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CUSTOM REPORT

Fuelled Up

An Updated Overview and Outlook of Canada's Propane Market and Industry

Presented to:

Canadian Propane Association (CPA)

Industry Strategy and Public Policy Division

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Preface

Canada's propane industry spans an extensive and complex supply-chain connecting producers and end-users. Markets for Canadian propane are just as versatile, including multiple energy uses across wholesale and retail-level end-use sectors, non-energy uses as a petrochemical feedstock, and exports to regional and overseas international markets.

This report takes stock of current and historical developments impacting Canada's propane supply-chain and provides a comprehensive market outlook to 2025. Estimates of the Canadian propane industry's footprint across the economy are developed and presented. Lastly, we highlight a series of domestic energy market factors, opportunities, policy and regulatory developments that may impact the outlook for Canada's propane markets and industry in the coming years.

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Contents

List of Abbreviations and Acronyms

Alberta Energy Company – **AECO**

Alberta Energy Regulator – **AER**

Billions of cubic feet per day – **bcf/d**

Canadian Association of Petroleum Producers – **CAPP**

Canadian Propane Association – **CPA**

Canadian Socio-Economic Information Management System (Statistics Canada) – **CANSIM**

Compound annual growth rate – **CAGR**

Comprehensive energy use database (Natural Resources Canada) – **CEUD**

Energy Information Administration (U.S.) – **EIA**

Ethane/propane mix – **E/P mix**

Electric vehicles **– EV**

Exajoules – **EJ**

Gigajoule – **GJ**

Greenhouse gases – **GHGs**

Gross domestic product – **GDP**

Innovation, Science, and Economic Development Canada – **ISED**

Input-Output (models) – **IO**

International Energy Agency **– IEA**

Kilo-tonnes (of greenhouse gases) – **kt**

Light-duty (trucks) – **LD**

Liquefied natural gas – **LNG**

Liquefied petroleum gases – **LPG**

Medium-duty (trucks) – **MD**

Million British thermal units – **MMbtu**

Millions of dollars **– $MM**

National Energy Board **– NEB**

Natural gas liquids – **NGLs**

North American Industry Classification System – **NAICS**

Petroleum Administration for Defense District (U.S.) – **PADD**

Petrochemicals development program **– PDP**

Polypropylene – **PP**

Propane dehydrogenation – **PDH**

Refined petroleum products – **RPPs**

Thousands of barrels per day – **kb/d**

Total primary energy supply – **TPES**

Western Canadian Sedimentary Basin – **WCSB**

West Texas Intermediate **– WTI**

Executive Summary

At a Glance

- **Canada's propane industry spans an extensive supply-chain from extraction to end-use. Markets for this versatile fuel are just as diverse.**

- **Propane production levels are expected to increase significantly in the coming years. Domestic demand will be supported by an emerging propane-based petrochemical industry, and exports will increasingly be diverted from U.S. to overseas markets.**

- **The industry's economic footprint extends across Canada's regions and sectors, supporting thousands of jobs and generating hundreds of millions of dollars in taxes and revenues.**

- **Fuel-switching opportunities across various end-use sectors can have a significant impact on propane demand and sales, while reducing Canada's GHG emissions.**

Canada's propane industry spans an extensive supply-chain from extraction to end-use. Many businesses across the country make-up the industry's robust distribution network, including oil and gas production companies; processing and storage firms; transportation and logistics businesses, and; wholesale and retail fuel marketers.

Canadian propane markets are just as diverse, with most of the supply coming from gas plants across Canada, and with industrial, commercial, and residential users accounting for a significant share of domestic demand – mainly across Ontario, Alberta, and Quebec. Exports to the U.S. are significant outlet for Canadian propane today, with exports accounting for about one-half of total demand. Increasingly, Canadian propane exports are going to overseas markets.

Over the outlook (2017-25), Canadian propane supplies are expected to increase by more than 20 per cent, driven by steady natural gas production levels, increasing natural gas liquids availability in the gas, and further supported by midstream infrastructure investments. Meanwhile, the demand side of the market will also change significantly in the coming years, driven by two key trends:

- large increases in domestic demand for propane used as a petrochemical feedstock, and
- a continued westward shift in exports that will see a large portion of Canadian propane redirected to overseas LPG markets.

The contribution of Canada's propane industry to the Canadian economy is measured based on the final value of Canadian propane sales. In 2016, $4 billion worth of Canadian propane was estimated to support a significant level of economic activity across the country, including:

- close to $3.5 billion in value-added gross domestic product (GDP)
- more than 17,000 jobs across Canada
- over $900 million in municipal, provincial, and federal tax and royalty revenues

Between 2017 and 2025, with sales expected to expand favorably, an annual average of $4.4 billion ($2016) worth of Canadian propane sales, are estimated to support:

- close to $4.4 billion in GDP across Canada per year
- close to 21,000 jobs annually across the economy
- close to $1 billion per year in government revenues including indirect taxes, personal income taxes, corporate taxes, carbon taxes, royalties, and payroll taxes across Canada

Although the outlook for Canada's propane markets and the industry's contribution to the Canadian economy are favorable, various factors may impact the industry in the coming years. These include:

- growing prospects for petrochemicals, driven by innovations in technology and consumer demand;

- recent export terminal projects to diversify exports toward overseas markets;
- evolving environmental considerations, and power generation needs in Canada's remote communities.

We also estimate fuel-switching opportunities across various end-use sectors in Canada have the potential to boost propane demand and sales significantly, all while helping to reduce Canada's greenhouse gas emissions.

Lastly, we believe that the industry may benefit and could maximize its potential by:

- supporting the resolution of any issues that are negatively impacting Canada's oil and gas extraction sector
- a better understanding of the impacts that climate-change policies might have on the propane industry, while promoting propane's role in a low-carbon economy
- supporting value-added and economic diversification policies, and
- a better understanding of fuel-switching opportunities across Canada's end-use sectors and potential implementation of such measures

We expect the insights presented in this study can provide a sensible and clear roadmap for the industry's future, its potential challenges, and ways in which it can maximize its potential opportunities across the country. In turn, we hope these findings help support a safe and thriving propane industry – one that plays a vital role in Canada's economy.

Chapter 1
Introduction and Context

Chapter Summary

- **Canada's propane industry spans an extensive supply-chain from extraction to end-use. Markets for this versatile fuel are just as diverse.**
- **This report provides an update to the previous version of the *Market Update* report completed for the Canadian Propane Association (CPA) in late 2014.**
- **Chapter 2 includes a comprehensive historical assessment and outlook for Canada's propane markets.**
- **Chapter 3 presents our estimates for Canadian propane sales and Canada's propane footprint across the economy.**
- **Chapter 4 identifies key issues and opportunities for propane in Canada's transition to a low-carbon economy.**

Canada's propane industry spans an extensive supply-chain from extraction to end-use. Many businesses across the country make-up the industry's robust distribution network, including oil and gas production companies; processing and storage firms; transportation and logistics businesses, and; wholesale and retail fuel marketers.

From a user perspective, propane is a versatile hydrocarbon that can be used across a range of energy and non-energy applications. Propane is also a fuel with a much lower greenhouse gas (GHG) emissions' footprint than most petroleum products.

As a flexible energy source, propane is used across a variety of end-use sectors covering agriculture, commercial, industrial, residential, and transportation users. Meanwhile, its fuel applications are just as diverse, including its use as a fuel for auxiliary equipment, cooking, industrial processes, and transportation, but also, to meet space and water heating needs.

Petrochemical feedstock is propane's main non-energy application, where the hydrocarbon is primarily used to produce plastics used to manufacture everyday consumer products. However, propane's non-energy applications can also be found in the oil and gas industry, where it may be used for hydraulic fracturing, miscible floods, and solvent applications.

As is the case with many of Canada's energy commodities, the propane industry in Canada relies substantially on export markets as a sales outlet, with the United States (U.S.) currently being Canada's primary export destination. However, the U.S. has recently become one of Canada's largest market competitors, putting pressure on Canadian propane producers and marketers to look for new sales outlets both at home and overseas.

As can be seen, the Canadian propane industry's footprint is complex and extensive, involving many businesses along a supply-chain which must respond to the ever-evolving dynamics across the energy supply and end-use sectors.

The Canadian Propane Association (CPA) is the national association for Canada's propane industry, representing over 400-member companies in every region of the country. The CPA promotes a vision of a safe and thriving propane industry that plays a vital role in Canada's energy sector.

As part of its mandate, a service to its members, and to better understand future challenges and opportunities, the CPA regularly engages external consultants to prepare a *"Market Study"* for Canada's Propane industry. The latest version of this study was completed in late 2014.

In the past four years, many changes that have had a direct impact on Canada's energy sector – and by extension, Canada's propane industry - have continued to unfold. These include, the energy-commodities price slump, the ongoing evolution of North American (and global) energy markets because of the shale revolution, and an increased level of awareness on the need to move towards a low-carbon economy - to name a few.

The Conference Board of Canada – Canada's largest non-partisan, non-profit, evidence-based research organization – was engaged by the CPA to provide an update to the previous version of the market study. That is the purpose of this report.

This first chapter provides a brief overview of the industry, and it explains the rationale and need for this project. This brief chapter also describes the contents of this report.

The second chapter presents a comprehensive historical overview of Canada's propane markets including production, demand, and trade, generally for the 2007 to 2016 timeframe. This serves to provide a lay-of-the-land for the role of propane in Canada's energy system, to illustrate the complexity of propane markets, and to outline the roles of the different supply-chain components of the propane industry across Canada. Chapter two also presents the outlook for Canada's propane markets to 2025.

Chapter three provides an estimate for the propane industry's economic footprint across the country. This footprint is developed using best-of-class interprovincial economic input-output (IO) models housed by Statistics Canada, combined with the Conference Board of Canada's proprietary macroeconomic and fiscal databases, to provide an estimate of the industry's contribution to the Canadian economy in the form of value-added as gross domestic product (GDP), employment, and government revenues. Two timeframes are presented for the economic footprint; 2016 to illustrate the most recent estimate of the industry's contribution to the Canadian economy, and a measure of the industry's footprint over the outlook timeframe.

Finally, chapter four identifies the issues and factors that will enhance propane's value and standing in a future low-carbon economy. The analysis underlines the importance of taking advantage of the strengths and opportunity that now exists while simultaneously dealing with the weaknesses and threats that may affect the industry in the coming years.

Appendix A at the back of the report outlines the sources of data and methodologies employed to generate the results presented in this report. This appendix was completed in response to the CPA's request for data transparency and disclosure, but most importantly, consistent with The Conference Board of Canada's approach to evidence-based applied research. An additional appendix includes regional-level summaries of Canada's propane markets and the industry's economic footprint.

Chapter 2
Canada's Propane Market: Overview and Outlook

Chapter Summary

- **Propane production in Canada comes primarily from natural gas processing. Production levels have largely been impacted by natural gas market developments.**
- **Domestic demand is diverse, and it is impacted by economic conditions, large-users' fuel flexibility, and weather events.**
- **Canadian exports go primarily to the U.S. markets, but have increasingly been diverted to overseas markets through the U.S. West and Gulf coasts.**
- **Canadian propane production levels are expected to increase by over 20 per cent between 2016 and 2025, driven by steady natural gas production levels, rising NGLs volumes in the gas, and further supported by midstream infrastructure investments.**
- **The development of a propane-based petrochemical sector in Alberta, and the completion of overseas LPG export terminals in British Columbia will be the biggest developments shaping Canada's propane markets over the coming years.**

Propane in the Context of Canada's Energy-mix

To understand propane's role in Canada's energy-mix we begin by providing an overview of primary energy production in Canada and the balance between supply, demand, and net trade. We then highlight the relationship between natural gas and natural gas liquids (NGLs) production – helping to set up the stage for a detailed discussion on Canadian propane markets.

Primary Energy

Primary energy production in Canada totalled 19.7 exajoules (EJs) in 2016.[1],[2] By source, approximately 80 per cent of this energy came in the form of crude oil and natural gas (combined), with primary electricity, coal, and natural gas liquids (NGLs) accounting for the difference, with much smaller shares of Canada's primary energy production in that year (at under 10 percent each). Just over 0.3 EJs of propane from gas processing plants were produced in 2016, accounting for less than two per cent of Canada's total primary energy production.[3]

Box 1. Defining Primary Energy Production and Availability

Primary energy production refers to production of energy commodities in their raw form, or before any transformation processes. In the Canadian context, this refers to production of fossil fuels - including all grades of coal (thermal and coking), all grades of crude oil (from pentanes plus and light condensates to extra-heavy oil sands bitumen), natural gas, and gas plant natural gas liquids (or NGLs: including ethane, propane, and butanes), but also, electricity from renewable and nuclear sources.

Meanwhile, ***secondary energy production*** refers to energy that has been transformed from its raw form to useable end-use commodities. In Canada, secondary energy production includes refined petroleum products - including refinery propane or liquefied petroleum gas (LPG), but also, electricity generated from thermal-fuel sources such as coal, fuel oil, or natural gas.

Primary energy availability (or demand) refers to the amount of energy that is available to be used within a jurisdiction (e.g., Canada), after accounting for trade flows and stock changes. It is generally defined and calculated as: *(primary energy production + imports) – (exports + stock adjustments);* as per Statistics Canada's energy supply and demand data, and consistent with the International Energy Agency's (IEA) definition of total primary energy supply (TPES).

For more information, see: (International Energy Agency 2018) and (Statistics Canada 2017).

[1] One exajoule equals one billion gigajoules (GJ). For reference purposes, one barrel of gasoline (of 159 liters) contains 5.5 GJs of energy, while the same volume of propane contains just over 4 GJs of energy. See: (National Energy Board 2016).

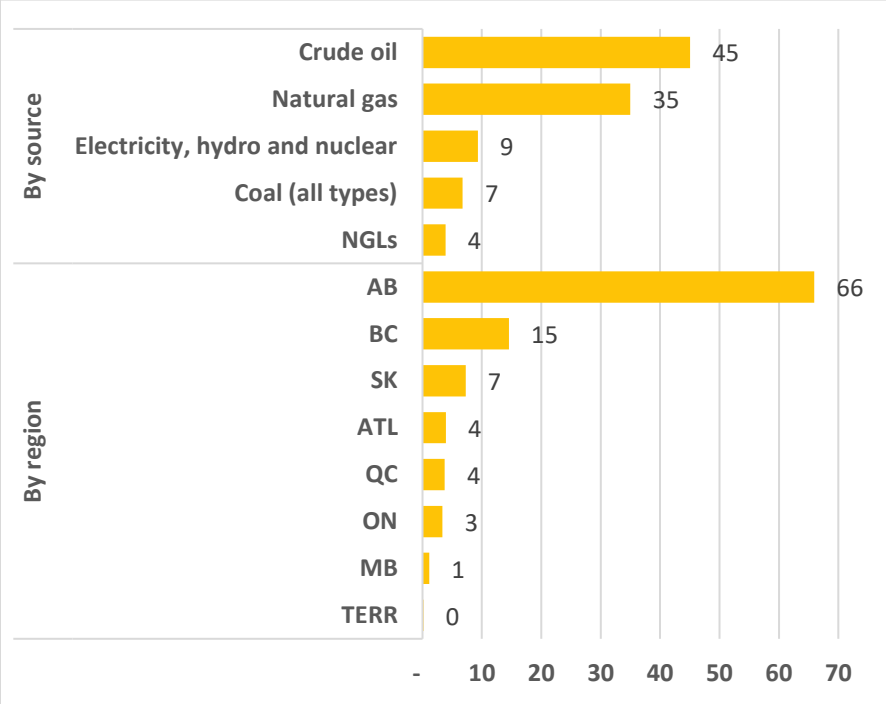
[2] Latest comprehensive data available (as of the time of wiring) on energy supply and disposition on a national and provincial/territorial basis.

