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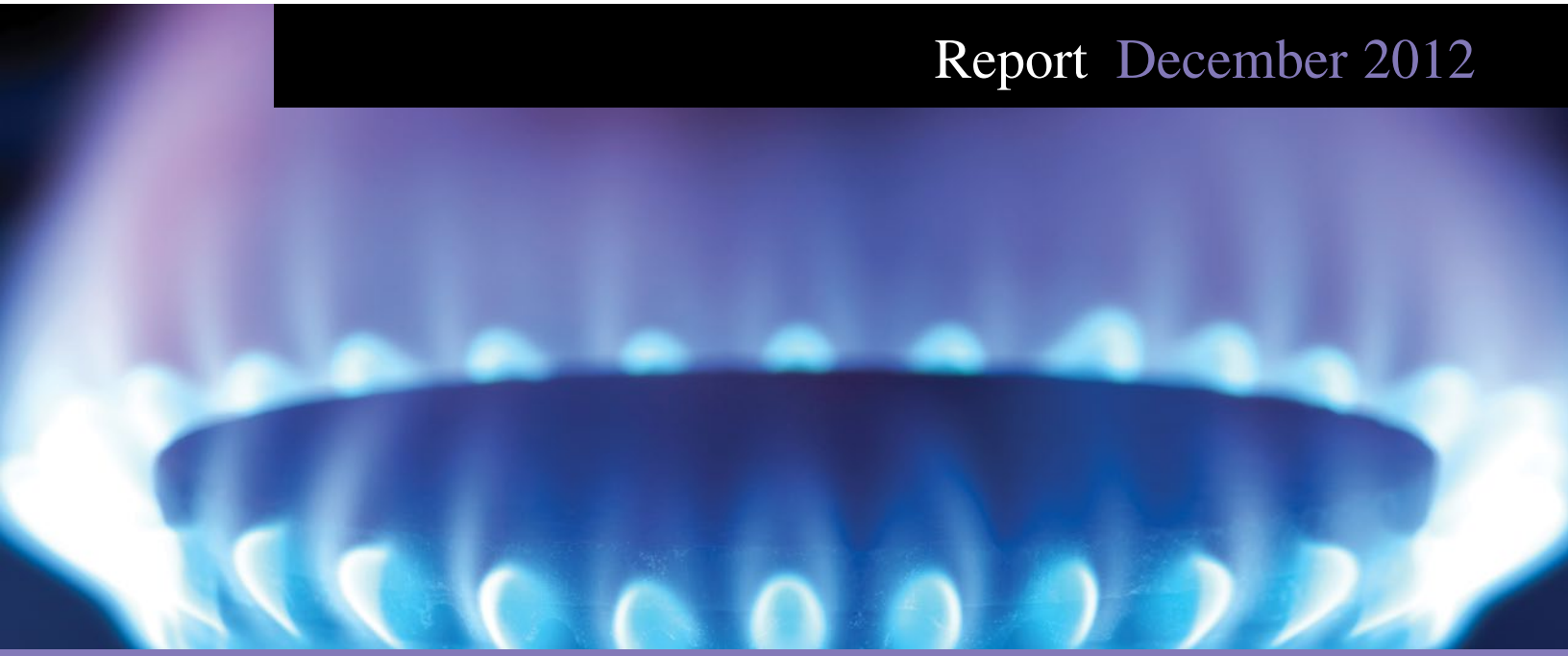
Report December 2012



The Role of Natural Gas in Powering Canada's Economy

ENERGY, ENVIRONMENT, AND TRANSPORTATION POLICY

The Conference Board of Canada
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The Role of Natural Gas in Powering Canada's Economy
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Preface

The natural gas industry has made important contributions to economic growth, investment, and employment in Canada. It will continue to do so, but in a changing environment. Recent developments in supply technologies have expanded production in the United States and have contributed to the current low price environment. In Canada, shale gas is beginning to supplement conventional natural gas production.

This report considers current and future markets for Canadian natural gas, from 2012 to 2035. Future requirements are profiled by the main sectors of the economy that use natural gas. Market growth will be led by new markets for liquefied natural gas (LNG) exports, growth in oil sands requirements for natural gas as a fuel, and growing capacity to generate electricity from natural gas. These market opportunities will lead to investments to ensure that supplies continue to be developed and infrastructure built. Upstream investments to increase production will represent the largest component of total investment. This report profiles the impact of this investment on economic growth, employment, income, corporate profits, and taxes paid.

CONTENTS

Acknowledgements

We gratefully acknowledge members of the Canadian Natural Gas Initiative for the funding they provided to make this report possible, and for their detailed comments on report drafts. We also wish to acknowledge the external reviewers who provided useful comments and feedback on the key themes in this report.

The findings of this report are solely those of The Conference Board of Canada. Any errors or omissions that remain are those of the Conference Board.

EXECUTIVE SUMMARY

The Role of Natural Gas in Powering Canada's Economy

At a Glance

- Demand for Canadian natural gas will double between 2012 and 2035, driven by production of liquefied natural gas, electricity, and bitumen in the oil sands.
- Increased demand will drive $386 billion in investment, generating $364 billion in real GDP, 131,460 jobs per year, $2.5 billion per year in corporate profits, and $5.3 billion per year in tax revenues over the next 24 years.
- Natural gas production will contribute another $576 billion to Canada's economy between 2012 and 2035, supporting 129,000 jobs per year.

This report examines the economic contribution that natural gas exploration, production, transportation, distribution, and consumption will make to the Canadian economy from 2012 through 2035. Natural gas plays an important but changing role in Canada's economy. It is a clean-burning fuel that results in fewer greenhouse gas emissions than other hydrocarbons. In 2010, Canadian raw natural gas production was 5.7 trillion cubic feet (tcf), or 37.7 per cent of Canada's primary energy supply, and satisfied 30.6 per cent of the country's final demand for energy. Canadians use natural gas to heat their homes, generate electricity, fuel industry, and provide transportation. Canada ranks 18th in the world in proven reserves of natural gas, third in production, and fourth in exports.

At the turn of the century, conventional natural gas resources in Canada and the United States were beginning to show signs of a potential decline in productive capacity. Net exports of natural gas from Canada reached a peak of 3.3 tcf in 2007, and have declined steadily since, falling just below 2.5 tcf in 2010. But large investments continue to be made to find and develop natural gas supplies, deliver natural gas to market, and enable the use of natural gas to provide energy services. Over the past decade, supply technologies in particular have evolved, improving the outlook for natural gas production.

Changing technologies are now transforming the industry. Horizontal drilling and formation fracturing technologies have played a key role in North American natural gas markets. With the development and application of these technologies, shale gas resources in several regions of the U.S. have come into production; as a result, total U.S. natural gas production has increased. This has contributed to the decline in net exports from Canada, and the trend is expected to continue as the U.S. becomes more self-sufficient in natural gas. In addition, shale gas development is proceeding in regions that are close to markets in Ontario. Pipeline projects and expansions are being developed to offer Ontario consumers additional choice in their gas supplies.

Canadian domestic demand is expected to double over the next 24 years, although some of this demand will be met by imports from the United States. On the supply side, we project marketable (as opposed to raw) Canadian natural gas production will decline from its current level of 5.3 tcf/year to just 4.8 tcf/year by 2019 as low prices continue to constrain drilling activity, then recover steadily to 5.5 tcf/year by 2030. Also, a portion of future production in British Columbia is expected to be converted to liquefied natural gas (LNG) for export to Asian markets. As a result, we expect there will be a continued decline in net Canadian exports to the United States. Upstream investment of $295 billion will be required to meet the anticipated production track as producers work to replace declining reserves and meet new market opportunities.

In Western Canada, shale gas development is currently strongest in British Columbia, with developments expected in Alberta as well. Additional shale gas opportunities exist in Quebec and New Brunswick, pending regulatory developments, decisions to proceed with development, and further exploratory work to prove up the resource.

British Columbia is expected to experience the most investment of any province in Canada as shale gas development proceeds and as LNG export projects are realized. Alberta is expected to continue as Canada's largest natural gas producer, although bitumen production and power generation will absorb an increasing share of Alberta's natural gas supplies. More traditional residential, commercial, and industrial markets for natural gas will continue to grow as the economy and population continue to grow.

Natural gas investments were quantified for this report based on projected natural gas demand within Canada and for export as LNG (primarily to Asian markets) or via the existing pipeline network (to U.S. markets). The LNG export market is expected to grow from zero currently to 20 million tonnes per year (about 1 tcf/year), while net exports via existing pipeline are expected to keep declining (with net exports by pipeline reaching just 1 tcf/year over the next decade).

Natural gas industry investments are projected to total $386 billion (in 2012 dollars) from 2012 to 2035, of which $349 billion is expected to be spent in the three westernmost provinces. The rest of the investment will be spread across the remaining provinces, and will occur primarily for power generation and natural gas distribution systems. In addition to the direct investments, Canadian natural gas consumers will continue to benefit as natural gas prices remain significantly lower than all other forms of energy.

The Canadian economy will enjoy significant benefits resulting from natural gas investment projected to occur over 2012 to 2035.

The Canadian economy will enjoy significant benefits resulting from natural gas investment projected to occur over 2012 to 2035. The benefits themselves will accrue in two distinct stages. First, there is the benefit from the capital investment itself, driving up construction activity and demand from supplier industries. Second, once the new infrastructure is in place, the operations phase results in increases in the production of natural gas, driving up wages and profits in the sector that trickle down throughout the economy. To quantify the impacts of these benefits, the Conference Board relied on its proprietary models of the national and provincial economies. First we assessed the provincial impacts of the capital investment, and then we estimated the economic impact of increased production at the national level.

A number of factors influence how natural gas investment will affect each province. Of course, the value of the direct investment in each province is the most influential component. But the results are also influenced by a province's dependency on imports, the demand generated for its exports from investment spending in other provinces, and the labour market conditions in each province. This analysis relied on Statistics Canada's interregional input-output model and the Conference Board's provincial forecasting model to determine the total economic impact (including direct, indirect and induced impacts) accruing to each province as a result of capital investment by natural gas producers.

The results from this economic impact analysis suggest that the largest contribution in real gross domestic product stemming from this investment will be in Alberta,

which will experience a cumulative $153.6 billion increase (in 2012 dollars) over 2012 to 2035. Although direct investment in Alberta will not be as high as in British Columbia, the province will benefit from a significant influx of interprovincial migrants in response to tight labour market conditions, as well as a higher indirect benefit stemming from the investment occurring across the country. While the total benefit in British Columbia will be lower than in Alberta, the province will still experience a substantial increase in real GDP, with a cumulative contribution of $116.2 billion stemming from natural gas investment. All of the provinces will benefit from the investment occurring across the country, and most provinces will benefit in proportion to the direct investment within their borders. Ontario, Quebec, and to a lesser extent Manitoba will experience the largest boost to exports in response to the significant demand generated in British Columbia and Alberta. In total, the cumulative increase in real GDP resulting from the infrastructure investment over the 24-year forecast will be $364 billion.

In addition to the stimulus generated by capital investment in natural gas, the subsequent boost to production will also benefit the economy. This scenario is built under the arbitrary assumption that natural gas production will increase by 365 billion cubic feet, or 1 bcf per day over the course of a year. The arbitrary increase was chosen to calculate the larger economic footprint of the natural gas industry, so that, under not too stringent assumptions, the results from this analysis could be used to calculate the impact of the natural gas industry both today and in the future.

Using our economic footprint analysis, we determined that today, total natural gas production in Canada supports nearly 130,000 jobs and generates over $24.5 billion in economic activity per year. By 2035, Canadian production is expected to reach 5.5 tcf, implying that the economic contribution and jobs supported by the sector will grow over time. Over the 24-year forecast horizon, natural gas production will contribute a cumulative $576 billion (in 2012 dollars) to the economy.

Through its investment and production, together, Canada's natural gas industry is forecast to contribute a cumulative $940 billion to the country's economy between 2012 and 2035. This estimate includes not only the economic activity generated directly by the industry but also the supply chain and other multiplier effects generated by the increase in income and profits. Through these direct, indirect, and induced impacts, the industry will also generate roughly 6.2 million person-years of employment, that is, it will support nearly 260,000 jobs per year over the next 24 years. In addition, the industry will add significantly to corporate and labour income and contribute to federal and provincial tax revenues. (See Table 1.)

Table 1
Cumulative Impacts Over 2012 to 2035
(2012 $ billions)

Real GDP	940.2
Employment*	6,178.0
Labour income	496.2
Pre-tax corporate profits	224.0
Federal and provincial tax revenues	203.3

*Employment impacts are expressed in thousands of person-years; all others are expressed in 2012 $ billions.
Sources: The Conference Board of Canada; Statistics Canada.

CHAPTER 1

Introduction

Chapter Summary

- Natural gas accounts for 37.7 per cent of Canada's primary energy supply, satisfies 30.6 per cent of energy demand, and makes up 42 per cent of Canada's energy exports.
- Over the past decade, natural gas supply technologies such as horizontal drilling and fracturing have unlocked shale gas resources and created new opportunities and challenges.
- This report details the long-term investments that Canada's natural gas industry must make, and their anticipated impacts on employment and economic growth.

Natural gas plays an important role in Canada's economy, particularly in its energy economy. Canada ranks 18th in the world in proved reserves of natural gas, third in production (the U.S. ranks first, followed by Russia), and fourth in exports.[1] The natural gas industry has a history that spans more than six decades of supplying a clean-burning fuel to meet growing market requirements in both Canada and the United States.

In 2010, Canada produced 5.7 tcf of raw natural gas (5.4 tcf of marketable natural gas), representing 37.7 per cent of the country's primary energy supply (energy in its raw form), and satisfying 30.6 per cent of the country's final demand for energy.[2] Natural gas represented 42 per cent of primary energy exports by energy content and 16.6 per cent by value. Natural gas accounted for 3.9 per cent of total merchandise trade in 2010. Sixty-one per cent of natural gas production was exported.

Natural gas has made a strong contribution to Canada's energy economy. It is readily available from British Columbia to Quebec, and is slowly growing in availability in Atlantic Canada. Retail price indexes indicate that natural gas has also experienced less price inflation since 1990 than either electricity or liquid fuels.

In its raw form, natural gas may include impurities such as nitrogen, carbon dioxide, or sulphur compounds in addition to methane, ethane, propane, and butane. Raw natural gas is processed at the point of production to remove some water and separate any crude oil or condensate. The raw gas is then transported by pipeline to a processing plant where much of the remaining water, carbon dioxide, sulphur, propane, and butane is removed

1 British Petroleum, *BP Statistical Review of World Energy*. Reserves measured at year-end 2010. Production ranking is for 2011.

2 Data relating to production, sales, exports, and prices in this introduction are taken from Statistics Canada's *Energy Statistics Handbook*, First Quarter 2012.

to meet transport specifications set by the pipeline company that will transport the natural gas to market. Odorant will be added before delivery to the customer. The natural gas that is delivered for consumption is a clean-burning product whose greenhouse gas and other emissions are small compared with other hydrocarbons.

The natural gas industry has been a strong performer in Canada's energy economy. Production, exports, deliveries, and supporting infrastructure have demonstrated a strong track record of dependability and growth.

The future holds both challenges and opportunities as the industry and its customers continue to evolve. In recent years, horizontal drilling and formation fracturing technologies have been improved and costs have been reduced to the extent that shale gas formations have become economic to produce. Primarily because of this increased unconventional gas production, natural gas production in the U.S. has outstripped market growth. The regional distribution of natural gas production in the U.S. has also changed significantly. The level and regional distribution of demand for Canadian natural gas in U.S. markets is changing. The changing U.S. market balance has resulted in lower natural gas prices for consumers and producers in both countries. This is occurring at a time when conventional natural gas resources in Western Canada have been maturing.

One of the challenges the industry must face is maintaining production levels in an environment of lower prices and reduced export demand from the United States. We project marketable (as opposed to raw) Canadian natural gas production will decline from its current level of 5.3 tcf/year to just 4.8 tcf/year by 2019 as low prices continue to constrain drilling activity, then recover steadily to 5.5 tcf/year by 2030. Another challenge is adjusting transportation infrastructure to accommodate the changing geographic distribution of natural gas supplies.

On the positive side, Canada is well endowed with unconventional shale gas resources. Much of this resource is in northeast British Columbia, Canada's second-largest current producer of natural gas. The National Energy Board has estimated the shale gas potential of the Horn River Basin to be 78 tcf. Earlier this year, Apache Corp. announced a discovery in the Liard Basin that could contain as much as 48 tcf of shale gas.[3] Efforts are under way to develop this shale gas resource to supply liquefaction and shipping terminals in the Kitimat region to export LNG to Asian markets.

