engaged in Manufacturing leather and allied products.

Exclusion(s): Establishments primarily engaged in:

- Manufacturing leather clothing (315, Clothing Manufacturing)

321 Wood Product Manufacturing

This subsector comprises establishments primarily engaged in Manufacturing products from wood. There are three industry groups in this subsector, comprising establishments engaged in sawing logs into lumber and similar products, or preserving these products; making products that improve the natural characteristics of wood, by making veneers, plywood, reconstituted wood panel products or engineered wood assemblies; and making a diverse range of wood products, such as millwork.

Exclusion(s): Establishments primarily engaged in:

- logging; and chipping logs in the field (113, Forestry and Logging)
- Manufacturing wood pulp, paper and paper products (322, Paper Manufacturing)
- Manufacturing wood kitchen cabinets and counters, and bathroom vanities (337, Furniture and Related Product Manufacturing)
- Manufacturing wood signs and coffins (339, Miscellaneous Manufacturing)

322 Paper Manufacturing

This subsector comprises establishments primarily engaged in Manufacturing pulp, paper and paper products. The manufacture of pulp involves separating the cellulose fibres from other impurities in wood, used paper or other fibre sources. The manufacture of paper involves matting these fibres into a sheet. Converted paper products are produced from paper and other materials by various cutting and shaping techniques.

323 Printing and Related Support Activities

This subsector comprises establishments primarily engaged in printing and providing related support activities.

324 Petroleum and Coal Products Manufacturing

This subsector comprises establishments primarily engaged in transforming crude petroleum and coal into intermediate and end products. The dominant process is petroleum refining, which separates crude petroleum into components or fractions through such techniques as cracking and distillation.

Exclusion(s): Establishments primarily engaged in:

- Manufacturing chemicals and chemical preparations from refined petroleum and coal products (325, Chemical Manufacturing)

325 Chemical Manufacturing

This subsector comprises establishments primarily engaged in Manufacturing chemicals and chemical preparations, from organic and inorganic raw materials.

Exclusion(s): Establishments primarily engaged in:

- field processing of crude petroleum and natural gas (211, Oil and Gas Extraction)
- beneficiating mineral ores (212, Mining (except Oil and Gas))
- processing crude petroleum and coal (324, Petroleum and Coal Products Manufacturing)
- smelting and refining ores and concentrates (331, Primary Metal Manufacturing)

326 Plastics and Rubber Products Manufacturing

This subsector comprises establishments primarily engaged in making goods by processing raw rubber and plastics materials. Rubber- and plastics-based activities are combined in the same subsector because the technical properties of these polymers are related.

Generally, establishments classified in this subsector manufacture products made of just one material, rubber or plastics, with the major exception of tire Manufacturing.

Exclusion(s): Establishments primarily engaged in:

- Manufacturing synthetic resins from basic organic chemicals (325210, Resin and Synthetic Rubber Manufacturing)
- compounding plastics resins from recycled materials (32599, All Other Chemical Product Manufacturing)

327 Non-Metallic Mineral Product Manufacturing

This subsector comprises establishments primarily engaged in Manufacturing non-metallic mineral products. These establishments cut, grind, shape and finish granite, marble, limestone, slate and other stone; mix non-metallic minerals with chemicals and other additives; and heat non-metallic mineral preparations to make products, such as bricks, refractories, ceramic products, cement and glass.

Exclusion(s): Establishments primarily engaged in:

- beneficiating non-metallic minerals (212, Mining (except Oil and Gas))

331 Primary Metal Manufacturing

This subsector comprises establishments primarily engaged in smelting and refining ferrous and non-ferrous metals from ore, pig or scrap in blast or electric furnaces. Metal alloys are made with the introduction of other chemical elements. The output of smelting and refining, usually in ingot form, is used in rolling and drawing operations to produce sheet, strip, bars, rods and wire, and in molten form to produce castings and other basic metal products.

Exclusion(s): Establishments primarily engaged in:

- Manufacturing metal forgings or stampings (332, Fabricated Metal Product Manufacturing)

332 Fabricated Metal Product Manufacturing

This subsector comprises establishments primarily engaged in forging, stamping, forming, turning and joining processes to produce ferrous and non-ferrous metal products, such as cutlery and hand tools, architectural and structural metal products, boilers, tanks and shipping containers, hardware, spring and wire products, turned products, and bolts, nuts and screws.

Exclusion(s): Establishments primarily engaged in:

- Manufacturing metal products by rolling, drawing, extruding, alloying or casting (331, Primary Metal Manufacturing)

333 Machinery Manufacturing

This subsector comprises establishments primarily engaged in Manufacturing industrial and commercial machinery. These establishments assemble parts into components, subassemblies and complete machines. They may make the parts themselves, using general metal-working processes, or purchase them.

Establishments tend to specialize in producing machinery designed for particular applications, and this is reflected in the structure of the industry groups and industries. A broad distinction exists between general-purpose machinery, that is designed to be used in a variety of industrial applications, such as pumping or machining, and special-purpose machinery, that is designed to be used in a particular industry, such as agriculture or printing. The first three industry groups consist of establishments that produce special-purpose machinery. Establishments that produce general-purpose machinery are classified in the remaining industry groups.