[3] Propane produced as LPG from refineries is not included in this total as it is considered secondary energy production (See Box 1).

On a regional basis, Alberta accounted for two-thirds of Canada's total primary energy production in 2016, followed by British Columbia at a distant second (accounting for 15 per cent of the total), and Saskatchewan at an even more distant third (at less than 10 per cent).

Figure 1 illustrates the breakdown for Canada's primary energy production for 2016, by source and by region. (See Figure 1) This figure highlights the importance of hydrocarbons (accounting for over 90 per cent of total production), and that of Western Canada (also about 90 per cent of the total), in the context of Canada's primary energy production.

Figure 1: Primary energy production in Canada in 2016, by source and by region, per cent of total



Source: The Conference Board of Canada; Statistics Canada (CANSIM Table 128-0016)

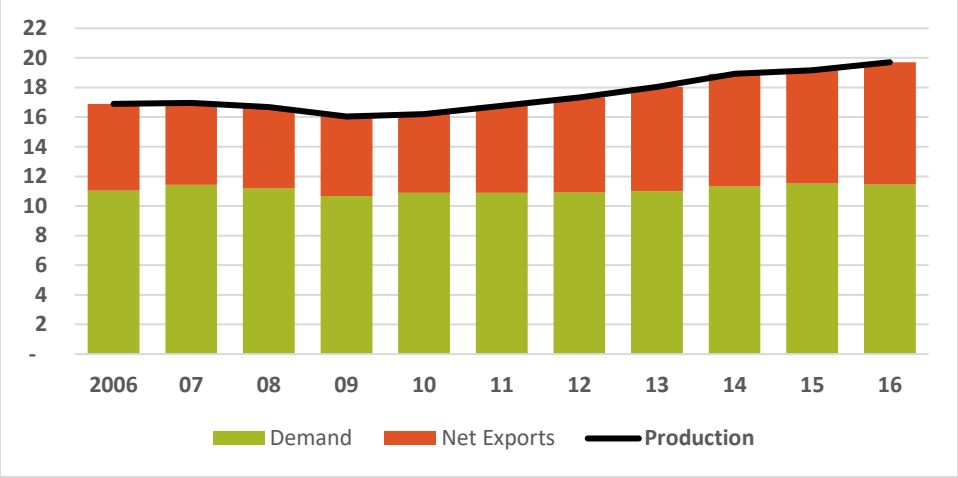
Even though Alberta's primary energy production is largely dominated by crude oil and natural gas (which combined, accounted for over 90 per cent of the province's primary energy production in 2016), Alberta is also a significant producer of coal (along with British Columbia) and gas plant NGLs. In fact, in 2016, the province accounted for over two-thirds of Canada's gas plant NGLs production, followed by Ontario at a distant second - accounting for less than 20 per cent of the total.

Given that gas plant NGLs "produced" (or fractionated) in Ontario are originally extracted in Western Canada (mainly in Alberta, but also in British Columbia - to a lesser extent), this further reinforces the importance of Alberta in the context of, not only total energy production, but also for gas plants NGLs production in Canada's context – propane, included.

Primary energy demand (or availability – See Box 1) in Canada was estimated at 11.4 EJs in 2016 – over 40 per cent below that year's production levels. This included: energy used for transformation processes - such as thermal electricity generation and energy used for crude oil refining; producers' own-use; non-energy uses - mainly for petrochemical feedstocks; and end-use energy demand - across the agriculture, commercial/institutional, industrial, residential, and transportation sectors. Propane demand in Canada was below 0.2 EJs in the same year, accounting for less than two per cent of Canada's total energy use.

Just as in 2016, energy production levels in Canada have significantly and consistently outpaced domestic demand requirements in recent history (See Figure 2).

Figure 2: Primary energy supply and demand in Canada, 2006-16, exajoules per year [EJs/yr]



Source: The Conference Board of Canada; Statistics Canada (CANSIM Table 128-0016)

In the decade prior to 2017, primary energy production in Canada increased at an annual pace over four times higher than that registered for energy demand (1.6 versus 0.4 per cent) – largely driven by rising oil sands production.[4] In turn, the net amount of energy available for exports increased by more than 40 per cent between 2006 (5.8 EJs) and 2016 (8.3 EJs). As such, export markets have and may to continue to be a key driver of growth for Canada's energy sector – subject to availability of cost-effective transportation and growing markets for Canadian energy.

Meanwhile, The Conference Board of Canada's macroeconomic models indicate that in the past decade, the real (or price-adjusted) value of Canada's energy commodities' net exports significantly outpaced the overall pace of Canada's economic growth – by close to a factor of four. Thus, not only are exports and trade an important avenue for growth for Canada's energy sector, energy exports contribute positively and substantially to Canada's economic prosperity.

[4] Unless otherwise stated, all average annual percentage numbers presented in this report refer to compound rates.

Box 2. A Note on Terminology and Statistical Classifications

Raw natural gas refers to gas as it is extracted at the wellhead from an underground reservoir. It constitutes a mixture of methane (CH_4) and other paraffinic hydrocarbons (NGLs), but also, nitrogen (N_2), carbon dioxide (CO_2), hydrogen sulfide (H_2S), helium (He), and other impurities.

Liquids-rich* or *wet gas refers to raw natural gas which contains high concentrations of NGLs. NGL prices are generally influenced by crude oil and refined petroleum product (RPP) prices, making their extraction and monetization a valuable proposition for natural gas producers when natural gas prices are low and crude oil prices are high.

Marketable (or sales) gas has been processed and treated for removal of most NGLs and impurities, as to meet the quality specifications (such as heating content) required for transport and end-use purposes. Marketable natural gas is primarily methane (usually over 90 per cent).[5] Throughout this report, unless otherwise specified, any mention of natural gas refers to marketable natural gas.

The term ***natural gas liquids (NGLs)*** generally refers to: (i) a group of hydrocarbons that includes ethane, propane, butanes, pentanes plus, and condensate – regardless of the source of production, or; (ii) any subset of these liquids, or; (iii) any individual component of this group. In Canada, NGLs are produced at three types of hydrocarbon processing facilities including natural gas processing plants, crude oil refineries, and oil sands upgraders.

Gas plant NGLs in this report refers to a mix of hydrocarbons that are extracted from the raw natural gas stream, either at a field-level or straddle (reprocessing plants), and then separated into individual specification liquid products at fractionation plants. Note however that although pentanes plus and condensate are produced as part of a gas plant's NGLs stream, Statistics Canada accounts for, and classifies, these two liquid hydrocarbons as part of their *crude oil and equivalent (COE) statistics*,[6] as opposed to under the statistics for gas plant NGLs (which include ethane, propane, and butanes).[7] **Throughout this report**, unless otherwise noted, **data presented for *gas plant NGLs* conforms with Statistics Canada's classification** (i.e., including ethane, propane, and butanes, but, excluding pentanes plus and condensates).

NGL yields are a measure of NGLs volumes extracted per volume of raw gas produced. ***Shrinkage*** refers to the amount by which marketable natural gas volumes "shrink" as a result of NGLs extraction.

We refer to ***liquefied petroleum gas (LPG)*** in this report when discussing propane/propane-mixes and butanes/butanes-mixes produced at refineries, conformant with Statistics Canada's definitions for refined petroleum products (RPPs) statistics.[8]

[5] For more on this see: *gas (raw)* and *gas (marketable)* in (Alberta Energy Regulator 2017)
[6] CANSIM Tables 126-0001 and 126-0003
[7] CANSIM Tables 128-0012 and 131-0002
[8] CANSIM Tables 128-0017, 134-0003, and 134-0004

Note however that the term LPG is also generally used when discussing ***global or overseas markets for propane and butanes*** (or propane/butane mixes). This is because, in general, international LPG statistics don't differentiate or provide a clear breakdown between propane and butanes.

Lastly, although they constitute a small (but growing) portion of NGLs production in Canada, some NGLs (including propane) are extracted from **off-gas streams at oil sands upgrading sites**.

The upgrading process for oil sands bitumen involves either the addition of hydrogen or the removal of carbon to reduce the crude's density, usually resulting in a much lighter product known as synthetic crude oil (SCO). The process is best understood as an intermediate or partial refining process. Upgrading facilities generate process gases (known as off-gases) which contain various liquid hydrocarbons, including propane. Although off-gases are generally used as fuel on site, at some oil sands upgrading operations, liquids are recovered from the off-gases (just like NGLs are recovered from raw natural gas), and are then fractionated into their individual components (just like a barrel of crude oil is broken into different refined petroleum products at a refinery).

Natural Gas

Canada is the world's fifth largest producer of natural gas.[9] The fuel is an important component of Canada's energy-mix (accounting for close to 40 per cent of Canada's primary energy demand in 2016), and a key driver of gas plant NGLs production.

Regionally, most of Canada's natural gas production comes from the Western Canadian Sedimentary Basin (WCSB) – spanning Canada's four westernmost provinces, in addition to the Yukon and Northwest Territories. However, small gas volumes are also produced in Ontario and New Brunswick, as well as offshore Nova Scotia.

Nearly 6.9 EJs of raw natural gas were produced in Canada in 2016, equivalent to 18 billion cubic feet per day (bcf/d). This accounted for just over one-third of Canada's total primary energy production in that year. Around 70 per cent of Canada's natural gas was produced in Alberta, with an additional 25 per cent produced in British Columbia,[10] with the remaining five per cent coming from smaller gas-producing regions across the rest of Canada.

Meanwhile, demand for natural gas in Canada was estimated at 4.4 EJs (or 11 bcf/d) in 2016 – equivalent to less than two-thirds of Canada's production levels. Demand was highest in Alberta – which accounted for one-half of Canada's gas demand, followed by Ontario (at 22 per cent), Saskatchewan, and British Columbia (at 10 per cent each). Quebec, the Atlantic provinces, and Manitoba (combined), accounted for the remaining less than ten per cent of Canada's demand.

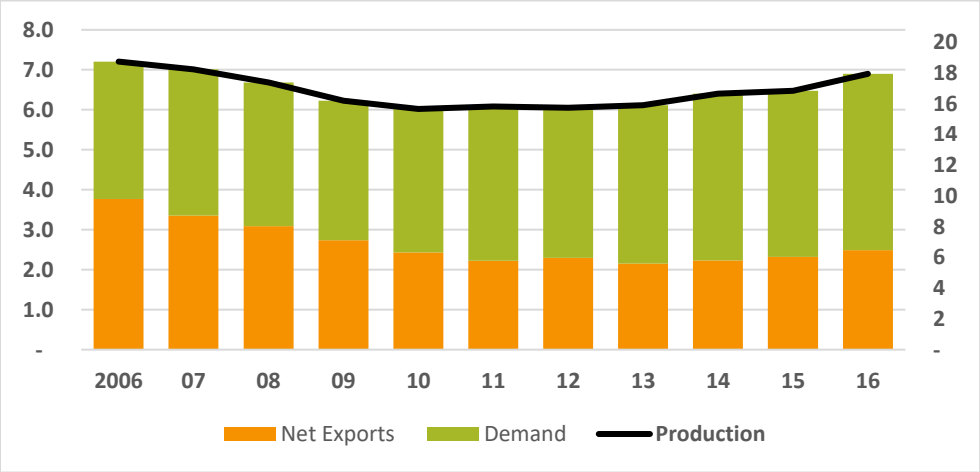
Net exports of Canadian natural gas totaled 2.4 EJs in 2016 (or 6 bcf/d) – equivalent to one-third of domestic production levels. British Columbia and Saskatchewan were the largest natural gas

[9] (National Energy Board 2017)
[10] Natural gas accounted for over 60 per cent of B.C.'s total primary energy production that year.

net exporters, at around 1.2 EJs each – yet, a significant portion of the gas exported from these provinces was produced in Alberta.[11]Ontario is Canada's largest net importer of natural gas.[12]

Over the past decade (2006-16), Canada's raw natural gas production levels fluctuated: declining by 4 per cent per year between 2006 and 2010; stabilizing around the 6.1 EJs mark (16 bcf/d) between 2011 and 2013, and; with production ramping up thereafter to reach almost 6.9 EJs by 2016 (18 bcf/d). Meanwhile, domestic demand for natural gas increased at a relatively steady pace in the same timeframe (of about 3 per cent per year), indicating that the overall downward trend in production levels was largely driven by trade. In fact, net exports of Canadian natural gas declined by more than 30 percent between 2006 and 2016. (See Figure 3)

Figure 3: Natural gas supply and demand in Canada, 2006-16, EJs/yr (left) and billions of cubic feet per day [bcf/d] (right)



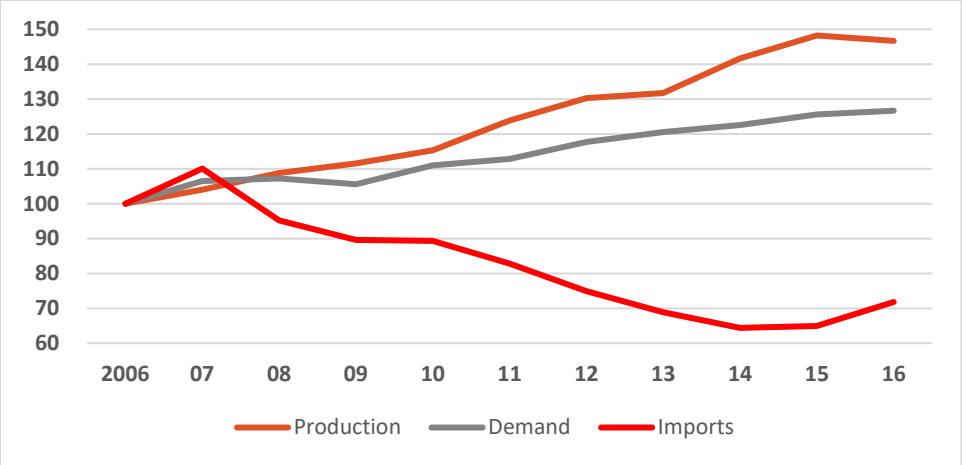
Source: The Conference Board of Canada; Statistics Canada (CANSIM Table 128-0016)

Given that all of Canada's natural gas exports are destined for the United States (U.S.), the decline in Canada's net exports of natural gas can be attributed to lower import requirements in nearby regional U.S. markets – although rising U.S. gas exports to Canada (i.e., Canadian gas imports) also played a role. In turn, the rapid decline in U.S. natural gas imports requirements in the past decade was driven by significant and unabated increases in domestic shale gas production (i.e., *the U.S. shale gas revolution*) - which largely outpaced the rate of growth for domestic natural gas demand (in the U.S.). (See Figure 4)

[11] Alberta's natural gas is exported to the United States (U.S.) via natural gas transmission pipeline systems that cross the border through other provinces (e.g., British Columbia, Saskatchewan, Manitoba, and even Ontario). As such, although Statistics Canada's data may show natural gas as an export from the province where the gas crosses the border into the U.S. (e.g., Manitoba), this doesn't necessarily reflect the province where the gas was originally produced (e.g., Alberta). This is also true with other energy commodities' trade data – including that for propane.

