



Report October 2011



Canada's Petroleum Refining Sector An Important Contributor Facing Global Challenges

ECONOMIC PERFORMANCE AND TRENDS



Canada's Petroleum Refining Sector: An Important Contributor Facing Global Challenges
by *Todd Crawford*

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Preface

Since 2003, rising oil prices have encouraged energy companies to actively explore and invest in oil development in Canada—the upstream segment of the sector. But the business of oil refining and processing is facing a very different set of circumstances in Canada.

This study researches and presents the economic contribution that Canada's refining industry currently makes. As well, the report examines the challenges the industry faces now and in the future. Our findings suggest that even if development and production of oil resources continue to grow strongly in Canada, the future economic benefits, job creation, and profits from oil refining and processing are much less assured.

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Acknowledgements

This research was undertaken by The Conference Board of Canada (CBoC) for the Canadian Petroleum Products Institute (CPPI). In keeping with Conference Board guidelines for financed research, the design and method of research, as well as the content of this study, were determined solely by the Conference Board. Only publicly available information was used in the creation of this study, and the Conference Board did not view any confidential information from CPPI or its members.

Todd Crawford, economist with the Board's Economic Forecasting and Analysis division, was the lead researcher on the project. Michael Burt, Alan Arcand, and Robin Wiebe also contributed to the design of the study and research. Pedro Antunes, Director of the Board's National and Provincial Forecast group, was project manager. Thanks are due to the Canadian Petroleum Products Institute's Peter Boag, President, and Carol Montreuil, Vice-President (Eastern Division), for their valuable insights and comments.

EXECUTIVE SUMMARY

Canada's Petroleum Refining Sector An Important Contributor Facing Global Challenges

At a Glance

- ♦ While growing global demand for oil creates attractive opportunities for Canada's upstream oil industry, the competitive challenges facing the refining industry are very different.
- ♦ Canada's refining industry has undergone a massive restructuring over the past 30 years. Since the 1970s, the number of operating refineries has dropped from 40 to just 19 today.
- ♦ Given the competitive pressures that Canadian refiners face, we build a hypothetical scenario under the assumption that, going forward, Canada permanently loses 10 per cent of its refining capacity as domestic production is replaced by imports.
- ♦ Under that scenario, real GDP is reduced by a cumulative total of \$4 billion, while 38,300 person-years of employment are lost over the 2011 to 2015 period.

the International Energy Agency (IEA) projects that world oil consumption will increase from about 84 million barrels a day at present to about 99 million barrels a day by 2035, an average annual growth rate of about 0.6 per cent.

Companies have invested billions of dollars into oil sands mines and in situ projects that will result in large increases in production of heavier oil.

However, all of this growth will likely be concentrated in non-OECD economies. In the OECD countries—with their relatively mature markets and policy measures to reduce oil consumption (including more stringent vehicle efficiency standards and promotion of alternative fuels)—oil demand is projected to decline. The same IEA outlook projects that demand in OECD North America (the most relevant market for the Canadian refining industry) will decline about 11 per cent from current levels by 2035. While growing global demand creates attractive opportunities for Canada's upstream oil industry, the competitive challenges facing the refining industry are very different.

Global demand for oil, driven by economic growth in developing economies, is expected to continue to increase over the next 25 years, even with significant further increases in energy efficiency. Oil products currently account for about 33 per cent of global energy demand, and will remain an important part of the energy mix over the foreseeable future. Even anticipating new policy measures to control GHG emissions,

Throughout its history, Canada has prospered from its energy resources. This has been even more evident during the past decade. Steady growth in global demand, coupled with a decline in production from conventional sources, has led to a rapid rise in oil prices and fervent exploration and development activity in Canada. Since 2003, Canada has seen a massive increase in investment related to oil production, particularly non-conventional production in

the oil sands. Companies have invested billions of dollars into oil sands mines and in situ projects that will result in large increases in production of heavier oil going forward. Moreover, rising oil prices have created favourable economic conditions, leading to increased profits, investment, job creation, and government revenues—all of which will continue to support economic growth going forward. Still, even though global demand for petroleum products continues to rise and the outlook for Canada's upstream energy sector is bright, Canadian refiners face a very particular set of challenges, since North American and other OECD markets will likely be characterized by declining demand.

The North American market for refined petroleum products has matured, and that will result in weaker demand growth going forward.

Canada's refining industry has undergone a massive restructuring over the past 30 years. Since the 1970s, the number of operating refineries has dropped from 40 to just 19 today. However, the reduction in numbers was offset by increased capacity at the remaining facilities, achieved through capital investment and efficiency gains. While production has continued to increase, the North American market for refined petroleum products has matured, and that will result in weaker demand growth going forward. Compounding the challenge is the advent of renewable fuels, although minor in terms of total Canadian market share, their relative importance is expected to grow over the coming years, and the industry will face the challenge of introducing these new component streams into the product mix while maintaining performance standards. Moreover, a strong dollar, tight labour markets, and rising wage pressures will continue to challenge Canada's competitiveness in North America and around the globe.

Today's modern refineries are capital intensive, require sophisticated engineering, and typically have a replacement cost of over C\$7 billion (not including land-acquisition costs).¹ In Canada, the costs of operating an aging refinery

network are substantial due to high energy and labour costs. Refineries operate under extreme winter conditions and require ongoing investment in maintenance and new equipment to improve efficiency and meet environmental and safety regulations. Without such investments, Canada could lose its position as a net exporter of refined products, competing with U.S. refineries that have already made significant progress retooling to accommodate heavier crude. Currently, U.S. refineries process around 2 million barrels per day of Canadian crude. Within the refining industry, some companies are vertically integrated—from exploration and development through to the refining and distribution end of the sector. Others concentrate solely on maximizing refining capacity and operate only within the downstream segment, while contributing equally to the performance of the industry. If the incentives to refine within Canada, or even North America, become thin, there is the potential for losses to Canada's refining capacity. Currently, modern super-refineries are being built in China, India, and other developing nations. These provide a new competitive source of refined products—especially gasoline—for export to North American markets.

Annual refining industry output growth has declined in five of the last six years.

Output from Canada's refining industry has expanded fairly steadily, despite the intense rationalization that occurred over the past three decades. Increased operating efficiency, reduced costs per unit, and increased capacity use helped to lift real gross domestic product in the refining industry to \$2.5 billion in 2009. That is up from an average of roughly \$2 billion in the 1980s, but down from peak production of \$2.9 billion reached in 2003. Employment has been more stable, with the downstream industry currently employing about 17,500 high-paid workers in refining and 82,000 lower-paid workers in gasoline retail operations in 2009. Over the past 10 years, estimates suggest that pre-tax returns in the refining industry have averaged 11 per cent. On a regional basis, the industry has gained in importance in Atlantic Canada.

1 CPPI estimate.

The industry averaged annual output growth of 2.8 per cent between 1993 and 2003 (a period that excludes the recession years of the early 1990s), but growth has now declined in five of the last six years. The recent weakness in the refining industry coincides with the upswing in oil prices, which resulted in higher fuel costs and weaker U.S. demand. Since 2001–02, real refining output has seen its share of total economic activity drop sharply, in line with the decline in other manufacturing sectors. Because no significant capacity additions are likely for the industry in the near term, the refining industry is likely to continue to see its relative importance in the Canadian economy wane going forward.

For every \$1 reduction in real GDP in the refining industry, total real GDP in the Canadian economy is reduced by \$3.

In terms of regional output, Atlantic Canada's economy is the most dependent on exports and production of refined petroleum products, as the region has experienced strong increases in capacity over time. On the other hand, Ontario refineries no longer account for the greatest portion of Canada's petroleum products. The industry in Ontario has seen its importance on the national stage decline—going from 34 per cent of total national output in the early 1980s to just 23 per cent in recent years. Quebec has seen little change in its output share over time, as refinery closures there have been largely offset by a doubling of capacity at the Ultramar refinery between 2000 and 2010. However, the province is likely to see its share of national production decline going forward due to the conversion of Shell's Montréal plant from a refinery to a terminal. British Columbia has seen the largest absolute drop in production. Five B.C. refineries have closed in the past 30 years, and the province now accounts for only 3 per cent of Canadian production. Alberta has expanded production, and thus its relative importance on the national stage. Still, the refining industry in Alberta as a share of provincial GDP peaked in 1984 at 0.5 per cent, and has fallen steadily since, dropping to 0.3 per cent by 2009.

Given the competitive pressures that Canadian refiners face, we build a hypothetical scenario under the assumption that, going forward, Canada permanently loses 10 per cent of its refining capacity as domestic production is replaced by imports.² In order to estimate the full employment and economic impacts over time, simulations were performed using The Conference Board of Canada's detailed proprietary model of the Canadian economy. The economic impact analysis is performed over the next five years under the assumption that refining capacity would be lost permanently, starting in 2011. The Loss of Refining Capacity scenario quantifies the broad impacts on a number of key economic indicators, including GDP, employment, income, profits, and tax revenues.

The model simulations allow us to capture the broader footprint that the refining industry has on the rest of the economy through the economic multiplier effects. The results presented highlight, at an aggregate level, the widespread effects the refining industry has across all sectors of the economy. Indirect effects are felt on demand for goods or services from industries that are direct suppliers, excluding the impact on crude oil extraction. Second-round induced effects, caused largely by decreased household spending and investment, produce a widespread (albeit smaller) impact on all sectors of the economy. For example, the loss of elevated salaries in refining would lead to a decline in consumer spending for the Canadian economy. The overall economic multiplier can be calculated as the change in total real GDP divided by the initial constant dollar reduction to refining output. Under our assumption, for every \$1 reduction in real refining GDP, total real GDP in the Canadian economy is reduced by \$3.

According to the Board's national model simulations, a permanent 10 per cent reduction in the real value-added of Canada's refining industry would have a significant impact on total real GDP and employment. Combining direct, indirect, and induced effects of the industry, real GDP is reduced by roughly \$800 million per year, or 0.06 per cent. Annual job losses peak at 8,100 in 2012, and the

² The 10 per cent reduction in refining capacity was arbitrarily chosen by The Conference Board of Canada for this evaluation, and does not reflect the view of CPPI. Such a reduction would be roughly equivalent to the closure of one large refinery.

unemployment rate is pushed permanently higher by just under 0.04 percentage points. Over the five-year simulation horizon, real GDP is reduced by a cumulative total of \$4 billion, while 38,300 person-years of employment are lost over the 2011 to 2015 period.

The loss of refining capacity scenario also suggests that the impact on federal and regional government finances is significant and permanent. Together, federal and provincial personal income tax revenues are down by about \$100 million per year—\$500 million cumulatively over the 2011 to 2015 period. Federal and provincial corporate income tax collections are down by about \$102 million per year, or a cumulative \$508 million. Personal, corporate, and indirect taxes produce the lion's share of the negative effects on the federal and aggregate provincial government balances. Over the five-year simulation horizon, the federal balance is eroded by a cumulative \$1.18 billion, while the aggregate provincial balances are down by a cumulative \$546 million.

Manufacturing GDP and employment are hard hit, but business service sectors suffer even greater losses in output and employment. Over the five-year simulation horizon, 7,700 jobs are permanently lost (see Table 1), with manufacturing accounting for 1,900 of those losses. While business services account for roughly half the GDP losses, together they account for a greater proportion of lost employment. Primary sector employment is not significantly affected because the loss of refining capacity scenario is assumed not to have any direct impact on the upstream segment of the industry.

Table 1
Industry Snapshot

Number of operating refineries, 2009	20
Annual output, 2009 (2002 \$ millions)	2,500
Refining employment, 2009	17,500
Gasoline retail employment, 2009	82,000
Refining industry's share of Canada's manufacturing (per cent)	1.6
Average rate of return, 2005–09 (per cent)	11.6
Average annual investment, 2005–09 (2002 \$ millions)	2,800
Total production, 2009 (barrels per day, 000s)	1,970
Total exports, 2009 (barrels per day, 000s)	420
Impact of a 10 per cent loss in refining capacity	
Real GDP (2002 \$ millions) per year	–806
Employment	–7,700
Government tax collections (\$ millions) per year	–231

Sources: The Conference Board of Canada; Statistics Canada; MJ Ervin & Associates.

CHAPTER 1

Introduction

Chapter Summary

- ♦ This study researches and presents the economic contribution that Canada's refining industry currently makes. It also examines the challenges the industry faces now and in the future.
- ♦ Our findings suggest that even if development and production of oil resources continue to grow strongly in Canada, the future economic benefits, job creation, and profits from oil refining and processing are much less assured.

The expectation of continued, solid growth in global demand for energy puts Canadians in an enviable position—as a nation, we are blessed with a plentiful and wide-ranging supply of valuable energy resources. Since 2003, rising oil prices have encouraged energy companies to actively explore and invest in oil development in Canada—the upstream segment of the sector. But the business of oil refining and processing is facing a very different set of circumstances in Canada. Companies operating in the refining industry

generally fall into one of two categories—those that are vertically integrated (that is, involved in both the upstream and downstream segments of the industry), and those that operate solely in downstream activities. While the breadth of their operations are different, their importance to the refining industry is equal. This study researches and presents the economic contribution that Canada's refining industry currently makes. It also examines the challenges the industry faces now and in the future. Our findings suggest that even if development and production of oil resources continue to grow strongly in Canada, the future economic benefits, job creation, and profits from oil refining and processing are much less assured.

Chapter 2 of this report outlines scenarios that detail crude oil's place in the future energy mix. Chapter 3 examines the entire value chain of the petroleum industry—from oil extraction to retail gasoline stations. Chapter 4 looks at historical supply and demand for refined petroleum products. It also gives a summary of the industry's trade balance. Chapter 5 summarizes economic data for the industry, including real GDP, employment, earnings, and corporate profits. Chapter 6 lays out the consequences for the Canadian economy of a drop in refining capacity, while Chapter 7 concludes.

Glossary

Barrel of oil (abbreviation bbl): 42 U.S. gallons, or 159 litres.

b/d: Barrels per day.

Mmbd or mbd: Millions of barrels per day or thousands of barrels per day. These are standard units for measuring the rate of oil consumption or production.

For example, in 2009, global consumption of oil is estimated to have averaged 84.1 million barrels per day, for a total of 30.7 billion barrels.

Greenhouse gas (GHG): Gas in the atmosphere that absorbs and emits radiation. Common examples include water vapour, carbon dioxide, methane, nitrous oxide, and ozone.

Carbon dioxide equivalent: The concentration of CO₂ that would cause the same level of radiative forcing as a given type of greenhouse gas. Expressed as parts per million, or ppm.

Downstream: Refers to the refining of crude oil and the selling and distribution of the derived products.

Upstream: The portion of the petroleum industry that accounts for exploration, development, and production of crude oil and natural gas.

Bitumen: A sticky form of petroleum that is generally of lower value than the light sweet varieties that have historically dominated Canadian production.

Upgrader: A facility that upgrades bitumen into synthetic crude oil.

In situ mining: One extraction method applied to bitumen. Typically used for deposits at depths greater than 100 metres. Bitumen is heated and stimulated, typically using steam, so that it will flow through to the wellhead.

Crude oil: Includes light sweet crude, medium sulphur heavy crude, sour light, sour heavy crude, synthetic crude.

Gross domestic product (GDP): The total amount of goods and services produced within the same economic “agent.” The agent can vary, but usually is defined as a country, a province, a state, or industry. Real GDP discounts changing prices, allowing for meaningful comparisons across time.