This report focuses on the economic impact of the investments that must be made in natural gas production capacity and infrastructure to keep pace with a dynamic market. The starting point is a sector-by-sector analysis of natural gas market requirements from 2012 to 2035, to determine the level of Canadian natural gas demand likely to be experienced. This analysis includes the potential for natural gas exports in the form of LNG. Based on these market requirements, the level of investment in each major industry segment is then projected. Finally, the impact of these investments on economic output, employment, and government balances are presented.

3 "Apache Discovers Massive Shale Gas Field in B.C."

CHAPTER 2

Natural Gas Markets Outlook

Chapter Summary

- Natural gas demand in Canada will double between 2012 and 2035. Bitumen production, electricity generation, and LNG exports will account for much of this growth.
- The strongest growth in natural gas requirements will be in Alberta (for bitumen production and electricity generation) and British Columbia (for LNG).
- There is a potential for strong growth in the number of natural gas vehicles on the road. Recent announcements signal the beginning of this market development, particularly for heavy-duty trucks.
- For most other sectors, modest growth in natural gas demand is projected as efficiency improvements partially offset growth in the number of households and in economic output.

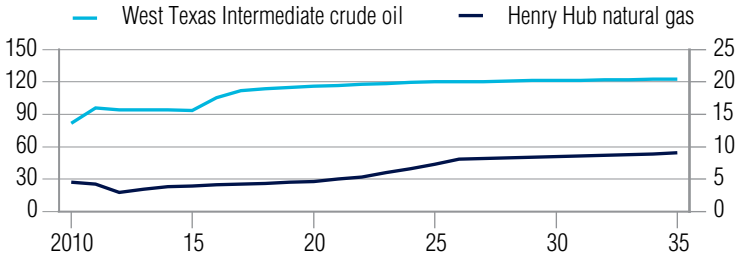
The investment likely to be made by the natural gas industry can be divided into two main components: investment in supply capacity, and investment in delivery infrastructure. Both of these categories are strongly influenced by market developments in domestic and external markets. As a result, the starting point for estimating investment requirements is to prepare an outlook for natural gas requirements in Canada, as well as assumptions about future natural gas exports. Natural gas trade is based on this forecast for Canada, plus adjustments based on the U.S. Department of Energy's 2012 long-term outlook.

Future Canadian natural gas requirements were projected using The Conference Board of Canada's proprietary models of the Canadian economy and the Canadian energy sector. Key assumptions about economic growth, population, and general price levels in the economy were taken from the macroeconomic models. Prices for natural gas, crude oil, and electricity were taken from various Conference Board analyses, updated for this outlook.

The crude oil and natural gas prices used for this report are shown in Chart 1. West Texas Intermediate (WTI) crude oil and natural gas at Henry Hub are key prices in North America because they are widely traded and underpin forward markets. The price track for WTI shows a continuation of the oversupply conditions of the recent past through 2015. As additional pipeline capacity comes into service to carry crude from the Chicago/Cushing region to the U.S. Gulf Coast, the price of WTI will recover to a more historical relationship with Brent and other international crudes. From 2016 onward, there will be only very nominal real growth in crude oil prices.

Natural gas presents a contrasting story. The scales on the chart are adjusted so that the left scale (crude oil) is six times larger than the right scale (natural gas). This represents approximately the relative energy content of the two fuels. If natural gas were priced relative to

Chart 1
Crude Oil and Natural Gas Price Assumptions
(2012 US$ per barrel—left; 2012 US$ per million Btus—right)



Source: The Conference Board of Canada.

crude oil strictly on the relative energy contents, the two fuels would track each other closely on the graph. However, other factors influence relative prices. Natural gas is less energy dense and more expensive to transport per unit of energy. Also, North American natural gas markets are not as strongly linked to world markets as are North American light crude markets. As a result, despite its clean-burning properties, natural gas has historically been priced at a significant wholesale discount to crude oil and refined products (comparing on an energy-content basis).

Until the oil price increases in the mid-2000s, crude oil often traded at a ratio of about 10:1 relative to natural gas. As oil prices rose from 2004 to 2008, natural gas prices rose less rapidly, increasing the discount. By 2010, natural gas supplies in the U.S. were increasing, primarily because of the rapid increase in shale gas production. The price ratio averaged 18:1 in 2010 and rose further in 2011. At the time of writing, the year-to-date average for 2012 was above 30:1.

The price outlook in Chart 1 continues the modest near-term recovery in natural gas prices that appears to be under way in the last half of 2012. The ratio of WTI crude to Henry Hub natural gas is forecast to fall to 25:1 by 2015, stay in that range through 2020, and then fall gradually through the rest of the forecast, reaching 13:1 by 2035. The shale gas revolution under way in the U.S. and emerging in Canada is expected to keep natural gas markets well supplied in the long term, keeping consumer prices lower and less volatile than in recent years.

The Conference Board's demand model accounts for consumers reacting to the relative prices of competing energy forms, both in determining their overall requirement for energy and in determining which fuels will meet that demand. Energy requirements are defined for each of Canada's provinces[1] for the following sectors:

- residential
- commercial, institutional, and public administration
- forestry
- agriculture
- mining
- construction
- transportation
- manufacturing
- electricity generation

The natural gas projection also includes demand for natural gas to produce LNG for export from British Columbia, as well as demand for natural gas used as fuel in bitumen production in Alberta. Natural gas demands are not reported for sector and province combinations where natural gas is not consumed in sufficient quantities to permit modelling. This may be due to the volume of consumption or data confidentiality because of only one or two consumers in a given sector.

Total natural gas demand for Canada from 2010 to 2035 is shown by province in Chart 2. Total natural gas demand is projected to double between 2012 and 2035, a compound annual growth rate of 2.8 per cent. Much of the growth is expected in Alberta (driven primarily by oil sands and electricity generation) and in British Columbia (driven primarily by LNG exports). The remaining provinces show natural gas demand driven primarily by growth in the population, commercial sector output, and industrial output.

1 Because natural gas is not broadly available in the territories, restricting the analysis to provincial energy markets excludes only very small volumes of current or future natural gas consumption.

Growth in natural gas consumption will occur primarily in three main sectors: bitumen production, LNG, and electricity generation. Together, these three sectors account for 79 per cent of the total growth in Canadian natural gas demand between 2012 and 2035. Chart 2 does not represent secondary demand for natural gas in Canada because it includes demand for natural gas to produce LNG for export. Secondary natural gas demand (Chart 2 without LNG demand) will rise from 3.3 tcf in 2012 to 5.2 tcf in 2035, which represents a more modest compound annual growth of 1.9 per cent. Growth in natural gas demand is anticipated to be slower than overall economic growth, notwithstanding the rapid growth in the three key sectors.

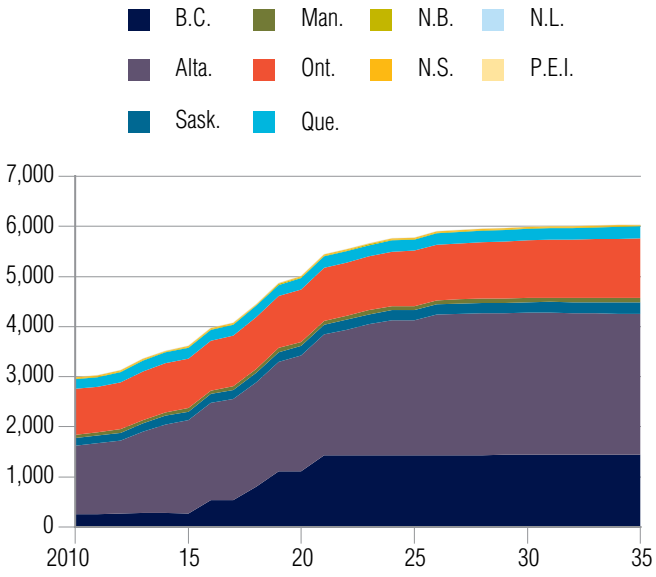
Growth in natural gas consumption will occur primarily in three main sectors: bitumen production, LNG, and electricity generation.

Chart 3 shows the contribution that each of the sectors modelled is expected to make to total natural gas demand and its growth over the period studied. Three of the sectors shown are not clearly visible on the chart because they do not consume large volumes of natural gas. They are shown separately in Chart 4. Finally, although forestry is one of the sectors modelled, it does not use natural gas in any appreciable volume and is therefore not included in this projection.

RESIDENTIAL, COMMERCIAL, AND PUBLIC ADMINISTRATION

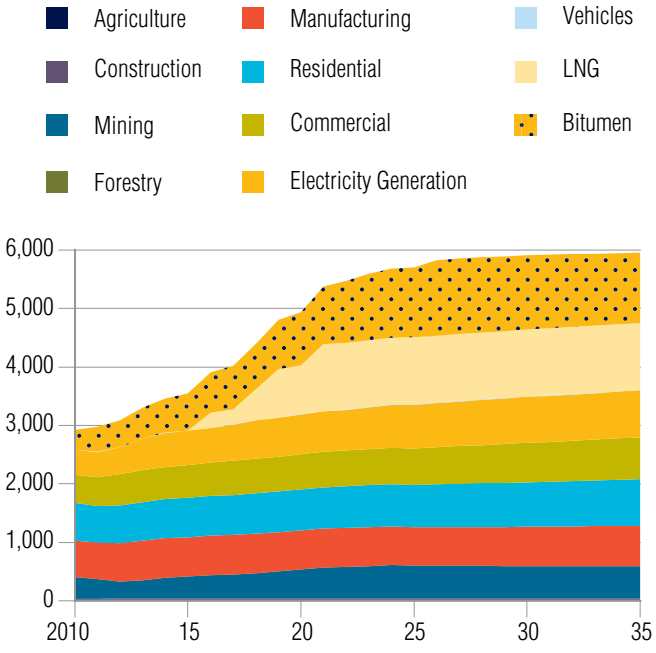
The residential, commercial, and public administration sectors combined accounted for 36 per cent of Canadian natural gas demand in 2010. Natural gas has become the fuel of choice for residential customers who have access to the fuel. It is cheaper, cleaner, and more efficient than competing fuels. Natural gas demand, like overall residential energy demand, is linked to population growth, house size, the number of occupants per housing unit, and the mix of single- and multi-family dwellings. Over the past 30 years, there has been a significant shift

Chart 2
Natural Gas Demand by Province
(billion cubic feet per year)



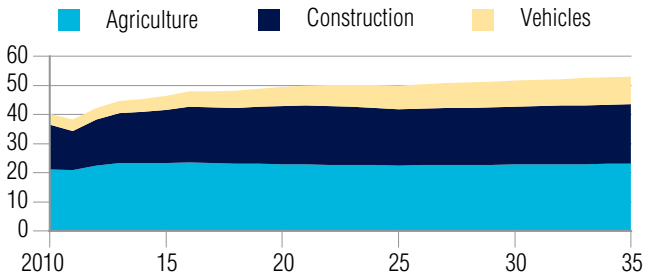
Source: The Conference Board of Canada.

Chart 3
Natural Gas Demand by Sector
(billion cubic feet per year)



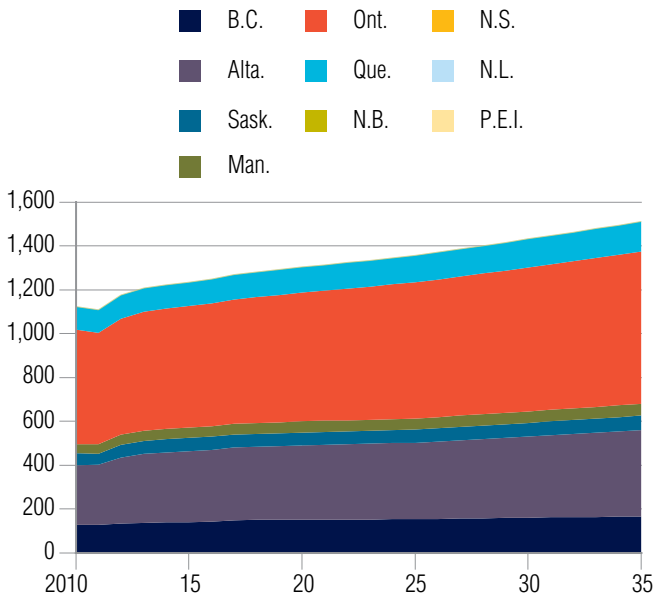
Source: The Conference Board of Canada.

Chart 4
Natural Gas Demand for Selected Sectors
(billion cubic feet per year)



Source: The Conference Board of Canada.

Chart 5
Residential, Commercial, and Public Administration Demand for Natural Gas
(billion cubic feet per year)



Source: The Conference Board of Canada.

toward better home insulation and higher-efficiency equipment for heating in particular. But the trend toward larger homes has partially offset the benefits of improved insulation and more efficient furnaces. On balance, energy consumption per capita in the residential sector will trend downward, as will energy consumption per dollar of output in the commercial and administration sectors.

This outlook is based on a continuation of historical normal weather patterns, based on the past 25 years. As a result, should future temperatures average higher levels than in the past, winter demands for natural gas for space heating in these sectors would be overstated, and summer demands for electricity used for air conditioning would be understated.

Natural gas demand in the commercial and public administration sectors is dominated by the need to provide hot air and hot water for buildings—primarily offices and warehouses. The commercial sector includes a broad range of business types and consumes small amounts of natural gas for cooking (restaurants, etc.), incineration (hospitals), and cogeneration of heat and electricity.

Natural gas demand in the commercial and public administration sector is projected to rise 1.75 per cent per year.

Chart 5 shows natural gas demand for the residential, commercial, and public administration sectors in each province. Annual demand will rise from 1.2 tcf in 2012 to 1.5 tcf in 2035, an annual growth rate of only 1.1 per cent. Residential natural gas demand will follow population growth, at a very slightly higher rate in each province. The trend toward larger homes with fewer occupants means that consumption per capita will rise slightly faster than the impact of more efficient equipment can offset. There is also a minor trend toward market penetration in Quebec (where natural gas is still not universally available, even in urban areas) and certain local regions of Atlantic Canada (where natural gas has been available to households for fewer than 20 years).

Natural gas demand in the commercial and public administration sector is projected to rise 1.75 per cent per year—substantially faster than demand in the residential sector, but slower than growth in commercial sector GDP. Commercial sector building operators are expected to continue and perhaps accelerate their focus on improving energy efficiency, thus partially offsetting the increases in natural gas demand that would otherwise occur.

MANUFACTURING

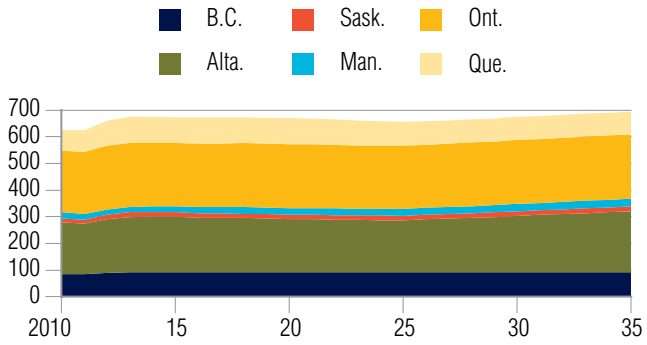
Canada's manufacturing sector continues to struggle to defend its eroding competitive position. Over 2012 to 2035, energy demand will be based on two key inputs: GDP growth and energy prices. Manufacturing GDP is forecast to rise at a compound annual rate of 1.7 per cent from 2012 to 2035. However, as electricity prices rise significantly in Ontario, manufacturing in that province must find more energy-efficient production processes and equipment. Wholesale natural gas prices are also expected to rise from their current levels, as are crude oil and refined product prices. As the weighted average price of energy rises, manufacturers will focus more on energy conservation. As a result, total energy demand in manufacturing is projected to rise just 0.5 per cent annually.

As the projection moves into the 2015–2020 period and beyond, wholesale natural gas prices are expected to begin to rise faster than inflation.

Natural gas demand in this sector is shown in Chart 6. Natural gas demand is estimated to have responded to the weak economic recovery that has continued between 2010 and 2012, and to have increased as a result of extremely low natural gas commodity prices. The emerging trend toward higher electricity prices in Ontario is expected to continue for at least the coming decade. Natural gas sales will benefit from these factors.