[12] However, some volumes of gas flowing into the southern Ontario market via the U.S. Midwest may originate in Western Canada.

Figure 4: U.S. natural gas production, demand, and import trends, 2006 = 100



Source: The Conference Board of Canada; U.S. Energy Information Administration (EIA)

Given that natural gas is a fungible commodity – that is, natural gas produced across any of North America's natural gas basins (e.g., the WCSB or any U.S. shale play) is of equal use to any customer – Canadian gas producers compete for market share with other gas supplies mainly on prices. Meanwhile, price differences are influenced by transportation costs from production basins to regional end-use markets, with transportation costs being a function of distance, mode of transport, and availability of (and ease of access to) transportation infrastructure.

Thus, considering gas-on-gas competition dynamics, we can see why the emergence of U.S. shales gas supplies near large end-use markets resulted in Western Canada's remote natural gas supplies falling out of favour in eastern U.S. and Central Canada's gas markets.

This can be illustrated by the regional distribution of Canada's natural gas (net) export declines in the past decade. (See Table 1) Table 1 shows that, other than in British Columbia's case, net exports of Canadian natural gas across most southbound border crossings have either stagnated or declined significantly in the past decade.[13]

In this context, it is important to remember that (except for in the Atlantic region) most volumes of gas exported from Canada to the U.S. are generally produced either in Alberta or British Columbia. Thus, the farther away from the WCSB export volumes had to travel to U.S. markets, the higher the transportation costs for Canadian natural gas were, and the more difficult it was to compete on a price basis with nearby U.S. supplies. Lastly, with Ontario becoming a net gas importer as of 2009, not only was Canadian gas displaced out of markets south of the border, it was also displaced by U.S. shale gas in its own backyard.

[13] Canadian gas competition with U.S. shale gas supplies in the U.S. West Coast/Pacific market is somewhat limited relative to other regional U.S. markets (i.e., Midwest and northeast) due to the configuration of the pipeline system in that region.

Table 1: Canada's net international exports of natural gas by region of transfer, bcf/d

Region	2006	2016	net change
New Brunswick	0.3	0.0	(0.2)
Quebec	0.2	0.2	0.1
Ontario	1.3	(1.3)	(2.6)
Manitoba	1.2	0.9	(0.3)
Saskatchewan	3.5	3.0	(0.5)
Alberta	0.0	0.1	0.0
British Columbia	2.5	3.1	0.5
Canada	**9.0**	**6.0**	**(3.0)**

Source: The Conference Board of Canada; Statistics Canada (CANSIM Table 129-0004/131-0004)

In sum, Canada's natural gas production levels were negatively impacted over the past decade by dwindling requirements for gas imports in the U.S. market (Canada's largest and only export destination), in turn, a function of increasing local U.S. production versus long-haul transport costs. Luckily, Canadian natural gas production levels were supported on the upside by steadily rising domestic demand levels – yet, U.S. gas imports into Canada also increased at the time.

Box 3. Lessons from Canada's Natural Gas Markets for Canadian Propane

Recent developments in North America's natural gas markets serve to draw a couple of lessons that are highly-relevant and instructive in the context of the outlook for Canadian propane.

The first lesson is that although exports were a key outlet for Canadian natural gas, high trade dependence had a direct and outsized negative impact on demand for and production of Canadian natural gas in the past decade. On the other hand, domestic markets played an important role in supporting Canadian natural gas production and in alleviating the volatility and uncertainty associated with high trade dependence and a reduced need for Canadian imports in the U.S.

In the context of Canadian propane, this means that **better understanding the potential competitive challenges and growth opportunities in Canada's domestic markets (including implications of various policy and regulatory changes) should be a strategic priority for Canada's propane industry**.

The second lesson is that the lack of a diversified export-customer base for Canada's natural gas exposed the industry to the changes and vagaries of a single export market. The need for more trade diversification has indeed been the main driver and *raison d'etre* behind a multitude of energy export project proposals that have sprung up across Canada in the last decade. These include crude oil export pipelines (to tidewater and the U.S. Gulf Coast), liquefied natural gas (LNG) export terminals (on both the east and west coasts), and more recently, west coast liquefied petroleum gas (LPG) export terminals - the only export projects being built thus far.

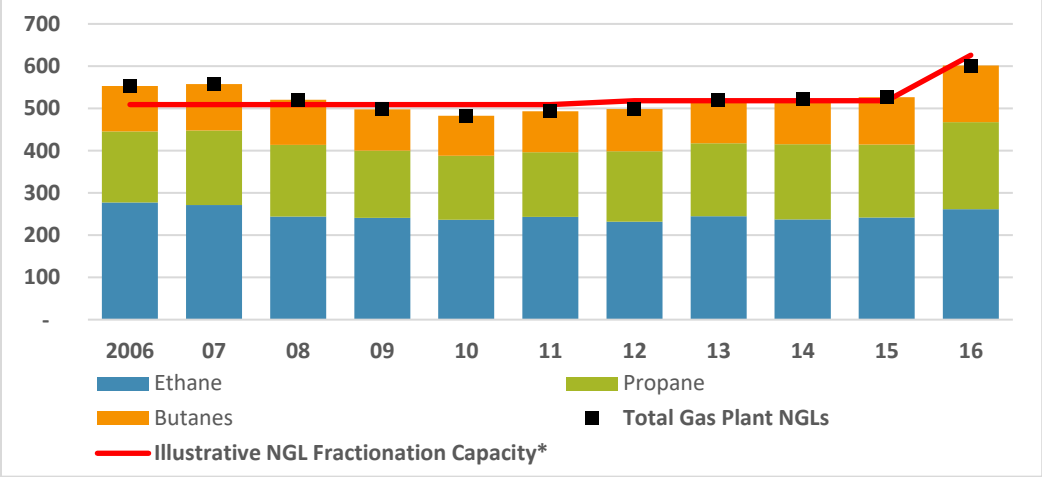
As such, **although Canadian propane exporters are already doing so, they need to continue to look for ways to diversify towards overseas markets and away from the U.S. – a place that was previously Canada's largest energy customer, but has now become one of our largest competitors.**

Natural Gas Liquids (NGLs)

Natural gas as produced from a reservoir is mostly methane (CH_4). However, entrained in the raw gas stream are other marketable hydrocarbons including ethane (C_2H_6), propane (C_3H_8), butanes (C_4H_{10}), pentanes plus (C_5+), and condensate.[14] These by-products (known as NGLs) (See Box 2) are generally extracted from the raw gas stream as a liquid mix at gas processing plants, and then, separated into individual specification (or "spec") NGLs at fractionation plants.[15]

Figure 5 provides a breakdown of gas plants NGLs production in Canada over the past decade. (See Figure 5) Total extraction of ethane, propane, and butanes at Canada's gas processing plants increased at an average pace of close to 1 per cent per year. This compares to the 0.4 per cent annual decline registered for raw natural gas production in the same timeframe, and a 1.6 per cent annual increase for total energy production. That is, gas plant NGLs' extraction levels managed to increase in the past decade despite a decline in natural gas production, but, NGLs' share of total energy production shrunk – outpaced by growth across other energy sources.

Figure 5: Gas plant NGLs production in Canada, 2006-16, thousands of barrels per day [kb/d]



**Refers to centralized NGLs fractionation capacity in Alberta at Fort Saskatchewan and Empress*

Source: The Conference Board of Canada; Company Websites (for fractionation capacity only); Statistics Canada (CANSIM Table 131-0002)

Propane accounted for a significant portion of the net increases registered in gas plant NGLs' production volumes over the past decade, followed by butanes. Meanwhile, ethane extraction volumes contracted. Thus, not only did gas plant NGLs' production levels decoupled from natural gas production trends, but individual NGLs displayed divergent production pathways.

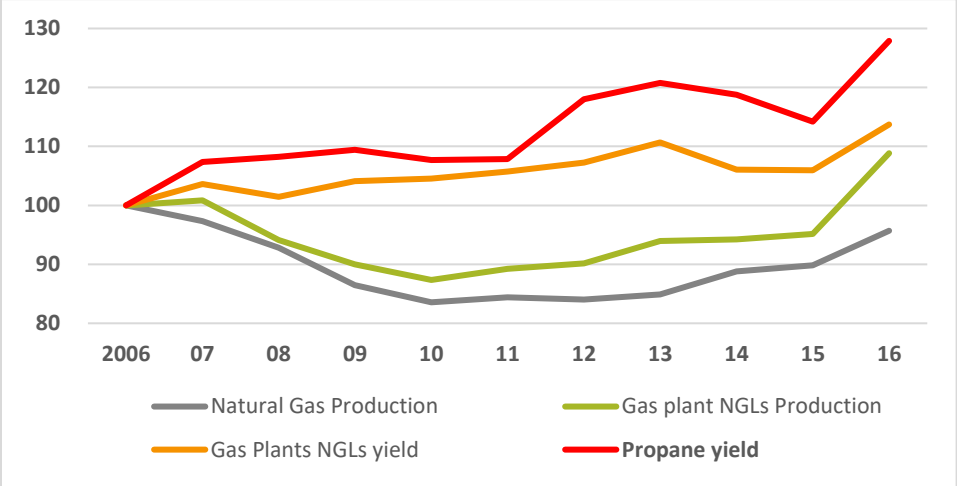
[14] Although pentanes plus and condensate are heavier forms of liquid hydrocarbons produced from the natural gas stream, the key difference is that one is produced as an individual liquid product at the field level (condensate), while the other one is generally fractionated out of an NGLs-mix (pentanes plus).
[15] Note that NGLs in Western Canada are also extracted at straddle plants or gas reprocessing facilities. However, due to their geographic location straddle plants only recover NGLs from exported gas volumes.

Although gas plant NGLs production levels fluctuated in the past decade (like natural gas), a significant increase in NGLs extraction was registered in 2016. This can be partially explained by the completion of a greater than 100 kb/d expansion in fractionation capacity in that year in Fort Saskatchewan (Western Canada's NGLs hub). However, the complex interplay of natural gas and NGLs production trends is also driven by other factors such as changes in gas composition, trends in gas processing volumes, and NGLs extraction economics - to name a few. (See Box 4)

Box 4. Rising NGL yields and the Move Towards Liquids-Rich Natural Gas in Western Canada

Given that extraction of NGLs from gas plants increased even though overall gas production levels declined in the last decade, has meant that NGLs yields have increased rapidly.[16] (See Figure 6 and Box 2 for relevant definitions) Increasing NGL yields can in turn be explained by the changing composition of the natural gas being produced in Western Canada.

Figure 6: Raw natural gas, gas plant NGLs, and NGLs yields trends, 2006 = 100



Source: The Conference Board of Canada; Statistics Canada (CANSIM Tables 128-0016/131-002)

For example, data from the Alberta Energy Regulator (AER) indicates that the share of Alberta's natural gas production coming from the southwest liquids-rich foothills area of the province increased from less than 30 per cent in 2006, to close to 50 per cent by 2016. This illustrates the trend of moving towards developing *wet* (or liquids-rich) gas resources in the province, and away from dry gas.[17] [18] Data from the AER's ST3 report also indicates that in the past seven years, the ratio of shrinkage over total raw gas production increased by more than 20 per cent in the province. This is a significant measure of increased gas processing, further illustrating that producers continue to chase after liquids-rich gas in Western Canada. (See Box 2 for a definition of "liquids-rich or wet gas")

[16] Propane yields have increased faster than total NGL yields, growing propane's share of the NGLs barrel and highlighting its growing importance in NGLs extraction economics

[17] (Alberta Energy Regulator 2018)

[18] Meanwhile, most of British Columbia's incremental natural gas production in the past decade has come from the wet portion of the Montney located in the northeast portion of the province.

Wet gas production has become an increasingly attractive value proposition for ailing Canadian natural gas producers in the past decade, helping them boost and diversify revenues (via NGLs extraction and marketing) at a time of persistently low natural gas prices. This has also increased the need for gas processing and NGLs fractionation and marketing infrastructure.

While most NGLs in Canada are extracted at natural gas processing plants (90 per cent of the total), smaller volumes of NGLs are also produced in the form of liquefied petroleum gases (LPG) from refineries, but also extracted at off-gas processing plants at selected oil sands upgrading sites. (See Box 2) For 2016, we estimate total Canadian NGLs production from all three sources at 670 kb/d (including ethane, propane, and butanes). (See Table 2)[19]

Table 2: Production of NGLs in Canada, by source, 2006-16, kb/d

	2006	07	08	09	10	11	12	13	14	15	16	10-yr net change	10-yr CAGR (%)
Gas Plant NGLs	553	558	521	498	483	493	498	519	521	526	602	49	0.9
Refinery LPGs	56	60	58	56	59	56	50	47	43	42	42	(13)	(2.7)
Upgrader off-gas liquids	12	11	10	11	11	12	13	12	19	23	26	14	8.1
Total NGLs	**621**	**629**	**589**	**564**	**553**	**561**	**561**	**578**	**583**	**591**	**670**	**49**	**0.8**

CAGR: compound annual growth rate

Source: The Conference Board of Canada; Alberta Energy Regulator (ST39); Statistics Canada (CANSIM Tables 131-002 and 128-0017)

Over the past decade, total NGLs production in Canada increased at an annual rate of 0.8 per cent – or half the pace of total energy production. In volume terms, increased production of NGLs from gas processing plants was responsible for the net increase in NGLs production levels - with gas plant propane and butanes driving this trend; while a decline in refinery LPG volumes was offset by an equivalent increase in extraction of NGLs at off-gas liquids-extraction plants.

Consistent with the regional breakdown for natural gas production, most natural gas processing and NGLs fractionators are in Alberta and British Columbia. However, an NGL fractionation plant in Sarnia (Ontario) is responsible for about ten to 15 per cent of the total volumes of spec NGLs produced in Canada – mainly propane and butanes. These NGLs are, however, originally transferred from Western Canada via the Enbridge system as an NGLs-mix. Farther east, a gas plant in Goldboro (Nova Scotia) extracts small volumes of NGLs from the Sable offshore project.

NGLs produced as refined products (LPG) originate at the major regional refining hubs across Canada in Western Canada, Atlantic Canada, Quebec, and Ontario.[20]

[19] Gas plants NGLs data from CANSIM Table 131-002; refinery LPGs data from CANSIM Table 128-0017 and; oil sands upgraders off-gas plants data from the AER's statistical report (ST) 39 for Aux Sable's Heartland Offgas Plant, InterPipeline's Offgas Fort McMurray plant, and InterPipeline's Offgas Horizon Liquid Extraction Plant.