CHAPTER 2

Oil's Place in the Future Energy Mix

Chapter Summary

- ♦ Thirst for energy from the developing world will ensure that global consumption of oil continues to grow. Despite continued efficiency gains, total demand for oil will increase from 84 million to 99 million barrels per day over the next 25 years.
- ♦ Policy measures to reduce greenhouse gas emissions, including more stringent vehicle fuel-economy standards and promotion of alternative fuels, are expected to help reduce refined product demand in mature OECD markets. North American demand for oil is forecast to decline by 11 per cent, going from 21.9 to 19.4 mbd.
- ♦ Even though global demand for refined products will rise over the next 25 years, Canadian refiners will likely face a North American market characterized by weaker demand.

The future of the refining industry hinges on future demand for its products. On a global basis, oil and refined petroleum products will remain an important part of the overall energy mix, at least over the next 25 years. (See Chart 1.) While demand for energy from the developed world is stabilizing, developing economies—particularly China, India, Brazil, and several Middle Eastern countries—will see

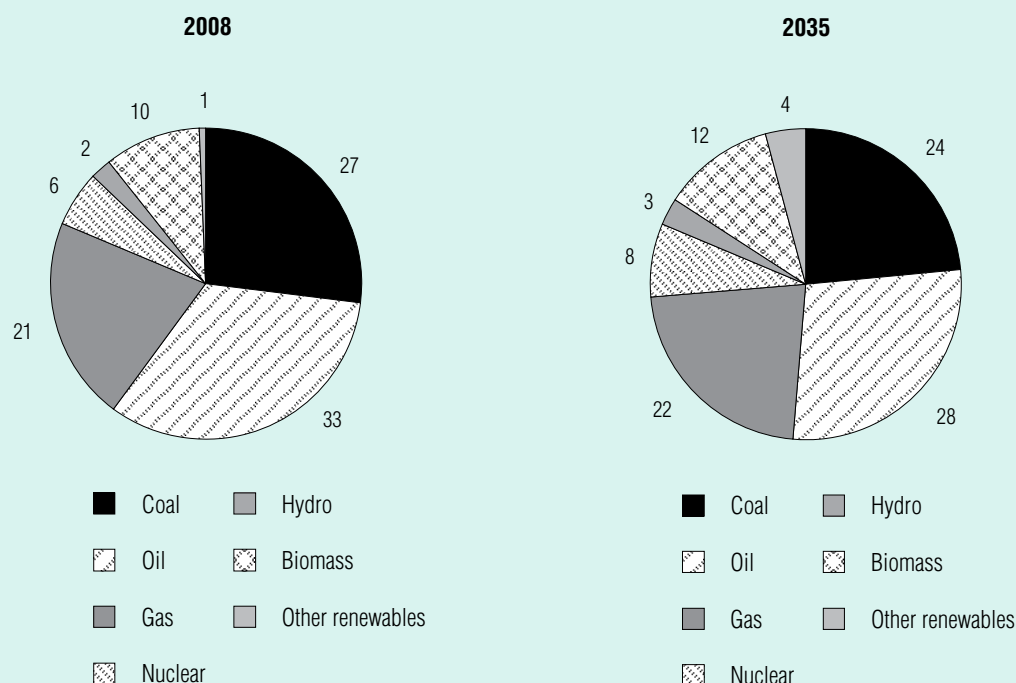
demand for energy grow rapidly, in line with increasing per capita production and income. Since 1980, global oil consumption has grown by just over 1 per cent per year. Over this period, each 1 per cent increase in global real gross domestic product resulted in a 0.3 per cent increase in oil demand.¹ Even as technology has helped alleviate demand for energy, a growing global population and increased production and income continued to boost consumption of oil. In recent years, concerns about greenhouse gas (GHG) emissions and sharp increases in energy prices have encouraged conservation and energy switching. Since 2004, the reduction in intensity of oil use has quickened, as the global economy pushes away from its dependence on fossil fuels. This downward trend in the relative use of oil per unit of output will weigh heavily on the future path of oil demand. Still, over the next 25 years, growth in demand and production of oil is expected to average about 0.6 per cent per year, roughly half the growth pace that occurred in the past 30 years.

THE BASE CASE

Future oil demand is affected by numerous factors, including population growth, scarcity of supply, rising prices, and policy action. However, under any given scenario, economic activity remains the fundamental driver of oil demand. Even with further improvements in

1 International Energy Agency data.

Chart 1
Oil Remains Prominent in Global Energy Mix
(per cent)



Note: Totals may not add to 100 due to rounding.
Source: International Energy Agency, *World Energy Outlook 2010*.

reducing oil intensity, oil will continue to be the single largest source of energy in the global energy mix. In 2008, oil accounted for 33 per cent of global energy consumption. According to the International Energy Agency (IEA),² that share will decline to only 28 per cent by 2035—even assuming certain policy actions are taken to curb increases in greenhouse gas emissions. Under this scenario, oil demand continues to climb in absolute terms, eventually reaching 99 mmbd by 2035, up from 84 mmbd in 2008.

Forecasts of global demand mask very important differences across regions. Regardless of various potential policy scenarios, developing countries will expand consumption of oil much quicker than developed regions. Non-OECD regions are projected to increase consumption by 19 mmbd

between 2009 and 2035. (See Table 2.) In absolute terms, China is by far the largest contributor to rising demand, as consumption there climbs from 8.1 mmbd in 2009 to 15.3 mmbd in 2035. Demand could expand at an even quicker pace if the yuan is allowed to appreciate vis-à-vis the U.S. dollar, effectively reducing the cost of oil imports for Chinese companies and citizens.

The transportation sector is expected to account for all the increase in oil consumption between now and 2035, as oil's use in the power generation sector is forecast to decline. (See Chart 2.) China accounts for more than half of the increase in oil consumption in the transportation sector. Demand for road transport will continue to expand because of rising incomes, which will increase vehicle ownership and freight usage. The potential for China's automobile fleet to grow is enormous. Estimated at 40 million, the total car fleet in China is now twice as big as it was just three years ago, yet vehicle ownership rates are well below average OECD levels. There are only 30 cars per 1,000 persons in China, compared with more than

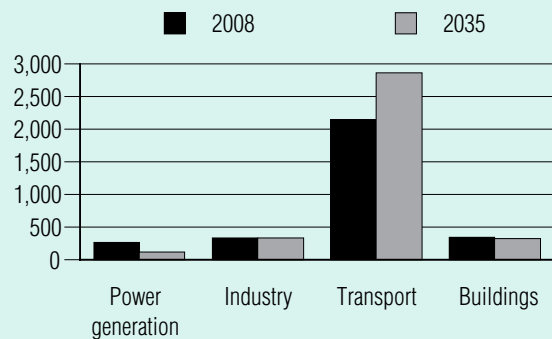
2 Unless otherwise specified, estimates in this chapter are based on the "New Policies" scenario from the IEA *World Energy Outlook 2010*. A detailed description of the assumptions involved in their forecast is detailed in Appendix A.

Table 2
Developing Countries Will Soon Lead the Demand for Oil (mmbd)

	2009	2015	2025	2035
OECD	41.7	41.1	38.2	35.3
North America	21.9	21.9	20.8	19.4
Europe	12.7	12.4	11.4	10.4
Pacific	7.0	6.9	6.1	5.6
Non-OECD	35.8	41.1	47.5	54.6
E.Europe/Eurasia	4.6	4.9	5.2	5.4
Asia	16.3	19.7	24.4	27.3
Middle East	6.5	7.5	8.5	9.2
Africa	3.0	3.1	3.4	3.8
Latin America	5.3	5.8	6.0	6.2
<i>Bunkers</i>	<i>6.5</i>	<i>7.0</i>	<i>7.9</i>	<i>9.1</i>
World	84.0	89.2	93.6	99.0

Source: International Energy Agency, *World Energy Outlook 2010*.

Chart 2
Transportation Sector Source of Future Oil Demand Growth (Mtoe)



Source: International Energy Agency, *World Energy Outlook 2010*.

700 in the United States and 500 in Europe.³ According to the IEA, the total stock of light-duty passenger vehicles in non-OECD countries is projected to increase four-fold by 2035, eventually reaching 850 million.

Other emerging regions, particularly India and the Middle East, will also play a large role in future demand growth. India's consumption of oil will rise alongside strong population growth and the rapid industrialization of the Indian economy, pushing the country's oil demand up to 7.5 mmbd in 2035. Meanwhile, in addition to being the world's largest oil-producing region, the Middle East has also emerged as a significant consumer of crude oil. Middle Eastern economies have derived tremendous benefit from the sharp rise in oil prices over the past decade. Real income in the region is expanding, boosting vehicle ownership rates. Moreover, many of these producing nations heavily subsidize their domestic fuel costs, bolstering demand above where it would normally be.

Efficiency gains will be the deciding factor in the outlook for future oil demand in the developed world, including Canada.

The continued rise in demand for oil from emerging economies is intuitive—these economies are expanding so quickly that increases in vehicle-fuel efficiency are outstripped by higher demand for road transport, new roads, and rising industrial production. On the other hand, the more developed economies of the world will experience relatively soft economic growth rates going forward. Moreover, because of higher saturation rates in OECD countries, vehicle ownership rates are unlikely to expand substantially. Thus, efficiency gains will be the deciding factor in the outlook for future oil demand in the developed world, including Canada. Among OECD nations, consumption of oil is expected to fall by 0.6 per cent a year between 2009 and 2035, resulting in a net decrease of 6 mmbd.

All three OECD regions are expected to reduce oil consumption going forward, with the rate of decline most pronounced in the Pacific region, followed by Europe. North American demand declines from 21.9 mmbd in 2009 to 19.4 mmbd in 2035, and Asia eventually replaces North America as the largest oil-consuming region in the world.

³ Various estimates place Canada's vehicle ownership rate between 500 and 600 per 1,000 persons.

Because the transportation industry currently accounts for the largest share of oil consumption, and is expected to be the main source of growth going forward, assumptions and uncertainty about future fuel efficiency are very important to the outlook for future oil demand. While the internal combustion engine is getting more efficient, rising income levels in many OECD countries have prompted a switch to larger, more energy-intensive vehicles. Moreover, energy demand is very inelastic. Despite the sharp rise in energy prices in 2008 and the great recession the following year, demand for oil dropped by only 2.2 per cent in 2009. By mid-2010, demand had already recovered to pre-recession levels.

Standardization of certain technical aspects is required before the electric vehicle can pose any real threat to the internal combustion engine.

Still, the anticipated solid rise in oil prices relative to overall inflation, coupled with policy initiatives to encourage renewable energy and conservation, should lead to the development of engines that are more efficient, and encourage the use of hybrid, electric, or other alternative technologies for transportation. However, achieving cost competitiveness for these alternative technologies is a difficult task. For hybrids, consumers pay a higher initial price, which is offset by lower fuel costs over time. But because North Americans pay a relatively low price at the pump (thanks to relatively low fuel taxes), the current payback period is roughly six years, hardly enough to prompt the majority of consumers to make the switch. Electric cars face even greater hurdles. First, standardization of certain technical aspects is required before the electric vehicle can pose any real threat to the internal combustion engine. Batteries and voltage, for example, would have to be standardized, at least within a region, if electric cars are to see an increase in market share. And even if these issues are overcome, it remains to be seen if individual consumers would accept the limitations of electric cars, such as decreased driving range and the lengthy times to recharge batteries.

It is expected that it would take either much higher prices at the pump or a reduction in the relative price of alternative technologies before significant gains in reducing gasoline consumption can be made in the North American market. Considering these difficulties, crude oil is expected to remain an important part of the global energy mix for the next 25 years. Even though its share of the global energy mix is expected to decline from 33 per cent in 2008 to under 28 per cent in 2035, oil consumption will still increase by roughly 0.6 per cent per year.

REDUCING GREENHOUSE GAS EMISSIONS

This outlook assumes that further policy actions to curb GHG emissions will be implemented on a relatively cautious basis. Currently, coal use accounts for the largest share of global GHG emissions, and options to reduce GHG emissions from this source—by replacing coal with other, lower-emitting, means of generating electricity—may be significantly cheaper than measures to reduce emissions from oil use. In contrast, oil is largely used in the transportation sector, where competitive alternatives are relatively limited. Therefore, efforts to dramatically reduce GHG emissions are likely to target coal first.

Nevertheless, many policy measures aim to manage GHG emissions in the transportation sector. Efforts to reduce the demand for driving and mandates to improve fuel efficiency in vehicles are under active consideration by governments the world over, and that will moderate oil demand over time. The outlook above anticipates such policy measures, and OECD North America oil demand is projected to be 7 per cent lower 25 years from now than it would be in a world where these policies were not enacted. It should be noted that Canada accounts for 2 per cent of global GHG emissions, of which just 4 per cent originate in the refining industry.

One other scenario considered by the IEA is the setting of a goal of limiting the global increase in temperature to 2 degrees Celsius above current levels. That would require the concentration of GHGs in the atmosphere to be limited

to 450 ppm of CO₂ equivalent. Such a scenario requires major initiatives, including the phasing out of fuel subsidies in net-importing countries, a cap-and-trade system in the power and industrial sectors, implementation of the Copenhagen Accord commitments, international agreements on fuel-efficiency standards for passenger and light-duty vehicles, as well as numerous other national commitments around the world. These changes would require significant international cooperation—an ambitious goal. In this scenario, global oil demand peaks over the next 15 years, and by 2035 is about 6 per cent lower than current levels. The drop is particularly prominent in OECD North America, where oil demand declines more than 30 per cent.

Mitigating some of the risk factors for the domestic refining industry is the possibility that the Canadian market will not undergo the same degree of change that is expected in the U.S. over the next 25 years.

The implications for the refining industry are clear; even if global demand for refined products is likely to increase under current policy assumptions, the gains will be concentrated in emerging markets around the world. Canadian refiners, primarily serving the North American market, will likely face declining demand going forward.

Mitigating some of these risk factors for the domestic refining industry is the possibility that the Canadian market will not undergo the same degree of change that is expected to take place in the U.S. over the next 25 years. First, Canadians already pay higher taxes at the pump, meaning future gains in reducing consumption through tax policy will be less effective in Canada than in the

United States. Average gasoline taxes in the U.S. are roughly 12 cents per litre. In Canada, the number can vary depending on the region of the country, but in 2006 the provincial tax rate on gasoline averaged about 14.5 cents per litre, on top of the 10 cents per litre national excise tax. In addition, gasoline is a taxable good under the GST/HST rules, which means the tax rate paid on gasoline in Canada is more than double the rate paid by American consumers.⁴ Because substitutes for gasoline in the transportation sector are limited in the short term, demand for gasoline likely becomes increasingly inelastic as prices move higher. Thus, reducing consumption of motor gasoline through tax policy would have a greater effect in the U.S. than it would here in Canada.

On the other hand, Canada has adopted the same overall GHG reduction target as the U.S.—a 17 per cent reduction from 2005 emission levels by 2020. However, the U.S., with its much greater reliance on coal-fired generation for electricity, has correspondingly much greater scope for relatively low-cost reductions from that sector than does Canada. For Canada to meet the target, greater reduction in other sectors (such as in transportation) would be required relative to the U.S. market. As well, the Canadian electrical generation sector utilizes petroleum at a much lower rate than its U.S. counterpart does. The U.S. currently has 3,768 generators powered by petroleum liquids or petroleum coke, which combined represent more than 60,000 megawatts of nameplate capacity, or 6 per cent of total U.S. electrical generation.⁵ On the other hand, only 4.5 per cent of total electrical generation capacity in Canada comes from oil.