Establishments primarily engaged in rebuilding machinery are included in the same industry as establishments Manufacturing the particular type of new machinery. Unless otherwise specified, establishments primarily engaged in Manufacturing parts, designed for use solely or principally with a particular machine, are classified in the same industry as establishments Manufacturing that type of machinery.

334 Computer and Electronic Product Manufacturing

This subsector comprises establishments primarily engaged in Manufacturing computers, computer peripheral equipment, communications equipment, and similar electronic products, as well as components for such products. The computer and electronic product Manufacturing industries employ production processes that are characterized by the design and use of integrated circuits and the application of highly specialized miniaturization technologies.

335 Electrical Equipment, Appliance and Component Manufacturing

This subsector comprises establishments primarily engaged in Manufacturing products that generate, distribute and use electrical power.

336 Transportation Equipment Manufacturing

This subsector comprises establishments primarily engaged in Manufacturing equipment for transporting people and goods. The industry groups are based on the various modes of transport - road, rail, air and water. Three industry groups are based on road transportation equipment - for complete vehicles, for body and trailer manufacture and for parts.

Establishments primarily engaged in rebuilding equipment and parts are included in the same industry as establishments Manufacturing new products.

Exclusion(s): Establishments primarily engaged in:

- Manufacturing equipment designed for moving materials and goods on industrial sites, construction sites, in logging camps and other off-highway locations (333, Machinery Manufacturing)

337 Furniture and Related Product Manufacturing

This subsector comprises establishments primarily engaged in Manufacturing furniture and related products. The processes used in the manufacture of furniture are standard methods of forming materials and assembling components, including cutting, moulding and laminating. The design of the article, for both aesthetic and functional qualities, is an important aspect of the production process. Design services may be performed by the furniture establishment's own work force or may be purchased from industrial designers. Furniture is classified based on the application for which it is designed. For example, an upholstered sofa is treated as household furniture, although it may also be used in hotels or offices.

Furniture is also classified according to the component material from which it is made. Furniture made from more than one material is classified based on the material used in the frame, or if there is no frame, the predominant component material. Upholstered household furniture is classified as such, without regard to the frame material.

Furniture may be produced on a stock or custom basis and may be shipped assembled or unassembled (knockdown). Establishments primarily engaged in Manufacturing furniture frames and parts are included.

Exclusion(s): Establishments primarily engaged in:

- Manufacturing furniture hardware (332, Fabricated Metal Product Manufacturing)
- Manufacturing seating for transportation equipment (336, Transportation Equipment Manufacturing)
- Manufacturing laboratory and hospital furniture (339, Miscellaneous Manufacturing)
- repairing, refinishing and reupholstering furniture (811, Repair and Maintenance)

339 Miscellaneous Manufacturing

This subsector comprises establishments, not classified to any other subsector, primarily engaged in Manufacturing activities. These establishments manufacture a diverse range of products, such as medical equipment and supplies, jewellery, sporting goods, toys and office supplies.



Appendix: Scope and methodology of the ICE survey

The ICE survey, which is conducted annually by Statistics Canada, provides estimates of energy consumption in the Canadian Manufacturing sector.

Target population

The target population of this survey is Canadian establishments that have North American Industry Classification System (NAICS) codes in the range of 310000–339990, which represents about 100 000 establishments.

Sampling

The sample includes approximately 4000 establishments. To reduce the burden of response on smaller establishments³⁵, they are excluded from the sampling process.

Data collection

The data collection period begins when questionnaires on energy use are mailed to selected establishments. The energy sources listed on the questionnaire include coal, coal coke, coke from catalytic cracking catalyst, coke oven gas, electricity, heavy fuel oil, middle distillates, natural gas, petroleum coke, propane, refinery fuel gas, spent pulping liquor, steam and wood.

Information is collected about other energy sources by asking respondents to state what energy source they use, if it is not listed in the questionnaire. Completion of the questionnaire is mandatory. A follow-up is done to ensure a maximum of responses. The response rate is approximately 90%.

Error detection

The completed questionnaires are verified (for example, to determine if obvious mistakes were made or if anything essential is omitted). If necessary, follow-up with respondents is done. Edit programs are run to find omissions and outliers (results that differ greatly from others in the same sample). In some cases, a statistical imputation is done.

Estimation

The Generalized Estimation System³⁶ is used to estimate energy consumption variables and to calculate coefficients of variation by industry. Estimates are then adjusted by a post-stratification weight to account for the portion of the population not covered by the sample.

Under the *Statistics Act*, confidentiality rules are applied before data are released or published. If necessary, data are suppressed to prevent the identification of an establishment.

³⁵ The term "smaller establishments" refers to establishments that make up the smallest shipment value by industry.

³⁶ The Generalized Estimation System software was developed by Statistics Canada.