[20] For more on Canada's refining sector see: (National Energy Board 2018)

Lastly, the three off-gas processing/liquids extraction plants – located at the Suncor base mine and CNRL Horizon integrated mining and upgrading sites, and at the Shell Scotford upgrading, refining, and petrochemical complex – are all located in northern Alberta.[21]

Propane Supply in Canada

Overview

Production

Including extraction as a gas plant NGL (over 90 per cent of the total) and production as a refinery LPG (under 10 per cent), Canada's total propane production levels were estimated at close to 220 kb/d for 2016.[22] Over the last decade, although Canadian propane production levels fluctuated, some trends across production sources and regions were apparent. (See Table 3)

Table 3: Canadian propane production, by source and by region, 2006-16, kb/d

	2006	07	08	09	10	11	12	13	14	15	16	10-yr net change	10-yr CAGR (%)
Gas Plants	185	181	173	161	156	155	168	172	174	175	201	16	0.9
Refineries	35	34	32	33	32	31	33	33	25	20	18	(16)	(6.2)
Total	**220**	**215**	**205**	**195**	**188**	**186**	**202**	**205**	**200**	**194**	**219**	**(0)**	**(0.0)**
Western Canada	118	113	108	108	104	108	120	125	126	124	143	25	1.9
Eastern Canada	102	102	97	87	84	78	82	79	73	70	77	(25)	(2.8)

CAGR: compound annual growth rate

Source: The Conference Board of Canada; Canadian Association of Petroleum Producers (CAPP);[23] Government of British Columbia;[24] Statistics Canada (CANSIM Table 128-0012)

First, the mute change in production levels between 2006 and 2016 was the result of higher gas plant NGLs volumes, but declining refinery LPG volumes. Second, as in the case with total gas plant NGLs, propane extraction from natural gas increased in the past decade despite lower natural gas production levels – with higher NGL yields from increased production of liquids-rich gas, in addition to the expansion of fractionation capacity in Alberta, explaining this trend. (See Box 4). Lastly, the increase in propane production volumes from gas plants in Western Canada, has been offset by nation-wide declines in refinery LPG production, but more so by a decline in propane production's levels at southern Ontario's fractionator facility in Sarnia. (See Figure 7)

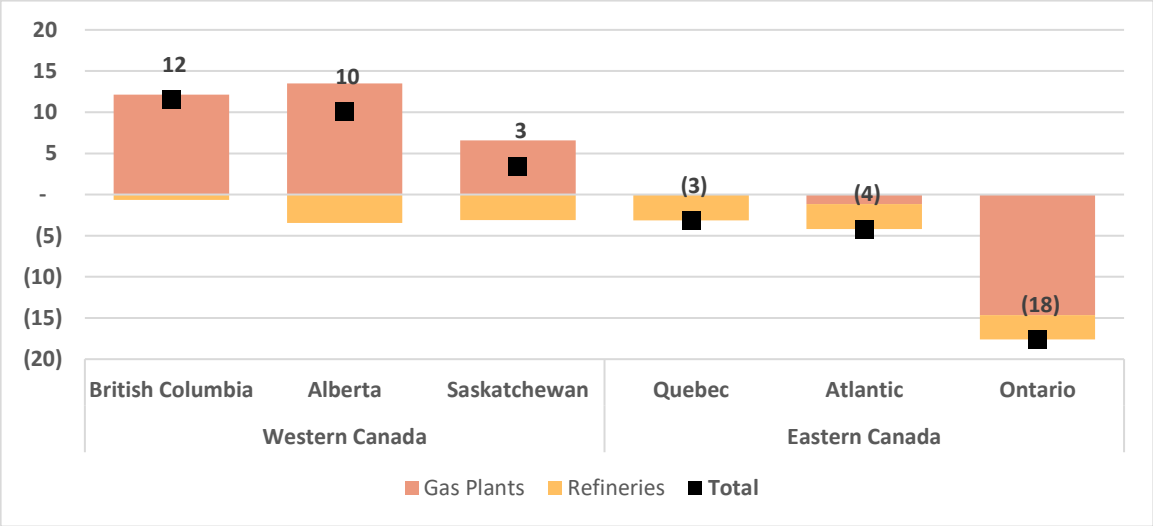
[21] For a comprehensive overview of energy transportation, processing, and storage infrastructure in Alberta, see: (Alberta Energy Regulator 2018). For a more specific description of NGLs infrastructure in Canada, see: (Murillo, Natural gas liquids (NGLs) in North America: An Update. Part II - Midstream and Downstream Infrastructure 2014).

[22] Including propane volumes from off-gas processing facilities – estimated at around 10 kb/d for 2016, the total production level for 2016 is closer to the 230 kb/d mark. We have, however, excluded propane production volumes from this source due to historical data availability and reliability issues.

[23] Gas plant propane production figures for Nova Scotia and Saskatchewan.

[24] Gas plant propane production figures for British Columbia.

Figure 7: Net changes in Canada's propane production between 2006 and 2016, by source and by region, kb/d



Source: The Conference Board of Canada; Canadian Association of Petroleum Producers (CAPP); Government of British Columbia; Statistics Canada (CANSIM Table 128-0012)

Given that most of the propane fractionated in Ontario comes originally from Western Canada, there are a couple of explanations for this latter trend.

NGL mixes received at the Sarnia fractionator (via Enbridge's mainline system) come from three main sources:

- the Plains Midstream fractionator in Fort Saskatchewan (about 50 per cent of the total)
- the Empress straddle or gas reprocessing plants at the Alberta/Saskatchewan border (40 per cent of the total)
- and, other unfractionated NGL-mixes extracted in Western Canada (10 per cent).

Regarding volumes from the Plains Midstream fractionator and other unfractionated NGL mixes, data from the AER's ST3 report indicates that the share of NGLs-mix fractionated in Alberta as a percent of the total NGLs mixes available in the province (including volumes coming in from British Columbia) increased from 60 per cent in 2010, to close to 75 per cent by 2017. Thus, lower volumes of NGL mixes in Alberta are being left unfractionated and are the available to be exported from the province, largely the result of increasing fractionation capacity in Fort Saskatchewan.

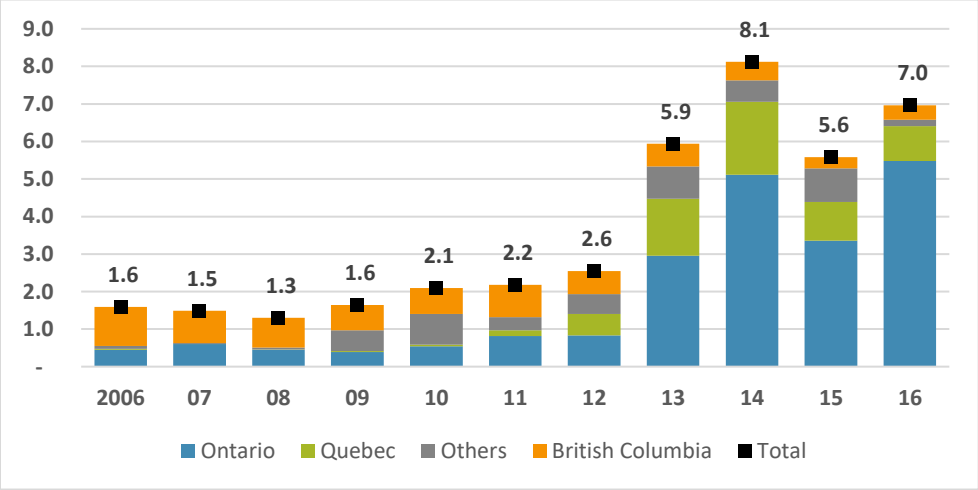
Meanwhile, NGLs extraction volumes at the Empress straddle plants have declined rapidly in the last few years because of declining eastbound natural gas exports from Alberta.[25] Leading to less volumes of gas being re-processed – although rising NGL yields have helped offset this decline.

As such, complex interactions between natural gas production levels and trade flows, gas composition and NGLs extraction economics, and the evolution of processing and transportation infrastructure have had an impact on gas plants NGLs production levels – including propane. In turn, the ongoing and anticipated evolution of these trends in the coming years will have an impact on the outlook for Canadian propane production – as discussed ahead.

Imports

Propane import volumes are small relative to Canadian production (and demand) levels.[26] Estimated at 7 kb/d for 2016, import levels nearly quadrupled relative to a decade earlier (2006). (See Figure 8)

Figure 8: Canadian propane imports, by region, kb/d



Source: The Conference Board of Canada; Statistics Canada (CANSIM Table 128-0012)

Prior to 2012, propane import levels lingered around the 1 to 2 kb/d mark. But, between 2012 and 2014 import volumes more than tripled - peaking at over 8 kb/d in 2014. Since 2015, import levels have remained around the 6 to 7 kb/d mark. And although Canadian imports have increased rapidly, there are some regional differences. For example, most of the increases in imports can be attributed to higher flows into Ontario (and Quebec, to a lesser extent), while decreasing imports into British Columbia are also evident.

[25] The Empress straddle plants are some of the largest sources of ethane extraction in Western Canada – helping explain the observed decline in ethane production levels from gas plants in the past decade.
[26] Imports accounted for an average of three per cent of total Canadian domestic demand in the last decade - with import dependency being the highest (but still low) in British Columbia (at 10 per cent), as well as in Saskatchewan, and Quebec (5 per cent each).

Certainly, declining propane production levels could have accounted for some of the increase in Ontario and Quebec's propane imports in the 2011-2014 timeframe.[27] Yet, the increase in imports also came at a time when U.S. propane surplus production and exports soared.

The uptick in Ontario's propane imports in 2013-14 can be further explained by a regional cold snap (i.e., the *Polar Vortex*), that placed significant pressure on regional heating requirements and propane prices at the time.[28]This timeframe also coincided with a transition in the ethylene-cracking feedstock slate for petrochemical manufacturers in Ontario. This switch first involved a move away from heavier (and costlier) feedstocks (such as gasoil, naphtha, and butanes) to U.S.-sourced propane and ethane/propane (E/P) mixes, and then, to a 100 per cent U.S.-sourced ethane feed.[29]

Total Supply

After accounting for supply adjustments,[30] propane supplies in Canada were estimated at just over 220 kb/d in 2016. While this is the same level as that recorded a decade earlier, supply levels fluctuated during this timeframe, impacted by some key trends. (See Table 4)

Table 4: Total propane supply in Canada, 2006-16, kb/d

	2006	07	08	09	10	11	12	13	14	15	16	10-yr net change	10-yr CAGR (%)
Production	**220**	**215**	**205**	**195**	**188**	**186**	**202**	**205**	**200**	**194**	**220**	**0**	(0.0)
Western Canada	118	113	108	108	104	108	120	125	126	124	143	25	1.9
Eastern Canada	102	102	97	87	84	78	82	79	73	70	77	(25)	(2.8)
Imports	**2**	**1**	**1**	**2**	**2**	**2**	**3**	**6**	**8**	**6**	**7**	**5**	15.9
Western Canada	1	1	1	1	2	1	1	1	1	1	0	(1)	(8.1)
Eastern Canada	0	1	0	0	1	1	1	5	7	5	6	6	29.8
Supply Adjustments	*2*	*10*	*19*	*8*	*2*	*19*	*49*	*12*	*- 12*	*18*	*- 4*	(6)	n.a.
TOTAL SUPPLY	**223**	**227**	**226**	**204**	**192**	**208**	**253**	**222**	**196**	**218**	**223**	**(1)**	(0.0)

CAGR: compound annual growth rate

Source: The Conference Board of Canada; Canadian Association of Petroleum Producers (CAPP); Government of British Columbia; Statistics Canada (CANSIM Table 128-0012)

[27] Imported propane prices were also competitive relative to Sarnia spot market prices during 2013-14, averaging $54 per barrel (bbl) for imports, compared to $58/bbl at Sarnia (over those two years).

[28] In fact, the supply constraints and resulting pricing spikes that developed during this timeframe prompted Canada's federal government to request a review of Canada's propane market. See: (National Energy Board and Competition Bureau 2014) and (National Energy Board 2016)

[29] For example, during 2013/14 Kinder Morgan used the eastern leg of the Cochin pipeline (Illinois → Ontario) to transport an E/P mix from the U.S. Midwest to the Sarnia petrochemicals cluster. After that, the Western leg of the Cochin pipeline (Alberta → Illinois) was converted from propane to diluent service and its flow direction was reversed. Now, Cochin's eastern leg has been connected to the UTOPIA pipeline as of the start of 2018. UTOPIA brings ethane from the U.S. Marcellus/Utica shale basin to petrochemical facilities in southern Ontario. Finally, as of 2013, Energy Transfer Partners has been operating the Mariner West pipeline, which transports ethane from the U.S. NE to southern Ontario's petrochemical facilities.

[30] Including stock adjustments, differences in inter-regional transfers, and statistical balances.

During the first half of the decade (before 2012), as refinery LPG production and propane import levels remained relatively unchanged, Canadian propane supplies largely declined because of lower natural gas production levels – impacting gas plants' NGLs production in Western Canada. This was the result of evolving dynamics in North America's natural gas markets at the time (at the onset of the U.S. shale revolution), that displaced Canadian gas in U.S. markets.

In the second half of the decade (from 2012 onwards), although LPG production levels at Canadian refineries declined steadily, propane supply levels in Canada managed to increase, as more propane was extracted from gas plants in the WCSB. This was driven by higher NGL yields and expansions in fractionation capacity. Higher NGL yields were the result of an increasingly liquids-rich stream of natural gas being explored for and produced in the region, which helped improve the economics of natural gas production in Canada - at a time of persistently low natural gas prices.

Higher import volumes also played a role in increasing propane supplies in this timeframe – although a minor one. With higher import levels driven by one-off weather-dependent developments, increased availability of competitively-priced U.S. propane supplies, and petrochemical feedstock adjustments in Ontario.

Supply Outlook

The outlook for Canadian propane production starts with our assessment of natural gas production over the outlook timeframe (defined as 2017 to 2025 in this report).

The Conference Board of Canada's natural gas production model is driven by a consensus-based natural gas price forecast and a statistically-derived forecast for NGLs prices, used together to estimate natural gas producers' revenues. This is put together with assumptions about drilling costs and profit re-investment ratios, to estimate the annual amount capital available for drilling and the resulting number of wells developed in Western Canada (subject to generic annual vintage decline curves and wells' initial production (IP) rates).[31]

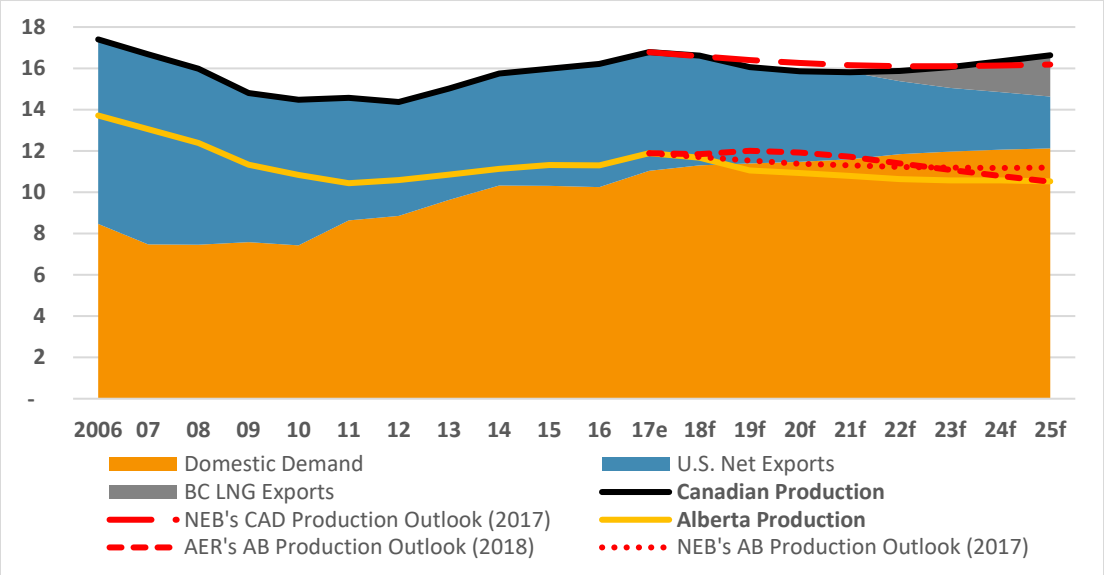
The results of our production model are then cross-checked and compared against other publicly-available and recently released production forecasts for Canadian natural gas,[32] and presented in a supply/demand framework based on an estimated "call" on Canadian natural gas – which is equal to the sum of domestic demand plus net exports.