4 Data on U.S. gasoline taxes are from the American Petroleum Institute. (See www.api.org.)

5 U.S. Energy Information Administration data.

CHAPTER 3

The Value Chain of Canada's Petroleum Sector

Chapter Summary

- ♦ Canada's petroleum sector is divided into three distinct segments: exploration, refining, and marketing.
- ♦ Canadian crude production will increase sharply over the next 20 years, as the significant investments in the oil sands lead to increased bitumen production.
- ♦ Canada's refining industry has undergone huge restructuring over the past 30 years. Since the 1970s, the number of refineries in Canada has dropped from 40 to just 19 in operation today—although capacity has increased over this period.
- ♦ Historically, Canada has been a net exporter of refined products. The volume of exports has shown a steady rise since 1980 when it averaged 128,000 barrels per day, climbing to 241,000 barrels per day in 1990, and to an average of 421,000 barrels per day over the past decade.

UPSTREAM—EXPLORATION AND PRODUCTION

The rise of the energy sector has been a huge factor in the performance of the Canadian economy over the past decade. Canada ranks fifth in the world in total energy production, behind only the U.S., China, Russia, and Saudi Arabia. On a per capita basis, Canada ranks second only to Saudi Arabia (the world's largest oil-producing country).

Because only a portion of its energy is consumed domestically, Canada has emerged as one of the world's largest energy brokers—ranking second in the world in natural gas exports, fourth in electricity exports, and in the top ten of oil exporting nations.¹ Virtually all our exports go to the U.S., which is both the world's largest consumer and largest producer of energy. In recent years, Canada has been the United States' number one supplier of imported oil. This has also led to significant investments in the development of a complex and comprehensive pipeline network.

The past decade has seen a massive increase in investment related to oil production, particularly non-conventional production in the oil sands. Companies have invested billions of dollars into oil sands mines and in situ projects that will result in large increases in production going

¹ Central Intelligence Agency, *World Fact Book*.

forward. Moreover, rising oil prices have increased revenues, generating new investment and bolstering government revenues, which will continue to boost Canada's economy well into the future.

Canada has only just begun to register meaningful increases in production. Much of the oil-related investment takes the shape of megaprojects that cost billions of dollars and often take years to complete. The recent recession reduced the near-term outlook for oil production, as many projects were delayed or cancelled. However, remaining proven reserves are estimated at 178 billion barrels—the second largest in the world. The magnitude of the resource base alone ensures that production will increase significantly in coming years.

Canadian refineries may have to retool to accommodate heavier crude inputs.

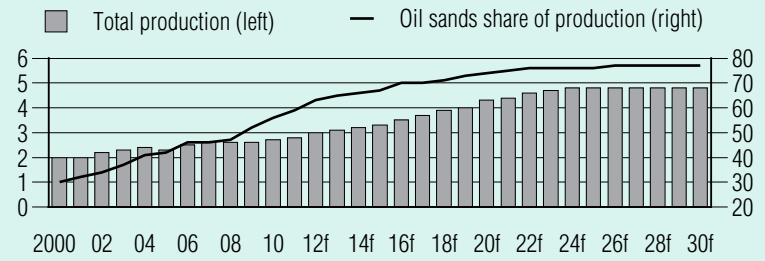
Increasing investment in the oil sands will push Canadian production higher, but will also result in a heavier average barrel of oil produced. Currently, the oil sands account for a little more than half of total Canadian production, but that share is projected to climb to 75 per cent by 2030.² (See Chart 3.) Bitumen is lower-priced, heavier crude with higher sulphur content than the light sweet crude that has dominated production in Canada historically. Canadian refineries wishing to take advantage of this situation may have to invest in coking and hydro-cracking technology going forward to accommodate the trend toward heavier crude. Making these improvements will allow them to process heavier barrels of crude while still allowing for the same yield in high-value products, such as gasoline and diesel. Alternatively, refiners may choose to optimize their operations by increasing capacity, thus reducing the average cost per barrel of refined products and leading to efficiency gains in their operations. Without such investments, Canada could lose its position

² The Conference Board of Canada, *Canadian Outlook Long-Term Economic Forecast: 2010*.

Chart 3

Domestic Production Trending Toward Heavier Crude

(production, mmbd; share of total production, per cent)



f = forecast

Sources: The Conference Board of Canada; Statistics Canada.

as a net exporter of refined products. (U.S. refineries have already made significant progress toward retooling their refining industry to accommodate heavier crude inputs. Indeed, the U.S. already processes around 2 mmbd of Canadian crude.)

REFINING

Today's modern refineries are capital intensive and require sophisticated engineering, with a typical replacement value exceeding C\$7 billion (not including land-acquisition costs). Plant operations are also expensive due to high energy, labour, and maintenance requirements. They operate under extreme winter conditions and need considerable investment in maintenance and new equipment to improve efficiency and meet environment and safety regulatory standards (including increasingly stringent product specifications). Due to the historic abundance of domestically produced light sweet crude oil and the strong demand for distillate products, most of Canada's refineries are cracking refineries. Currently, more coking capacity is being added as inputs shift to heavier oil sands output. Integrated oil companies are active through the entire process—from exploration and production through to refining and distribution of their products in retail stores across Canada. These represent some of the largest companies in Canada, including Imperial Oil,

Suncor, Husky Energy, and Shell. However, integrated oil companies are joined by more regional ones—such as Irving Oil, Ultramar, Chevron, and North Atlantic Refining—to form the bulk of the transportation fuel manufacturing industry in Canada. Industry rationalization, beginning in the early 1970s, cut the number of refineries in Canada from nearly 40 to just 19 today. However, the reduction in numbers was offset by an increase in capacity at the remaining facilities. These capacity increases were achieved through significant capital investments that contributed to the growth in the efficiency of the sector. And because of these investments, total refining capacity has not changed dramatically over time, even though the number of operating refineries is much less today than in the 1970s. United States refineries underwent similar consolidation as refiner-marketers concentrated production.

What Is Refining?

Refining is the manufacturing stage of petroleum production. Various refining stages produce outputs, including gasoline, diesel, heating fuels, jet fuels, and lubricants. The resulting yield mix is called the “product slate.”

There are three main refinery configurations, the most simple of which is referred to as a topping plant. Such a configuration typically features only a distillation unit and a catalytic reformer. Results from such plants closely reflect natural yields from their input crude. They usually process only condensates or light sweet crude, unless markets for heavy fuel oil are economically available. Asphalt plants are topping refineries processing heavy crude oil.

A more sophisticated refinery carries cracking technology, which allows the production of gasoline and other distillates from the gas-oil portion of the crude barrel.

Finally, coking refineries thermally crack the residual fuel, the heaviest material in the crude barrel. Such technology is costly, but is able to thermally crack the heaviest crude into lighter product, allowing the refiner to extract higher value-added products—such as gasoline and diesel—from much lower-quality crude.

Oil price shocks in 1973 and 1979 raised gasoline prices and reduced gasoline demand. By 1980, the North American auto industry was building smaller vehicles and phasing out traditional rear-wheel drive vehicles in favour of more efficient front-wheel drive designs. The United States cut its national speed limit

to 55 miles per hour. Domestically, the crisis spawned Petro-Canada and the National Energy Program. Oil price hikes also engendered increased competition from natural gas and electricity, particularly for residential heating.

Not surprisingly, demand for gasoline and other petroleum products declined. Gasoline consumption in Canada fell 18 per cent between 1981 and 1987. This cut the utilization rate, increasing competition and lowering the average rate of return for refiners. The resulting industry rationalization cut the national refinery count—from 40 in the 1970s, to 29 by the end of the 1980s, and finally to the 19 in operation today. (See Table 3.)

Closures during the 1970s included Imperial Oil's shutdown of refineries in Edmonton, Winnipeg, Regina, and Calgary, and Gulf Oil closures in Saskatoon and Edmonton. This removed 250,000 b/d of refining capacity from the market.

Expansions at the remaining refineries mean that refined products capacity is actually higher than it was in the mid-1970s, despite the long list of closures.

Consolidation accelerated during the period of weak economic growth in the early 1980s. Gulf closed refineries in Point Tupper (Nova Scotia), Calgary, Kamloops, and Montréal, while Shell shuttered similar facilities in St. Boniface (Manitoba) and Oakville (Ontario). Together, these closures amounted to more than 500,000 b/d of refining capacity. However, total Canadian refining capacity declined less than the sum of these closures, as capacity was boosted at several other facilities.

Rationalization slowed during the 1990s, although that decade still saw Imperial Oil eliminate refineries in Port Moody (British Columbia) and Norman Wells (Northwest Territories). Ultramar also closed one in Halifax, while Suncor closed its lube plant in Mississauga. Some 200,000 b/d of refining capacity was eliminated that decade.

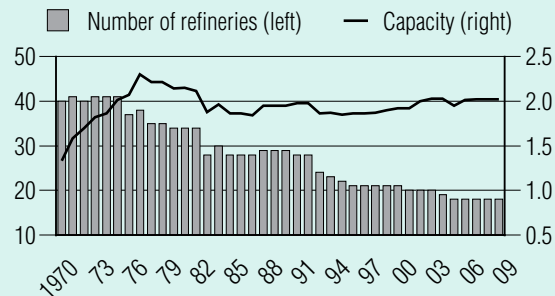
Subsequent demand growth for petroleum products has kept current Canadian refineries busy, and utilization rates have averaged above 90 per cent over the past decade.

And since 2000, only one refinery—Petro-Canada's Oakville facility, which produced 80,000 b/d—has closed. Meanwhile, expansions at the remaining refineries mean that refined products capacity is actually higher than it was in the mid-1970s (see Chart 4), despite the long list of closures over the past 30 years. More recently, following an unsuccessful search for a buyer, Shell closed its Montréal refinery in the fall of 2010 and began work on expanding its Montréal distribution terminal. That brought the number of refineries operating in Canada down to 19.

Chart 4

Refining Capacity

(number of refineries in Canada; refining capacity, mmbd)



Source: Canadian Petroleum Products Institute.

MARKETING

Crude is delivered to Canadian refineries by pipeline and tanker ships. A refinery's crude source hinges on transportation costs and the type of crude it requires. Refineries in Eastern Canada use a much higher share of imported crude because transportation of Western Canadian output is too expensive and the necessary pipeline infrastructure is lacking. Also, as Atlantic Canada relies heavily on imported crude, which can include light sweet crude, medium sulphur heavy crude, and, in some cases, sour light or sour heavy crude, the refineries in Eastern Canada are configured to allow for a more diverse crude slate.

Because Western Canada is landlocked, refineries there have historically used domestic production as their crude input. Ontario refiners have also been served by domestic

Table 3

List of Current Facilities

(capacity, b/d)

Company	City	Capacity
North Atlantic Refining	Come By Chance	115,000
Imperial Oil	Dartmouth	89,000
Irving Oil	Saint John	300,000
Suncor	Montréal	130,000
Ultramar	Levis	265,000
Imperial Oil	Nanticoke	120,000
Imperial Oil	Sarnia	120,000
Shell	Sarnia	75,000
Suncor	Sarnia	85,000
Suncor	Mississauga	15,600
Nova	Sarnia	78,000
Consumers' Co-op	Regina	100,000
Moose Jaw Refining	Moose Jaw	14,000
Husky	Lloydminster	29,000
Suncor	Edmonton	135,000
Imperial Oil	Edmonton	185,000
Shell	Scottford	100,000
Chevron	Burnaby	55,000
Husky	Prince George	12,000

Source: NRCan; CPPI; various company annual reports and websites.

production, via pipelines originating in Alberta and linked to Sarnia, which is the main refining hub serving Canada's most populous province. Nearly 75 per cent of crude input in these two regions is either conventional light sweet crude or synthetic crude. Synthetic crude is a high-quality crude input derived through upgrading bitumen. Refineries in Western Canada and Ontario are expected to see significant changes in their crude input going forward as they attempt to accommodate a growing share of oil sands production.

Distributing petroleum from Canada's relatively few refineries to its more numerous product terminals (generally near major markets) requires a complex system of pipelines, ships, railways, and trucks. Such multiple transportation methods combine with frequently long

transportation distances to challenge refiners' ability to maintain product specifications. Degradation or contamination of product in transit can necessitate costly reprocessing upon delivery as quality is closely regulated. Increasingly stringent environmental regulations exacerbate such concerns.

In an effort to counter these challenges, distributors have adopted various transportation solutions. For example, product exchanges occur when one refiner trades product in one location for similar product in another. This cuts transportation costs and environmental exposure, while increasing refiners' economies of scale. Thus, it is not uncommon for the base gasoline component at a branded outlet to be produced by a competitor. However, in such cases, gasoline can still be distinguished by the use of proprietary additives.

Pipelines are the safest, most reliable, and cost-effective way of transporting large petroleum volumes, but their enormous construction costs limit them to locations requiring high volumes for an extended period.

If product exchanges are unavailable, companies need alternative shipping arrangements. Resulting choices are dictated by geography, required product volume, and relative transportation costs. Most Canadian petroleum products are shipped from refineries to terminals in different Canadian cities. Bulk terminals allow marketers to purchase finished products at posted truck-loading rack prices. While some terminals are at refineries, most are storage facilities that receive petroleum products processed elsewhere. Not all refiners are wholesalers. Output at Irving and Chevron refineries, for example, is generally limited to supplying their branded facilities.

Pipelines are the safest, most reliable, and cost-effective way of transporting large petroleum volumes, but their enormous construction costs limit them to locations requiring high volumes for an extended period of time. Indeed, a pipeline's payback period often starts at 15–20 years. Design and approval periods can also be

very long; for example, although initiated in 2005, the Québec City Ultramar pipeline only recently received government approval. Where volumes cannot justify pipeline construction, petroleum products are transported to terminals by truck, rail, and ship. In Atlantic Canada, all terminals are serviced by marine tankers. Railways and trucks dominate elsewhere. Truck transportation is the most expensive, but also the most flexible. Trucks transport all gasoline from terminals or refinery loading facilities to retail outlets.

As of 2008, Canada had nearly 13,000 gasoline stations, down from an estimated peak of 20,360 stations in 1989.

Most product terminals are owned and operated by one of three national oil companies (Shell, Suncor Energy, and Imperial Oil) or a handful of regional refiners (Irving Oil, Ultramar, North Atlantic Refining, Federated Co-op, Husky, and Chevron). Remaining terminals are operated by independent importers, such as Norcan, Olco, Vopak, and IMTT. These operate in three distinct regions: Western Canada, Ontario, and Quebec–Atlantic Canada, each of which had historically been self-sufficient. But that changed in 2005 with the closing of the Oakville refinery, which required Ontario to import from Quebec refineries.