D

Appendix: Glossary

Biomass

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

Boiler

A pressurized system in which water is vaporized to steam by heat transfer from fuel combustion. Steam thus generated may be used directly as a heating medium or converted to mechanical energy.

Chained dollars

A methodology that takes into account fluctuations in relative prices and the composition of output over time.

Energy efficiency

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

Energy intensity

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

Energy source

Any substance that supplies heat or power (for example, petroleum, natural gas, coal, renewable energy and electricity). The following are definitions used to report energy use according to Statistics Canada's *Industrial Consumption of Energy Survey Guide*.

• **Coal**

➤ **Bituminous Coal** – A dense, black coal, often having well-defined bands of bright and dull material with a moisture content of usually less than 20 percent. Used primarily for generating electricity, making coke and space heating.

➤ **Sub-bituminous Coal** – A black coal used primarily for thermal generation, with a moisture content of between 15 and 30 percent.

➤ **Lignite** – A brownish-black coal of low rank, containing 30 to 40 percent moisture and volatile matter. Also known as brown coal because the texture of the original wood is distinct. Used almost exclusively for electric-power generation.

➤ **Anthracite** – A hard, black, lustrous coal containing a high percentage of fixed carbon, a low percentage of volatile matter and little moisture content. Burns with a nearly smokeless flame.

• **Coal Coke** – A hard, porous product made from baking bituminous coal in ovens at high temperatures. Often used as a fuel and a reducing agent in smelting iron ore in blast furnaces.

• **Coke from Catalytic Cracking Catalyst** – Coke produced from the refining process of breaking down the larger, heavier and more complex hydrocarbon molecules into simpler and lighter ones.

• **Coke Oven Gas** – The difference between the thermal value of coal charged to coke ovens less the thermal value of the resultant coke production, with an allowance for heating and losses. Report in thousands of cubic metres in the gaseous state.

• **Electricity** – A form of energy emanating from electric charges at rest or in movement.

• **Heavy Fuel Oil** – All grades of residual-type fuels, including low-sulphur. Usually used for steam and electric power generation and diesel motors. Includes fuel oil nos. 4, 5 and 6.

- **Middle Distillates**
 - **Light Oil** – Condensable products (primarily benzene, toluene, xylene and solvent naphtha) obtained during distillation of coke oven gas, following removal of coal tar.
 - **Diesel** – All grades of distillate fuel used for diesel engines, including low-sulphur content (lower than 0.05%). Does not include diesel used for transportation off the plant site.
 - **Other Middle Distillates** – Includes light fuel oil (nos. 1, 2 and 3), kerosene, mineral lamp oil, stove oil, furnace fuel oil, gas oils and light industrial fuel. Does not include gasoline used for transportation off the plant site.
- **Natural Gas** – A mixture of hydrocarbons (principally methane) and small quantities of various hydrocarbons existing in the gaseous phase or in solution with crude oil in underground reservoirs.
- **Petroleum Coke** – Marketable grades of coke produced in delayed or fluid cokers that may be recovered as relatively pure carbon. Also, a residue that is the final product in the condensation process in cracking. May be sold as is or further purified by calcination.
- **Propane** – A normally gaseous straight-chain hydrocarbon (C₃H₈) extracted from natural gas or refinery gas streams. It can also take a liquid form.
- **Refinery Fuel Gas** – The remaining un-separated gaseous fractions produced in refinery distillation or cracking processes, after marketable products have been extracted, usually consumed as refinery fuel. Also known as still gas.
- **Spent Pulping Liquor** – A by-product of the paper-making process containing carbohydrate and lignin decomposition products. Also known as black liquor.
- **Steam** – A gas resulting from the vaporization of a liquid or the sublimation of a solid, generated by condensing or non-condensing turbines.
- **Wood** – Wood and wood energy used as fuel, including round wood (cord wood), lignin, wood scraps from furniture and window frame manufacturing, wood chips, bark, sawdust, forest residues, charcoal and pulp waste.

Exchange rate

The price of one national currency in terms of another.

Fossil fuel

Any naturally occurring organic fuel, such as petroleum, coal and natural gas.

Gigajoule (GJ)

1 gigajoule equals 1×10^9 joules (see Petajoule).

Gross domestic product (GDP)

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

Gross output

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.

Household

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

Imputation

A statistical process that entails the replacement of missing values with a realistic value through analysis, using the information available about the unit in question.

Petajoule

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

Primary energy use

Represents the total requirement for all uses of energy, including energy used by the final consumer (see Secondary energy use), non-energy uses, intermediate uses of energy, energy in transforming one energy form to another (e.g. coal to electricity) and energy used by suppliers in providing energy to the market (e.g. pipeline fuel).

Production employee

Includes all employees working directly in manufacturing operations, such as processing, assembling, storing, handling and packing.

Secondary energy use

Energy used by final consumers for residential, agricultural, commercial, industrial and transportation purposes.

Standard Industrial Classification

A classification system that categorizes establishments into groups with similar economic activities.

The references used to create this summary report are listed below. References linked to the text are indicated with Roman numerals. Other references provide clarification or understanding of an industrial process and background information.

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