However, long-distance transportation costs in Canada are rising, partly offsetting the impact of lower commodity prices. Rising transport costs may also be contributing to the declining share of Canadian natural gas consumed in Ontario as imports from the U.S. rise. As the projection moves into the 2015–2020 period and beyond, wholesale natural gas prices are expected to begin to rise faster than inflation. For the manufacturing sector, the share of total energy demand met from natural gas will rise marginally from 38 per cent in 2010 to 39 per cent over the first decade of the projection, then fall just as gradually back to 38 per cent by the end of the outlook. Although natural gas and electricity do not compete directly in the manufacturing sector in Canada (outside Quebec in particular), industrial electricity prices are expected to rise more rapidly than natural gas prices over the coming decade or more. Electricity demand will grow more slowly per dollar of GDP than will natural gas demand, resulting in a growing share of natural gas in total manufacturing energy demand. These changes are expected to be very small.

Chart 6
Manufacturing Demand for Natural Gas
(billion cubic feet per year)

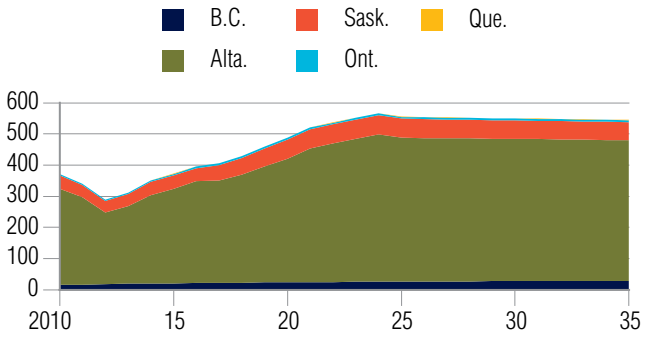


Source: The Conference Board of Canada.

MINING AND OIL AND GAS PRODUCTION

Energy demand in the mining sector as reported by Statistics Canada includes the energy consumed for a broad range of sub-sectors, including minerals, metals, coal, crude oil, bitumen, and natural gas production. Mining activities can include significant volumes of energy that fall into the category of producer consumption. For oil and gas, these activities include field losses due to fugitive losses or flaring. The data also report the "shrinkage" that occurs as raw natural gas is processed to remove impurities and to remove valuable liquids such as ethane, propane, and butane. But for this report,

Chart 7
Mining Demand for Natural Gas
(billion cubic feet per year)



Source: The Conference Board of Canada.

the projection of demand for natural gas in the mining sector is based on secondary energy use, and does not include producer consumption directly. For natural gas, it captures marketable rather than raw gas production. Further, because bitumen extraction represents such a large component of mining natural gas demand and is expected to grow significantly, it is treated separately.

Chart 7 presents provincial demands for natural gas for the mining sector as defined in this report. Mining sector total energy consumption (not shown) is dominated in all provinces except Alberta by liquid fuels (primarily diesel fuel) and electricity (which may be self-generated for larger mines). Natural gas demand in the mining sector is primarily related to the fuel requirements of upstream oil and gas production and processing. As the chart indicates, after a sharp initial reduction due to decreased upstream activity, natural gas demand for mining will rise 2 per cent per year for just over a decade, and then remain relatively constant as conventional oil and gas activities continue to be challenged by an ever-maturing resource base. Natural gas demand in this sector will not recover to its 2010 level for a decade. The recovery period in British Columbia is somewhat shorter because of unconventional natural gas activity to supply LNG projects as they develop later this decade.

ELECTRICITY GENERATION

Future opportunities for natural gas as fuel for electricity generation differ greatly among the provinces. As a result, the projection for natural gas consumption in this sector was built up for each province based on the following factors:

- installed generating capacity for each generating station in service
- retirement dates (or a service-life assumption where actual dates are not available)
- generating capacity under construction
- other generating capacity that is planned or announced
- market requirements for electric energy
- ability of the grid to integrate renewable energy
- policy statements about the role of renewable, nuclear, or other generation technologies
- load factors for each technology in each province
- heat rates for thermal stations (used to determine fuel requirements)
- assumptions about refurbishment or repowering of existing stations
- projections of electricity trade

The projection began with an assessment of current and future generating capacity for each of the generating technologies used or proposed in each province. Capacity factors and heat rates based on historical performance were applied to determine the energy generated and fuel required in the base year (currently 2010 in the model). Based on energy generated and net trade, a supply/demand balance and reserve margin was calculated.

The outlook for overall electricity demand in each province was generated by the overall demand model for each sector. Generating capacity was retired based on scheduled dates (where they were known) or an assumption about operating life. Similarly, refurbishment or repowering decisions could also be represented. Capacity additions include units under construction, based on the assumption that construction will be completed on time and the unit powered up. Where more capacity is expected to be needed to meet market requirements (including a reserve margin), additions were based on announced projects.

The timing of these projects was not always known and may need to be adjusted based on the projected electricity demand for the province.

Provincial policy statements and operating constraints were also reflected in the technology choice for capacity additions. For example, British Columbia has a stated policy that new generation capacity will use renewable energy technologies. The Kitimat LNG project is designed to operate using purchased hydroelectricity. The electricity requirements of future LNG projects in British Columbia may be met by renewable sources or self-generated from natural gas at the LNG liquefaction terminal. This forecast does not include additional natural-gas-fired generation in British Columbia to supply LNG plants.

For Alberta, the list of announced wind projects exceeds 13,000 megawatts (MW) of additional capacity. But the Alberta Electric System Operator (AESO) has determined that an operating constraint currently prevents expansion beyond the 1,000 MW of wind power now installed or under construction. We can relax this assumption in the longer term as ramp rate[2] conditions and wind variability are better understood and operating practices adjusted. However, it is unlikely that more than a small fraction of the announced wind generating capacity can be integrated into the Alberta system.

In Ontario, the provincial government has established a feed-in tariff that ensures access and price stability to renewable generators. This has a significant impact on future generation technology choices. Ontario has also been working toward two additional nuclear units at the Darlington station, although progress has been slow. Should the province accelerate the planning for additional nuclear units, it could significantly affect the need for additional natural gas units.

Two key results of these projections for the natural gas industry are the level of natural-gas-fired capacity expected to be added between 2012 and 2035 and the quantity of natural gas expected to be consumed. (See Table 2 and

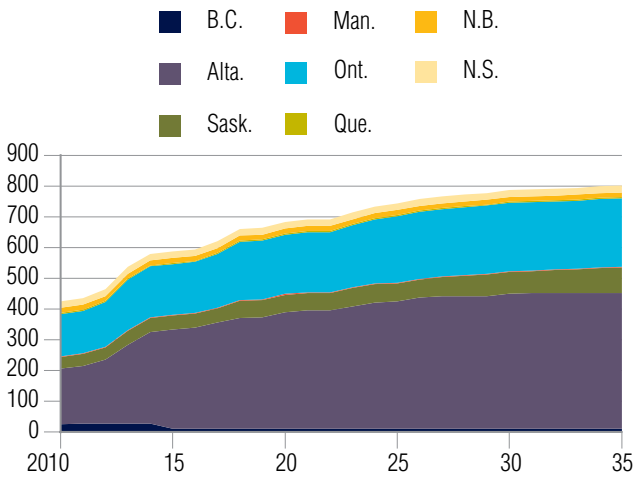
2 Ramp rate refers to the rate at which electric energy produced by a generating unit increases as the unit powers up or decreases as the unit powers down. This is a constraint on the ability to integrate wind power into a thermal system.

Table 2
Natural Gas Generation Capacity Net Additions
(MW)

	Existing capacity	2012–2015	2016–2020	2021–2025	2026–2030	2031–2035	Cumulative 2012–2035
British Columbia	1,377	72	–	–	–	–	72
Alberta	5,511	2,474	1,000	500	500	–	4,474
Saskatchewan	1,609	260	400	100	500	500	1,760
Manitoba	129	–	–	–	–	–	–
Ontario	9,219	1,743	1,900	1,600	300	–	5,543
Quebec	1,402	–	–	–	–	–	–
New Brunswick	348	–	–	–	–	–	–
Nova Scotia	415	–	–	–	–	–	–
Newfoundland and Labrador	81	–	–	–	–	–	–
Prince Edward Island	–	–	–	–	–	–	–

Source: The Conference Board of Canada.

Chart 8
Electricity Generation Demand for Natural Gas, 2010–35
(billion cubic feet per year)



Source: The Conference Board of Canada.

Chart 8.) Capacity additions including those already under construction are concentrated in Alberta, Saskatchewan, and Ontario.

Alberta faces the largest challenge of any province in adjusting to recent changes in federal power plant emissions regulations, and will need to replace end-of-life conventional coal units with a cleaner alternative. Natural gas is expected to play a prominent role in that transition for both Alberta and Saskatchewan. Natural gas capacity additions in Ontario will result primarily from growing natural gas demand, the transition off coal, and limited options for future renewable energy capacity additions to what is primarily a thermal grid—that is, power generation that includes nuclear, coal, natural gas, and biomass technologies. Other provinces either have limited access to natural gas (Atlantic Canada) or rely primarily on large hydro generation supplemented by wind power.

The natural gas that will be consumed for electricity generation is shown in Chart 8. Natural gas consumption will rise by 3.2 per cent per year, almost doubling by the end of the outlook period. The strongest growth will occur in the near term in Alberta and Ontario. Natural gas generating stations have the advantage of shorter lead times than most other technologies, and both provinces face tight capacity markets in the coming years. The drop in natural gas consumption in British Columbia will result from an assumption that the Burrard Inlet station will be taken out of service or reduced to emergency use only in 2015.

TRANSPORTATION

HEAVY-DUTY VEHICLES

Natural gas vehicles are an underdeveloped market for natural gas in Canada. Recent attention has focused on heavy-duty vehicles, with either compressed or liquefied natural gas as the fuel. For heavy-duty trucks or buses, the conversion cost can be substantial (as high as $80,000 per vehicle for an LNG system in a heavy-duty truck). Because of the low energy density of natural gas, even when trucks and buses are powered by LNG, they have a limited range compared with a standard diesel powered truck.

Recent attention has focused on heavy-duty vehicles, with either compressed or liquefied natural gas as the fuel, but the conversion cost can be substantial.

However, there have been recent moves toward LNG use for heavy-duty trucks in Canada. The Quebec-based trucking firm Robert Transport announced in late 2010 it would buy 180 heavy-duty LNG trucks powered by technology from Westport Innovations Inc. The fuel supply and infrastructure were to be provided by Gaz Métro Transport Solutions. Three LNG filling stations along the corridor between Montréal and Toronto would supply LNG to the trucks.[3] Robert Transport was also anticipating access to fiscal incentives from the Government of Quebec. In British Columbia, Vedder Transport has

3 Robert Transport, *Robert Transport Orders 180 Peterbuilt Trucks.*

acquired 50 heavy-duty LNG-powered trucks. These trucks are fuelled by a single station in Abbotsford built by FortisBC.[4]

The long-term future of natural gas as a fuel for heavy-duty trucks remains uncertain. The upfront capital investment is large, particularly for independent owner-operated trucking firms. Limited infrastructure remains a significant barrier as well. On the positive side, natural gas prices are currently much lower than diesel. This situation is expected to continue for at least the next decade. Even in the longer term, although natural gas may begin to close the pricing gap, the discount will persist.

The number of heavy-duty gas vehicles will rise to 425 in 2015, 2,950 in 2020, and 9,675 by 2035, requiring about five additional LNG filling stations each year.

For this study, it was assumed that the number of heavy-duty natural-gas-powered vehicles (trucks and buses) will rise slowly, gaining 0.5 per cent market share annually. The earliest penetration was assumed in British Columbia and Quebec, the two provinces that have incentives in place. Based on these assumptions, the number of heavy-duty gas vehicles will rise to 425 in 2015, 2,950 in 2020, and 9,675 by 2035. An average of five additional LNG filling stations will be required each year to supply this growing fleet. Natural gas consumption will increase only modestly, starting at 0.15 billion cubic feet (bcf) in 2015, rising to 1.1 bcf in 2020 and to 3.2 bcf by the end of the outlook.

LIGHT-DUTY VEHICLES

Light-duty vehicles are also an underdeveloped market for natural gas in Canada, primarily because of very limited consumer acceptance, driven by a lack of fuelling infrastructure and limited knowledge of the conversion costs and options. Natural gas conversion kits have been available for a broad range of vehicle models for many years, at a cost that ranges between $2,000 and $6,000 per vehicle. Some retail gasoline service stations have been modified to supply compressed natural gas (CNG), yet consumers are reluctant.

The limited range and lack of filling infrastructure are perhaps two of the most important limiting factors from the consumer's point of view. Limited range means natural-gas-powered cars have to be refilled at least twice as often as gasoline vehicles. Also, when CNG vehicles were first introduced, the fill time was much longer than for a gasoline vehicle, although fast-fill stations have been available for some time. Dual fuelled gasoline/CNG vehicles have also been more common than dedicated CNG vehicles to avoid the inconvenience of finding a filling station when travelling.

For this report, the number of light-duty natural gas vehicles is projected to rise based on a small capture rate for new vehicles. The number of natural gas vehicles will rise from 10,000 in 2013 to 100,000 by 2020 and to 250,000 by the end of the projection. The number of filling stations will rise, from an initial level of 200, by an average of 200 stations per year. Total natural gas consumption will rise from 0.1 bcf in 2013 to 1.2 bcf in 2020 and 2.3 bcf by the end of the outlook. This represents a very small contribution to overall natural gas demand in Canada.

LIQUEFIED NATURAL GAS

Exports of LNG from British Columbia are a potential emerging market for natural gas, based on technological advances in horizontal drilling and formation fracturing that have unlocked the resource potential for unconventional natural gas. Recent efforts have focused on the appropriate pace of development and on finding additional new markets for shale and tight gas production. Although Canada does not currently export LNG, efforts to develop new markets for Canadian natural gas have provided new momentum for projects targeting LNG exports to Asian markets.

4 Lockwood, "The Price of Gas These Days."

Historically, three countries have provided the primary markets for LNG in Asia: Japan, Korea, and Taiwan. Natural gas sales in these markets are expected to keep growing to about 120 million tonnes per annum (mtpa) in 2015 and 140 mtpa in 2025.[5] Emerging markets in China and India could add significant incremental demand, rising to as much as one-third of the total Asian market by 2025.[6]

The potential to develop British Columbia's natural gas resources to produce LNG for export has attracted significant attention.[7] The Kitimat LNG project, the first large-scale proposal, has proceeded through the regulatory stages, receiving the necessary permits. This report anticipates a plant with an initial liquefaction module—called an LNG train—with a capacity of 5 mtpa at a capital cost of $4.5 billion. (One tonne of LNG represents 54.7 gigajoules of energy, or 46.7 thousand cubic feet of natural gas.) First deliveries are currently expected in 2017. A second LNG train with a capacity of 5 mtpa is anticipated to begin construction in 2016, with first delivery of LNG beginning in 2019. Kitimat LNG is a joint venture between Apache Resources, Encana Corp., and EOG Resources. Natural gas produced in northeast British Columbia will be transported to the LNG terminal via the Pacific Trail pipeline, which would be constructed by Spectra Energy at a cost of $1 billion.[8] The 468-km pipeline would have a diameter of 42 inches, suggesting that additional compressor stations could increase the capacity well beyond the 1.4 bcf/d required to supply the two LNG trains.

Shell Canada has also announced an LNG liquefaction plant and export terminal for Kitimat. Its project includes two trains of 6 mtpa each, at an estimated cost of $12 billion. Shell's partners for the project are Mitsubishi Corp., Korean Gas Corp., and PetroChina Co. Natural gas would be carried to this plant from the Fort St. John region via the Coastal Gaslink, a 700-km pipeline with a design capacity of 1.7 bcf/d sponsored by TransCanada. Coastal Gaslink is estimated to cost $4 billion.

Petronas and Progress Energy have also announced their intent to jointly develop a two-train LNG terminal capable of exporting 7.4 mtpa. The details of this project have yet to be released.

The Haisla First Nation and LNG Partners have announced plans for an LNG export facility with an initial capacity of 0.7 mtpa, which could be expanded to 1.8 mtpa. This project would not have a dedicated pipeline associated with it.

Several companies have announced plans for LNG liquefaction plants, pipelines, and/or export facilities in British Columbia.