Retailing is the final stage of the petroleum products value chain. As of 2008, there were nearly 13,000 gasoline stations in Canada. That is down from an estimated peak of 20,360 stations in 1989, and represents a drop of 38 per cent over two decades. This rationalization coincided with the arrival of larger retailers, which offered diversified customer services, such as convenience stores on site and other ancillary business (e.g., restaurants, car washes, fast-food outlets). Thus, while many retail gasoline stations closed, the average throughput increased, resulting in efficiency gains on the distribution side of the industry. Today, there are still roughly 3.8 gasoline stations for every 10,000 Canadians.³

3 MJ Ervin & Associates, *National Retail Petroleum Site Census—2008*.

Gasoline stations can be broken into two broad categories: integrated refiner-marketers and non-refiner marketers. The first category represents those stations that fall under the price control of one of the major oil companies, while the latter includes stations that may market gasoline from one of the major oil companies in Canada but that set their own prices. For example, only 16 per cent of stations fall under the direct price control of the three major Canadian oil companies, but 37 per cent of stations carry their brand of gasoline. In total, 28 per cent of all gasoline stations are price controlled by 10 refining companies in Canada. Thus, the vast majority of the Canadian market is served by operators that are not involved in the refining process.

Employment in the retailing segment of the Canadian downstream sector declined substantially in the 1990s, as the labour force fell from 113,000 in 1991 to a trough of 74,000 in 1998. Since then, the industry has enjoyed steady job creation, pushing up its labour force to 82,000 by 2009. Workers in gasoline stations earn a relatively low wage of roughly \$436 per week, less than half the average earnings in the upstream and refining segments of the industry. But because employment at gasoline stations is greater than in the refining and oil-related portions of the upstream sector combined, the retailing portion of the petroleum production process still contributes meaningfully to value-added.⁴

4 The Conference Board separates oil-related employment from natural gas-related employment in the upstream sector in its semi-annual CIOS report on the oil extraction industry. The most recent estimate suggests oil-related employment in the upstream sector is 56,700.

CHAPTER 4

Supply and Demand

Chapter Summary

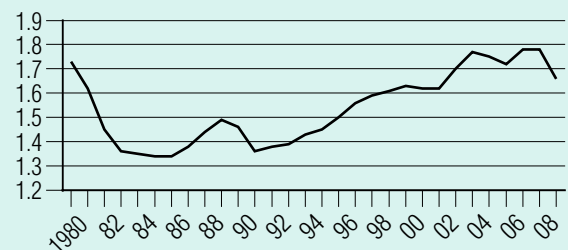
- ◆ Demand from motorists for gasoline has accounted for the lion's share of increased consumption of petroleum products in Canada over the past 20 years.
- ◆ Canada is a net exporter of refined products. Exports have risen from 128,000 barrels per day in 1980 to an average of 432,000 barrels per day in the last five years.

NATIONAL DEMAND PROFILE

Demand for petroleum products has evolved over time, in tandem with the performance of the Canadian economy. Weak economic growth and the oil shocks of the 1970s pushed demand for all refined products—not just gasoline—lower. Indeed, demand for refined products in Canada fell from 1.7 mmbd in 1980 to 1.55 mmbd in the mid-1980s. Although demand did experience a brief recovery, the Persian Gulf War drove oil prices up once again, putting renewed downward pressure on demand, which bottomed out in 1991 at 1.36 mmbd. Since then, demand has experienced a prolonged period of expansion (as did the Canadian economy over the same period), with annual growth averaging 1.2 per cent between 1992 and

2009. Moreover, if we exclude 2008 and 2009—when demand contracted sharply because of the recession—the rate of increase climbs to 1.7 per cent a year. Nevertheless, over the past five years, demand has remained at a level consistent with that seen in the early 1980s. (See Chart 5.)

Chart 5
Domestic Sales of Refined Products
(mmbd)

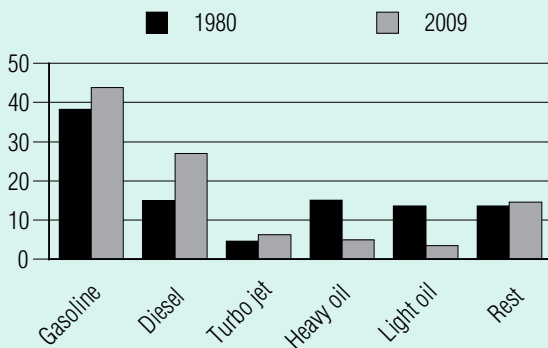


Source: Canadian Petroleum Products Institute.

The relative mix of products has changed over time. Gasoline demand represents roughly 44 per cent of all refined products consumed in Canada, up from 38 per cent in 1980. Diesel demand, which is driven primarily by on-road requirements, decreased briefly in the early 1990s, but has since been the fastest-growing component of demand for refined products, averaging 2.9 per cent growth between 1993 and 2009. Expanding requirements for diesel and gasoline have come at the expense of residual fuels, particularly heavy and light fuel oils.

(See Chart 6.) Their share of relative demand fell from 54 per cent in 1980 to 26 per cent in 2009. This sharp decline can be attributed to an increase in the availability of hydroelectric and nuclear power, which have partially replaced oil-fired electrical generation, as well as the increased use of relatively cheaper natural gas for space-heating use. Going forward, the industry also faces important demand challenges related to mandated integration of biofuels. Moreover, the advent of new technologies that would increase fuel efficiency in the transportation sector will play a role in future demand for the industry's products.

Chart 6
Demand Mix Is Changing
(share of total demand, per cent)



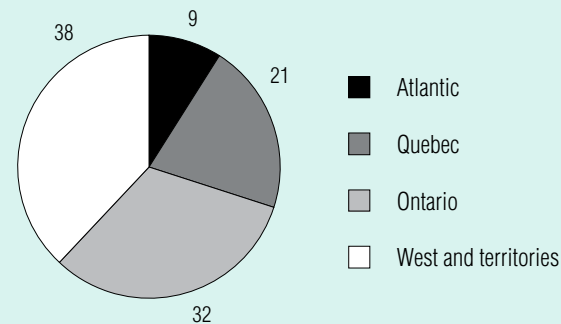
Sources: Statistics Canada; The Conference Board of Canada.

REGIONAL DEMAND PROFILE

Total domestic sales of refined products are split roughly equally across three regions if Quebec and the Atlantic provinces are combined as one region. Western Canada and Ontario account for a little more than two-thirds of total product demand, while Quebec and Atlantic Canada account for the rest. (See Chart 7.) However, each of these regions has slightly different patterns of consumption based on the relative importance of the transportation industry in their respective economies and their preferred method of electrical generation.

In Atlantic Canada, distillate demand (primarily diesel and light fuel oil) account for 40 per cent of total sales. This is almost entirely due to a higher rate of consumption of furnace oil, which continues to satisfy a big share of

Chart 7
Regional Demand
(share by region, per cent)



Sources: Statistics Canada; The Conference Board of Canada.

space-heating requirements in the region. Indeed, light fuel oils account for 15 per cent of total sales in Atlantic Canada, whereas they account for just 3 per cent of total consumption in Canada as a whole. Atlantic Canada also consumes a fair amount of heavy fuel oil, which is largely used for electricity generation but also includes marine bunker. Petroleum-fired capacity represents a greater share of total electrical capacity in Atlantic Canada than it does in Central or Western Canada. Still consumption of these heavier oils is on the decline. Heavy fuel oil accounted for 37 per cent of Atlantic Canadian demand in 1980, but accounts for only 10 per cent today.

Historically, light fuel oil accounted for a significant portion of total sales in Quebec. Over time, however, electricity has replaced furnace oil as the primary source of space heating in Quebec. As such, the share of light fuel oil has fallen from nearly 20 per cent of refined products to just 5 per cent over the past 30 years. The majority of refined products consumed today in the province are transportation-related fuels; motor gasoline, diesel, and turbo jet fuel account for two-thirds of consumption in Quebec.

Similarly, at 53 per cent, motor gasoline alone accounts for the majority of consumption in Canada's most populous province—Ontario. Indeed, gasoline demand outpaces demand for distillate fuels by more than two to one. And because of the large chemical manufacturing industry in Ontario, demand for petrochemical feedstock

is much higher there than in any other region of Canada. Provincial demand is composed almost entirely of three products—motor gasoline, diesel, and petrochemical feedstock. Together, they account for 87 per cent of total sales.

Because of the large chemical manufacturing industry in Ontario, demand for petrochemical feedstock is much higher there than in any other region of Canada.

Product demand has been most consistent in Western Canada. Diesel and motor gasoline account for 74 per cent of sales in the four Western provinces, a share that has stayed roughly constant over time. Petrochemical feedstock is the only other refined product that accounts for a meaningful portion of consumption in Western Canada.

SUPPLY

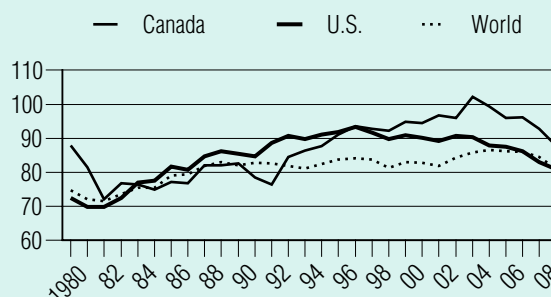
Canadian refiners have been able to boost capacity over time, despite the intense rationalization that has taken place over the past three decades. The industry is estimated to have increased capacity by more than 40 per cent since the early 1970s when 40 refineries were in operation; this has increased operating efficiency and achieved reduced costs per unit production.

The industry has also boosted capacity utilization rates. The national capacity utilization rate has averaged 95.6 per cent over the past decade, up from an average rate of 78 per cent in the 1980s and 86.5 per cent in the 1990s.¹ A utilization rate of about 95 per cent is considered optimal, as it allows for normal shutdowns and required maintenance.² As a comparison, the United States' average capacity utilization was 87.6 per cent over the past decade, and global utilization rates have averaged just 84.2 per cent. (See Chart 8.)

1 British Petroleum, *BP Statistical Review of World Energy*.

2 Natural Resources Canada, "Energy Sources."

Chart 8
Refinery Utilization Rate
(per cent)

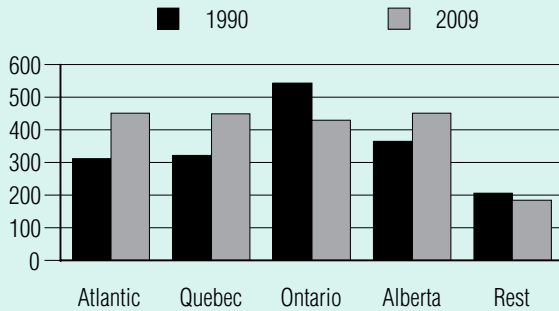


Source: BP Statistical Review of World Energy—June 2010.

The industry has also invested heavily over time. Between 1980 and 2009, the refining industry spent nearly \$40 billion (2002 dollars) to expand and improve operations. This reinvestment, along with improved capacity utilization rates, pushed production of Canadian refined products from 1.6 mmbd in the early 1980s to an average of 2 mmbd over the past decade. In addition, Canadian refiners have invested heavily to comply with increasingly stringent environmental and safety standards.

In terms of regional output, Atlantic Canada has posted the largest increase. (See Chart 9.) In 2009, the four provinces combined to produce nearly 450,000 b/d—up from 360,000 b/d in 2000, and more than triple their combined output in the early 1980s. Alberta has also seen a dramatic rise in production, allowing Edmonton to emerge as a major refining hub in Canada. Total refined products production in Alberta was also 450,000 b/d in 2009, up 80 per cent from 25 years ago but roughly the same as in 2000. Saskatchewan has also increased production, but to a lesser extent and today accounts for only 5 per cent of total production. British Columbia has seen the largest absolute drop in production. Four smaller refineries in the province have closed over the past 30 years, and the province now accounts for only 3 per cent of Canadian production.

Chart 9
Regional Production
(b/d, 000s)



Sources: Statistics Canada; The Conference Board of Canada.

Having dropped 24 per cent since 2000, Ontario is the only other province that has seen a significant drop in refinery throughput. Nevertheless, the bulk of refining capacity in Canada remains in central Canada. Quebec and Ontario combined to produce 880,000 b/d in 2009, representing 40 per cent of total refined products production.

FUELS REFORMULATION AND BIOFUELS

Compounding the supply challenges are the advent over the last decade of important regulatory requirements in terms of fuel reformulation, including biofuels.

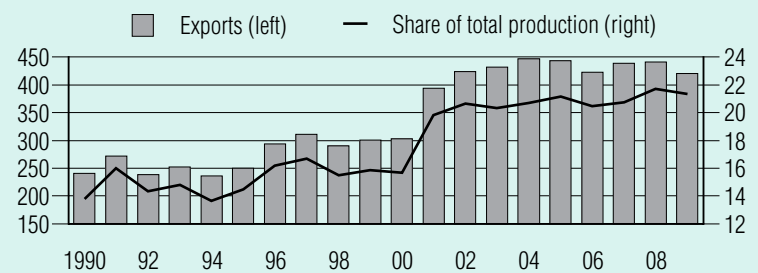
For example, current Canadian transportation fuel formulations are now virtually sulphur free. This was achieved through careful regulatory design in consultation with the refinery industry over the 2002–07 period and through investments of \$5.4 billion in technology by Canadian refiners. The result is significant reductions in tailpipe emissions.³ Refineries will also be facing similar challenges with respect to their stack emissions, as governments are preparing to upgrade current air emissions regulations.

Regulated at the federal level and by several provincial governments as well, the industry has seen the mandated domestic requirements for biofuels volumes increase to 1.4 billion litres a year, a 300 per cent increase, between 2004 and 2008.⁴ This has required sizable investments that have seen the industry either blend imported biofuels or operate their own biofuels manufacturing facilities. Although minor in terms of total Canadian market share (1.5 per cent), the relative importance of biofuels is expected to grow over the coming years, and the industry will face the challenge of introducing these new component streams into the product mix while maintaining performance standards.

EXPORT INTENSITY ON THE RISE

Historically, Canada has been a net exporter of refined products. Because capacity has increased more quickly than domestic sales over the past 30 years, Canadian refiners have been able to export the majority of their incremental production. The volume of exports has shown a gradual rise over that period—from 125,000 b/d in 1980, to 240,000 b/d in 1990, and 300,000 b/d by 2000. Exports have averaged almost 430,000 b/d over the past decade. (See Chart 10.)

Chart 10
Export Intensity on the Rise
(exports, 000s b/d; share of production, per cent)



Sources: Statistics Canada; The Conference Board of Canada.

3 CPPI estimate.

4 Statistics Canada, Natural Resources Canada.

Because domestic demand has remained relatively constant over time while production has increased, export intensity is on the rise. Today, the industry exports 21 per cent of total production, more than double the average export rate in the 1980s. The average percentage of production exported for all manufacturing industries in Canada is 48 per cent.

The industry has been able to put excess capacity to use by increasing exports. However, as is the case with most exporting industries in Canada, petroleum exporters depend heavily on the United States as a market. Over the past five years, 93 per cent of all exported refined products have gone to our southern neighbours, the world's largest consumer of refined products. The remaining 7 per cent of exports are distributed across many countries, including the Netherlands, Spain, Bahamas, and the United Kingdom.

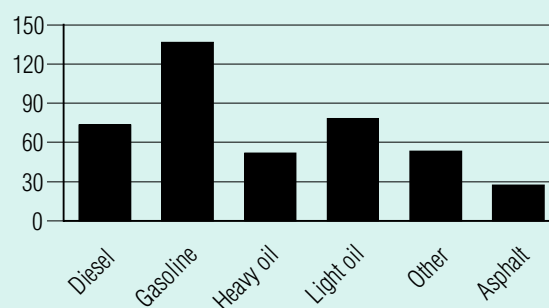
Motor gasoline has historically accounted for the largest share of imports, accounting for one-third of the total in recent years.