Our resulting outlook for Canadian natural gas production is relatively flat, increasing by a mere 0.4. bcf/d between 2016 and 2025 – representing a moderate and conservative average growth rate of 0.3 per cent per year. (See Figure 9)

[31] More details on The Conference Board of Canada's methodology for estimating future natural gas, NGLs, and propane production volumes are available in the appendix.

[32] The AER's and NEB's forecasts are adjusted to match our model's 2017 production levels. This ensures that the forecasts are comparable from the start – putting the emphasis on trends rather than levels.

Figure 9: Canadian natural gas production and disposition outlook, bcf/d



e= estimate; f= forecast

Source: The Conference Board of Canada; AER (ST98); NEB (Canada's Energy Future)

Regionally, we anticipate Alberta's natural gas production levels to decline and to close in on 10 bcf/d by the end of the outlook. Meanwhile, British Columbia's production levels increase by more than 1.3 bcf/d (in net), approaching 6 bcf/d by 2025.[33] Note that our outlook for natural gas production in Alberta, British Columbia, and Canada, is consistent with the base cases for similar and recently-published natural gas forecasts from the AER and the NEB.

Domestic demand growth is a key driver of our production outlook, increasing at an average pace of close to 2 per cent annually to 2025, representing a net increase of almost 2 bcf/d in volume terms. Domestic demand will be driven by still-increasing oil sands production levels and their growing requirements for natural gas, but also, natural gas use for power-generation across Canada – driven in part by coal plant retirements and fuel switching initiatives.

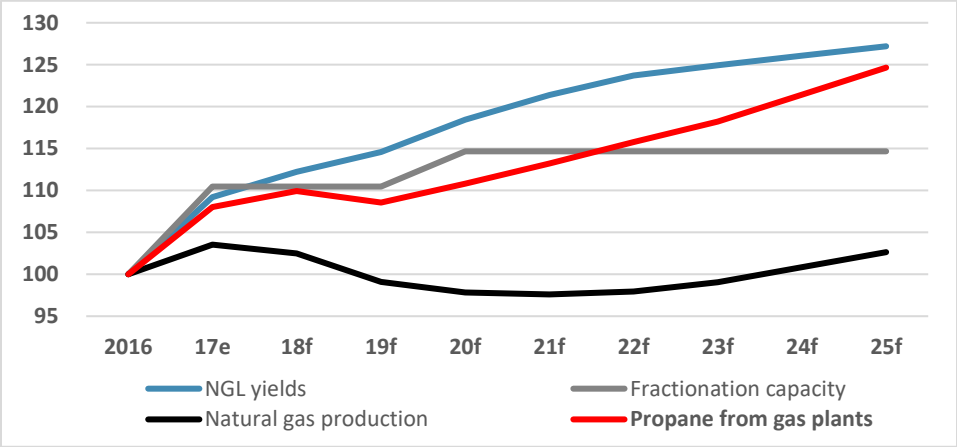
Net exports are expected to continue to decline over the outlook, although at a slower pace than in the previous decade, declining by close to 1.5 bcf/d by 2025 (relative to 2016's levels). This will be driven by a continued decline of net exports to the U.S. – which decline by 3.4 bcf/d by 2025, in turn caused by lower exports from Canada to the U.S. and increasing imports of U.S. natural gas in Central Canada.[34] Lastly, we also assume some level of LNG exports out of British

[33] Although British Columbia's production levels are not shown in Figure 9, the difference between Canadian and Alberta's production is a good way to measure production levels in that province, given that British Columbia accounts for 90 per cent of the natural produced outside of Alberta over the outlook.
[34] Note that our natural gas trade outlook for the U.S. is consistent with the latest (2018) long-term projections for U.S. natural gas flows into and from Canada, as per the U.S. Energy Information Administration's (EIA) Annual Energy Outlook (AEO).

Columbia to materialize over the outlook - starting at 0.5 bcf/d in 2022 and increasing by the same amount each year to reach 2 bcf/d by 2025.

Overall, we believe our natural gas production outlook to be reasonably conservative, to strike a good balance between potential upside and downside risks, and to be consistent with other views of the market from trustworthy and reputable sources. But despite our relatively flat outlook for natural gas production in Canada, continued increases in NGLs yields, in addition to anticipated increases in fractionation capacity, will lead to a sizeable boost in propane production from gas plants over the outlook (mainly in Western Canada). (See Figure 10).

Figure 10: Canadian natural gas and NGLs production trends, 2016 = 100



e= estimate; f= forecast

Source: The Conference Board of Canada; Company Websites (for fractionation capacities)

Driven by still-favourable NGLs extraction economics and a growing share of liquids-rich natural gas in Western Canada, we anticipate NGL yields in Canada to increase by about 30 per cent over the outlook (in line with forecasts from the AER and the NEB). Meanwhile, after accounting for a total of 75 kb/d of expansions in fractionation capacity completed at Fort Saskatchewan in 2017 – at the Pembina and Plains Midstream facilities, in addition to an anticipated 30 kb/d addition of propane-plus fractionation capacity at Empress (slated for 2020), we estimate growth in gas plants NGLs production in Western Canada to be substantial over the outlook.

In net, we anticipate propane production from gas plants in Canada to increase by 25 per cent between 2017 and 2025 – equivalent to a 50 kb/d increase from 2016's levels, and surpassing the 250 kb/d mark by the end of the outlook. More than one third of this net increase has already materialized as of the end of 2017 (mainly in Alberta), with another quarter of the increase estimated to take place in British Columbia in the latter part of the outlook (from LNG exports). As such, even after accounting for the potential risk of no LNG export terminals off Canada's west coast, we estimated that propane production from gas plants in Canada could still increase by 35 to 40 kb/d in the coming years.

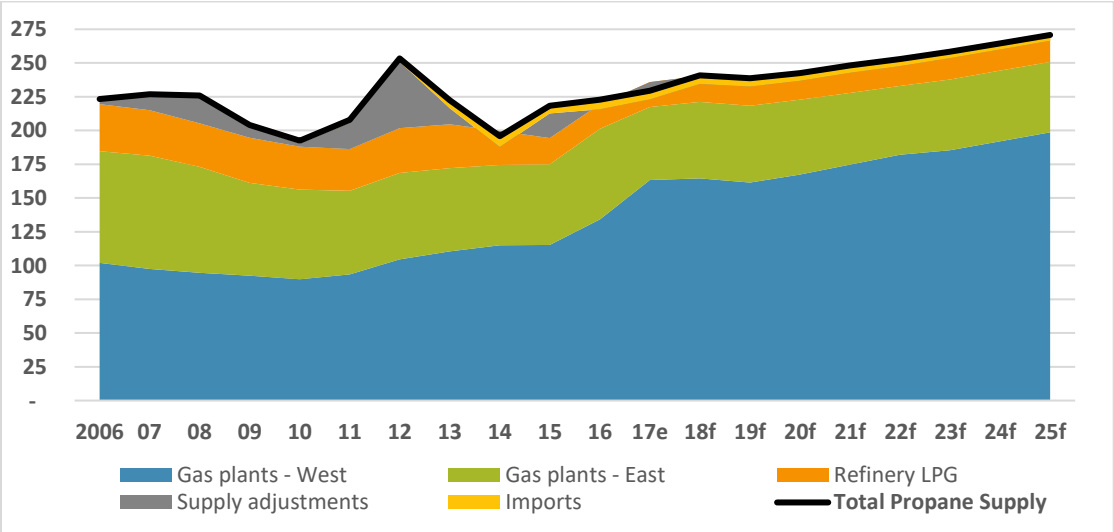
Our 50 kb/d estimated net increase in gas plant propane production in Canada consist of a 65 kb/d increase out of Western Canada (70 per cent of it in Alberta), and a 15 kb/d decline in production in Eastern Canada – mostly in Ontario. This latter development will be the result of more NLG mixes being fractionated in Western Canada, plus the impact of new spec-product fractionation at Empress (as of 2020) – both resulting in lower west-to-east flows of unfractionated NGL mixes.

We use the NEB's forecast for RPPs production in Canada to drive our forecast for refinery LPG production – thus assuming no changes in the product slate, LPG yields, or LPG composition. As such, our estimate for propane production as a refinery LPG is a flat 19 kb/d over the outlook.

We estimate import requirement across Canada based on the regional balances of domestic production versus demand requirements, and after accounting for international exports, inter-regional flows across Canada, and a tapering level of supply adjustments over the outlook timeframe. Our estimates indicate that propane imports will remain a relatively small component of the propane supply mix in Canada (averaging 2 per cent over the outlook), declining from 7 kb/d in 2016, to 4 kb/d by 2025. We note however, that if import requirements were higher than anticipated in our outlook, U.S. supplies could be easily accessed by market participants in Eastern Canada.

After accounting for gas plants and refinery production, imports, and supply adjustments, total Canadian propane supply is expected to increase from just over 220 kb/d in 2016, to more than 270 kb/d by 2025. This represents a 20 per cent increase over the outlook – a far cry from the almost non-existent growth registered in the previous decade. (See Figure 11).

Figure 11: Canadian propane supply outlook, kb/d



e= estimate; f= forecast

Source: The Conference Board of Canada

The increase in supply will be primarily driven by increases in production of propane from gas plants in Western Canada – mainly in Alberta and British Columbia. Meanwhile, gas plants' propane volume increases will be moderated by a conservative outlook for natural gas production in Canada, but supported on the upside by increasing NGL yields and NGLs extraction economics, but also, expanding fractionation capacity in the region.[35]

By any measure, this increase in supply is substantial, and will lead to adjustments on the demand side of the market (including domestic demand and exports) – as discussed next.

Propane Demand in Canada

Overview

Domestic Demand

As a versatile fuel, propane has a wide range of energy and non-energy applications. (See Box 5) For example, propane is used as a fuel in remote areas for space and water heating, while other residential applications may include its use as a cooking fuel. Other examples of day-to-day uses of propane include crop drying operations in the agriculture sector, its use as an alternative automotive fuel in road transport, and even its use as a petrochemical feedstock for manufacturing plastics used in everyday consumer products (propane's non-energy use).

Statistics Canada's energy demand data is generally presented across seven broad end-users, including five energy end-use sectors and two additional categories: producers' use and non-energy uses. This classification applies to demand data for propane, with the categories being:

- *Producers' own-consumption/uses:* which include the uses of propane by propane-producing firms like natural gas producers and processors, fractionators, and refineries.
- *Non-energy uses*: which refers to the uses of propane for non-fuel/non-combustive purposes – i.e., mainly in the form of a petrochemical-manufacturing feedstock.
- *Industrial end-uses*: which include the fuel use of propane by the mining and oil and gas extraction industries (NAICS 21);[36] the construction sector – including residential and non-residential construction (NAICS 23), and; the manufacturing sector (NAICS 31-33).
- *Transportation end-uses:* which include the fuel use of propane by the transportation industry (generally, NAICS 48-49) for transportation purposes. Note that this category excludes the use propane as an automotive fuel in other end-use sectors – such as in the agriculture, commercial, or residential sectors. Thus, the use of propane in this end-use category mainly refers to the use of propane in commercial vehicle fleets.
- *Agriculture end-uses*: which refers to the fuel use of propane by the agricultural, hunting, and trapping industries (most industries under NAICS 11, excluding forestry).

[35] We note a potential upside for higher than anticipated midstream infrastructure investments and NGLs production in Alberta from a recent announcement by the provincial government on $500 million available for such investments through the petrochemical feedstock infrastructure program.
[36] NAICS stands for the North American Industry Classification System, which is a statistical framework that classifies industries across the Canadian economy. For more on this, see: (Statistics Canada 2017)

- *Commercial (and other institutional) end-uses*: which include propane fuel uses by all industries outside of those accounted for in the industrial, transportation, and agriculture end-use categories. For example, this includes the use of propane by service industries, wholesale and retail trade, but also, government institutions such as hospitals, schools, and universities.
- *Residential end-use*: including the use of propane by households such as it uses as a heating or cooking fuel in single family residences, apartments, condominiums, and farms homes; but also, the use of propane as an automotive fuel by individuals.

Clearly identifying these categories allow us to better understand the changes that have taken place in demand for propane in Canada across the different use sectors. A general discussion of the overall trends in propane demand across Canada in the past decade follows. Meanwhile, the outlook section provides a detailed discussion of demand on a sector-by-sector/regional basis.

Box 5. Propane's Energy Uses in Canada

Households
Furnaces
Hot water heaters
Fireplaces and patio heaters
Ovens and cooktops
Fridges and dryers
Pool heaters and generators

Transportation
School and transit buses
Taxis and limousines
Courier vans
Police cars
Trucks and vans of all sizes

Agriculture
Heating livestock facilities, including barns and brooding pens
Heating commercial greenhouses
Powering irrigation systems
Drying grains and crops
Controlling pests and weeds without chemicals

Industry
Mining operations – powering generators, remote camp heating, cooking and refrigeration, and specialized operational equipment
Construction worksite heating
Powering forklifts
Heat for metal processing
Back-up power generation at key institutions

Other Uses
Sideline heaters at professional football games
Road crews laying hot asphalt
As a propellant in aerosol cans – propane is non-toxic and doesn't harm the earth's ozone layer
Commercial lawn mowers
Commercial food service – in permanent kitchens, at catered events or in food trucks
As a petrochemical feedstock to make plastics products

Source: Canadian Propane Association

For 2016, Canadian propane demand was estimated at 107 kb/d, equivalent to close to 50 per cent of total supply (consistent with the average share registered in the past decade). Across Canada, Alberta and Ontario were the largest regional markets, accounting for 33 and 40 per cent of total demand for propane (respectively) that year. Meanwhile, the West to East regional split for Canadian propane demand indicates that each region has consistently accounted for about one-half of Canada's total propane demand in the past decade. (See Table 5)

Table 5: Canadian domestic propane demand, by sector and by region, kb/d

By end-use	2006	07	08	09	10	11	12	13	14	15	16	10-yr net change	10-yr CAGR (%)
Industrial use	32	34	36	34	38	42	51	44	41	39	36	4	1.1
Commercial use	20	23	25	23	25	27	31	26	25	24	26	6	2.6
Residential use	9	11	11	10	11	12	14	11	10	10	12	2	2.3
Non-energy use	20	20	20	17	19	24	32	18	10	9	11	(9)	(5.4)
Transportation use	8	9	10	8	9	9	10	8	7	7	8	0	0.4
Agriculture use	5	6	6	5	6	7	7	6	6	6	7	2	2.9
Producers own-use	7	6	6	5	4	5	6	6	5	7	6	(1)	(0.8)
Total Domestic Demand	**102**	**109**	**115**	**102**	**111**	**126**	**151**	**119**	**104**	**103**	**107**	**5**	**0.5**
of which													
Wholesale	*59*	*60*	*63*	*55*	*60*	*71*	*89*	*68*	*56*	*55*	*54*	*(5)*	*(0.9)*
Retail-level	*43*	*49*	*52*	*47*	*50*	*55*	*62*	*51*	*48*	*48*	*53*	*10*	*2.2*
By Region													
Alberta	*31*	*32*	*33*	*30*	*35*	*42*	*53*	*45*	*40*	*40*	*36*	*5*	1.4
Other Western Canada	*15*	*17*	*19*	*17*	*15*	*14*	*16*	*15*	*15*	*14*	*11*	*(3)*	(2.6)
Western Canada	***46***	***48***	***52***	***47***	***51***	***56***	***69***	***60***	***55***	***54***	***47***	***1***	***0.3***
Ontario	*36*	*40*	*44*	*40*	*44*	*54*	*66*	*43*	*34*	*32*	*43*	*8*	2.0
Other Eastern Canada	*21*	*20*	*18*	*14*	*16*	*16*	*16*	*16*	*16*	*17*	*17*	*(4)*	(2.0)
Eastern Canada	***56***	***60***	***62***	***55***	***60***	***70***	***83***	***59***	***49***	***49***	***60***	***4***	***0.7***

CAGR: compound annual growth rate

Source: The Conference Board of Canada; Statistics Canada (CANSIM Table 128-0012)

By end-user, the industrial sector was the largest user of propane in Canada in 2016, accounting for over one-third of total Canadian demand, with the mining and oil and gas extraction industries accounting for about 80 per cent of total industrial-uses. The commercial end-use sector was the second largest user of propane across Canada in the same year - accounting for close to one-quarter of the total. This was followed by the residential and non-energy use sectors (at about ten per cent of the total each), with propane uses across the transportation, producers' own-use, and agriculture uses each accounting for less than ten per cent of demand.