Most recently, Spectra Energy and BG Group announced their intention to develop plans for an 850-km pipeline from northeast British Columbia to Kitimat. The line would cost $8 billion and have a capacity of 4.4 bcf/day. It would supply an LNG export facility that BG Group plans to develop. Details about the LNG facility have not yet been released. However, the pipeline capacity would be enough to serve about 30 mtpa of LNG exports, suggesting that this single line could supply all of the proposed projects.

This report does not assume that all projects will proceed. If that were to happen, Canada would go from no LNG exports to being the second-largest LNG supplier in the world over a very short period. For this report, we assumed that four LNG trains will be constructed, totalling 20 mtpa of capacity. The natural gas requirements, based on our assumptions of capacity and timing, are shown in Chart 9. Trains are expected to start deliveries in 2016, 2018, 2019, and 2021, as shown in the chart. The resulting capital investments for both LNG terminals and supporting pipelines are based on the capacity required to export 20 mtpa, suggesting a probable future consolidation of the announced plans for pipelines in particular.

5 Poten & Partners, *2015–2035 LNG Market Assessement*, 6.

6 Ibid., 7.

7 The information on LNG projects and costs is dynamic. The data cited in this section are taken from Hamilton, "Shell, Asian Energy Giants to Build Largest LNG Plant in B.C." and company websites.

8 The pipeline costs cited here are those put forward by Kitimat LNG and Pacific Trail Pipelines.

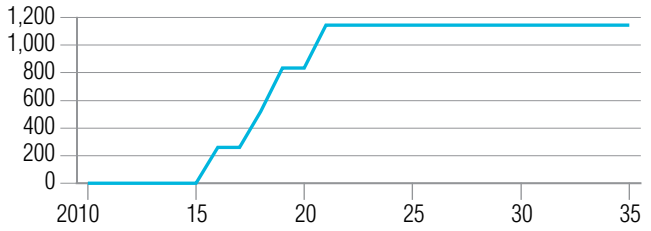
BITUMEN PRODUCTION

Bitumen is produced in three main regions of Alberta (Athabasca, Peace River, and Cold Lake) using two basic techniques (mining and in situ). Currently, mining technologies are used only in the Athabasca oil sands, whereas in situ technologies are used in all three regions. The Athabasca is the most important region, both in terms of current production and anticipated future projects. Natural gas is used by bitumen mines to raise steam used in centrifuges to separate the bitumen from the sand. For in situ technologies, the steam is injected into the oil sands zone to release bitumen from the underground sands and allow it to flow to a production well. Because the cost of natural gas is a significant component of operating costs, and because of the growing pressure on water supplies, bitumen producers continue to research ways to reduce the steam requirements per barrel of bitumen produced.

The overall outlook for bitumen production is shown in Chart 10. This outlook was developed based on a review of existing projects, new projects under construction, projects that have received or applied for regulatory approvals, and other announced projects. Total bitumen production is projected to triple between 2010 and 2035, although this represents the capacity from only about 60 per cent of the projects that have been announced.

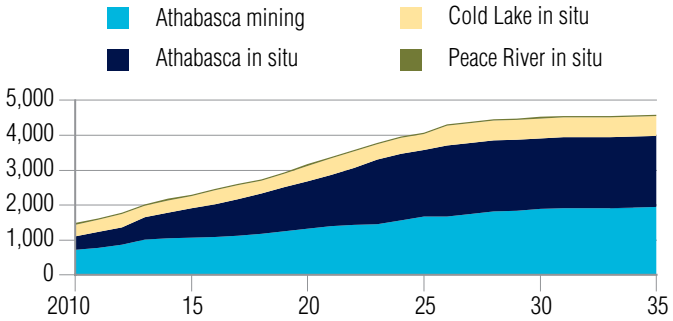
The Athabasca region accounts for most of the projected increase in production, and within the Athabasca region, in situ production methods will rise from 37 per cent of the region's production in 2012 to 50 per cent by 2020 and 55 per cent three years later. This is important because the current average natural gas requirement for in situ production is 1.35 thousand cubic feet (Mcf) per barrel of bitumen produced—compared with 0.7 Mcf/barrel of bitumen for mining projects.

Chart 9
LNG Demand for Natural Gas, 2010–35
(billion cubic feet per year)



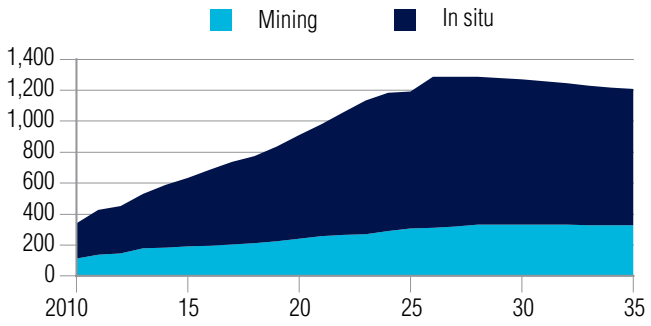
Source: The Conference Board of Canada.

Chart 10
Bitumen Production, 2010–35
(thousand barrels per day)



Source: The Conference Board of Canada.

Chart 11
Natural Gas Consumption for Bitumen Production, 2010–35
(billion cubic feet per year)



Source: The Conference Board of Canada.

Chart 11 shows projected natural gas requirements for bitumen production.[9] The rapid growth through 2026 will result from rapid growth in bitumen production. In the last 10 years of the outlook, bitumen production is projected to level off, while the natural gas requirement per barrel of bitumen will continue to decline, resulting in an overall decline in natural gas consumption in this sector.

SUPPLY/DEMAND BALANCE

Demand from the various sectors of the economy outlined in this chapter will lead to a doubling of natural gas demand in Canada (including LNG export projects) by 2035, while conventional natural gas production in Alberta and Saskatchewan is expected to decline for at least the coming decade. Alberta faces a particularly strong challenge from declining natural gas production and rapidly rising natural gas consumption for bitumen extraction and electricity generation. Consumers in Eastern Canada are likely to rely more and more on imported U.S. natural gas as shale gas development continues and pipeline capacity expands.

The net volume of natural gas exported by pipeline to the United States is assumed to be the balancing factor in the outlook. Net exports of natural gas have been declining steadily since 2007, reaching just 2.45 tcf in 2010. This downward trend is expected to continue. This outlook assumes that net pipeline exports will fall to just 1 tcf in 2020. Beyond that, incremental supplies of natural gas from drilling levels above those assumed for this report, or from frontier sources not included in the investments shown in Chapter 3, may be required to prevent further decline in pipeline exports. This report does not include the impact of frontier natural gas development, either in the Mackenzie Delta or offshore Newfoundland, because there is still too much uncertainty as to whether it will proceed. Either development would add significant investments to those quantified in Chapter 3.

9 Note that the natural gas demand for bitumen and synthetic crude production shown in Chart 11 does not include gas produced with the bitumen—that is, solution gas. Alberta does not include natural gas produced with bitumen in the category of marketable natural gas.

CHAPTER 3

Natural Gas Industry Investments

Chapter Summary

- From 2012 to 2035, a projected $386 billion (in 2012 dollars) will be invested by the natural gas industry, $295 billion of which (76 per cent) will occur in the upstream segment of the industry.
- Investments in British Columbia are expected to be about equal to investments in Alberta. Together, these two provinces will account for $335 billion (2012 dollars), or 86.7 per cent of the total investment.
- Additional potential investments could occur should LNG capacity, bitumen production, or shale gas production exceed the forecast levels.
- Investments in additional natural-gas-fired electricity generation capacity will be focused in Ontario, Alberta, and Saskatchewan.

This chapter outlines the investments that the natural gas industry will be required to make between 2012 and 2035, based on the market requirements described in Chapter 2. The investments, which total $386 billion in 2012 dollars, are presented by province and by industry segment in Table 3, and then also broken down by time periods in tables 4 to 9. The upstream industry, which includes exploration, production, gathering systems, and liquids extraction facilities, will account for almost 76 per cent of the total investment.

Meanwhile, investments in LNG liquefaction facilities in British Columbia will almost equal investments in the distribution system for the nation as a whole. On an annual basis, the average level of investment is expected to be $16 billion, including all industry segments. These investments include only the capital cost of constructing the assets, and exclude operations and maintenance costs. This approach is typical of economic impact assessments. Chapter 4 includes an additional analysis of the economic footprint of natural gas production in the Canadian economy.

DISTRIBUTION SYSTEMS

Distribution system investments can be divided into two main categories: those required to accommodate market growth, and those required to maintain the distribution systems in good operating condition. Total distribution system investments in Canada through to 2035 are shown in Table 4. The investments required to accommodate market growth are based on a relationship between the total capacity of the natural gas plants in service and the volume of natural gas delivered by the distribution utilities in each province. The market demand projections from Chapter 2 were used to determine the growth in overall system deliveries and the resulting investment required to meet that growth. Investment to replace depreciating assets was also included based on the rate of depreciation allowed by the regulator. Investments in vehicle filling stations are not included in the tally of distribution system investments.

Table 3
Natural Gas Industry Sector Investments by Sector
(2012 $ millions)

	N.L.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Canada
Distribution system	0	0	120	171	3,654	13,798	599	456	6,354	4,864	30,015
LNG liquefaction terminals	0	0	0	0	0	0	0	0	0	29,260	29,260
Pipelines	0	0	0	0	0	0	0	0	0	7,260	7,260
Natural gas vehicles and infrastructure	0	0	0	0	213	1,502	114	184	596	591	3,200
Power generation	90	0	0	0	0	9,977	0	3,168	8,244	0	21,479
Upstream natural gas industry	0	0	0	200	6,853	0	0	10,153	138,873	139,042	295,121
Total	90	0	120	371	10,720	25,277	713	13,960	154,066	181,017	386,335

Source: The Conference Board of Canada.

Table 4
Distribution System Investment in Canada
(2012 $ millions)

	Average Annual Investment					
	2012–2015	2016–2020	2021–2025	2026–2030	2031–2035	Cumulative 2012–2035
Investment	1,833	1,318	1,076	1,070	1,073	30,015

Source: The Conference Board of Canada.

As shown in Table 4, distribution system investments are expected to average just over $1 billion (in 2012 dollars) annually throughout the outlook period.

LNG LIQUEFACTION TERMINALS

Projected investments in LNG liquefaction and export terminals are shown in Table 4. The investments will begin in 2014 with the construction of the first train of the first project. A second train would begin construction in 2016. A second LNG project would follow, with construction beginning in 2017 for the first train and 2019 for the second. We assumed the facilities will cost $1 billion per million tonnes of liquefaction capacity. The investments in Table 4 represent the capital cost of construction and exclude operating and maintenance costs. The electric power required for the liquefaction process was assumed to be purchased. The full 20 mtpa of capacity would therefore be in service by the end of 2021.

It is important to note that the LNG investments shown in Table 5 are subject to uncertainty with respect to timing, cost, and the level of capacity that will actually be developed. The government of British Columbia has identified the potential to export up to 35 mtpa of LNG by 2025. However, Canada does not currently have an LNG export facility in operation, and numerous competing projects are expected to serve Asian markets. The 20 mtpa considered for this analysis could be considered aggressive in that it would take Canada very quickly into the top five LNG producers in the world. On the other hand, it could be considered pessimistic given the market potential in Asia and the potential shale gas resource in northeast British Columbia.

Table 5
Investment in LNG Liquefaction Terminals in Canada
(2012 $ millions)

	Average Annual Investment					
	2012–2015	2016–2020	2021–2025	2026–2030	2031–2035	Cumulative 2012–2035
Real investment	1,040	4,422	598	0	0	29,260

Source: The Conference Board of Canada.

Table 6
Pipeline Investment in Canada
(2012 $ millions)

	Average Annual Investment					
	2012–2015	2016–2020	2021–2025	2026–2030	2031–2035	Cumulative 2012–2035
Investment	206	1,089	198	0	0	7,260

Source: The Conference Board of Canada.

LNG capacity of 20 mtpa operating for 30 years would consume about 30 tcf of natural gas (and would require significantly larger amounts of natural gas to maintain 1 tcf of LNG production annually). However, this is only a fraction of the shale gas resource believed to be in place.

There are additional benefits of LNG facilities for British Columbia. The shale gas resource that would provide natural gas to the facilities is expected to be rich in natural gas liquids. LNG facilities use refrigeration cycles to cool the natural gas, eventually liquefying it. The propane, butane, and ethane in the input natural gas will liquefy at their critical temperatures, all of which are above that of methane, the primary component of LNG. This will provide additional products that can be sold to markets or re-injected into the LNG prior to transport—whichever is financially and operationally best. Conversely, if the shale gas is developed and delivered to market via pipelines, the natural gas liquids in excess of pipeline inlet specifications must be removed at expansions to existing processing plants, or at new processing plants.

Finally, LNG is currently priced relative to crude oil, which means that under current conditions the delivered market price less transport and liquefaction costs is significantly higher than the price producers receive for pipeline sales. Although it is likely that at least some of this price differential would be negotiated away, the opportunity for this "premium netback," based on the pricing formula linked to crude oil, may persist for natural gas sold into LNG markets.

PIPELINE INVESTMENTS

This report considers only pipeline investments that would be required for new long-distance transmission. Investments in field gathering systems are included in the upstream investments. Canada's east–west transmission capacity exceeds current natural gas flows by a margin that suggests investments in expansion capacity are unlikely. Similarly, Atlantic Canada is not expected to see incremental natural gas transmission investments in the projection period. The primary source of investment in long-distance transmission is expected to be the capacity required to move incremental natural gas production in British Columbia to the LNG export facilities described above. Pipeline investments projected for Canada from 2012 to 2035 are shown in Table 6.

NATURAL GAS VEHICLES

Natural gas vehicles have been available in Canada for decades, but have not yet made significant inroads in the market. The lack of filling-station infrastructure and resulting inconvenience for consumers is one of the key reasons for the lack of interest in the light-duty vehicle market segment. Vehicle conversion kits are available for a broad range of models, as is installation by qualified technicians. The time required to repay the conversion cost with fuel savings depends on the vehicle, annual distance driven, and the cost differential between natural gas and gasoline. Because the range between fills for natural gas vehicles is shorter than for gasoline, conversions typically retain the gasoline fuel system, making the vehicle dual-fuelled. The percentage of kilometres driven on natural gas versus gasoline is therefore another factor in the time required for cost recovery.

British Columbia and Quebec have programs to encourage natural gas vehicles. Alberta, Saskatchewan, Manitoba, and Ontario show market penetration starting in 2015.

For this analysis, we assumed an incremental cost of $4,000 per light-duty vehicle operating on natural gas. The filling infrastructure required was assumed to cost $250,000 per station. This includes the cost of compressors to deliver high-pressure natural gas to the vehicle, an island for the natural gas pump, the pump itself, and the safety equipment required to meet regulations. The natural gas pumps could be installed at retail gasoline filling stations, or could be dedicated infrastructure for light-duty fleets. Because the fuel that will be delivered is compressed natural gas, there would no need for storage facilities—the natural gas was assumed to be compressed at the time of filling. We assumed a ratio of 50 light-duty natural gas capable vehicles per natural gas filling station, and the growth in the vehicle fleet described in Chapter 2. The underlying assumption was that 1 per cent of the new vehicles purchased will be able to run on natural gas.

British Columbia and Quebec both have programs to encourage natural gas vehicles, and the penetration into these markets was assumed to continue from 2012 onward. Alberta, Saskatchewan, Manitoba, and Ontario show market penetration beginning in 2015. The Atlantic provinces were not assumed to have sufficient natural gas delivery infrastructure to support light-duty natural gas vehicles. The level of investment in natural gas vehicles (both light and heavy duty) and filling infrastructure is shown in Table 7.

Heavy-duty natural gas vehicles represent a significant market opportunity, as described in Chapter 2. The initial conversion cost was assumed to be $80,000 per vehicle, with 2 per cent of new heavy-duty trucks assumed to be fitted for LNG. The filling station infrastructure was assumed to cost $2 million per station, with each station serving 100 vehicles.

Table 7
Natural Gas Vehicle and Infrastructure Investment in Canada
(2012 $ millions)

	Average Annual Investment					
	2012–2015	2016–2020	2021–2025	2026–2030	2031–2035	Cumulative 2012–2035
Stations	42	83	74	51	54	1,477
Vehicles	39	93	95	62	62	1,723
Total	82	176	170	113	116	3,200

Source: The Conference Board of Canada.