The range of products exported is generally consistent with the overall production mix in Canada. (See Chart 11.) Four products make up more than 80 per cent of all refined product exports. Not surprisingly given its prominence in the production mix, motor gasoline has historically accounted for the largest share of exports, accounting for one-third of the total in recent years. Diesel fuel accounts for another 17 per cent, as on-road diesel requirements in the U.S. dwarf those in Canada. Light and heavy fuel oils represent a combined 31 per cent and make up the bulk of the remaining export mix. The mix of products exported has remained largely constant over time.

IMPORTANCE OF TRADE VARIES BY REGION

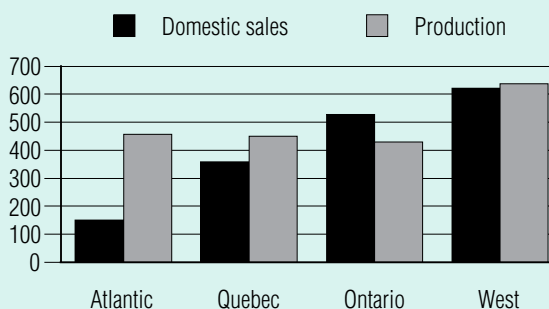
Chart 12 details regional production relative to domestic sales, broken down by the main producing regions in Canada. As it shows, three of the four regions in Canada are self-sufficient when it comes to satisfying demand for refined products. The chart also indicates the relative export capacity of each region.

Chart 11
Transport Fuels Prominent in Export Mix
(000s b/d)



Sources: Statistics Canada; The Conference Board of Canada.

Chart 12
Export Capacity
(000s b/d)



Sources: Statistics Canada; The Conference Board of Canada.

Ontario is the only main refining region in Canada that is not self-sufficient when it comes to satisfying regional demand for refined products. Historically, production exceeded sales in Ontario; but since the closure of the Oakville refinery in 2005, the province has fallen into a slight deficit. Imports into Canada's largest-consuming province (the bulk of which come from Quebec) have increased more quickly than supply has declined, however, and Ontario still accounted for 8 per cent of total exports in 2009. Ontario's importance in terms of exports has been falling steadily for the past 30 years. In the 1980s, the province was responsible for more than 40 per cent of the industry's exports.

At the same time, Quebec has seen a dramatic rise in export capacity. Provincial exports have averaged nearly 50,000 b/d over the past five years; roughly double the average rate a decade earlier. Domestic demand has grown at a relatively slow pace over the past 20 years, leaving roughly 10 per cent of provincial production available for export. Despite the gains in absolute trade, the province's position relative to other exporting regions in Canada has remained roughly constant over time, last year accounting for 11 per cent of the industry's exports. Those export dynamics, however, are likely to undergo change in the near future due to the closure of Shell's Montréal East refinery. The closure means that nearly 25 per cent of the province's historical production of gasoline and distillates has been shut down, resulting in a shift in trading patterns.

Eastern provinces have accounted for more than 90 per cent of Canadian gasoline exports in each of the last five years.

Despite representing more than 20 per cent of Canadian production, Alberta accounts for a much smaller share of the industry's exports, as its refineries supply product to the three other Western provinces. In relative terms, Alberta accounts for slightly less than 4 per cent of refined product exports.

Atlantic Canada is the country's largest exporter. Although similar to other regions in terms of production levels, nearly two-thirds of production in Atlantic Canada is destined for exports, a share that has risen substantially over time as refinery capacity on the East Coast has tripled in the past 30 years. Exports are predominantly motor gasoline. In fact, Atlantic Canada actually exports more than twice as much gasoline as it consumes. Indeed, Eastern provinces have accounted for more than 90 per cent of Canadian gasoline exports in each of the last five years.

IMPORTS PLAY VALUABLE ROLE

As the importance of exports to the Canadian economy has increased over time, so has the importance of imports. In 1980, Canada imported just 48,000 b/d of refined petroleum products. However, that number has increased dramatically since then, with imports averaging 276,000 b/d over the last five years. The U.S. accounts for 40 to 60 per cent of imports in any given year, but Canada also receives sizable volumes of refined products from the United Kingdom, Russia, Belgium, Peru, and Finland.

The net export position of the refining industry varies by product. For example, motor gasoline and diesel account for about 50 per cent of all imports of refined products; and yet these very same products also make up the bulk of the refining industry's exports. This suggests that the industry imports in regions of the country where importing costs less than does shipping refined products from elsewhere in Canada. Such movements are efficient and ultimately keep costs down for the end-users. Even though transport-related fuels account for the majority of imports, Canada maintains a net-export position of approximately 86,000 b/d in these two fuels alone.

Because oil-fired electrical generation capacity has decreased over time, imports of heavy fuel oil have fallen dramatically—dropping to just 14,000 b/d in 2009 from a peak of 62,000 b/d in 1998. And because, outside of the Atlantic provinces, Canada has relatively little domestic need for furnace oil, we import almost no light fuel oil. Thus, Canada has a very strong net export position in fuel oils.

Canada is a net importer of turbo-jet fuel and other refined products.⁵ Per barrel of crude refined, these fuels tend to account for a small share of production as refineries are configured in such a way that each

5 Statistics Canada defines "other petroleum products" as "wax and candles, and unfinished products. Unfinished products being the volume in process in a refinery at any particular point in time that cannot be identified in end-product terms. Also, imports or purchases of blending agents in inventory where the end product may be in doubt."

barrel of oil results in roughly the same amount of each refined product. Thus, Canadian companies likely find it more cost-effective to import the small quantities required to satisfy domestic demand, rather than to over-produce products that are more commonly used, such as gasoline and diesel.

Refinery configuration around the world may ultimately play a part in determining the fate of the Canadian refining industry. The majority of incremental refining capacity is being added where demand growth is expected to be strongest going forward—Asia. On-road requirements in Asia will require more diesel fuel than motor gasoline, as vehicle fleets in Asia are more “diesel-centric” and will remain so in the future. The North American vehicle fleet, on the other hand, will remain heavily dependent on motor gasoline.

Diesel and gasoline account for a significant share of the output per barrel of crude refined, and opportunities to tweak the refining process more heavily toward one product or the other are limited. Therefore, because global refining capacity will rise over the next 30 years, markets will see an attendant rise in the amount of motor gasoline available, potentially increasing imports from foreign markets. The rise in global refining capacity could lead to a more integrated market for petroleum products going forward, creating future risk of import competition to Canadian refiners.

CHAPTER 5

Economic Contribution of Canada's Refining Industry

Chapter Summary

- ♦ The relative importance of the refining industry to the Canadian economy has fallen over time.
- ♦ Among the main producing regions in Canada, the refining industry is most important to the Atlantic provinces.
- ♦ Since 1980, the industry has cumulatively invested nearly \$40 billion (in 2002 dollars) in its operations, including a significant amount directed toward meeting increasingly stringent environmental regulations.
- ♦ Capital intensity in the refining industry was \$241/hr worked, compared with \$31/hr in the manufacturing sector in general.
- ♦ Over the past 10 years, estimates suggest that the pre-tax rate of return in the refining industry averaged 11 per cent.
- ♦ Refinery workers earn high wages.

Output has expanded steadily in line with rising production over time. Excluding the recession years of the early 1990s, the industry has averaged annual output growth of 2.8 per cent between 1993 and 2003, but growth has since declined in five of the last six years.

The recent weakness in the refining industry coincides with a prolonged upswing in oil prices, which resulted in higher fuel costs. The combination of higher fuel prices and the global recession did weaken global demand for oil. However, domestic consumption of refined products remained fairly steady throughout this period, as the higher prices for oil, which is priced in U.S. dollars, were partly offset by the rise of the Canadian dollar. But U.S. demand was hit by the double whammy of higher gasoline prices and a weaker greenback, and consumption of gasoline fell by an average of 0.9 per cent per year from 2004 to 2009. Accordingly, Canadian exports of refined products dropped over the 2004–09 period, while imports rose substantially.

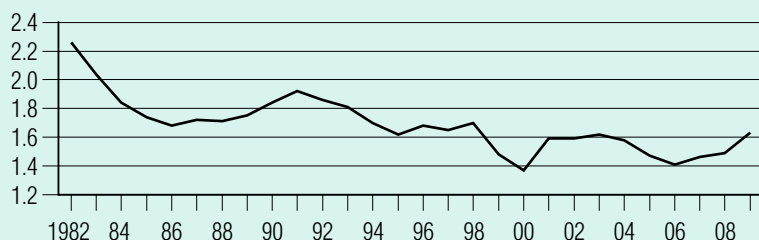
Output in the refining industry accounted for 2.3 per cent of Canada's manufacturing industry in 1982, a share that has decreased steadily over time. (See Chart 13.) Even though the industry's output has increased in absolute terms, it has not kept pace with the expansion of the manufacturing industry, nor of the Canadian economy as a whole. Its relative share of output jumped in each of the last three years, as output declined more slowly than it did in the larger manufacturing industry, which contracted significantly as a result of the downturn in the U.S. economy. Because no significant capacity additions

REFINING OUTPUT PEAKED IN 2003

Real GDP in the refining industry was \$2.5 billion in 2009—up from an average of approximately \$2 billion in the 1980s, but down from a peak of \$2.9 billion in 2003.

are likely for the industry in the near term, the refining industry is likely to continue to see its relative importance in the Canadian economy wane going forward.

Chart 13
Refining Output as a Share of Canada's Manufacturing
(per cent)



Sources: Statistics Canada; The Conference Board of Canada.

REGIONAL OUTPUT

Estimates of regional output in the refining industry are unavailable due to confidentiality laws at Statistics Canada. Nevertheless, output estimates can be created by studying the different production profiles across Canada. To do so implicitly requires the assumption that price effects across regions have been similar over time in this industry—a non-stringent assumption since prices for major refined products, such as motor gasoline and diesel, tend to move together over time (discounting brief regional fluctuations in any given year). Creating these estimates allows us to examine the relative importance of the refining industry across Canada. Moreover, because of the uniform nature of output in the industry, it is expected that production would be in tandem with real GDP.

Table 4 shows that Ontario has historically accounted for the largest share of refining activity in Canada. However, existing refineries in Ontario have not expanded sufficiently to offset refinery closures over the past three decades, and therefore the province has seen its importance on the national stage decline—from 34 per cent of national output in the early 1980s, to just 23 per cent in recent years.

Atlantic Canada has experienced the largest increase over time. While nameplate capacity has remained largely consistent since the 1970s, Atlantic Canada was successful at significantly increasing exports over the 10 years spanning 1986 to 1995, boosting output and increasing its share of national production. Atlantic Canadian refineries today account for the majority of the country's exports of refined products.

The large increases in domestic crude oil production have also helped Alberta expand refinery production, and its relative importance on the national stage. Moreover, refinery closures in neighbouring provinces have allowed Alberta to expand capacity to satisfy domestic demand in the Western provinces. This is evidenced by the fact that other Western provinces have seen their share of national output fall from 13 per cent to 8.5 per cent in the past 25 years. Quebec has seen little change in its output share over time, as the wave of plant closures in the early 1980s was offset by major capacity increases at Ultramar's operations in the 2000s. But going forward, the province is likely to see its share of national production decline.

REFINING INDUSTRY MOST IMPORTANT TO ATLANTIC PROVINCES

Regional refining industries hold relatively different levels of importance across Canada. Moreover, in all regions except Atlantic Canada, the industry's importance has dwindled over time. This phenomenon has been most pronounced in the Western provinces, excluding Alberta. For example, the refining industry today accounts for just 0.1 per cent of real GDP in British Columbia and Saskatchewan, about one-third the level in 1982.

The refining industry's share of real GDP in Central Canada has also fallen. Today, refining activity accounts for 0.2 per cent of real GDP in Quebec, and just 0.1 per cent of real GDP in Ontario. Thirty years ago, the industry was twice as important to those provinces. Alberta's refining industry has also seen a decrease in relative importance, as growth in the upstream sector (and, as

Table 4

Importance of Atlantic Canada's Refining Industry Increases Significantly
(percentage of national refining output, by region)

	1982–85	1986–90	1991–95	1996–00	2001–05	2006–09
Atlantic Canada	9.7	15.9	18.7	19.3	22.5	23.0
Quebec	23.5	18.0	19.2	20.2	20.7	22.3
Ontario	34.1	32.5	30.1	29.0	26.6	23.0
Alberta	19.5	21.3	21.1	24.2	23.2	23.3
Other Western provinces	13.3	12.2	10.8	7.3	7.1	8.5

Sources: Statistics Canada; The Conference Board of Canada.

a result, the economy as a whole) has far outpaced that of the refining industry. The refining industry in Alberta peaked as a share of provincial GDP in 1984 at 0.5 per cent, but had fallen to 0.3 per cent by 2009.

The story is different in Atlantic Canada. As a share of regional GDP (excluding Prince Edward Island, which has no refining capacity), the refining industry makes up 1 per cent of the economy, more than double what it did in the early 1980s. Moreover, a closer look reveals that the refining industry accounts for more than 10 per cent of manufacturing output in the Atlantic provinces, a rate that far exceeds the industry's importance on the national stage and is more than double the 4 per cent the industry covers in Alberta. As New Brunswick's provincial economy accounts for roughly one-third of real GDP in the Atlantic provinces, and New Brunswick is home to Canada's single largest refinery, the industry's importance to that province is likely much greater still.

REFINING INDUSTRY IS VERY CAPITAL INTENSIVE

Firms use two primary inputs to produce goods and services—capital and labour. Capital, also referred to as physical capital, is the stock of fixed assets used to produce other goods. Examples of capital are trucks, tools, machinery, equipment, buildings, and factories. Labour refers to the work done by humans. In this study, we use hours worked to measure labour.

Definition of Key Terms

Hours worked is the total number of hours worked by all employed people in the business sector.

Labour input is obtained by aggregating the total number of hours worked by all workers, classified by education, work experience, and class of workers (e.g., paid workers versus self-employed) using wages as weights.

Labour composition is the ratio of labour input to hours worked. Changes in labour composition reflect, in part, the shifts in the educational attainment and work experience of the workforce.

The **capital stock** is the stock of fixed reproducible business assets (equipment and structures) and government assets (roads and bridges).

Capital input measures the services derived from the capital stock.

The **capital-labour ratio** is the capital stock divided by hours worked.

An **intermediate input** is an input to production that has itself been produced and that is used up in production.

Multifactor productivity accounts for increases in output not caused by increases in capital input and labour input. A gain in MFP results from technological progress, organizational change, and exploiting scale economies.

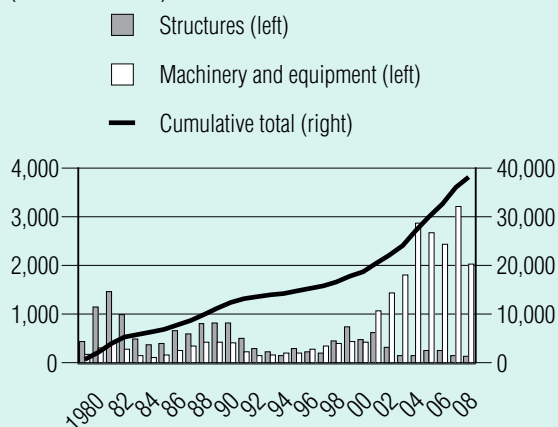
Dividing capital by labour yields the capital-labour ratio. This ratio, which is also referred to as capital intensity, measures how much capital is used per unit of labour. In general, labour will be more productive the greater amount of physical capital it has at its disposal.