Wholesale-level demand (including producer's own-use, non-energy uses, and industrial demand) declined by almost 10 per cent in the past decade despite increases in industrial demand and mainly driven by lower non-energy demand. Retail-level demand (including commercial, residential, transportation, and agriculture end-uses), increased by close to 25 per cent in the same timeframe – largely from increases in commercial, residential, and agriculture demand for propane. In turn, retail-level's share of the total domestic market increased from about 40 per cent of the total in 2006, to close to 50 per cent a decade later (in 2016).

Note that although total domestic demand for propane increased only slightly in the past decade, demand levels fluctuated greatly in this timeframe - from anywhere between 100 to 150 kb/d. Rapid demand increases were registered between 2010 and 2012, followed by a sharp decline the following three-years. While these fluctuations in demand were broad-based (by sector and by region) during both the upswing and downswing periods, the industrial sector (mainly in Alberta) and the non-energy use sector (mainly in Ontario) saw the largest changes in demand levels. As such, both these sectors (combined) accounted for two-thirds of the swings in domestic demand levels registered between 2010 and 2015.

Changes in demand across the industrial sector can be explained by fluctuating activity levels in the oil and gas sector – due to the rise and fall of energy prices (and drilling activity); while an adjustment in the feedstock slate for petrochemical manufacturing facilities in Ontario in the same timeframe, helps explain the changes in non-energy use demand. Furthermore, as retail-level demand also fluctuated between 2010 and 2015, changes in overall propane demand can also be explained by overall economic activity levels as well as one-off weather-related events.

On a more disaggregated basis, net increases in propane demand in the past decade were the largest across the industrial sector (mainly in Alberta and Ontario), the commercial sector (in Alberta, Ontario, and Quebec), and in the residential sector (across Ontario, Quebec, and Alberta). However, propane used in the agriculture sector increased at the fastest pace among all end-use sectors - with gains across Quebec and Ontario accounting for most of the growth. Lastly, although Ontario and Alberta accounted for most of the regional gains in demand in this timeframe, demand growth across the Territories and in Saskatchewan was well-above average.

Declines in demand levels were registered across the non-energy use sector in the past decade (mainly in Quebec and Ontario), while regionally, the largest declines in demand occurred across Quebec (in non-energy use but also in industry), and in British Columbia (broad-based, but largely driven by declines across industrial, transportation, and producers' own uses).

While it is difficult to point to a single salient trend on demand for Canadian propane in the past decade, there are a handful of key findings from our regional/sector-level historical overview:

- The fact that the fluctuation in demand levels was broad-based across sectors and regions indicates that changes in propane demand can be largely driven by external (ongoing and one-off) factors beyond market-specific drivers – for example, economic conditions and weather-related events.
- From a retail-level perspective, although the commercial and residential end-use sectors are some of the largest end-use sectors in Canada, they have accounted for a significant level of the increases in demand and are some of the fastest growing sectors for propane use in Canada, other sectors like agriculture are also growing fast.
- From a wholesale-level perspective, history has shown that the scale and variability of propane demand across the industrial and non-energy use sectors can have a significant impact on overall propane demand in Canada.

- Lastly, on a regional basis, Ontario and Alberta remain the largest and some of the fastest growing markets for propane across Canada, but other markets like Saskatchewan and the territories are also growing fast.

Exports

Like many other industries in Canada, and as in the case with most energy commodities, exports are an important outlet for Canada's propane. In 2016, about 155 kb/d of propane were exported, accounting for just over one half of total propane demand in that year.

Although data from the NEB indicates that all of Canada's exports went to U.S. markets in 2016, based on export and import data from the U.S. EIA for PADD V (West Coast), we estimate that about ten per cent of Canada's propane exports (by volume, or 11 kb/d) went to overseas LPG markets via the Ferndale LPG export terminal in Washington state in 2016.

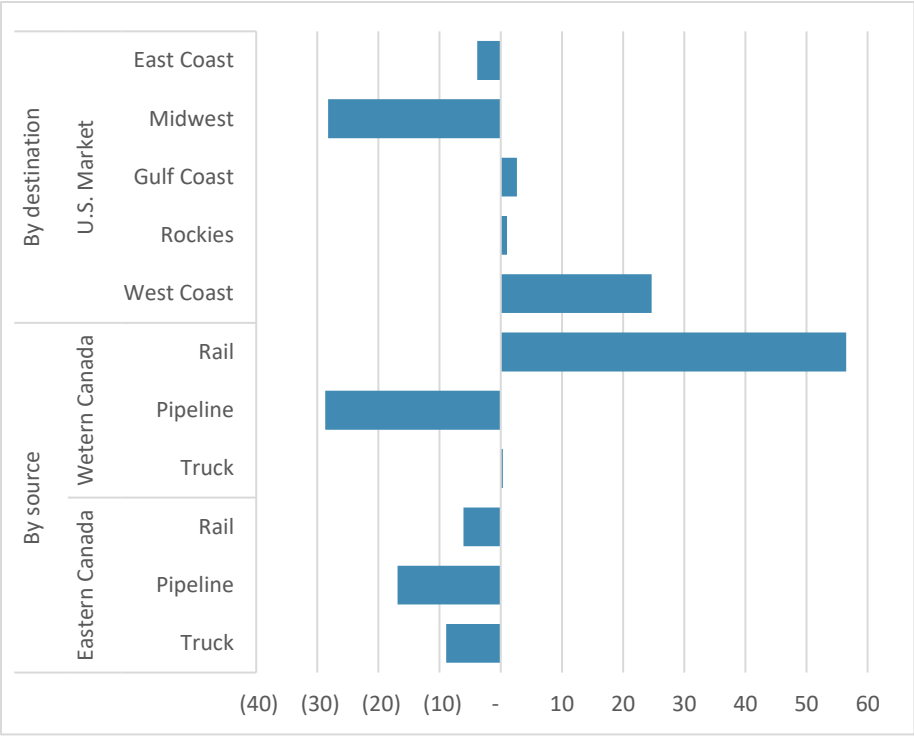
Meanwhile, data from Innovation, Science, and Economic Development (ISED) Canada indicates that although exports to the U.S. accounted for 98 per cent of total Canadian propane exports in 2016 (by value), propane exports also were also registered for various other markets including Mexico, the Caribbean, Europe, Central Asia, and even New Zealand.[37] In turn, these are all new markets being accessed via West Coast waterborne Canadian LPG cargoes, although it is likely that Canadian exports to Mexico are also taking place via rail through the U.S. Gulf Coast.[38]

Canadian propane export levels have fluctuated in the past decade in line with production trends – declining between 2006 and 2010, and then generally increasing thereafter. Yet, export volumes remained little unchanged when comparing 2006 and 2016. Below the headline number however, some significant changes were taking place in terms of the destination, the source, and the transport mode of Canadian propane exports. (See Figure 12).

Much as in the case with natural gas, propane markets in the U.S. have undergone a significant transformation in the past decade – arguably, a much bigger one. U.S. propane production levels nearly doubled in the past decade, while overall demand levels declined,[39] leading to import displacement (primarily of international LPG shipments), and a significant rise in U.S. propane exports – which increased twentyfold in the past decade. With oversupplied markets in the U.S. Midwest and lower import needs in the U.S. East Coast, Canadian exports shuffled away from those markets towards other regional U.S. markets – mainly the U.S. West Coast and Gulf Coast markets. In fact, between 2006 and 2016, the share of Canadian propane exports going to the U.S. Midwest declined from over 60 per cent of the total to under 40 per cent. Meanwhile, the share of exports going to the U.S. West Coast market more than tripled, from just above ten per cent in 2006 to more than 30 per cent a decade later.[40]

[37] See: (Innovation, Science, and Economic Development Canada 2017)
[38] Exports to Mexico continued to increase rapidly in 2017. See: (National Energy Board 2018)
[39] See: (ICF International 2017)
[40] We estimate one-quarter of Canadian exports to the West Coast are flowing through to global markets.

Figure 12: Net change in propane exports between 2006 and 2016, by destination and by source, kb/d



Source: The Conference Board of Canada; NEB (Commodity Tracking System)

This shift in regional propane exports was accompanied by a significant change in the source of exports and the way those propane volumes were moved to U.S. markets. For example, exports out of Eastern Canada (mainly, Ontario) declined rapidly in the past decade, with the region's share of Canada's exports dropping from one-half in 2006, to a quarter of the total by 2016.

Meanwhile, removal of propane service and flow reversal of the Cochin pipeline in 2014 – which used to move spec propane from Western Canada to the U.S. Midwest and Eastern Canada markets – resulted in a significant increase in rail shipments out of Western Canada. In fact, propane exports out Alberta and British Columbia, via rail, doubled and quadrupled (respectively) between 2014 and 2016. And, while rail presented a costlier transport proposition for Canadian propane producers and marketers (putting downward pressure on spot market prices in Western Canada), it also provided them with more flexibility – illustrated by the ongoing and previously unthought of westbound shift in export flows.

Total Demand

Total demand (or disposition) of Canadian propane was estimated at just over 220 kb/d in 2016, and it was roughly equally split between domestic demand and exports. Meanwhile, the regional distribution of total demand was about 40 per cent for Eastern Canada and 60 per cent for Western Canada. (See Table 6)

Table 6: Total Canadian propane disposition, kb/d

	2006	07	08	09	10	11	12	13	14	15	16	10-yr net change	10-yr CAGR (%)
Domestic Demand	102	109	115	102	111	126	151	119	104	103	107	5	0.5
Exports	119	117	110	99	81	81	99	100	90	112	115	- 4	(0.3)
Total Disposition	**221**	**226**	**225**	**201**	**192**	**208**	**250**	**220**	**194**	**215**	**222**	**1**	**0.1**
of which													
Western Canada	*105*	*106*	*113*	*102*	*94*	*104*	*123*	*114*	*107*	*126*	*134*	*29*	*2.5*
Eastern Canada	*116*	*120*	*112*	*99*	*97*	*104*	*127*	*106*	*87*	*89*	*88*	*- 28*	*(2.7)*

CAGR: compound annual growth rate

Source: The Conference Board of Canada; Statistics Canada (CANSIM Table 128-0012)

Total disposition levels were little unchanged (in net terms) over the last decade, although some fluctuation was certainly apparent – mainly between 2010 and 2015 and largely driven by changes in domestic demand. Those changes can in turn be attributed to changing activity levels in the oil and gas sector, and changes in petrochemical feedstocks. However, overall domestic demand levels were also impacted by general economic activity and weather-dependent events.

Exports levels also fluctuated in the last decade. But it was the composition of exports what changed the most, with more export volumes coming out of Western Canada, primarily via rail. This shift has in turn meant that although domestic demand levels increased in Eastern Canada in the past decade, propane volumes that were previously exported out of Ontario are now increasingly being exported out of Alberta and British Columbia, leading to an increase in total disposition levels out of Western Canada – at the expense of Eastern Canada.

Demand Outlook

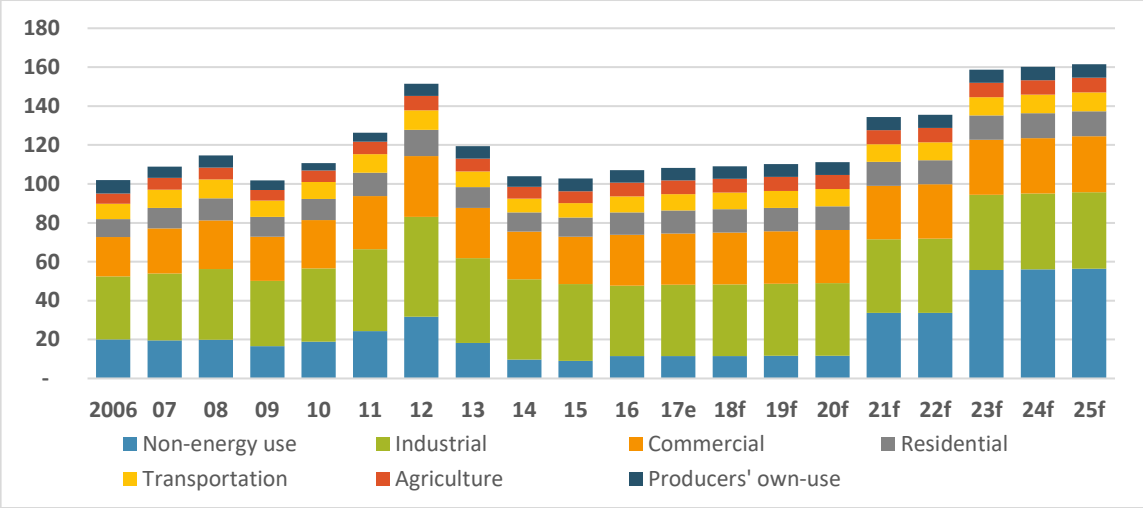
Domestic Demand

Domestic demand for propane in Canada is estimated to increase by more than 50 per cent by 2025, reaching the 160 kb/d mark by the end of the outlook - surpassing the previous peak of 150 kb/d (registered back in 2012). (See Figure 13) Over 90 per cent of the anticipated increases in Canadian domestic demand are estimated to take place after 2020 – thus, only moderate increases in demand levels are expected in the next couple of years.

Across most domestic end-use sectors, we anticipate demand for propane to follow trends in population and economic growth. The primary exception to this pattern is in non-energy use, particularly as a feedstock for plastics manufacturing in Alberta (see Figures 13 and 14). There are also automotive fuel opportunities. Both trends are further discussed in their respective sections below.