Table 8
Investments in Natural-Gas-Fired Electricity Generation
(2012 $ millions)

	Average Annual Investment					
	2012–2015	2016–2020	2021–2025	2026–2030	2031–2035	Cumulative 2012–2035
Alberta	1,161	360	180	180	0	8,244
Saskatchewan	117	144	36	180	180	3,168
Ontario	784	684	576	108	0	9,977
Canada	2,062	1,188	810	468	180	21,479

Source: The Conference Board of Canada.

ELECTRICITY GENERATION

Since the 1980s, natural gas combined-cycle technology has been the most energy-efficient thermal generation technology available. It also offers the lowest capital cost per MW of installed capacity and the shortest lead times for planning and building new generating units or stations. The most important limiting factor has been uncertainty over the future cost of the natural gas used as fuel, followed by potential uncertainty of supply. The technologies that have added shale gas to the economic resource base have ensured that natural gas will be available in large quantities for many years to come. This has partly addressed the issues around uncertainty of supply. The current low price environment for natural gas is expected to persist for years to come, but perhaps not for decades, leaving fuel cost uncertainty as a key issue for new generating projects.

The investments in electricity generation facilities shown in Table 8 are based on the Conference Board's assessment of market requirements and technology choices in each province. The initial capital cost was assumed to be $1.8 million per MW of installed capacity for natural-gas-fired units. Much of the capacity assumed to be installed is either already under construction or at advanced stages of planning. Alberta and Ontario in particular are becoming capacity constrained. Ontario is in the final stages of shutting down its coal-fired capacity (to be completed by 2014), and Alberta must deal with 2,871 MW of coal-fired capacity that will reach decision points on repowering or replacement by 2020. Changes to federal emissions regulations will play a key role in determining how much new natural-gas-fired capacity will be installed. (See Table 2 for the assumptions used in this report.)

UPSTREAM NATURAL GAS INVESTMENTS

Continued investment in the exploration for and production of natural gas in Canada is essential to being able to meet the market demands identified in Chapter 2. However, very low natural gas prices are currently putting extreme pressure on the industry's ability to invest in new production. This price pressure has resulted in large part from surges in shale gas production in the United States. In recent years, natural gas demand has been rising in the U.S., but production has been rising faster, resulting in declining exports from Canada.

The duration of the current period of low prices depends in part on access to new markets. Canadian natural gas producers do not currently have any ability to reach markets outside Canada and the United States. The U.S. has almost no LNG production capacity (one small plant in Alaska), and LNG import capacity is being underutilized. This leaves North America as an isolated market where the continental supply/demand balance determines the market clearing price.

Natural gas supply from the Western Canada Sedimentary Basin (WCSB) depends on a number of critical factors. As the conventional resource base has matured, the size of incremental discoveries has been declining steadily. Initial production rates per well have been declining

in each region, and the rates at which production from each well declines from that initial rate have been increasing. This means that more wells must be drilled to maintain a given level of production. The pending development of shale gas and tight gas resources in northeast British Columbia in particular has the potential to reverse this trend. However, the reversal remains in the future.

The methodology used to determine upstream natural gas investments for this report was simple. It began with the demand levels identified in Chapter 2, as well as assumptions about the current and future prices of natural gas and crude oil. These factors were used to estimate statistically the number of rigs that will be actively drilling for oil or natural gas. Rig counts were separated between the three provinces that contain portions of the (WCSB). The active rig count was used to statistically estimate the number of natural gas wells that will be completed in each of the provinces' various production regions—regions determined by the Petroleum Services Association of Canada. Once the well completions were determined for each province, assumptions for existing production, initial production rates, and decline rates for each region were applied to determine future natural gas supply.

Initial production rates and production decline rates were applied to determine the natural gas production available from new wells to supplement existing production. This provided an outlook for natural gas production, which was aggregated up to the provincial level.

Wellhead prices were applied to determine the wellhead revenue stream. Revenues from natural gas liquids were based on the historical level of liquids production per unit of natural gas production. Wellhead revenues plus a reinvestment rate provided a level of investment available. This investment was allocated between exploration activities, wells, gathering systems, and processing plants, based on historical data from the Canadian Association of Petroleum Producers (CAPP). See Appendix B for additional detail. For example, CAPP does not report upstream spending for land, geophysical work, or drilling separately for oil vs. gas. For this analysis, that spending was allocated based on historical shares of wellhead revenues. The historical data were used as a cross-check against the affordability of the level of drilling activity looking forward (via the reinvestment rate).

The level of drilling activity is a key determinant of future natural gas production capacity, yet it is subject to considerable uncertainty, particularly because of the current low prices. For example, the average number of successful natural gas well completions in Alberta through the 1990s, a period of low prices, was 2,938 wells per year. Prices went up later in the decade as pipeline capacity came into better balance with productive capacity. In the first decade of the 2000s, a period of strengthening prices (reaching record highs), an annual average of 10,249 natural gas wells were completed.

The level of drilling activity is a key determinant of future natural gas production capacity, yet it is subject to considerable uncertainty.

In 2011, the number of completions fell to 3,345, and 2012 appears to be even weaker. This projection is based on an average from 2012 to 2035 of just over 5,000 wells per year in Alberta, 865 wells per year in British Columbia, and 380 wells per year in Saskatchewan. Total natural gas production in Alberta will decline to just 73 per cent of its 2012 level by 2020, then rise slowly to just under 80 per cent of current levels by the end of the projection. Natural gas production in Saskatchewan will decline slowly but steadily, falling to just 55 per cent of the current level by 2035. Production in British Columbia will increase primarily because of shale and tight gas required to supply LNG exports. Production from that province will increase by two-thirds by 2025, after which the growth will continue at a more moderate pace. Upstream investments by province are shown in Table 9.

The upstream investments shown for Quebec reflect the potential for shale gas development in that province. Although there is currently a moratorium on shale gas drilling, the industry and government are working together and to engage stakeholders to determine whether regulations can be crafted to allow development to proceed.

The investments presented for Quebec should be considered highly speculative. A regulatory framework that allows activity and provides appropriate returns may not be achieved. The level of drilling activity, costs, and resulting production estimates may not be realistic. To

Table 9
Upstream Natural Gas Investments
(2012 $ millions)

	Average Annual Investment					
	2012–2015	2016–2020	2021–2025	2026–2030	2031–2035	Cumulative 2012–2035
British Columbia	1,840	4,976	7,410	7,227	6,723	139,042
Alberta	2,798	4,301	5,451	7,115	8,669	138,873
Saskatchewan	323	402	420	451	500	10,153
Quebec	0	87	409	437	437	6,853
New Brunswick	10	10	10	10	10	240
Canada	4,971	9,776	13,700	15,240	16,339	295,161

Source: The Conference Board of Canada.

date, only 10 wells have been drilled to test the prospects of shale gas production. Only a couple of production tests are available from which to form judgments about future well performance. And there are no wells with a production history. Overall, our assumptions for Quebec rest on a shaky platform. The investments shown assume a ramp-up to 70 wells per year by 2020 that collectively satisfy about half of Quebec's natural gas requirements. A more aggressive outlook is certainly possible, as is a continuation of the current situation with no drilling permitted.

The investments shown for New Brunswick represent a continuation of the long-term historical trend for natural gas upstream activity. They do not include the potential for shale gas development, since there is insufficient knowledge of the resource base, natural gas composition, production characteristics, and cost structure to include even a speculative forecast. New Brunswick is expected to have strong resource potential for shale gas. The province has been reviewing its regulations for shale gas development, and has engaged stakeholders to hear their views. A recent report recommends "a comprehensive business case for the development of a shale gas industry in New Brunswick detailing and evaluating the positive and negative impacts for both the short and the long term."[1] As the province proceeds with consultations and analysis, shale gas development may provide economic opportunities in addition to those described in this report.

1 LaPierre, *The Path Forward*, 16.

CHAPTER 4

Estimating the Economic Footprint of Natural Gas Industry Investments

Chapter Summary

- The investments detailed in Chapter 3 will benefit the Canadian economy through both the resulting infrastructure and resulting natural gas production.
- The total investment of $386 billion (2012 dollars) will contribute $364.3 billion to Canada's GDP between 2012 and 2035, of which 72 per cent will be generated in Alberta and British Columbia.
- The investments will generate 3.2 million person-years of employment, or an average of 131,460 jobs annually.
- The resulting corporate profits will be $2.5 billion per year, labour income will be $10.7 billion per year, and federal and provincial taxes will be $5.3 billion per year.
- Natural gas production will contribute another $576 billion to Canada's economy over the next 24 years, supporting roughly 129,000 jobs per year.

This chapter estimates the total economic impact of the natural gas investment discussed in Chapter 3. This investment yields two distinct types of benefits: the gains realized when the investment dollars are being spent on infrastructure and the gains realized when the additional infrastructure translates into increased production. To highlight the impact of each of these two distinct benefits, they are discussed separately below. First, we examine the total economic benefit by province resulting from the investment, and then we estimate the impact of increased natural gas production on the Canadian economy. Finally, we summarize the findings of this analysis.

ECONOMIC IMPACT OF INVESTMENT SPENDING

This section outlines the methodology used to calculate the total economic impact by province resulting from the investment flows, and then provides the results from the impact analysis.

ECONOMIC IMPACT METHODOLOGY

To calculate the real total economic impact of the capital investment described in Chapter 3, it was necessary to rebase the investment flows from 2012 dollars to 2002 dollars. This was necessary because 2002 is the base year that Statistics Canada has adopted for the National Income Accounts, and so the Conference Board's forecasting models also have a 2002 base year. For discussion purposes, total real GDP figures were rebased to 2012 dollars to maintain consistency with the previous chapter.

Next, a simulation was produced using Statistics Canada's interregional input-output model. This simulation provides the average supply-chain (or indirect) impacts of

the energy investment in machinery and equipment and in structures for each of the provinces. Finally, the Conference Board's provincial forecasting model was simulated to determine the total economic impact of the projected new investment. The analysis evaluates the combined direct, indirect, and induced economic impacts where:

- **Direct impacts** measure the value added[1] from the investment; they are the impacts directly attributed to the employees, the wages earned, and the firms' revenues generated by the construction of the infrastructure.
- **Indirect impacts** relate to determining the value that the investment generates economically to other industries through the supply chain. For example, increased construction activity will boost demand for intermediate inputs and generate increased activity in the financial services sector.
- **Induced impacts** are derived from the purchases of employees and reinvestment of profits from both the construction and supplier industries. These (usually smaller) impacts lead to more employment, wages, income, and tax revenues and have widespread impacts on the economy.

As a result, increased demand not only will have direct impacts on the economy but will spread through the economy through a series of multiplier effects. Indirect effects are first felt because of an increase in demand for products and services from industries that are direct suppliers. Second-round induced effects produce a smaller but more widespread impact on all sectors of the economy, largely through a general increase in consumer spending.

Moreover, direct, indirect, and induced impacts will extend outside regional and national boundaries to suppliers and related industries in other provinces and, indeed, other countries. Depending on the industrial makeup of each of the regions, the economic impacts can vary significantly. For example, the manufacturing bases in smaller provinces are not as diversified as in the largest provinces and, as a result, machinery and equipment bought in the smaller provinces will have a much higher import content than, say, machinery and equipment purchased in Ontario. Thus, we find that investment spending in smaller provinces tends to have smaller impacts, while provinces that have a greater capacity to provide these products benefit from activity in other regions.

Increased demand for natural gas not only will have direct impacts on the economy but will spread through the economy through a series of multiplier effects.

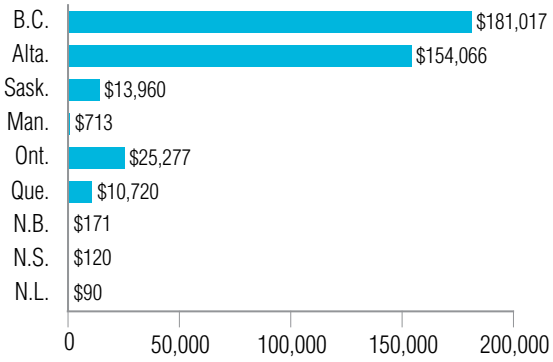
Given the detailed nature of this investment spending and the importance of assessing cross-regional effects, the study relied on the use of Statistic Canada's detailed model of regional industrial structure in order to assess the direct and indirect effects to related industries across regions. Statistics Canada's interregional input-output model has the advantage of finely detailing the industrial structure within an industry as well as containing detailed linkages for input commodities to other industries, because it breaks down roughly 300 industries and over 700 commodities. As many of these links are unpublished (to maintain confidentiality), Statistics Canada has the advantage of being able to assess much more accurately both the direct and indirect effects of specific investment profiles provided on a regional basis.[2]

While the Conference Board's provincial forecasting model contains a more aggregate industrial sector, it has the benefit of assessing the impact of additional income, through changes in wages and profits, on a wide range of economic indicators. Moreover, the Conference Board's model allows for the analysis to be carried out over a time period, whereas Statistics Canada's input-output model produces a point-in-time measure of the impact. The direct and indirect effects obtained from the input-output model simulations were used as guides when simulating the Conference Board's model of the provincial economies to produce the overall economic impact by province of potential investment in upstream natural gas over 2012 to 2035.

1 Value added or net output 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.

2 For more information about Statistics Canada's interregional input-output model see Erik Poole, *A Guide to Using the Statistics Canada Input-Output Model*.

Chart 12
Total Natural Gas Investment Spending 2012–35
(2012 $ millions)



Source: The Conference Board of Canada.

RESULTS FROM THE ECONOMIC IMPACT ANALYSIS OF INVESTMENT SPENDING

The total cumulative value of natural gas investment in 2012 dollars in this economic impact analysis—or economic "shock"—will be $386 billion from 2012 to 2035. The direct investment in each province is, of course, the main factor determining the overall economic benefit accruing to each region. By far, the largest investment occurs in British Columbia and Alberta. (See Chart 12.) Even though the largest increases will occur in the two westernmost provinces, the benefit of their investments will cascade throughout the Canadian economy, with every province experiencing an increase in economic output due to this investment.

Direct investment is the main driver of the impact analysis results. But when conducting a simulation over a long time period that considers interregional linkages, there are many other factors that can contribute to or lessen the impact in a particular region.

As small, open economies, all of the provinces are dependent on trade. As a result, the impact in each region depends on how much it imports in response to the direct investment and how much it exports in response to demand from the direct investment in other provinces. Indeed, one of the most important aspects of this analysis is the differing international and interprovincial trade movements resulting from the investment flows, as captured by Statistics Canada's input-output framework.

Another important consideration when examining the impact of this investment is the labour markets in each region. In provinces where labour scarcity is already an issue, large-scale investment spending will lead to an increase in interprovincial migration to the region. This has the effect of magnifying the impacts in regions that are net recipients of migrants and dampening the benefits in regions with outmigration.

In a traditional impact analysis, an economic multiplier can be calculated to show the increase in real GDP and employment resulting from a fixed amount of investment. Since this is a multifaceted analysis that considers the linkages between regions (such as trade flows and population movements), the impact in each region depends on what is happening not only in that particular province but also in all the other provinces. And, since the dollar value of the investment in each province changes throughout the time period considered in this scenario, it is impossible to calculate a meaningful economic multiplier for each region. Therefore, the results of this analysis are presented as the cumulative benefit realized in each region, with more detailed impact, or "shock," results by province available in Appendix A.

While British Columbia will have the highest dollar value of investment, it is Alberta that will experience the largest increase in real GDP.

While British Columbia will have the highest dollar value of investment, it is Alberta that will experience the largest increase in real GDP, estimated at $153.6 billion (in 2012 dollars) over 2012 to 2035. (See Table 10.) For both British Columbia and Alberta, the total impact on real GDP will be less than the value of the investment, as a notable proportion of the benefits associated with the investment in these provinces accrue outside their borders.

Table 10
Key Economic Indicators: Cumulative Impact of $386-Billion Investment, 2012–2035
(level difference, shock minus control)

	N.L.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.
Real GDP at basic prices (2012 $ millions)	672	45	842	582	17,963	57,171	3,955	13,274	153,615	116,211
Total employment (person-years)	2,967	632	10,083	6,181	198,731	559,696	39,235	92,434	949,662	1,295,431
Labour income (millions)	176	32	572	349	12,344	41,327	2,474	6,770	104,360	87,720
Federal personal income tax collections ($ millions)	28	5	83	48	1,639	6,330	327	1,031	16,822	15,050
Provincial personal income tax collections ($ millions)	18	3	59	29	1,925	4,093	267	464	6,981	5,612
Total indirect taxes ($ millions)	44	9	146	85	3,684	10,145	512	1,994	14,081	21,351
Corporate profits ($ millions)	255	6	104	62	1,787	6,791	637	4,093	31,397	15,374
Corporate taxes ($ millions)	10	3	74	28	637	1,673	122	482	6,458	4,695
Total taxes ($ millions)	99	20	361	190	7,885	22,240	1,229	3,970	44,342	46,708

Sources: The Conference Board of Canada; Statistics Canada.