Therefore, industries with high capital-labour ratios—referred to as capital-intensive industries—enjoy high levels of productivity.

Strong investment over the past 30 years has made the refining sector one of the most capital-intensive industries in the Canadian business sector. Since 1980, the industry has cumulatively invested nearly \$40 billion (2002 dollars) in its operations, including a significant amount directed toward meeting increasingly stringent environmental regulations. (See Chart 14.) Investment over that period has trended increasingly toward machinery and equipment, rather than new structures. It is because of heavy investment in machinery and equipment that the industry has been able to increase efficiency, and therefore increase total refinery throughput while experiencing an overall contraction in the number of refineries in operation. In 2006, the amount of physical capital per hour worked in the sector was \$241.¹ In contrast, capital intensity in the manufacturing and business sectors was \$31 and \$38, respectively.²

Chart 14

Investment
(2002 \$ millions)



Sources: Statistics Canada; The Conference Board of Canada.

It comes as no surprise then that the refining industry can boast a high level of productivity. Output per hour worked in the sector was \$68 in 2006.³ In comparison, output per hour worked in the broader manufacturing sector was \$50, while it was \$42 for the business sector as a whole.

LABOUR PRODUCTIVITY GROWTH HAS BEEN STRONG, BUT RECENT TRENDS ARE WORRISOME

Labour productivity growth has been generally strong in the refining sector. From 1962 to 2006, labour productivity (based on real value-added) increased at an average annual rate of 3.4 per cent. This was stronger than labour productivity growth in manufacturing as a whole (2.9 per cent) and in the overall business sector (2.1 per cent).

However, Canada's productivity performance in recent years has been poor. In fact, after averaging 2.8 per cent per year from 1962 to 1984, average annual labour productivity growth in the business sector slowed to an average of 1.2 per cent from 1985 to 2009. This is almost a full percentage point per year below the performance recorded in the United States over the same period.

A similar pattern is observed in the refining industry. From 1962 to 1984, labour productivity growth in the sector averaged 4.2 per cent per year. But growth then slowed, averaging just 2 per cent per year from 1985 to 2006. Even more worrisome, labour productivity actually fell by an annual average rate of 4.2 per cent between 2000 and 2006. A more detailed examination of why labour productivity has declined over time can be found in Appendix B.

WORKFORCE PROFILE

The refining industry has experienced only minor fluctuations in its labour force in recent years. National-level data for the industry are available beginning in 1987, when

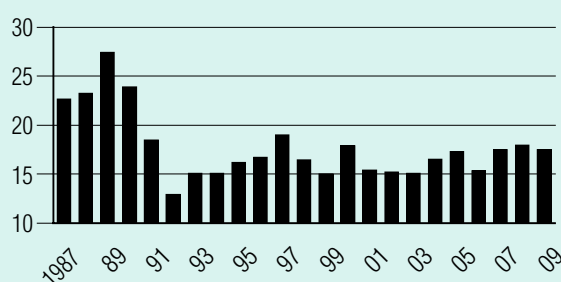
1 Data based on Statistics Canada productivity tables (table number 383-0022).

2 Geometric (infinite) end-year net capital stock.

3 Chained (2002) dollars.

the workforce was more than 22,000. However, because this marked a period of great rationalization for the industry during which underutilized refineries began to shut their doors in favour of larger, more efficient refineries, the labour force experienced a period of significant contraction in the early 1990s. (See Chart 15.) The labour force peaked at 27,400 workers in 1989. By 1992, that number had dropped more than half to 12,500. The early 1990s marked a period of weak demand for the Canadian economy, which was mired in recession. However, discounting minor fluctuations, the labour force has since rebounded, standing at approximately 17,500 workers in 2009.

Chart 15
Refinery Employment Peaked in 1989
(000s)



Sources: Statistics Canada; The Conference Board of Canada.

On a regional basis, the industry's employment has been tracked only since 1991; thus, we don't see the large contraction shown at the national level. As such, employment levels across the country exhibit minimal variation over the 1991–2009 period. Quebec and Alberta are two exceptions. Since 1991, employment has increased by 600 in Quebec and by 700 in Alberta. (See Table 5.)

Conversely, Ontario has suffered an overall decrease in employment, shedding approximately 1,000 jobs as the refining industry there has seen a drop in overall national prominence.

Because the industry's production has increased over time while exhibiting minimal labour force growth, the industry has seen positive shifts in throughput per worker. On a national basis, workers in the industry have seen their average throughput increase from 40,500 barrels

of refined products per year in the early 1990s to an average of 44,000 barrels over the last five years, representing efficiency gains of roughly 8 per cent over that period. (See Table 6.)

Table 5
Regional Employment
(average employment, 000s)

	1991–95	1996–00	2001–05	2006–09
Atlantic provinces	2.5	3.0	2.7	2.5
Quebec	3.4	3.7	3.4	4.0
Ontario	5.6	5.8	5.6	5.7
Alberta	2.8	3.0	3.0	3.5
Other Western provinces	1.3	1.5	1.2	1.4

Sources: Statistics Canada; The Conference Board of Canada.

Table 6
Regional Productivity
(average annual throughput per worker, barrels)

	1991–95	1996–00	2001–05	2006–09
Atlantic provinces	47,146	45,214	63,216	70,508
Quebec	36,041	37,437	47,102	42,169
Ontario	34,493	34,694	36,299	30,208
Alberta	48,153	56,112	59,208	50,506
Other Western provinces	51,833	33,442	43,459	46,435
Canada	40,489	40,432	47,939	43,931

Sources: Statistics Canada; The Conference Board of Canada.

Regionally, Ontario has performed poorly on this metric. Despite keeping its labour force relatively constant over time, production has fallen. This has resulted in a 12 per cent decrease in the amount of throughput per worker, from 34,500 barrels per year to just 30,000.

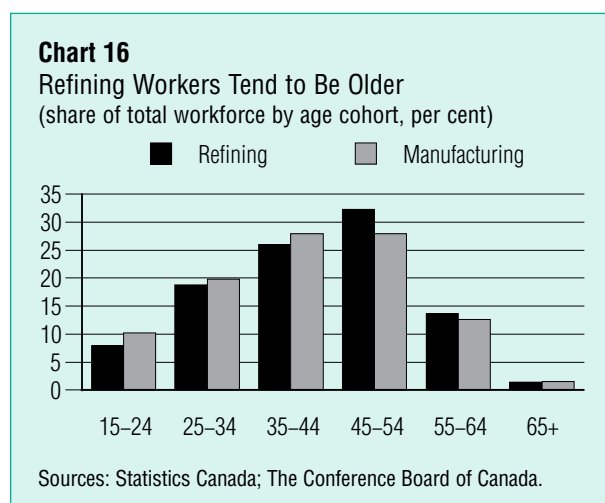
Additionally, Ontario's refining industry exhibits the lowest labour productivity among all regions of the country. On the other hand, the remaining three main refining regions in Canada have realized dramatic improvements in their output per worker. In terms of absolute productivity, Atlantic Canada outpaces the national average by a wide margin. In 2009, each refinery worker in Atlantic Canada produced 91,000 barrels of refined products,

more than double the national average, and 120 per cent more efficient than they were in 1991. This year—2009—was an unusual one in that the Atlantic provinces shed nearly 1,000 jobs while still managing higher production. But output per worker has averaged more than 70,000 barrels per worker since 2006.

Productivity in Alberta remained constant between 1991 and 2009; however, the refining industry in Canada's main oil-producing province has decreased noticeably since the early 1990s. Provincial employment numbers jumped during the most recent oil boom as labour markets became incredibly tight and companies scrambled to acquire valued labour, pulling down output per worker in all provincial industries over that period. Quebec has also increased productivity—from 30,000 barrels per year per worker in 1991 to 36,000 in 2009. But throughput per worker peaked at 50,000 barrels per worker in 2003, which means the more recent trend in Quebec is downward. This is due entirely to the fact that the industry's labour force in Quebec has swelled in the past five years, rising to 4,500 in 2009.

LABOUR FORCE CHARACTERISTICS

Census data show that demographic and educational composition of the industry in 2006 was skewed toward older and better-educated, Canadian-born males. Census evidence suggests that the industry could be missing an opportunity to increase recruitment among newcomers to Canada and among women. (See Chart 16.)



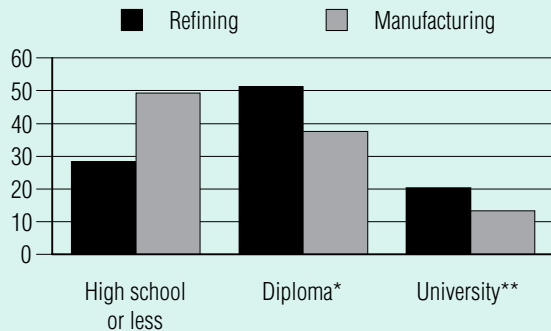
Women are rare in this industry, making up only one-fifth of its labour force. The industry's scarcity of women is acute even by the standards of the broader manufacturing industry, which is 71 per cent male. However, this is most likely due to the occupational mix in the industry. The predominant occupations in the industry have historically attracted more men than women.

The relatively advanced age of the workforce suggests experience is abundant, but also hints at a looming demographic challenge as retirements accelerate. While this situation is hardly unique to the refining industry, resulting skill shortages could emerge earlier here. Workers over 45 make up 47 per cent of the industry's labour force, compared with 42 per cent manufacturing-wide. Moreover, the largest cluster of the industry's workers is the 45–54 group. Calculations based on the current retirement age suggest that up to a quarter of those workers will retire within the next decade.

Education is also important for the industry. Well over two-thirds (73 per cent) of workers in this industry have a post-secondary qualification, including 20 per cent who hold at least a bachelor's degree. By contrast, only half (51 per cent) of workers in the broader manufacturing sector have post-secondary education and only 13 per cent have at least a bachelor's degree. The prevalence of skilled trades is illustrated by the large share—51 per cent—of the labour force that is made up of workers with a “diploma below bachelor level, including apprenticeship and trades.” Laboratory technicians and similar occupations would hold similar credentials. The broader manufacturing sector also contains a large collection of diploma-level employees, but they make up a smaller (37.5 per cent) proportion of its workforce. (See Chart 17.)

Only 14 per cent of the industry's labour force consisted of immigrants (defined as persons who are, or have been, landed immigrants in Canada) in 2006, compared with 28 per cent in the broader manufacturing sector. (See Chart 18.) The industry, which clearly values education, could thus be neglecting a source of future employment. Immigrants are relatively well-schooled. Census data show that fully one-quarter of new arrivals have university degrees, compared with only 16 per cent of non-immigrants.

Chart 17
Refining Workers Tend to Be Better Educated
(per cent)

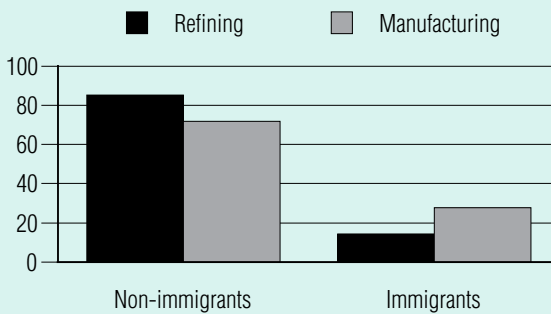


*includes apprenticeship and trades

**bachelor's and post-graduate degrees

Sources: Statistics Canada; The Conference Board of Canada.

Chart 18
Immigrants Make Up Small Share of Labour Force
(per cent)



Sources: Statistics Canada; The Conference Board of Canada.

The data also show that at least some newcomers could have industry-relevant skills. One-quarter of immigrants possessing post-secondary qualifications listed their major field of study as “architecture, engineering, and related technologies,” compared with 22 per cent of non-immigrants. A further 5 per cent of immigrants said they had studied “physical and life sciences and technologies,” compared with 3 per cent of non-immigrants.

When grouped by National Occupational Classification (NOC), data show that a fifth of the industry’s workers list “natural and applied sciences” as their primary occupation, compared with only one in twelve workers in the broader manufacturing sector. This is consistent with the refining industry’s emphasis on science and

technology. In both the refining industry and across manufacturing, the largest occupational category is “trades, transport, equipment operators.” Approximately 24 per cent of the industry’s labour force is employed in these occupations, which is slightly higher than the 22 per cent for the manufacturing industry as a whole—further emphasizing the importance of skilled trades in the refining industry.

PROFITS

Corporate profits are also a critical part of the value-added that the refining industry provides to the Canadian economy. Higher corporate profits increase the incentive to invest in new equipment, which is vital to the future performance of the economy. Combined profits in the upstream, refining, and marketing segments of the petroleum industry totalled \$6.6 billion in 2009, but that figure is down sharply due to the effects of the recession—profits averaged \$18.7 billion per year in the five years leading up to the recession.⁴ In 2008, record-high crude oil prices helped push petroleum sector profits to \$29 billion—accounting for 13 per cent of all corporate profits in Canada that year. In recent history, the bulk of profits have accrued to upstream activities, but the refining industry also accounts for a significant share. Profits in the refining industry averaged \$7.6 billion per year, which accounts for about 40 per cent of total profits from well to the end-user.

Refining requires significantly higher capital investment than many other industries.

In general, the more capital-intensive an industry is, the higher its pre-tax profit rate of return will be, a fact that is true in both the upstream and the refining portions of the greater petroleum industry. Refining requires significantly higher capital investment than many other industries, and construction of a new refinery will often span several years before investors begin seeing revenues. Moreover, because costs are elevated and front-end

4 Statistics Canada, CANSIM table 187-0001.

loaded, the payback period for a refinery can be lengthy, adding to the financial uncertainty of a project. Over the past 10 years, estimates suggest that pre-tax returns in the refining industry have averaged 11 per cent. Returns in the industry do exhibit moderate fluctuations over time, peaking at 12.8 per cent in 2004, and bottoming out at 6.7 per cent in 2009. Given that 2009's lower rate of return was likely a result of the recession rather than falling productivity, the refining industry's rate of return is expected to converge to historical norms as the recovery stabilizes in North America. The upstream segment of the industry earns a slightly higher rate of return than refiners. We estimate that return rates for oil-extraction-related activities averaged 12.3 per cent over the same period. However, the rate of return exhibited large fluctuations in the upstream sector, depending on the price of crude. Upstream, capital investment decisions are based on assumptions about the future path of crude prices. Swings in the price of crude lend considerable volatility and risk to upstream capital investment projects. When oil prices reached record levels in 2008, the upstream return jumped to 17 per cent. But last year, when crude prices were driven sharply lower because of weak global demand, the rate dropped to just 2.3 per cent.

At the retail level, the industry earns a much lower rate of return than the upstream segment. Gasoline stations are not capital intensive, suggesting that the required rate of return on any given project is much lower. Furthermore, they do not face the risks to revenue and profits associated with volatile crude oil prices. Price changes in their input costs are directly passed on to the end-consumer. In some instances, regulatory bodies dictate pump prices. As such,

gasoline stations rely more heavily on the volume of output to generate profits than they do on prices. Between 2000 and 2009, gasoline stations earned a 1.2 per cent pre-tax rate of return, which is in line with the broader retail sector in Canada rather than with the oil-refining and extraction segments of the industry.