We must also note that there is upside potential to our domestic demand outlook for propane, as Canada's carbon pricing approach shifts the relative prices of competing fuels across end-use sectors. Higher carbon prices favor cleaner fuels like propane, although there is not sufficient experience with the range of carbon prices proposed by Canada and the provinces to accurately quantify the impact on propane demand over the outlook at this point.

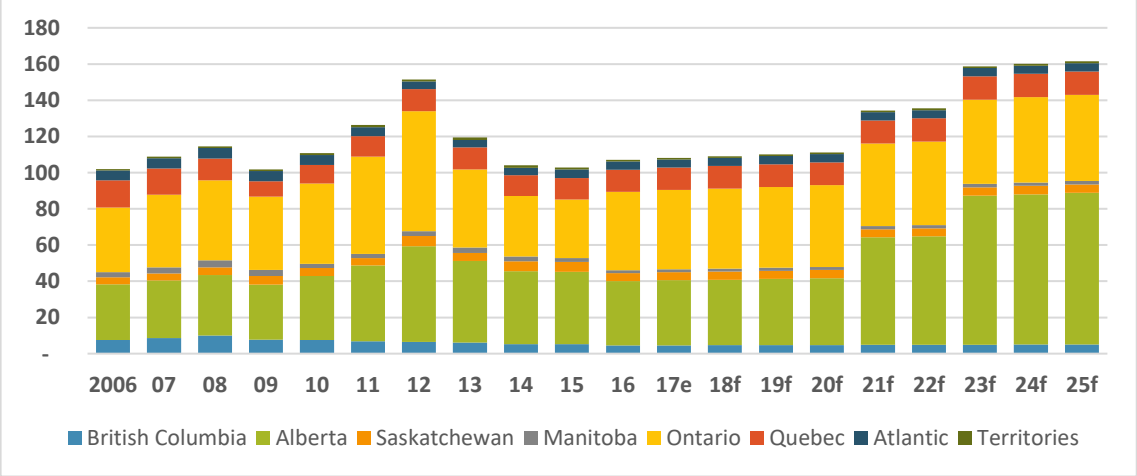
Figure 13: Total domestic propane demand by end use, kb/d



e= estimate; f= forecast

Source: The Conference Board of Canada

Figure 14: Total domestic propane demand by region, kb/d



e= estimate; f= forecast

Source: The Conference Board of Canada

We anticipate growth in domestic demand to be dominated by Alberta's petrochemical industry – partly stimulated by the government's Petrochemical Diversification Program (PDP), but also driven by favorable propane-upgrading economics (propane to petrochemicals), as well as due to increasing propane availability in the province (due to liquids-rich natural gas production).

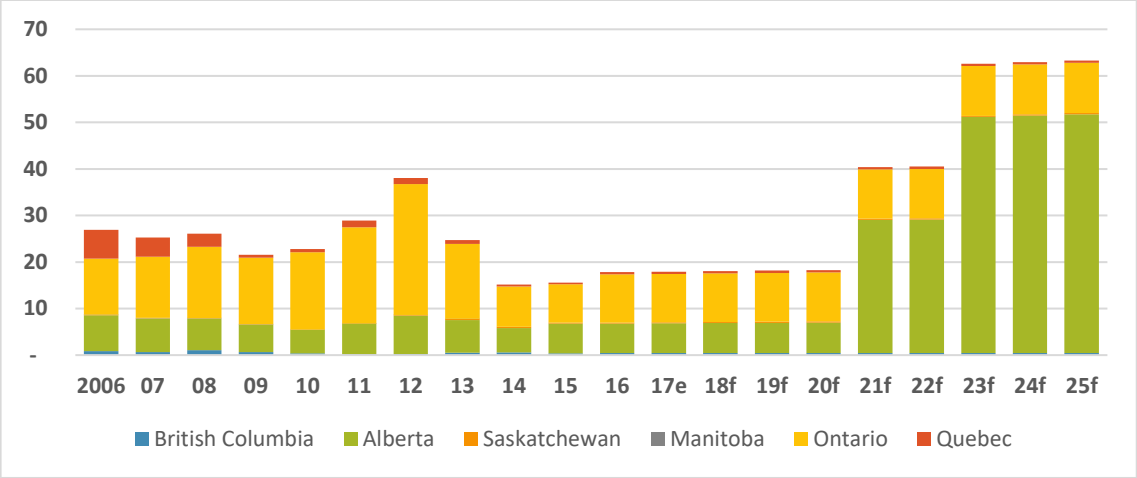
Another sector that shows promise for above-average growth is transportation. The demand for transportation services in Canada for both people and goods has been growing with the economy. Although the share of propane vehicles in the total fleet has not grown much through time, growth in the overall vehicle fleet has benefited automotive propane demand.

The following sections of this chapter provide a discussion of domestic propane demand at a more detailed level by end-use sector, while providing the corresponding regional breakdown.

Producer Consumption and Non-Energy Demand

Propane consumed in the process of fractionating NGLs mixes to produce specification products and propane consumed at refineries to produce specification propane is considered producer consumption. Propane used as a feedstock to produce petrochemicals is considered non-energy use. These two categories combined are shown in Figure 15. (See Figure 15)

Figure 15: Producer consumption and non-energy propane demand by region, kb/d



e= estimate; f= forecast

Source: The Conference Board of Canada

As Figure 15 shows, Alberta and Ontario dominate these uses of propane. The sharp increases in non-energy propane use in Alberta in 2021 and 2023 (44 kb/d, combined) correspond to the anticipated start dates for two projects under development as part of the government of Alberta's PDP initial round. These projects include:

- Inter Pipeline's $3.5 billion Heartland Petrochemicals Complex in Strathcona county, which is currently under construction and expected to begin operations in 2021. This will be Canada's first on-purpose integrated propylene/polypropylene (PP) production facility. The project will convert 22 kb/d of Western Canadian propane into propylene, via propane de-hydrogenation (PDH), and will then convert propylene into polypropylene – a common plastic polymer used in everyday consumer products.
- Meanwhile, the $3.7 billion Canada Kuwait Petrochemical Corporation's project (a joint venture between Pembina and Kuwait's Petrochemical Industries Company) is at the final planning stage of a similarly- sized PDH/PP complex to be built in Sturgeon county. Although no FID has been announced for this project, a decision is expected in 2018. We assume this project to be online by 2023 in our outlook.

Note that although these two projects represent and significant increase in propane demand in Canada, we believe there is potential for even more propane-based petrochemical demand in Canada beyond what we are currently anticipating. This is the case given the government of Alberta's recent announcement of a second round of the PDP (worth another $500 million in royalty credits), in addition to the government's ($500 million) petrochemical feedstock infrastructure program – which could further boost propane supplies in the province.[41]

Lastly, it is worth noting that propane-based PDH/PP development opportunities have also been explored for the Sarnia-Lambton region in Ontario.[42] However, propane supplies for those facilities would be imported from the U.S. Marcellus/Utica shale gas regions – thus having negligible impact on demand for Canadian propane.

Industrial Propane Demand

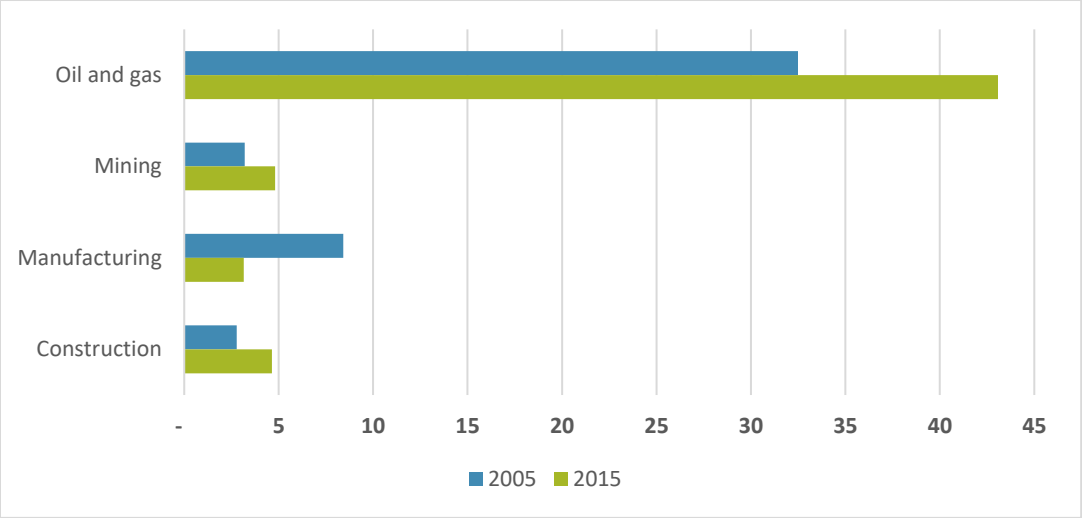
Data from Natural Resources Canada's Comprehensive Energy Use Database (CEUD) indicates that propane accounted for under two per cent of the total energy used by Canada's industrial sector in 2015.[43] This share has increased marginally in the previous decade, mainly at the expense of lower use for electricity and other fuels including wood waste and pulping liquor, heavy fuel oil, and petroleum coke. However, natural gas and diesel's uptake and share of industrial fuel use in the sector increased rapidly at the same time, eclipsing any gains made by propane, and making them the biggest competing fuels for propane in this end-use sector.

The industrial sector is Canada's largest user of propane, accounting for one-third of total domestic demand. The oil and gas industry accounted for close to 80 per cent of the sector's total use of propane in 2015, followed by mining, construction, and manufacturing. In the decade prior to 2016 (2005-15) industrial propane demand increased the fastest across the construction and mining industries but increased the most in the oil and gas industry – propane usage in oil and gas fluctuates in line with drilling activity levels. Demand for propane declined in the manufacturing sector at the same time, but this can be explained by lower energy use, output and sector activity during this time. (See Figure 16)

Going forward, industrial propane demand is expected to grow only moderately through 2025. (See Figure 17) As such, the sector will be relegated to second place for propane demand in Canada by the early 2020's, eclipsed by the rapid and significant anticipated increase in demand for petrochemical feedstock in Alberta. The outlook for industrial propane demand follows the trend in industrial production, but at a slower pace to reflect efforts to improve energy efficiency, as well as competitive pressures from natural gas' lower carbon footprint, prices, and availability.

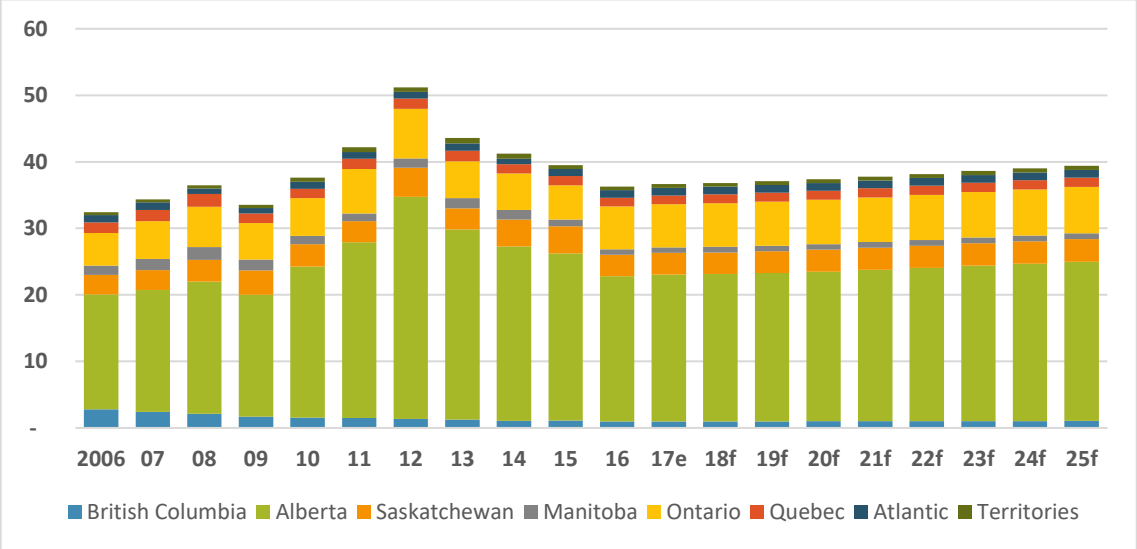
[41] See: (Government of Alberta 2018), (Government of Alberta 2018), and (Government of Alberta 2018)
[42] See: (Chemical Market Resources Inc. and Polymer Consulting International Inc. 2015)
[43] Latest available comprehensive use data at the time of writing. See: (Natural Resources Canada 2018)

Figure 16: Industrial propane demand by user, petajoules (PJ)



Source: The Conference Board of Canada; Natural Resources Canada (CEUD)

Figure 17: Industrial propane demand outlook by region, kb/d



e= estimate; f= forecast

Source: The Conference Board of Canada

Diesel fuel use in the industrial sector may be disadvantaged versus propane due to relative fuel price differences, and in the context of adoption of and increasing carbon prices. However, the fuel may trump propane on use flexibility and energy density. One area of possible upside in the industrial sector, is the use of propane as a solvent for in-situ bitumen recovery - which has the potential to increase from an estimated 8 kb/d in 2016, to between 12 and 14 kb/d by 2025.[44]

[44] See: Figure 9 on pp. 9 in (National Energy Board 2018)

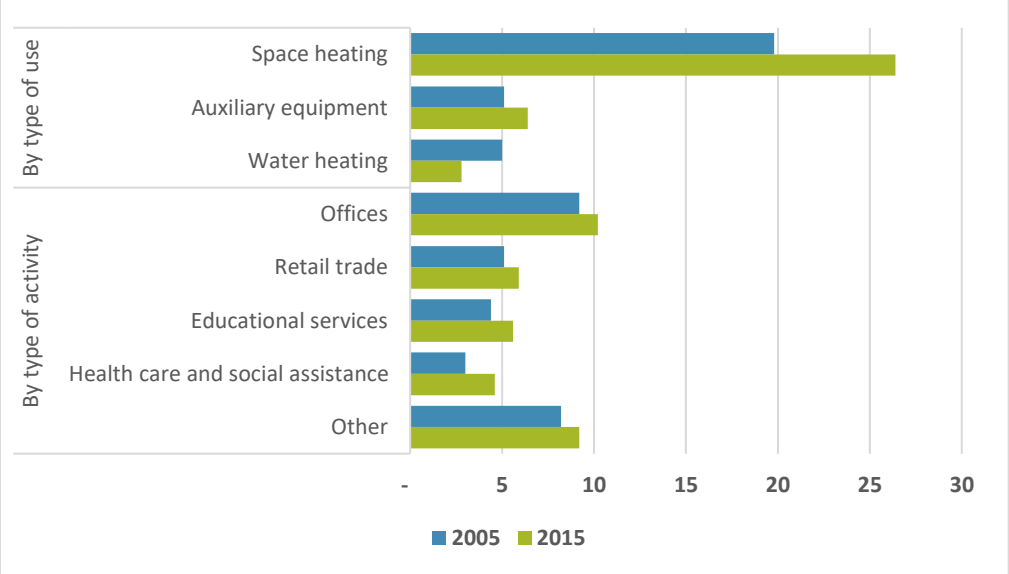
Commercial Propane Demand

Canada's commercial sector is large and diverse, including business and government services. Energy demand in the sector is just as diverse and includes fuel demand for space heating and cooling applications (combined accounting for 60 per cent of the sector's total demand), the use of auxiliary equipment and motors (20 per cent), as well as water heating and lighting applications (10 per cent each). The sector also includes numerous building types such as offices, schools, hospitals, warehouses, shopping centers, hotels, and restaurants – to name a few.