There are a number of reasons why Alberta's real GDP impact will be higher than British Columbia's despite the fact that it will have lower direct investment. First, the share of machinery and equipment investment in Alberta will be slightly lower than in British Columbia. Since machinery and equipment investment tends to have relatively high import content, a smaller share of spending on machinery and equipment in the investment profile translates into less import leakage. Second, the results from Statistic Canada's interregional input-output model show that the investment spending in all the provinces will have a larger indirect economic benefit in Alberta than in British Columbia. This suggests that this investment profile will generate, on aggregate, more indirect demand for products and services produced in Alberta than in British Columbia. Finally, there are significant differences in the provincial labour markets. While British Columbia is able to meet almost all of the increased demand for workers internally, the labour market in Alberta is very tight. As a result, in this scenario, interprovincial migration to Alberta will increase strongly.[3]

The population increase will help fuel demand for other housing and other goods and services, leading to further economic benefits in Alberta.

The results in Saskatchewan are similar to Alberta, but on a smaller scale. Total real GDP in Saskatchewan is forecast to increase by $13.3 billion over 2012 to 2035—less than the direct investment in the province, as a portion of the benefit will be realized by suppliers in other provinces and internationally. On the other hand, the tight labour markets in Saskatchewan will result in an influx of interprovincial migrants, helping to boost the economic impact in the province.

The scenario that plays out in Quebec, Ontario, and Manitoba is different because these provinces, with their relatively diversified manufacturing bases, benefit not only from the direct investment in their economies but also from the increased demand stemming from the significant investments in Western Canada. As a result, these provinces will have the largest increase in exports in response to the demand from Alberta and British Columbia. The sheer size of the supplier industries in Quebec and Ontario will result in a significant boost to

3 This report does not attempt to account for any potential misalignment in the demand and supply of skilled workers but rather assumes that the available supply of workers in the province is capable of meeting the increased labour demand.

these economies as they benefit from the indirect and induced impacts generated by the large investments in the West.

Investment in Atlantic Canada will be relatively small, but the massive demand for goods and services generated by the investment activity in Central and Western Canada will benefit the region as it supplies goods and services to other provinces. Collectively, Atlantic Canada will benefit to the tune of $2.1 billion from 2012 to 2035 thanks to the investment in natural gas infrastructure across the country. In total, the cumulative impact across Canada will be a $364.3-billion increase in real GDP.

Across Canada, a total of 3.2 million person-years of employment will be created by the direct, indirect, and induced impacts of the natural gas investment. This suggests that over 2012 to 2035, natural gas investment will support roughly 131,000 jobs per year in the Canadian economy.

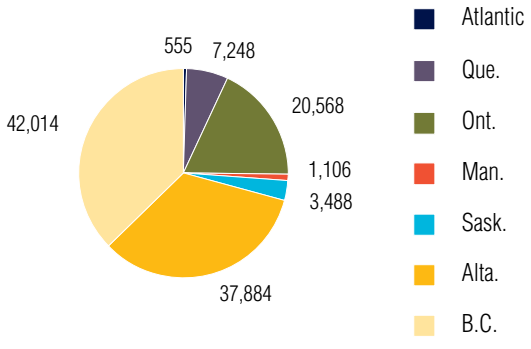
Interestingly, while Alberta had the largest impact on real GDP, it is British Columbia that will create the most new jobs in this scenario. At first glance, it may seem like there is a disconnect between the GDP and employment impacts, but this dichotomy is a result of differences in labour productivity. The latest data from Statistics Canada show that for 12 of 15 private sector industries, the level of labour productivity in Alberta is significantly higher than in British Columbia. Higher labour productivity means that each worker in Alberta produces more output and, as a result, the increase in real output in Alberta can be accomplished with relatively fewer workers. Overall, as a result of the investment in this scenario, British Columbia is expected to create 1.3 million person-years of employment, while Alberta will create 950,000.

The smallest jobs impact will be in Atlantic Canada (where the smallest output gains are realized), with a few thousand person-years of employment created over the study's time horizon. Ontario stands to create 560,000 person-years of employment, while 199,000 person-years of employment will be created in Quebec. Decent job gains will also be realized in Saskatchewan (92,400 person-years) and Manitoba (39,200 person-years).

The impact on labour income by province depends on two factors: the employment created in each industry and provincial wages in each industry. High-wage Alberta will lead the pack in gains in labour income, with a cumulative increase of $104.4 billion (in nominal terms—that is, not adjusted for inflation), followed by British Columbia ($87.7 billion) and Ontario ($41.3 billion). The rest of the national increase in labour income will be distributed among the rest of the provinces, in line with their respective increases in employment. Employees will not be the only group to profit, as employers will also realize significant benefit from this investment. Nationally, corporate profits will be up a cumulative $60.5 billion, with the largest gains in Alberta, British Columbia, and Ontario.

The significant increase in corporate profits and labour income will have a positive impact on government revenues. In this scenario, taxes on individuals—personal and federal income taxes as well as indirect (sales and excise) taxes—will increase by a cumulative $112.9 billion across the country. (See Chart 13.) Corporate taxes will also be up by a notable amount, with the largest increases again in Alberta ($6.5 billion), British Columbia ($4.7 billion), and Ontario ($1.7 billion).

Chart 13
Tax Revenues From Individuals, 2012–35
(increase in personal and federal income taxes and indirect taxes resulting from $386-billion natural gas investment, $ millions)



Sources: The Conference Board of Canada; Statistics Canada.

ECONOMIC FOOTPRINT OF NATURAL GAS PRODUCTION

Natural gas production will provide long-term benefits to communities and governments in the form of higher incomes and more employment. In this section, we estimate the economic footprint of natural gas production, that is, the economic activity and jobs supported by the production of natural gas in Canada over 2012 to 2035.

METHODOLOGY AND ASSUMPTIONS

Building on data from Statistics Canada on natural gas production volumes and real output in the oil and gas extraction industry, we used the Conference Board's medium-term national model to produce a scenario in which natural gas production will increase by roughly 365 bcf. Natural gas extraction will stimulate economic activity in Canada through a spreading out of demand for other goods and services. Indirect effects (or supply-chain impacts) will be felt in industries that are suppliers to natural gas producers. Induced impacts will be generated when employees of the these industries increase their spending and when owners, earning higher profits, increase investment. These lead to broader impacts on production, employment, wages, income, and tax revenues, which can be felt across a wide range of industries. The Conference Board's Canadian forecasting model captures the sum of the direct, indirect, and induced impacts on Canada's economy, based on its estimated historical relationships. The model incorporates a detailed modelling of prices, households, and businesses.

Comparing this scenario of an increase in natural gas production with a control scenario of no increase generated the economic impact of this boost to natural gas production on a wide range of economic indicators tracked by the model. Effectively, the economic impact analysis quantified the combined direct, indirect, and induced economic impacts on economic indicators that include GDP, employment, income, profits, tax revenues, and government balances.

This scenario was built under an arbitrary assumption that natural gas production will increase by 365 bcf, equivalent to 1 bcf of production per day over a year. The analysis also assumed that there will be no significant capacity constraints or transportation and logistical hurdles to increasing production. The increase in natural gas production of 365 bcf allows us to assess the larger footprint that total natural gas production has on the economy. In effect, we can assess the value-added production, income, and number of jobs that natural gas production supports in the economy both today and in the future.

RESULTS OF THE ECONOMIC IMPACT ANALYSIS OF NATURAL GAS PRODUCTION

Table 11 summarizes the findings of the economic impact analysis on a number of key economic indicators for Canada. The estimates provide the economic multipliers that allowed us to assess the broader economic footprint, including supply-chain and other impacts, that extra natural gas production will have on the Canadian economy. Employment will be 8,850 jobs higher under the increased natural gas production scenario, or "shock." Real GDP (in 2012 dollars) will be boosted by just under $1.7 billion, pushed up mostly by increases in labour income and profits.

Table 11
Increased Natural Gas Production of 365 bcf: Key Economic Indicators
(level difference, shock minus control)

Real GDP (2012 $ millions)	1,687
Employment (level)	8,854
Personal income (2012 $ millions)	1,039
Pre-tax corporate profits (2012 $ millions)	530
Personal income tax (2012 $ millions)	148
Corporate income tax (2012 $ millions)	102
Indirect taxes (2012 $ millions)	64
Federal government balance (2012 $ millions)	240
Regional government balance (2012 $ millions)	176

Sources: The Conference Board of Canada; Statistics Canada.

The impact on federal and regional government finances will also be significant. Together, federal and provincial real personal income taxes will be up by $148 million, while higher profits will bolster corporate income tax collections up by $102 million. Sales and excise taxes will increase as a result of the more generalized increase in income and consumer spending. Thus, total real indirect taxes will increase by $64 million. Increased personal, corporate, and indirect taxes will account for about 75 per cent of the positive effects on the federal and aggregate provincial government balances, although various other cost and revenue items (such as royalties) will also contribute positively to government books. A larger portion will be added to provincial coffers as a result of royalty revenues from natural gas extraction.

Table 12 highlights the employment impacts by industry. Total job gains of about 8,850 are expected, with primary industries accounting for most (6,170) of these. Other industries will experience considerably fewer job gains in comparison. Wholesale and retail trade will gain 640 jobs, and transportation and commercial services industries will each see gains of about 600 additional jobs.

Table 12
Increased Natural Gas Production of 365 bcf: Labour Market
(level difference, shock minus control)

Total employment	**8,854**
Primary	6,173
Construction	459
Utilities	74
Manufacturing	33
Other commercial services	605
Wholesale and retail trade	642
Transportation and storage	592
Finance, insurance, and real estate	63
Public sector	181

Source: The Conference Board of Canada.

Under not too stringent assumptions, these economic multipliers allow us to assess the economic contribution of additional natural gas production to Canada's economy. In the next section, we use these estimates to assess the industry's current and future footprint on Canada's economy.

CALCULATING THE BROADER FOOTPRINT OF NATURAL GAS PRODUCTION

Today, annual natural gas production in Canada is estimated at 5,320 bcf. Our impact analysis of the broader footprint of the sector on the Canadian economy suggests that production of 5,320 bcf supports nearly 130,000 jobs and generates over $24.5 billion in economic activity (in 2012 dollars). (See Table 13.) The industry supports about $15.1 billion in household income and $7.7 billion in profits when accounting for direct, supply chain, and induced impacts throughout Canada. Moreover, together, federal and regional government balances are improved by just over $6 billion.

Table 13
Natural Gas Production's Broad Footprint on Canada's Economy, 2012
(economic activity and jobs supported by Canadian production)

Real GDP (2012 $ millions)	24,587
Employment (level)	129,042
Personal income (2012 $ millions)	15,130
Pre-tax corporate profits (2012 $ millions)	7,724
Personal income tax (2012 $ millions)	2,151
Corporate income tax (2012 $ millions)	1,493
Indirect taxes (2012 $ millions)	931
Federal government balance (2012 $ millions)	3,507
Regional government balance (2012 $ millions)	2,552

Sources: The Conference Board of Canada; Statistics Canada.

The capital investment profile discussed in earlier sections is expected to keep natural gas production relatively stable over the forecast horizon. Still, by 2035, Canadian production is expected to reach 5,500 bcf per year, implying that the economic contribution and jobs supported by the sector will grow over time. In 2035, the industry will support roughly 133,000 jobs. Over the 24-year forecast horizon, the industry's economic contribution will add up to $576 billion (in 2012 dollars).

SUMMARY OF ECONOMIC IMPACTS

The natural gas investments discussed in Chapter 3 will have a significant benefit on the Canadian economy, both during the investment phase and then again when production increases in response to the additional infrastructure. In this section, we examined the total economic impact (including direct, indirect and induced impacts) by province of the projected investment flows and then the impact of the national economy resulting from a sustained increase in natural gas production.

Of course, the most influential component of the capital investment spending by natural gas producers is the allocation of the investment spending itself—provinces that receive large investment inflows benefit the most in this scenario. But the direct investment itself is not the only component of this analysis; trade flows and labour market conditions also factored meaningfully into the total provincial economic impacts.

The results of our analysis show that the two provinces with the largest direct investment, British Columbia and Alberta, will also experience the biggest economic gain. However, Alberta stands to gain more than British Columbia, despite having lower direct investment, because its tight labour markets will draw a significant number of migrants to the province and because it will benefit more from the trade flows associated with the investment occurring in other provinces. All provinces are expected to benefit from the investment either directly within their region or in other provinces. Most provinces will benefit in proportion to the direct investment within their borders, but Ontario, Quebec, and to a lesser extent Manitoba will have the largest increase in exports in response to the significant demand generated in British Columbia and Alberta.

As a result of investments in the natural gas industry, cumulatively over 2012 to 2035, real GDP across the country is expected to increase by $364.3 billion, with close to three-quarters of that gain occurring in Alberta and British Columbia. The investment will also create 3.2 million person-years of employment across the country and boost tax collection (corporate, indirect, and personal and federal income taxes) by a cumulative $127 billion.

Including direct, indirect, and induced impacts, the lift to economic activity will boost employment by 8,850 jobs.

The significant investments in natural gas infrastructure will help support and lift production. To determine the economic impact of increased natural gas production, we simulated the impact of an increase in natural gas production using the Conference Board's econometric model of the national economy. The results from this analysis show that increasing natural gas production by 1 bcf/d over the course of a year translates into a $1.7-billion increase in real GDP (in 2012 dollars). Including direct, indirect, and induced impacts, the lift to economic activity will boost employment by 8,850 jobs, which will lift real personal income and result in an increase of $148 million in real federal and provincial income taxes and an average $60 million real increase in sales and excise taxes. Corporate taxes will also go up by $102 million per year. Increased tax receipts will account for about 75 per cent of the positive effects on the federal and aggregate provincial government balances, although decreased employment insurance and various other cost and revenue items (such as royalties) will also contribute positively to government books.

Clearly, the investment in natural gas infrastructure projected to occur through 2035 will result in substantial economic benefit to the country. The investment alone will add a cumulative $364.3 billion in real terms to

economic output. Moreover, today, total natural gas production in Canada will support nearly 130,000 jobs and generate over $24.5 billion in economic activity (in 2012 dollars) per year. By 2035, Canadian production is expected to reach 5.5 tcf, implying that the economic contribution and jobs supported by the sector will grow over time. Over the 24-year forecast horizon, natural gas production will contribute a cumulative $576 billion in real terms to the economy.

Between now and 2035, Canada's natural gas industry will contribute a cumulative $940 billion to Canada's economy through its investment and production. This estimate includes not only the economic activity generated directly by the industry, but also the supply chain and other multiplier effects generated by the increase in income and profits. Through these direct, indirect, and induced impacts, the industry will also generate roughly 6.2 million person-years of employment, that is, it will support employment of nearly 260,000 per year over the 24-year forecast horizon.

CHAPTER 5

Conclusion

Chapter Summary

- The anticipated $386 billon (in 2012 dollars) in natural gas sector investment from 2012 to 2035 will generate $364.3 billion in additional GDP, more than 131,000 new jobs per year, and increased tax revenues.
- Benefits will be focused the most where natural gas is produced, but Canada's manufacturing, construction, and services industries will benefit in every province.
- In addition to the stimulus generated by investment, natural gas production is expected to contribute a cumulative $576 billion to Canada's economy between 2012 and 2035, supporting another 129,000 jobs per year.
- The future of Canada's natural gas industry depends critically on investment in exploration and production. Regulatory frameworks for LNG projects and for unconventional natural gas development will also play a key role in facilitating market growth.

This report's long-term outlook for Canada's natural gas sector sets out the level of investment required in the country's natural gas industry from 2012 to 2035, as well as the economic, employment, and fiscal impacts that will accompany that investment.