Corporate profits have a positive effect on the footprint the refining industry leaves throughout the Canadian economy. Profitable industries tend to re-inject profits back into the economy through new investment and job creation. Moreover, as previously mentioned, the refining sector is comprised in part by some of Canada's largest companies—Imperial Oil, Suncor, Husky Energy, and Shell—which make up a meaningful share of available equity in Canadian stock markets. Thus, many Canadians are already invested in the refining sector, through private investment or through pension funds, and will continue to hold a stake in its future.

REFINING INDUSTRY ENJOYS HIGH WAGES

The refining industry pays above-average wages and salaries. In 2009, average weekly earnings in the sector, including overtime, were \$1,371. That compares with \$824 for all industries. (See Table 7.)

The wage premium has increased, thanks to above-average wage growth. In 1991, a worker in the industry earned about 50 per cent more than the Canadian average. Now a worker in this industry earns two-thirds more than the average worker. From 1992 to 2009, average wage

Table 7
Average Weekly Earnings
(all employees, including overtime, \$)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Industrial aggregate	656	657	673	691	709	737	755	788	810	824
Goods-producing industries	824	828	850	877	898	930	948	998	1,029	1,029
Manufacturing	796	799	819	838	863	896	905	941	949	918
Refining	1,075	1,118	1,105	1,127	1,116	1,176	1,231	1,220	1,280	1,371

Sources: Statistics Canada; The Conference Board of Canada.

growth in the sector outpaced the industry aggregate by 0.5 percentage points per year (2.7 per cent versus 2.2 per cent).

As well, wage growth did not seem to be affected by the most recent recession. Indeed, average weekly earnings in this sector climbed by 5 per cent in 2008 and by 7.1 per cent in 2009. In contrast, the industry composite increased by just 2.2 per cent on an annual average basis over those two years.

Refinery workers now earn 50 per cent more than do workers in the overall manufacturing sector. In 1991, that wage gap was 33 per cent.

The wage gap also continues to widen between the refining industry and the manufacturing industry as a whole. Indeed, wage growth in the manufacturing sector has been tepid the past five years, in line with weak production. From 2005 to 2009, average weekly earnings in the manufacturing sector increased by just 1.2 per cent

per year. As a result, refinery workers now earn 50 per cent more than do workers in the overall manufacturing sector. In 1991, that wage gap was 33 per cent.

There are several reasons why the refining industry enjoys significantly higher wages than the manufacturing industry as whole. First, the sector's workforce is better educated and has a higher skill set. Presumably, higher education levels lead to a more productive labour force, allowing for higher-than-average wages.

In addition, a recent Conference Board of Canada compensation survey found that 56 per cent of employers in the industry are having difficulty recruiting and/or retaining talent. This was particularly true for engineering positions and for skilled trades, which form a significant share of the industry's labour force.⁵ Tight labour markets result in increased competition for skilled labour, pushing wage growth higher relative to the economy as a whole.

5 The Conference Board of Canada, *Compensation Planning Outlook 2011*, 2010.

CHAPTER 6

Economic Impact of Lost Refining Capacity

Chapter Summary

- ♦ Given the competitive pressures that Canadian refiners face, a scenario is built under the assumption that, going forward, Canada permanently loses 10 per cent of its refining capacity as domestic production is replaced by increased net imports. We also assume that there are no significant transportation or logistical hurdles.
- ♦ According to the Board's national model simulations, real GDP is reduced by roughly \$800 million per year, or 0.06 per cent, while annual job losses peak at 8,100 or 38,300 person-years over the five-year period.
- ♦ The impact on federal and regional government finances is also significant and permanent. Over a five-year simulation horizon, the federal balance is eroded by a cumulative \$1.18 billion, while the aggregate provincial balances are down by a cumulative \$546 million.
- ♦ Manufacturing GDP and employment is hit hard, but business service sectors suffer even greater losses in output and employment.

In previous chapters, we drew from historical data to examine the size and economic contribution that the refining industry has on employment, income, and output in Canada. In this chapter, we broaden the

analysis to examine the impacts that a future loss to refining capacity might have on the Canadian economy by quantifying full economic impacts. Even though rising oil prices have encouraged energy companies to actively explore and invest in Canada's upstream segment of the sector, the business of oil refining and processing is facing a very different set of circumstances. Flat North American demand for its products, competitive pressures from producers in overseas and developing economies, and domestic pressures arising because of tightening environmental standards are just some of the challenges that refiners currently face. As such, even if development and production of oil resources continues to grow strongly in Canada, the economic benefits, job creation, and profits that we might expect in the future from oil refining and processing are much less assured.

In order to estimate the full employment and economic impacts over time, simulations were performed using The Conference Board of Canada's detailed proprietary model of the Canadian economy. The economic impact analysis is performed over the medium-term forecast horizon under the assumption that refining capacity would be lost permanently, starting in 2011. As such, the Conference Board's latest economic outlook for Canada provided the backdrop for the analysis. Specifically, the CBoC's model is used to produce a scenario in which direct real GDP generated by the refining sector is reduced by 10 per cent. However, the operations of Canadian refineries stimulate economic activity in Canada through a spreading out of demand for other goods and services. Indirect effects are felt on those industries that are suppliers to

petroleum refiners. Induced impacts are generated when employees of the aforementioned industries lower their spending and owners deal with weaker profits by cutting back on investment. These lead to broader impacts on production, employment, wages, income, and tax revenues, and can be felt across a wide range of industries.

Comparing the “loss of refining capacity” scenario to the control scenario generates the economic impact of this lost capacity on a wide range of economic indicators tracked by the economic model. Effectively, the economic impact analysis quantifies the combined direct, indirect, and induced economic impacts on economic indicators that include GDP, employment, income, profits, tax revenues, and government balances. The overall economic multiplier is calculated as the total real GDP impact divided by the reduction in real GDP directly attributed to the refining industry.

LOSS OF REFINING CAPACITY SCENARIO

Given the competitive pressures that Canadian refiners face, this scenario is built under an arbitrary assumption that Canada permanently loses 10 per cent of its refining output as domestic production is replaced by increased import content. In other words, the scenario is built under the assumption that the reduction in refining capacity is not due to a decline in Canadian or external demand for gasoline or other refined products, but rather that refinery capacity in Canada is shut down in favour of foreign-based production. The scenario is built under the assumption that there are no significant transportation or logistical hurdles to increasing net imports. The reduction in capacity is assumed to begin in 2011 with a full 10 per cent decline, and the impacts are measured over the five years spanning 2011 to 2015.

Competitive pressures have led to significant reductions in Canadian capacity in the past, suggesting that this scenario, while abrupt, is not unlikely to occur. Examples of reductions of this magnitude abound, both in the 1980s and 1990s. As such, the 10 per cent reduction in refining capacity was arbitrarily chosen by the Conference Board for illustrative purposes, keeping in mind that

(under not very strict assumptions) one can assume that results would be relatively linear. That is, if the reduction in refining capacity were 5 per cent instead of 10 per cent, simulation results would be roughly halved from those presented. The Conference Board acknowledges that specific impacts can differ from the average case presented here, depending on specific dynamics within a refining region.

Over the five-year horizon, real GDP is reduced by a cumulative total of \$4 billion and 38,300 person-years of employment are lost.

It is important to note that the loss of refining capacity scenario is assumed to have no impact on the upstream segment of the industry. The reduction in domestic refining capacity suggests that a greater portion of Canadian production of crude oil will be refined abroad. The scenario is created by increasing net imports of petroleum and other refined products (a negative for the economy), while at the same time offsetting the effect on oil production by increasing net crude oil exports. The effect created by this scenario serves to isolate the economic contribution of only the manufacturing portion of the downstream segment of the industry without directly affecting crude oil extraction. In addition, the model simulations allow for capturing the broader footprint that the refining industry has on the rest of the economy through the economic multiplier effects.¹

Table 8 summarizes the findings of the economic impact analysis on a number of key economic indicators for Canada. According to the Board’s national model simulations, a permanent 10 per cent reduction in the real value-added of Canada’s refining industry would have a

1 Essentially, our economic impact analysis captures direct, indirect, and induced economic impacts, but excludes the indirect impacts on the upstream segment of the industry—specifically, crude oil production. Typical input–output simulations, as performed using Statistics Canada’s Input–Output model of the Canadian economy, result in much larger impacts than those presented here since the indirect multiplier on oil extraction is greater than 3 to 1. That is, for a \$1 reduction in refining GDP, there is a \$3.29 reduction in GDP in oil and gas extraction.

Table 8

Loss of Refining Capacity: Economic Impact
(impact on key indicators)

	2011	2012	2013	2014	2015	Total over period
Real GDP (2002 \$ millions)	-720	-774	-813	-847	-876	-4,032
GDP (\$ millions)	-1,218	-1,202	-1,223	-1,220	-1,104	-5,967
GDP deflator (percentage difference)	-0.02	-0.01	-0.01	0.00	0.00	n.a.
Employment (level, 000s)*	-8.0	-8.1	-7.7	-7.3	-7.2	-38.3
Unemployment rate (percentage point)	0.04	0.04	0.04	0.03	0.03	n.a.
Personal income (\$ millions)	-596	-604	-603	-596	-595	-2,994
Pre-tax corporate profits (\$ millions)	-559	-525	-554	-571	-475	-2,683
90-day Treasury bill rate (percentage point)	-0.01	-0.01	-0.01	-0.01	-0.01	n.a.
Current account balance (\$ millions)	-806	-750	-764	-769	-677	-3,767
Personal income tax (\$ millions)	-106	-105	-100	-96	-93	-501
Corporate income tax (\$ millions)	-107	-100	-105	-108	-89	-508
Indirect taxes (\$ millions)	-27	-30	-31	-30	-30	-148
Federal govt. balance (\$ millions)	-240	-243	-240	-237	-220	-1,179
Regional govt. balance (\$ millions)	-110	-114	-112	-110	-99	-546

n.a. = not applicable

*Employment is measured in person-years.

Note: Difference equals shock minus control.

Source: The Conference Board of Canada.

significant impact on total real GDP.² Combining direct, indirect, and induced effects, real GDP is reduced by roughly \$800 million per year, or 0.06 per cent. Over the five-year simulation horizon, real GDP is reduced by a cumulative total of \$4 billion and 38,300 person-years of employment are lost. Annual job losses peak at 8,100 in 2012, whereas the unemployment rate is increased permanently by just under 0.04 percentage points.

The current account balance deteriorates by \$753 million (current dollars) per year, largely due to the direct impact on net trade flows generated by the requirements of the scenario—an increase in crude oil net exports that is more

than offset by an increase in net imports of petroleum and other refined products. The simulation results suggest that decreased economic activity would place modest downward pressure on prices and interest rates—changes that help counteract the negative economic impacts of the scenario.

Together, federal and provincial personal income taxes are down by about \$100 million per year.

In current dollars, GDP is down by an average of \$1.2 billion per year over the simulation horizon, pushed lower mostly by reductions in labour income and profits. The impact on federal and regional government finances is also significant and permanent. Together, federal and provincial personal income taxes are down by about \$100 million per year—\$500 million cumulatively over

2 Value-added, or GDP, is the difference between total revenue and the sum of expenses on parts, materials, and services used in the production process. Summing the value-added across all industries in a region will yield the GDP in that region.

the 2011 to 2015 period. Federal and provincial corporate income tax collections are down by about \$102 million per year, or a cumulative \$508 million. Sales and excise taxes associated with gasoline consumption are not directly affected by the switch to foreign-refined petroleum products; however, sales taxes are lowered by the more generalized drop in income and consumer spending. Thus, total indirect taxes drop, on average, by \$30 million per year. Lower personal, corporate, and indirect taxes account for the lion's share of the negative effects on the federal and aggregate provincial government balances, although higher debt-servicing costs, increased employment insurance, and various other cost and revenue items also contribute negatively to government books. In current dollar terms, federal and provincial/territorial governments stand to see their balances deteriorate by a combined \$345 million per year. A larger portion is taken from federal coffers, since its share of personal and corporate income taxes is larger. Over the five-year simulation horizon, the federal balance is eroded by a cumulative \$1.18 billion while the aggregate provincial balances are down by a cumulative \$546 million.

Table 9 presents the impact on real GDP by expenditure component. The direct impact of the drop in refining capacity is felt on the net trade flows. A boost in net

imports of petroleum and other refined products is partially offset by a lift to net exports of crude oil. Still, total real net exports fall steadily, down \$475 million in 2011 and \$557 million in 2015. Trade impacts incorporate the effects of lower household spending, which is affected by the overall job losses and the decline in real after-tax income. Investment is down as well, as lower economic activity erodes profits and the incentive to invest in new capital. Real private investment in structures is lowered by roughly \$28 million per year, while investment in new machinery and equipment falls \$70 million per year. Residential construction is lower because of weakened household income. Government spending on goods and services is generally unaffected by the simulation, while inventories contribute only modestly to lower real GDP.

Table 10 presents results on an industry-by-industry basis, highlighting the impact of the scenario on real refining GDP—down an average of 10 per cent, or \$269 million, per year. Other manufacturing sectors are also indirectly affected by the drop in refining capacity and the generally weaker economic conditions. Still, the bulk (81 per cent) of the impact on manufacturing comes from the direct impact attributed to the reduction in petroleum and other refined products. Private service sector industries

Table 9
Loss of Refining Capacity: Economic Impact
(impact on components of gross domestic product, 2002 \$ millions)

	2011	2012	2013	2014	2015	Total over period
Consumer expenditures	-159	-187	-193	-191	-188	-919
Total government spending	0	0	0	0	0	0
Private capital investment	-74	-87	-95	-101	-106	-463
Structures	-22	-26	-29	-31	-32	-140
Machinery and equipment	-55	-65	-72	-76	-79	-348
Residential construction	-22	-22	-20	-19	-18	-101
Final domestic demand	-247	-286	-298	-298	-298	-1,427
Change in inventories	-7	-7	-7	-7	-8	-37
Net exports	-475	-485	-506	-532	-557	-2,556
Gross domestic product at market prices	-720	-774	-813	-847	-876	-4,032

Note: Difference equals shock minus control; totals are created using Fisher aggregation.
Source: The Conference Board of Canada.

Table 10**Loss of Refining Capacity: Economic Impact**

(impact on components of gross domestic product by industry, 2002 \$ millions)

	2011	2012	2013	2014	2015	Total over period
Real gross domestic product	-747	-785	-811	-832	-853	-4,029
Total goods	-369	-382	-394	-404	-415	-1,964
Primary	-7	-8	-9	-10	-11	-45
Utilities	-24	-25	-26	-27	-27	-129
Construction	-24	-26	-27	-27	-28	-131
Manufacturing	-315	-323	-332	-340	-349	-1,659
Attributable to refined products	-256	-263	-269	-276	-283	-1,347
<i>Percentage change from control</i>	-10.0	-10.0	-9.9	-10.0	-10.1	
Business services	-355	-379	-392	-402	-412	-1,939
Wholesale and retail trade	-46	-48	-47	-45	-44	-230
Transportation and warehousing	-66	-69	-71	-73	-75	-354
Information and cultural services	-22	-24	-24	-25	-26	-121
Finance, insurance, and real estate	-115	-127	-134	-140	-145	-662
Professional, scientific, and technical	-44	-46	-48	-49	-50	-238
Other business services	-61	-65	-68	-70	-71	-335
Public sector	-22	-24	-25	-26	-27	-124

Note: Difference equals shock minus control.