As identified in Chapter 4, the anticipated $386 billon (in 2012 dollars) in natural gas sector investment from 2012 to 2035 will generate $364.3 billion in additional GDP. The investment will be centred in British Columbia ($181 billion), Alberta ($154 billion), Ontario ($25 billion), and Saskatchewan ($14 billion). British Columbia and Alberta dominate the investment because of the large capital infusions that will be required for upstream developments in both provinces and to build and supply LNG facilities in British Columbia. Alberta, Saskatchewan, and Ontario will benefit from investments related to electricity generation from natural gas as well.

By contrast, Alberta will experience the greatest increase in GDP, followed by British Columbia. Ontario and Quebec will benefit from a greater share of GDP than investment. This is because an important share of the investment in natural-gas-producing provinces purchases goods and services from other jurisdictions, including Ontario and Quebec.

Similar but more pronounced effects are evident in the employment data. Although only 7 per cent of the direct investments will occur in Ontario, the province will receive 18 per cent of the resulting employment and 16 per cent of the total increase in labour income. The average employment generated from the investments will be more than 131,000 jobs per year.

Corporate taxes will be most strongly affected in Alberta. Provincial direct and indirect taxes will also increase in every province. Personal and corporate income taxes

will contribute on average $3.1 billion per year to governments across Canada, with indirect taxes generating an additional $2.2 billion per year on average. Note that the tax revenues cited do not include natural gas royalty payments, which represent the resource owners' share of the value of production.

Clearly, the natural gas industry contributes to Canada's economy, and to each province. Canada's natural gas industry contributes clean, secure, low-cost energy to heat homes, energize industry, and generate electricity. Every province benefits from the investments made. People are employed and taxes paid. The entire country benefits, even though the benefits are focused the most where natural gas is produced. Even so, Canada's manufacturing, construction, and services industries benefit in every province.

The regulatory frameworks for LNG projects and for unconventional natural gas development will play a key role in facilitating market growth.

What's more, as this report shows, investing in the natural gas industry supports production, which brings further benefits to the economy. Even though natural gas production is not expected to increase significantly over the next 24 years—production in Alberta and Saskatchewan is expected to decline, while production in British Columbia will increase, with Quebec having potential to benefit from shale gas production in the medium and long term—overall production is still expected to contribute a cumulative $576 billion to Canada's economy, supporting another 129,000 jobs per year. Overall, therefore, Canada's natural gas industry will generate roughly $940 billion in real GDP over the next 24 years and support nearly 260,000 jobs per year.

As identified in Chapter 2, natural gas markets are diverse. Growth opportunities in electricity generation, LNG exports, and vehicles are either emerging or would benefit from greater emphasis. British Columbia will be the focus of much of this market development activity. The regulatory frameworks for LNG projects and for unconventional natural gas development will play a key role in facilitating market growth. British Columbia stands to experience $140 billion in investment—more than $5.8 billion per year on average. This level of investment will require a careful and consistent regulatory approach to support the long-term economic viability of the facilities to be constructed while at the same time ensuring that the natural environment is protected and all stakeholders have the opportunity to present their views.

Fully 74 per cent of the investments made will be in the upstream industry segment, primarily in Alberta and British Columbia, with smaller investments in Saskatchewan and potentially Quebec. The upstream segment includes exploration, production, gathering systems, and liquids extraction facilities (with the exception of deep-cut ethane extraction, where no incremental investments are anticipated). The future of Canada's natural gas industry depends critically on these upstream investments being made. Conventional natural gas in Alberta has been the mainstay of the industry for decades, but is now in decline. A fiscal system that is stable, attractive, and continues to support the viability of the industry is critical. British Columbia faces the challenge of developing on two fronts: unconventional shale gas production and infrastructure to support LNG exports. Here again, regulatory and fiscal measures that enable development will be keys to success.

APPENDIX A

Detailed Results of Economic Impact Analysis of Natural Gas Investment Spending by Province

Table 1
Newfoundland and Labrador: Key Indicators
(impact of $386-billion increase in natural gas investment spending; level difference, shock minus control)

	Averages					Cumulative
	2012–2015	2016–2020	2021–2025	2026–2030	2031–2035	2012–2035
Real GDP at basic prices (2002 $ millions)	11	20	21	18	19	435
Agriculture, forestry, fishing, and hunting	0	0	0	0	0	3
Mining	8	13	12	12	13	277
Manufacturing	1	1	1	1	1	28
Construction	0	0	2	0	0	12
Utilities	0	0	0	0	0	8
Information and cultural industries	0	1	1	1	1	15
Transportation and warehousing	1	1	1	1	1	20
Wholesale and retail trade	0	1	1	1	1	17
Finance, insurance, and real estate	1	1	1	1	1	19
Community, business, and personal services	1	2	2	1	1	33
Government services	0	0	0	0	0	3
Total employment (person-years)	83	139	173	107	108	2,967
Agriculture and other primary sector (including mining)	22	39	33	28	35	759
Manufacturing	10	15	13	11	10	286
Construction	0	0	43	1	0	221
Utilities	1	1	1	1	1	26
Transportation and warehousing	11	18	15	13	13	339
Wholesale and retail trade	9	14	19	11	10	305
Finance, insurance, and real estate	3	4	4	3	3	83
Other commercial service industries	27	46	45	37	34	919
Government services	1	2	1	1	1	31
Unemployment	–30	–51	–61	–32	–30	–993
Labour income ($ millions)	4	8	11	6	7	176
Federal personal income tax collections ($ millions)	1	1	2	1	1	28
Provincial personal income tax collections ($ millions)	0	1	1	1	1	18
Total indirect taxes ($ millions)	1	2	3	2	2	44
Corporate profits ($ millions)	6	11	12	11	12	255
Corporate taxes ($ millions)	0	0	0	0	0	10

Source: The Conference Board of Canada.

Table 2
Prince Edward Island: Key Indicators
(impact of $386-billion increase in natural gas investment spending; level difference, shock minus control)

	Averages					Cumulative
	2012–2015	2016–2020	2021–2025	2026–2030	2031–2035	2012–2035
Real GDP at basic prices (2002 $ millions)	1	2	2	2	2	37
Agriculture, forestry, fishing, and hunting	0	0	0	0	0	3
Mining	0	0	0	0	0	0
Manufacturing	0	0	0	0	0	6
Construction	0	0	0	0	0	0
Utilities	0	0	0	0	0	0
Information and cultural industries	0	0	0	0	0	3
Transportation and warehousing	0	0	0	0	0	3
Wholesale and retail trade	0	0	0	0	0	5
Finance, insurance, and real estate	0	0	0	0	0	7
Community, business, and personal services	0	0	0	0	0	8
Government services	0	0	0	0	0	1
Total employment (person-years)	20	32	27	26	25	632
Agriculture and other primary sector (including mining)	1	2	1	1	1	30
Manufacturing	2	4	3	3	3	77
Construction	0	0	0	0	0	0
Utilities	0	0	0	0	0	2
Transportation and warehousing	2	3	3	2	2	61
Wholesale and retail trade	3	5	4	4	4	102
Finance, insurance, and real estate	1	2	2	1	2	36
Other commercial service industries	9	15	13	12	12	302
Government services	1	1	1	1	1	23
Unemployment	–9	–14	–12	–11	–11	–275
Labour income ($ millions)	1	2	1	1	1	32
Federal personal income tax collections ($ millions)	0	0	0	0	0	5
Provincial personal income tax collections ($ millions)	0	0	0	0	0	3
Total indirect taxes ($ millions)	0	0	0	0	0	9
Corporate profits ($ millions)	0	0	0	0	0	6
Corporate taxes ($ millions)	0	0	0	0	0	3

Source: The Conference Board of Canada.

Table 3
Nova Scotia: Key Indicators
(impact of $386-billion increase in natural gas investment spending; level difference, shock minus control)

	Averages					Cumulative
	2012–2015	2016–2020	2021–2025	2026–2030	2031–2035	2012–2035
Real GDP at basic prices (2002 $ millions)	18	31	28	28	29	649
Agriculture, forestry, fishing, and hunting	0	0	0	0	0	7
Mining	1	1	1	1	1	24
Manufacturing	4	7	6	6	6	138
Construction	1	1	1	1	1	15
Utilities	0	1	1	1	1	12
Information and cultural industries	1	2	2	2	2	46
Transportation and warehousing	1	2	2	2	2	43
Wholesale and retail trade	2	4	4	4	4	85
Finance, insurance, and real estate	2	4	4	4	4	91
Community, business, and personal services	5	8	7	7	8	169
Government services	1	1	1	1	1	19
Total employment (person-years)	323	515	436	408	398	10,083
Agriculture and other primary sector (including mining)	10	16	13	13	13	311
Manufacturing	44	73	63	59	56	1,430
Construction	12	12	11	10	10	258
Utilities	2	3	2	2	2	54
Transportation and warehousing	19	32	27	25	24	613
Wholesale and retail trade	55	88	72	68	66	1,690
Finance, insurance, and real estate	14	22	19	19	19	452
Other commercial service industries	159	255	215	200	196	4,966
Government services	9	16	14	13	12	309
Unemployment	–143	–228	–187	–168	–159	–4,275
Labour income ($ millions)	15	26	24	25	27	572
Federal personal income tax collections ($ millions)	2	3	3	4	4	83
Provincial personal income tax collections ($ millions)	1	2	2	3	3	59
Total indirect taxes ($ millions)	4	6	6	7	7	146
Corporate profits ($ millions)	3	5	4	4	5	104
Corporate taxes ($ millions)	2	3	3	3	4	74

Source: The Conference Board of Canada.

Table 4
New Brunswick: Key Indicators
(impact of $386-billion increase in natural gas investment spending; level difference, shock minus control)

	Averages					Cumulative
	2012–2015	2016–2020	2021–2025	2026–2030	2031–2035	2012–2035
Real GDP at basic prices (2002 $ millions)	13	21	19	19	20	448
Agriculture, forestry, fishing, and hunting	0	1	0	0	0	11
Mining	0	0	0	0	0	7
Manufacturing	4	7	7	7	7	155
Construction	1	1	1	1	1	21
Utilities	0	0	0	0	0	10
Information and cultural industries	1	1	1	1	1	19
Transportation and warehousing	1	2	1	2	2	35
Wholesale and retail trade	1	2	2	2	2	37
Finance, insurance, and real estate	1	2	2	2	2	51
Community, business, and personal services	3	4	4	4	4	92
Government services	0	0	0	0	0	10
Total employment (person-years)	207	314	265	249	242	6,181
Agriculture and other primary sector (including mining)	8	14	11	10	10	260
Manufacturing	50	82	71	66	63	1,612
Construction	21	18	13	13	12	363
Utilities	2	3	3	3	3	63
Transportation and warehousing	14	23	19	18	17	442
Wholesale and retail trade	21	30	25	23	22	589
Finance, insurance, and real estate	7	12	10	10	10	245
Other commercial service industries	79	125	106	100	98	2,462
Government services	4	8	6	6	6	146
Unemployment	–77	–119	–97	–88	–82	–2,237
Labour income ($ millions)	10	16	15	15	16	349
Federal personal income tax collections ($ millions)	1	2	2	2	2	48
Provincial personal income tax collections ($ millions)	1	1	1	1	1	29
Total indirect taxes ($ millions)	2	4	3	4	4	85
Corporate profits ($ millions)	2	3	2	3	3	62
Corporate taxes ($ millions)	1	1	1	1	1	28

Source: The Conference Board of Canada.

Table 5
Quebec: Key Indicators
(impact of $386-billion increase in natural gas investment spending; level difference, shock minus control)

	Averages					Cumulative
	2012–2015	2016–2020	2021–2025	2026–2030	2031–2035	2012–2035
Real GDP at basic prices (2002 $ millions)	405	582	636	668	688	14,495
Agriculture, forestry, fishing, and hunting	5	9	8	8	9	194
Mining	6	11	10	10	10	225
Manufacturing	88	147	133	135	141	3,133
Construction	50	43	81	90	90	1,716
Utilities	10	18	16	16	17	375
Information and cultural industries	18	31	28	29	30	663
Transportation and warehousing	15	27	24	24	25	564
Wholesale and retail trade	75	89	119	129	132	2,647
Finance, insurance, and real estate	45	79	71	72	75	1,662
Community, business, and personal services	87	119	139	147	151	3,130
Government services	5	9	8	8	8	186
Total employment (person-years)	6,562	8,185	8,879	8,835	8,597	198,731
Agriculture and other primary sector (including mining)	148	236	188	174	171	4,434
Manufacturing	978	1,513	1,356	1,265	1,213	30,645
Construction	777	618	1,116	1,190	1,138	23,419
Utilities	34	59	52	51	52	1,206
Transportation and warehousing	214	345	290	274	267	6,733
Wholesale and retail trade	1,504	1,550	1,937	1,967	1,900	42,787
Finance, insurance, and real estate	278	450	391	384	394	9,206
Other commercial service industries	2,549	3,281	3,437	3,425	3,362	77,721
Government services	80	133	112	105	103	2,580
Unemployment	–2,029	–2,526	–2,707	–2,671	–2,581	–60,536
Labour income ($ millions)	309	436	535	599	652	12,344
Federal personal income tax collections ($ millions)	38	52	72	82	91	1,639
Provincial personal income tax collections ($ millions)	43	58	84	98	110	1,925
Total indirect taxes ($ millions)	91	118	165	184	198	3,684
Corporate profits ($ millions)	47	69	75	83	93	1,787
Corporate taxes ($ millions)	17	25	27	29	33	637

Source: The Conference Board of Canada.

Table 6
Ontario: Key Indicators
(impact of $386-billion increase in natural gas investment spending; level difference, shock minus control)

	Averages					Cumulative
	2012–2015	2016–2020	2021–2025	2026–2030	2031–2035	2012–2035
Real GDP at basic prices (2002 $ millions)	1,528	2,236	1,994	1,869	1,916	46,185
Agriculture, forestry, fishing, and hunting	5	9	8	8	9	191
Mining	18	32	29	29	30	670
Manufacturing	212	372	334	338	354	7,839
Construction	287	245	212	123	105	4,574
Utilities	21	37	34	34	36	788
Information and cultural industries	65	114	102	104	109	2,402
Transportation and warehousing	57	101	90	92	96	2,121
Wholesale and retail trade	252	335	297	266	269	6,845
Finance, insurance, and real estate	269	471	422	428	448	9,925
Community, business, and personal services	264	385	343	322	331	7,958
Government services	78	136	122	124	130	2,870
Total employment (person-years)	22,558	28,621	24,158	21,113	20,000	559,696
Agriculture and other primary sector (including mining)	275	446	368	346	343	8,613
Manufacturing	2,062	3,388	2,955	2,751	2,617	66,802
Construction	5,809	4,391	3,484	2,224	1,607	81,769
Utilities	119	205	179	173	174	4,129
Transportation and warehousing	894	1,446	1,213	1,131	1,088	27,963
Wholesale and retail trade	4,130	4,960	4,123	3,495	3,346	96,141
Finance, insurance, and real estate	1,387	2,257	1,952	1,905	1,931	45,772
Other commercial service industries	6,671	9,469	8,143	7,459	7,314	188,607
Government services	1,212	2,060	1,741	1,630	1,581	39,906
Unemployment	–8,517	–11,003	–9,390	–8,270	–7,875	–216,762
Labour income ($ millions)	1,271	1,821	1,756	1,756	1,915	41,327
Federal personal income tax collections ($ millions)	176	263	271	270	322	6,330
Provincial personal income tax collections ($ millions)	115	173	177	176	201	4,093
Total indirect taxes ($ millions)	320	458	442	418	455	10,145
Corporate profits ($ millions)	220	322	282	274	304	6,791
Corporate taxes ($ millions)	52	80	70	68	75	1,673

Source: The Conference Board of Canada.

Table 7
Manitoba: Key Indicators
(impact of $386-billion increase in natural gas investment spending; level difference, shock minus control)

	Averages					Cumulative
	2012–2015	2016–2020	2021–2025	2026–2030	2031–2035	2012–2035
Real GDP at basic prices (2002 $ millions)	85	140	124	127	132	2,955
Agriculture, forestry, fishing, and hunting	2	3	3	3	3	61
Mining	2	3	3	3	3	65
Manufacturing	17	30	27	27	29	634
Construction	4	4	3	3	3	83
Utilities	2	3	3	3	3	65
Information and cultural industries	5	8	7	7	8	167
Transportation and warehousing	8	14	13	13	14	299
Wholesale and retail trade	16	25	22	23	24	535
Finance, insurance, and real estate	14	24	21	22	23	504
Community, business, and personal services	12	18	16	16	17	376
Government services	4	8	7	7	8	166
Total employment (person-years)	1,279	1,920	1,652	1,621	1,631	39,235
Agriculture and other primary sector (including mining)	35	56	46	43	42	1,079
Manufacturing	231	383	339	325	316	7,734
Construction	89	76	56	59	58	1,606
Utilities	9	15	14	14	14	319
Transportation and warehousing	101	161	137	131	128	3,188
Wholesale and retail trade	261	376	322	322	331	7,797
Finance, insurance, and real estate	78	127	112	113	117	2,656
Other commercial service industries	397	592	510	505	515	12,201
Government services	79	134	115	110	109	2,653
Unemployment	–520	–790	–702	–708	–732	–16,743
Labour income ($ millions)	61	105	102	112	126	2,474
Federal personal income tax collections ($ millions)	7	13	13	15	18	327
Provincial personal income tax collections ($ millions)	6	11	11	12	14	267
Total indirect taxes ($ millions)	14	23	21	23	24	512
Corporate profits ($ millions)	18	30	26	27	31	637
Corporate taxes ($ millions)	3	6	5	5	6	122

Source: The Conference Board of Canada.

Table 8
Saskatchewan: Key Indicators
(impact of $386-billion increase in natural gas investment spending; level difference, shock minus control)

	Averages					Cumulative
	2012–2015	2016–2020	2021–2025	2026–2030	2031–2035	2012–2035
Real GDP at basic prices (2002 $ millions)	244	385	340	372	393	8,426
Agriculture, forestry, fishing, and hunting	4	7	6	6	6	137
Mining	33	59	52	53	56	1,234
Manufacturing	33	57	51	52	55	1,208
Construction	69	85	73	95	103	2,061
Utilities	3	6	5	5	5	118
Information and cultural industries	5	8	7	7	8	174
Transportation and warehousing	8	13	12	12	13	278
Wholesale and retail trade	36	59	51	56	58	1,264
Finance, insurance, and real estate	27	48	43	44	46	1,009
Community, business, and personal services	20	32	28	31	32	698
Government services	7	12	11	11	11	247
Total employment (person-years)	3,041	4,428	3,705	3,951	3,971	92,434
Agriculture and other primary sector (including mining)	165	272	223	212	212	5,259
Manufacturing	325	536	469	447	431	10,709
Construction	1,041	1,279	1,038	1,294	1,322	28,828
Utilities	15	26	23	22	23	529
Transportation and warehousing	76	122	103	98	95	2,398
Wholesale and retail trade	568	855	708	723	724	17,323
Finance, insurance, and real estate	143	234	205	204	210	4,839
Other commercial service industries	587	897	760	783	789	18,494
Government services	121	207	177	168	164	4,056
Unemployment	–921	–1,352	–1,152	–1,242	–1,271	–28,770
Labour income ($ millions)	166	273	262	319	367	6,770
Federal personal income tax collections ($ millions)	24	38	38	50	61	1,031
Provincial personal income tax collections ($ millions)	11	18	18	22	26	464
Total indirect taxes ($ millions)	53	82	79	92	104	1,994
Corporate profits ($ millions)	110	181	159	181	209	4,093
Corporate taxes ($ millions)	13	22	19	21	24	482

Source: The Conference Board of Canada.

Table 9
Alberta: Key Indicators
(impact of $386-billion increase in natural gas investment spending; level difference, shock minus control)

	Averages					Cumulative
	2012–2015	2016–2020	2021–2025	2026–2030	2031–2035	2012–2035
Real GDP at basic prices (2002 $ millions)	2,687	4,206	4,105	4,500	4,945	99,522
Agriculture, forestry, fishing, and hunting	10	17	15	15	16	357
Mining	373	654	587	595	623	13,786
Manufacturing	365	639	573	581	608	13,468
Construction	731	890	1,072	1,364	1,623	27,669
Utilities	33	57	51	52	55	1,209
Information and cultural industries	55	96	86	88	92	2,030
Transportation and warehousing	81	141	127	128	134	2,974
Wholesale and retail trade	287	439	428	468	513	10,396
Finance, insurance, and real estate	355	622	558	566	592	13,110
Community, business, and personal services	358	580	545	578	622	13,060
Government services	40	69	62	63	66	1,464
Total employment (person-years)	29,745	41,353	39,284	41,582	43,917	949,662
Agriculture and other primary sector (including mining)	1,489	2,422	1,986	1,887	1,897	46,915
Manufacturing	3,019	4,811	4,161	3,882	3,699	94,841
Construction	10,281	12,022	13,642	16,468	18,645	345,010
Utilities	155	259	224	216	217	5,203
Transportation and warehousing	850	1,333	1,107	1,031	993	25,723
Wholesale and retail trade	4,634	6,338	5,723	5,862	6,098	138,636
Finance, insurance, and real estate	1,214	1,919	1,650	1,611	1,634	38,925
Other commercial service industries	7,449	11,164	9,888	9,784	9,922	233,586
Government services	655	1,084	904	841	812	20,823
Unemployment	–10,246	–14,448	–13,874	–14,794	–15,696	–335,049
Labour income ($ millions)	2,260	3,636	4,077	5,081	6,270	104,360
Federal personal income tax collections ($ millions)	342	537	636	837	1,081	16,822
Provincial personal income tax collections ($ millions)	142	223	264	348	449	6,981
Total indirect taxes ($ millions)	312	476	545	690	855	14,081
Corporate profits ($ millions)	773	1,272	1,242	1,429	1,717	31,397
Corporate taxes ($ millions)	158	268	257	293	348	6,458

Source: The Conference Board of Canada.

Table 10
British Columbia: Key Indicators
(impact of $386-billion increase in natural gas investment spending; level difference, shock minus control)

	Averages					Cumulative
	2012–2015	2016–2020	2021–2025	2026–2030	2031–2035	2012–2035
Real GDP at basic prices (2002 $ millions)	2,071	4,567	3,992	3,835	3,819	89,346
Agriculture, forestry, fishing, and hunting	14	24	21	22	23	502
Mining	123	216	193	196	205	4,543
Manufacturing	179	314	282	286	299	6,616
Construction	549	1,668	1,471	1,333	1,240	30,755
Utilities	33	59	52	53	56	1,233
Information and cultural industries	57	99	89	90	94	2,087
Transportation and warehousing	66	115	103	105	110	2,427
Wholesale and retail trade	249	570	466	441	438	10,564
Finance, insurance, and real estate	381	668	599	607	636	14,070
Community, business, and personal services	351	712	606	592	602	13,963
Government services	70	123	110	112	117	2,585
Total employment (person-years)	31,292	71,340	59,608	53,211	49,893	1,295,431
Agriculture and other primary sector (including mining)	832	1,362	1,102	1,041	1,053	26,125
Manufacturing	2,126	3,499	3,048	2,874	2,774	69,479
Construction	10,773	32,912	28,130	24,111	21,477	576,239
Utilities	131	226	198	193	196	4,583
Transportation and warehousing	779	1,267	1,074	1,015	995	24,875
Wholesale and retail trade	5,115	11,136	8,745	7,859	7,581	197,069
Finance, insurance, and real estate	1,536	2,516	2,205	2,181	2,250	51,900
Other commercial service industries	8,764	16,304	13,309	12,247	11,908	303,902
Government services	1,236	2,118	1,798	1,690	1,657	41,261
Unemployment	–12,691	–29,376	–24,580	–21,931	–20,534	–532,866
Labour income ($ millions)	1,614	4,165	3,938	3,972	4,179	87,720
Federal personal income tax collections ($ millions)	232	654	670	718	783	15,050
Provincial personal income tax collections ($ millions)	84	238	243	268	306	5,612
Total indirect taxes ($ millions)	376	1,000	952	977	1,041	21,351
Corporate profits ($ millions)	341	758	657	663	725	15,374
Corporate taxes ($ millions)	102	236	201	202	218	4,695

Source: The Conference Board of Canada.

APPENDIX B

Energy Modelling Methodology

This appendix describes briefly the methodology used to develop energy supply, demand, and price outlooks for this project.

ENERGY PRICES

Crude oil, natural gas, and electricity prices are key determinants of energy demands. For crude oil, the marker price used for this outlook was West Texas Intermediate (WTI) at Cushing, Oklahoma. For natural gas, the marker price was at Henry Hub, Louisiana. Both prices are used by NYMEX as the reference point for futures trading. The price outlook used for both WTI and Henry Hub natural gas was based on a combination of Conference Board analyses, public forecasts, and the forward strip (sales of future contracts).

Retail prices for refined petroleum products were based on a statistical relationship between WTI and refinery wholesale prices for gasoline, diesel, light fuel oil, and heavy fuel oil. Transportation and distribution margins were added for each province to determine the pre-tax retail price of each product to consumers. The margins were held constant in real terms through the forecast.

Retail natural gas prices were determined based on wellhead price projections for each producing province. Wellhead prices in Canada were based on historical relationships between such prices and Henry Hub. Intra-provincial transportation costs were added to determine border prices. Long-distance transport costs were added as appropriate to determine city-gate natural gas prices in each province. Provincial average distribution costs were added to determine consumer prices.

Retail electricity prices started from average wholesale electricity costs in each province. These prices were held constant in real terms in all provinces except Ontario, where the most recent provincial long-term outlook was used to proxy the anticipated future increase in wholesale electricity costs. Transmission and distribution margins were added to determine consumer prices.

ENERGY DEMANDS

Energy demands were determined based on statistical relationships that capture the influences of prices, population, economic growth, weather, and efficiency improvements. For each sector in each province, total energy demand was estimated using the relevant explanatory variables. The energy price in each relationship represents the weighted average price of energy consumed in each province/sector combination. The weights used were the amount (in TJ) of each form of energy consumed in the previous year.

Total energy was then split by fuel based on share equations that capture historical shares and changes in relative prices. In each province/sector combination, there are up to four main fuels for which share equations were

calculated. In addition, there is an "other fuels" category that captures all energy forms that are not explicitly represented.

The sectors modelled using this total energy and fuel shares equations include:

- residential
- commercial and public administration
- manufacturing
- mining
- agriculture
- construction
- forestry

ELECTRICITY GENERATION

The power generation sector was modelled for each province based on the generation technologies currently in use, as well as those expected to be used in the outlook period. For each technology in each province, the analysis began with lists of generating capacity in operation, under construction, approved by a regulatory body, and planned or announced. For each category, information was gathered about installed (or planned) capacity, in-service date, and service life prior to refurbishment or retirement.

The total potential capacity available in each year in each province was estimated for each technology, and compared with the total electricity demand predicted by the demand model. Adjustments were made for net electricity trade. The total potential capacity was then adjusted to determine the capacity expected to be in operation in each year. The adjustments include assumptions about load factor and reflect any constraints that might be required to reflect the integration of wind, solar, and other variable generation technologies.

The installed capacity for each generation technology, together with load factor assumptions, determines the energy generated. For thermal technologies, a heat rate based on historical performance was applied to determine the fuel required. The heat rate for natural gas also reflected the anticipated future balance between simple and combined cycle technologies.

NATURAL GAS VEHICLES

Natural gas demand in vehicles was projected using an aggregate capital stock approach. In each province, the existing light-duty vehicle stock was modelled for five main vehicle fuels: gasoline, diesel, hybrids, plug-in electric vehicles, and natural gas vehicles. The total light-vehicle stock was projected based on population and economic growth. For each vehicle category, the stock of vehicles in service was adjusted annually for retirements and for new vehicle purchases. New vehicle purchases in total were calculated as the total vehicle requirement minus the sum of operating vehicles from the previous year and vehicle retirements in the current year. The number of new vehicles purchased in each fuel category was based on historical market shares adjusted for assumptions about the uptake of new technologies. The total number of vehicles in each category was combined with kilometres travelled and fuel efficiency to determine the total fuel consumed.

Heavy-duty vehicles and fuel consumption were projected in a similar manner. The vehicle categories were heavy-duty diesel trucks, heavy-duty gasoline trucks, heavy-duty natural gas trucks, diesel buses, gasoline buses, and natural gas buses.

Marine transportation was not included in the model framework. Any future natural gas demand for marine transport was therefore excluded from this analysis.

LNG

The demand for natural gas to produce liquefied natural gas was projected based on the assumed level of exports and the volume of natural gas required to be converted to LNG. The level of exports was based on published studies of the demand for LNG in Asia, competing supplies, and judgment. There is considerable uncertainty in this outlook, given that Canada does not currently export LNG, and only one facility has received all of the approvals necessary to proceed.

BITUMEN

The demand for natural gas for bitumen production was based on available data about current and future bitumen production projects. The projects were tracked for mining vs. in situ projects in the Athabasca, Peace River,

and Cold Lake regions. Operating projects were assumed to continue at their historical production level. Additional projects currently under construction were assumed to proceed based on their announced in-service dates. Projects that have been approved but have not committed to construction were treated as a group for each technology/region combination, and were added to arrive at the overall forecast.

The total bitumen production in this outlook was compared to projections made by the National Energy Board, Alberta's Energy Resources Conservation Board, and the Canadian Association of Petroleum Producers.

Once the level of bitumen production was determined, natural gas consumption per barrel of bitumen or synthetic crude was applied to determine the level of natural gas consumption. Any natural gas that is produced with the bitumen and used within the project was excluded to ensure that only marketable natural gas was considered. This was done because only marketable natural gas is modelled in the supply analysis.

NATURAL GAS SUPPLY AND RELATED INVESTMENTS

Natural gas supplies were projected based on historical production, future activity, price, economic growth, and other assumptions. Projections were based on regional definitions within each province as determined by the Petroleum Services Association of Canada (PSAC). Alberta includes seven regions, British Columbia includes three (although natural gas is produced from only one region), and Saskatchewan includes three (two with significant natural gas production). Natural gas supplies were modelled for each region.

Natural gas production was modelled starting from recent historical data for each region, plus an estimate of the historical exponential decline rate in aggregate. Production from new wells in each year was based on the number of well completions projected in each region, an estimate of the initial production rate, and an assumed production decline rate. Initial production rates in British Columbia were adjusted to reflect the impact of higher rates for shale gas than for conventional gas.

The number of natural gas well completions in each province was based on statistical analysis of historical trends, comparisons with published forecasts, and any necessary adjustments. The analysis began with an estimate of the active rig count in each province that reflected primarily oil prices, natural gas prices, and economic growth. Once the number of active rigs in each province was determined, the number of natural gas well completions in the province was estimated using a statistical relationship that includes the rig count and relative oil/gas prices. The well completions in each province were distributed between PSAC regions based on historical patterns plus anticipated future trends.

The projected levels of drilling activity, natural gas wellhead prices, natural gas production, and investment were linked through the investment component of the model. This was necessary to ensure that the overall activity level, wellhead revenue, and reinvestment of that revenue were consistent and achievable. Natural gas wellhead revenues were calculated based on the volume of natural gas produced and the wellhead price. The value of natural gas liquids from conventional natural gas production was held constant as a share of wellhead natural gas revenues. For shale gas production, the value of natural gas liquids was assumed to be equal to the value of natural gas production to reflect the liquids-rich shale gas that is expected to be developed as a priority. The natural gas wellhead price for natural gas used to produce LNG was assumed to follow crude oil pricing. This resulted in a significant price premium for natural gas volumes that would currently be realized if LNG were being produced. In the long term, as natural gas prices rise relative to crude oil, this netback premium for LNG will slowly erode.

The level of investment in upstream natural gas activities began with historical relationships estimated from data in the *Statistical Handbook* produced by the Canadian Association of Petroleum Producers. The CAPP data identify total upstream investments in oil and gas by province, as well as the detail for land acquisition, seismic activity, drilling, field facilities, processing, operating costs, and royalties. The CAPP handbook does not separate conventional crude oil expenditures from natural gas expenditures. To determine natural gas investment, the expenditures that are not separated between oil and

gas were assumed to be allocated based on the shares of wellhead revenues. The historical level of natural gas investment was compared with the historical level of wellhead revenues from natural gas and related liquids. This reinvestment rate provided a starting point for the projection of upstream natural gas investment in each province. The reinvestment rate was applied to future wellhead natural gas revenues to determine a first estimate of natural gas upstream investment in each province. This investment level divided by the number of well completions in each province each year provided an estimate of the future investment per well, including land, seismic activity, gathering, and processing. Input parameters in the entire natural gas supply analysis could then be adjusted to ensure that investment per well reflected historical performance adjusted for anticipated future changes.

APPENDIX C

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Publication 13-181
E-copy: Complimentary

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