Source: The Conference Board of Canada.

are also significantly affected, with real GDP down by an average of \$388 million per year over the simulation horizon. The generalized decrease in business activity drags the finance, insurance, and real estate industry lower, as well as hurting many other business services.

Private service sector industries are also significantly affected, with real GDP down by an average of \$388 million per year over the simulation horizon.

The results presented highlight, at an aggregate level, the widespread effects the refining industry has across all sectors of the economy. Indirect effects are felt on demand for goods or services from industries that are direct suppliers, excluding (as noted earlier) the impact

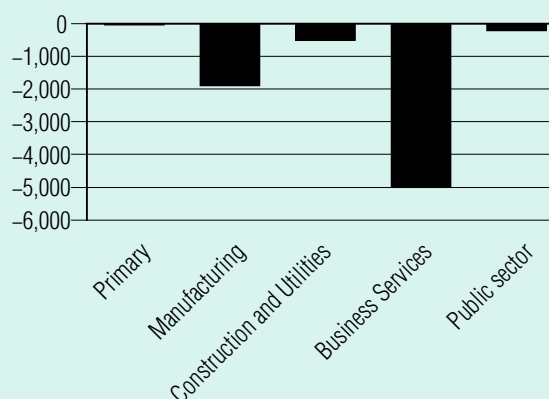
on crude oil extraction. Second-round induced effects, caused largely by decreased household spending and investment, produce a widespread (albeit smaller) impact on all sectors of the economy. The overall economic multiplier can be calculated as the change in total real GDP divided by the initial constant dollar reduction to refining output. Under our assumptions, for every \$1 reduction in real refining GDP, total real GDP is reduced by \$3. Because the refining industry is highly capital intensive, the overall economic and employment multipliers associated with this industry are elevated. Specifically, relatively small reductions in refining GDP and employment lead to large reductions in profits and income—which in turn result in sizable impacts on production and employment levels across many other industries.

Employment impacts by industry follow the increase in GDP by industry, as displayed in Table 11. Job losses are relatively stable, averaging 7,700 per year over the simulation horizon, with manufacturing accounting for 1,900 job losses per year. While business services account for roughly half the GDP losses, together they account for a greater proportion of lost employment, given that most of these industries have lower capital-to-worker ratios—and, thus, lower productivity levels. (See Chart 19.) The unemployment rate is raised, but the impact is modest at the national level, with a 0.04 per cent decline registered over the five-year simulation horizon.

Chart 19

Loss of Refining Capacity Scenario: Employment Impact

(average annual employment gains/losses, by industry)



Sources: Statistics Canada; The Conference Board of Canada.

Table 11

Loss of Refining Capacity: Economic Impact (impact on labour markets, person-years, 000s)

	2011	2012	2013	2014	2015	Total person-years
Total employment	-8.0	-8.1	-7.7	-7.3	-7.2	-38.3
Primary	0.0	0.0	0.0	0.0	0.0	-0.2
Construction	-0.4	-0.4	-0.4	-0.4	-0.4	-1.9
Utilities	-0.1	-0.1	-0.1	-0.1	-0.1	-0.6
Manufacturing	-2.2	-2.0	-1.8	-1.7	-1.8	-9.5
Other commercial services	-2.8	-3.0	-3.0	-2.9	-2.8	-14.4
Wholesale and retail trade	-0.8	-0.8	-0.7	-0.6	-0.5	-3.5
Transportation and storage	-1.0	-1.0	-0.9	-0.9	-0.9	-4.7
Finance, insurance, and real estate	-0.5	-0.5	-0.5	-0.5	-0.5	-2.5
Public sector	-0.3	-0.3	-0.2	-0.2	-0.1	-1.1
Unemployed	7.1	7.2	7.0	6.8	6.7	34.7
Unemployment rate (percentage point)	0.04	0.04	0.04	0.03	0.03	n.a.

n.a. = not applicable

Note: Difference equals shock minus control.

Source: The Conference Board of Canada.

CHAPTER 7

Conclusion

Chapter Summary

- ♦ Flat North American demand for refined products, competitive pressures from producers in overseas and developing economies, and domestic pressures arising because of tightening environmental standards are just some of the challenges that Canadian refiners face.
- ♦ The economic impact analysis is performed over the next five years, starting in 2011, under the assumption that 10 per cent of refining capacity is permanently lost.
- ♦ Over the five-year simulation horizon, real GDP is reduced by a cumulative total of \$4 billion while an average of 7,700 jobs are lost per year.

The future of Canada's energy sector is promising. The rapid development of large economies such as China and India ensure that global demand for crude will continue to expand at a healthy clip and crude oil prices will continue to rise. Global demand for crude oil has already recovered from the 2008–09 recession and is expected to expand steadily over the next 25 years. This past decade, a steep rise in crude oil prices swelled industry profits and encouraged energy companies to invest heavily in Canadian oil exploration and extraction—the upstream segment of the sector. However, the business of oil refining and processing

is facing a very different set of circumstances. Flat North American demand for refined products, competitive pressures from producers in overseas and developing economies, and domestic pressures arising because of tightening environmental standards are just some of the challenges that Canadian refiners face.

As such, the continued development and production of oil resources brings no guarantees of future strength in the oil refining sector. Refining companies, whether vertically integrated or not, are large international players, able to shift capital investments and move production to wherever opportunities are most fruitful. As such, this research study focused on the economic contribution that Canada's refining industry currently makes and on the challenges that the industry is facing now and in the future. Our findings suggest that even if the upstream segment of the industry continues its robust expansion in Canada, the economic benefits, job creation, and profits that we might expect in the future from oil refining and processing are less certain.

Today's modern refineries are capital intensive, require sophisticated engineering, and typically have a replacement cost well over C\$7 billion, not including land-acquisition costs. In Canada, refinery operations are expensive due to high energy, labour, and maintenance requirements. Over the past 30 years, Canada's refining industry has been forced to restructure, investing significant sums to upgrade aging facilities and to meet increased safety and environmental regulatory standards. Since the 1970s, the number of refineries has dropped by more than one half,

even as production has continued to increase. However, the North American market for refined petroleum products is mature, resulting in soft growth in demand going forward. Moreover, a strong dollar, tight labour markets, and rising wage pressures will continue to challenge Canada's competitiveness on a North American basis. Moreover, and given the very open and trade-exposed nature of this commodity sector, modern super-refineries being built in China, India, and other developing nations will provide a new competitive source of refined products—especially gasoline—for export to North American markets. In coming years, the industry will also face major challenges related to the mandated integration of alternative fuels, such as biofuels, and the advent of new technologies in the transportation sector.

Refining will face major challenges related to alternative fuels and new technologies in the transportation sector.

Despite the intense rationalization that occurred over the past three decades, output from Canada's refining industry has expanded fairly steadily. Increased operating efficiency, reduced costs per unit, and increased capacity use helped lift real GDP in the industry to \$2.5 billion in 2009. That is up from an average of roughly \$2 billion in the 1980s, but down from peak production of \$2.9 billion in 2003. Employment in the industry has been more stable, with the industry employing about 17,500 high-paid workers in 2009. Given the competitive pressures that Canadian refiners face, we build an arbitrary scenario under the assumption that, going forward, Canada permanently loses 10 per cent of its refining capacity as domestic production is replaced by imports. Competitive pressures have led to significant reductions in Canadian capacity in the past, suggesting that this scenario, while abrupt, is not unlikely to occur. For example, refinery output was down significantly in 2005 and 2006—corresponding to the period when the Oakville, Ontario, refinery closed. And the closure of Shell's Montréal refinery will reduce Canadian refining capacity by approximately 7 per cent in 2011.

The economic impact analysis is performed over the next five years, starting in 2011, under the assumption that 10 per cent of refining capacity is permanently lost.

The model simulations allow for capturing the broader footprint that the refining industry has on the economy, through the economic multiplier effects. Because the refining industry is very capital intensive, the overall economic and employment multipliers associated with the industry are elevated, suggesting that a relatively small reduction in refining GDP and employment leads to sizable reductions in production and employment across many other industries. Under our assumption, for every \$1 reduction in real refining GDP, total real GDP is reduced by \$3.

Over the five-year simulation horizon, real GDP is reduced by a cumulative total of \$4 billion while an average of 7,700 jobs are lost per year. Manufacturing accounts for 1,900 of these annual job losses, while business service industries, which account for roughly half the GDP losses, are responsible for the lion's share of remaining lost employment. The reduction in economic activity, employment, and profits will also serve to weaken the fiscal position of the federal and aggregate provincial governments. Reductions in personal, corporate, and indirect taxes are largely responsible for a cumulative \$1.18-billion deterioration in the federal government balance over the five-year simulation horizon. Similarly, the aggregate provincial balances are down by a cumulative \$546 million over the 2011 to 2015 period.

As discussed throughout this report, the refining industry has remained an important contributor to Canada's economy despite the challenges and changes that have occurred over the past three decades. Today, just 19 large, capital-intensive refineries produce enough to supply most of Canada's consumption of refined products while also contributing significantly to exports, tax revenues, and job creation at a regional and national level. Looking ahead, the industry will continue to face pressures from global and local factors—slumping North American demand and competitive pressures from foreign producers, climate change and stricter environmental standards, and the push toward fuel reformulation, including renewable fuels, are just a few examples. Our findings suggest that even if development and production of oil resources continue to grow strongly in Canada, the future economic benefits, job creation, and profits from oil refining and processing are much less assured.

APPENDIX A

Description of “New Policies” and “450” Scenarios

Quoted figures of future demand for oil in this report are based on the International Energy Agency’s *World Energy Outlook 2010*. The outlook details three scenarios: Current Policies, New Policies, and 450 (ppm). The Current Policies scenario is equivalent to the reference case—only initiatives that are currently on the books are assumed. Thus, this scenario assumes no further attempts to decrease the concentration of greenhouse gases going forward. The Conference Board considers this situation unlikely and therefore chooses to focus on the New Policies scenario, and considers the 450 scenario as the alternative. The IEA provides a description of policy changes assumed in each scenario. We provide an excerpt of the descriptions here. For a full listing of measures and policies on a region-by-region (or country-by-country) basis, consult Annex B of the IEA report.

NEW POLICIES SCENARIO

The New Policies scenario takes into account all policies and measures included in the current policies scenario, as well as the following:

- ♦ cautious implementation of the Copenhagen Accord commitments by 2020

- ♦ continuation of the European Union Emissions Trading Scheme (EU ETS), and introduction of the cap-and-trade system in the rest of the OECD+ after 2020
- ♦ phase-out of fossil-fuel consumption subsidies in all net-importing regions by 2020
- ♦ extension of nuclear plant lifetimes by 5 to 10 years, with respect to the Current Policies scenario, on a plant-by-plant basis
- ♦ for 2020–35, additional measures that maintain the pace of global decline in carbon intensity (measured as emissions per dollar of gross domestic product, in purchasing power parity terms) established in the period 2008–2020

450 SCENARIO

The 450 scenario takes into account all policies and measures included in the New Policies scenario, some of which are assumed to be substantially strengthened and extended, plus the following:

- ♦ implementation by 2020 of the high-end range of the Copenhagen Accord commitments, where they are expressed as ranges

- ♦ cap-and-trade system in the power and industry sectors, from 2013 in OECD+ countries and after 2020 in other major economies (OMEs)
- ♦ international sectoral agreements for the iron and steel and the cement industries
- ♦ international agreements on fuel-economy standards for passenger light-duty vehicles, aviation, and shipping
- ♦ national policies and measures, such as efficiency standards for buildings and labelling of appliances
- ♦ the complete phase-out of fossil-fuel consumption subsidies in all net-importing regions by 2020 (at the latest) and in all net-exporting regions by 2035 (at the latest)—except for the Middle East, where it is assumed that the average subsidization rate declines by 20 per cent by 2035
- ♦ extension of nuclear plant lifetimes by 5 to 10 years with respect to the New Policies scenario, on a plant-by-plant basis

APPENDIX B

Labour Productivity and the Refining Industry

Why has labour productivity growth in the refining industry been so weak? One way to find out is to conduct a growth accounting decomposition. Here we turn to labour productivity based on gross output (due to data availability). This exercise, based on the neoclassical growth accounting framework, allows us to decompose labour productivity growth into its four components: the contribution of capital intensity, the contribution of intermediate input intensity, the contribution of labour composition, and multifactor productivity growth. In other words, for labour productivity to increase, at least one of four things must occur: capital intensity must increase, intermediate input intensity must increase, labour quality (labour composition) must improve, or technological progress must be made. The growth accounting decomposition results for

the refining sector, available from Statistics Canada, are reported in the “Labour Productivity Growth” table. We focus on labour productivity growth in three periods—1962 to 1984, 1985 to 2006, and 2000 to 2006.

The contributions of capital intensity and labour composition were fairly constant over the 1962 to 2006 period. Therefore, we can eliminate these two factors as causes for the sharp slowdown in labour productivity growth. Capital intensity contributed 0.1 percentage points of the 2.9 per cent increase in labour productivity in 1962–84 and 0.1 percentage points of the 0.3 per cent labour productivity increase in 1985–2006. Capital intensity also contributed 0.3 percentage points to growth in 2000–06 even though labour productivity fell. At the same time, labour composition contributed nothing to labour productivity growth from 1962 to 1984, 0.1 percentage points over the 1985–2006 period, and 0.0 percentage points once again from 2000 to 2006.

Instead, the blame lies with the other two factors—intermediate input intensity and multifactor productivity growth. In particular, the contribution of intermediate input intensity has fallen dramatically over time. Intermediate inputs contributed 2.4 percentage points to labour productivity growth over 1962–84, but only 0.2 percentage points over 1985–2006. But this masks what occurred in the early stages of the 21st century. In 2000–06 alone, intermediate input intensity could be blamed for 3.9 percentage points of the 4.3 percentage point drop in labour productivity growth.

Labour Productivity Growth
(per cent)

	1962–06	1962–84	1985–06	2000–06
Labour productivity, based on value-added	3.4	4.7	2.0	–4.2
Labour productivity, based on gross output	1.6	2.9	0.3	–4.3
Capital intensity	0.1	0.1	0.1	0.3
Intermediate input intensity	1.3	2.4	0.2	–3.9
Labour composition	0.0	0.0	0.1	0.0
Multifactor productivity	0.2	0.4	0.1	–0.6

Sources: Statistics Canada; The Conference Board of Canada.

What is going on here? The main intermediate input in the refining industry is, of course, oil. And productivity in the upstream sector has been falling in recent years; as well, productivity has declined and the product mix has trended toward a heavier barrel of oil. This is feeding through to the refining industry where lower-quality input into the refining process means, all else being equal, a drop in the higher-value-added products from the same quantity of inputs—thereby reducing the industry's productivity.¹

At the same time, multifactor productivity growth in the industry weakened from an annual average rate of 0.4 per cent from 1962 to 1984 to 0.1 per cent from 1985 to 2006. From 2000 to 2006, multifactor productivity fell by an average of 0.6 per cent annually. This implies that technological progress and other efficiency gains have been lacking in the sector in recent years.

1 Gross output and value-added methods of estimating productivity.

APPENDIX C

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