In 2015, propane accounted for close to four per cent of the total energy used in the commercial sector – the largest share for the fuel across all its domestic end-uses.[45] And although this share is small, it has increased marginally over time - propane is now the third-largest fuel used in the sector after natural gas and electricity (propane's largest competitors in the commercial sector). Heavy and light fuel oils' use and shares in the commercial sector have declined over time, higher prices and carbon intensity for these fuels are attributes that makes them good candidates for substitution and growing propane's market share in the commercial sector going forward.

Figure 18 displays demand for propane in the commercial sector in 2015 and a decade earlier by type of use and by subsector activity. (See Figure 18)

Figure 18: Commercial sector propane demand by type of use and by subsector activity, PJ



Source: The Conference Board of Canada; Natural Resources Canada (CEUD)

[45] In 2009 (latest available data), propane as the main fuel source accounted for 6 per cent of Canada's commercial sector total building stock and floor space – as per Natural Resources Canada's Survey of Commercial and Institutional Energy Use (SCEIU). See: (Natural Resource Canada 2012)

Space heating and auxiliary equipment are propane's largest fuel use applications in the sector (combined accounting for over 90 per cent of the total in 2015). These have also been the largest sources of propane demand growth in the last decade – space heating, primarily.

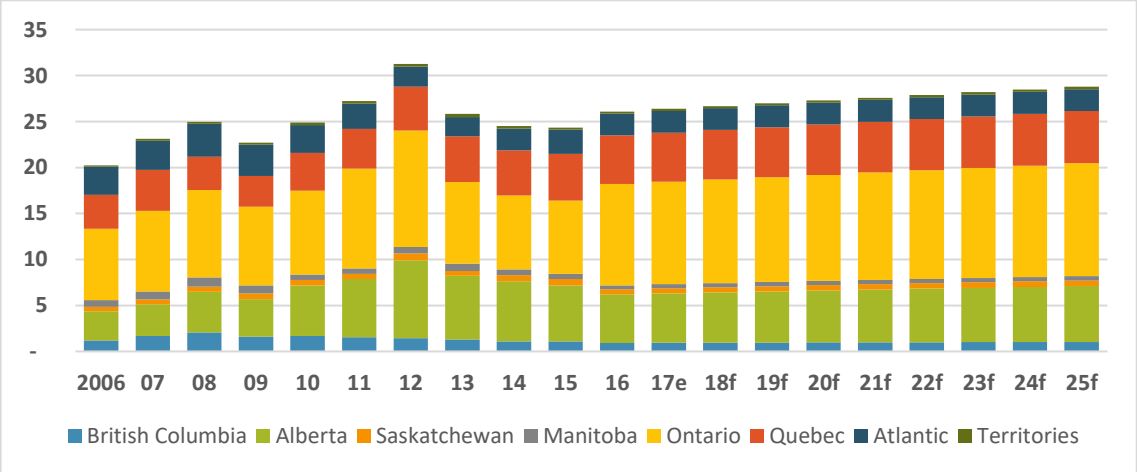
By type of activity, office buildings were the largest users of propane within the commercial sector in 2015, followed by retail trade operations, educational institutions, and health care facilities. These four users in turn accounted for three quarters of total propane use in the commercial sector the same year, with the remaining 25 per cent used across a variety of other end-users. The top four users have also been responsible for over 80 per cent of the growth in demand over the last decade, with growth being particularly strong across health care facilities and educational institutions.

Currently, the commercial sector is the second largest end-use sector for propane (behind only the industrial sector), with demand levels in the sector being more than double those in the residential sector – the next largest end-use sector for propane. Ontario, Alberta, and Quebec, combined, account for more than 80 per cent of Canada's commercial propane demand.

For Ontario and Quebec, their shares of commercial propane demand (42 and 20 per cent, respectively) are broadly consistent with provincial shares of national population and gross domestic product (GDP). Meanwhile, Alberta's share of commercial propane demand (over 20 per cent) is double its share of Canada's population, but just in line with its share of GDP.

Through 2025, commercial propane demand is projected to rise more slowly than GDP, as energy-efficiency measures continue to be implemented across the services sector and the Canadian economy. Meanwhile, increased demand in Ontario, Alberta, and Quebec will account for the bulk of the anticipated increases in commercial demand over the outlook. (See Figure 19)

Figure 19: Commercial propane demand outlook by region, kb/d



e= estimate; f= forecast

Source: The Conference Board of Canada

Residential Propane Demand

Most residential propane use occurs in areas that do not have access to natural gas, while propane can also be mixed with air and delivered via distribution pipelines just like natural gas.[46] Residential propane systems generally require onsite storage tanks, but otherwise operate very much like those for natural gas or heating oil.

In the last decade, propane's share of the residential fuel mix has remained relatively steady at about one per cent of the total. Meanwhile, electricity and natural gas have increased their share and use of energy in the sector, making them the biggest competitors for propane in the residential market going forward. As in the case with the commercial sector, the use and share of fuel oil demand in residences has declined over time. Thus, based on the fuel's higher emissions footprint and comparable price point, there's an opportunity for propane to displace fuel oil's usage in the residential sector going forward.

Energy demand in Canada's residential sector is dominated by space and water heating applications (combined accounting for 85 per cent of the total), and less so by appliances, lighting, and space cooling needs. Demand for propane residential uses is no different with the fuel being primarily used for space and water heating applications.[47] In fact, space heating applications accounted for close to 80 per cent of the use of propane in the residential sector in 2015, with water heating accounting for the difference. Despite space heating applications dominating propane residential demand, it is water heating applications that have registered growth in the last decade.

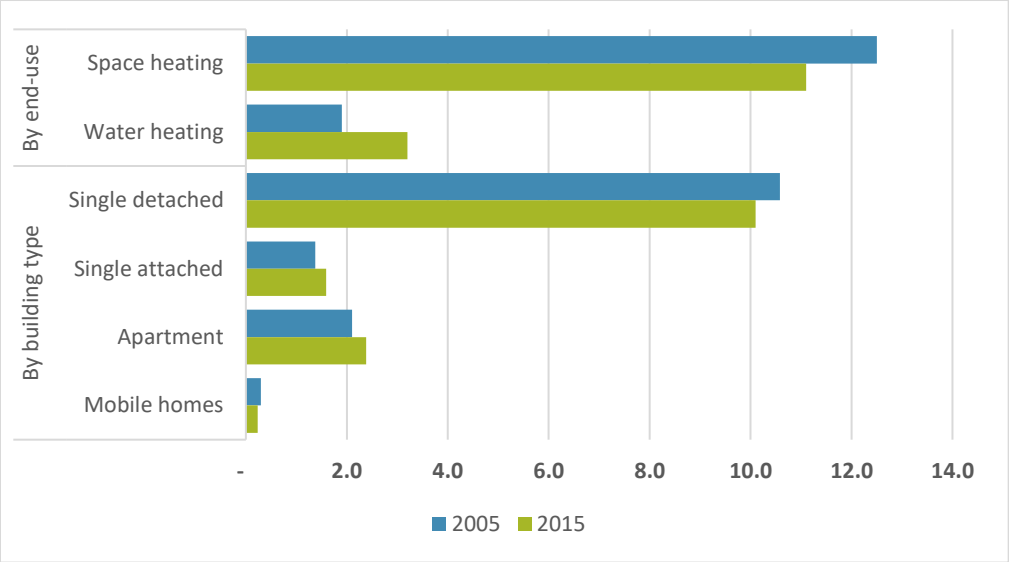
Meanwhile, in 2015, single detached homes were the largest users of residential propane – at over 70 per cent of the total. However, residential demand growth has mainly occurred across single attached homes and apartments, while it has declined across single detached and mobile homes. (See Figure 20)

Residential propane use by province is shown in Figure 21. (See Figure 21) Historically, Ontario's share of residential propane demand in Canada has fluctuated considerably. The province currently accounts for about two thirds of Canada's total residential propane consumption, and this share is expected to hold through the outlook period.

[46] For example, the town of Revelstoke in southeastern British Columbia has a commercial and residential piped propane distribution system.

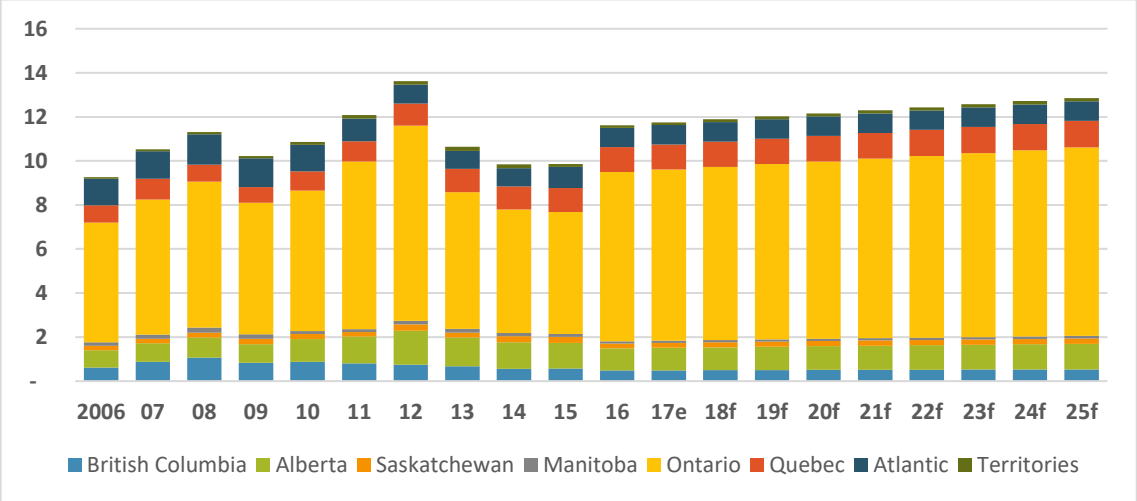
[47] Although Statistics Canada's data for residential propane demand includes automotive fuel uses by households, a cross examination of the data indicates that propane used in the "commercial" transport sector (as defined by Statistics Canada) matches Natural Resources Canada's total transportation sector demand for propane (including passenger vehicles). This indicates that automotive propane demand for passenger vehicles (including cars and trucks) is mainly for commercial fleets (such as taxis, limos, etc.).

Figure 20: Residential sector propane demand by type of use and building type, PJ



Source: The Conference Board of Canada; Natural Resources Canada (CEUD)

Figure 21: Residential Propane Demand by Region, kb/d



e= estimate; f= forecast

Source: The Conference Board of Canada

Ontario and Alberta's population growth are expected to rise faster than the national average in the coming years. As such, although increasing energy efficiency would normally constrain the pace of growth in residential propane demand going forward, a faster than average growth rate for population growth in these provinces will keep residential propane demand growth steady in the coming years. The two provinces, combined, are estimated to account for over 80 per cent of the net increase in residential propane demand over the outlook.

Transportation Propane Demand

Propane used as an automotive fuel accounted for less than one per cent of all fuels used for road transportation across Canada in 2015. Despite the fuel's small share, propane was the fourth-largest fuel used in road transport in the same year - after gasoline, diesel, and ethanol. Diesel and gasoline have increased their shares and use in the transportation sector in the past decade, making them propane's biggest incumbent competitors. Propane can compete favorably with these fuels on a price point and carbon intensity basis, but less so on availability of vehicle models and the required refueling infrastructure.

Meanwhile, biofuels, natural gas, and electricity are all emerging as alternative fuel sources in Canada's transportation sector, supported by government incentives, favorable fuel prices, and lower carbon intensity relative to traditional transport fuels. Although propane can compete on a relative fuel price basis with some of these fuels, propane's relatively higher carbon intensity compared to these fuels may pose a challenge. We note that these fuels – some more than others - face the same challenges as propane in increasing their share of the transportation market including limited models' availability and refueling infrastructure.[48]

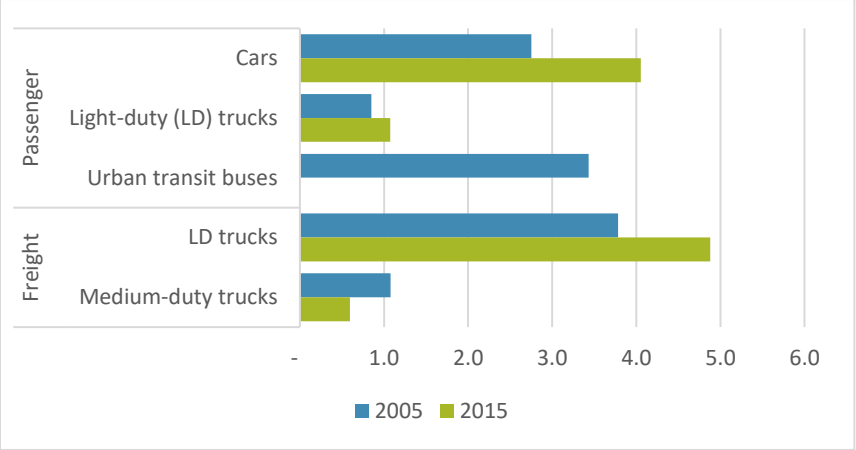
In 2015, automotive propane demand was dominated by light-duty (LD) freight trucks and passenger cars – together accounting for over 80 per cent of demand from the transportation sector. LD passenger trucks and medium-duty (MD) freight trucks accounted for the difference. Although total propane demand from transportation has changed little in the past decade, behind the headline numbers some trends are worth noting. For example, weak demand growth has been largely impacted by a large decline in the use of propane for urban transit bus fleets. However, demand for propane from both passenger cars and LD freight trucks has increased strongly in the same timeframe. (See Figure 22) And although no public data is available on the stock on propane vehicles in Canada, we use fuel efficiency, fuel use, and kilometers travelled data, by vehicle type, and by province, to estimate the stock of propane vehicles for 2015 (the latest year for which comprehensive energy use data for the road transport sector is available).

We estimate that close to one half of the stock of propane vehicles in Canada is passenger cars, with the other half accounted for by LD passenger truck and LD and MD freight trucks. (See Table 7) Ontario, British Columbia, Alberta, and Quebec (combined) are estimated to account for over 95 per cent of the stock of propane vehicles across the country. And although a total of more than 94,000 propane vehicles might seem like a significant number, this number is less than 0.5 per cent of the more than 26 million road vehicles that were estimated to be in service

[48] Data from Natural Resources Canada indicates that there are currently 796 propane fueling stations, 39 compressed and liquefied natural gas stations, three biofuel stations, and 3,267 electric vehicle charging stations across Canada. This compares to an estimate of close to 12,000 gasoline stations operating in Canada at the end of 2016. See: (Kent Group Ltd. 2017) and (Natural Resources Canada 2018)

the same year in Canada (2015), and even a lower share of the 27 million global LPG vehicle fleet.[49]

Figure 22: Transportation sector propane demand by vehicle type, PJ



Source: The Conference Board of Canada; Natural Resources Canada (CEUD)

Table 7: Estimated stock of propane vehicles in Canada in 2015, by vehicle type and by region, and number of propane fueling stations

Region	Passenger cars	Ligh-duty passenger trucks	Light and medium-duty freight trucks	**Total propane vehicles**	**Propane fuelling stations**
British Columbia	11,351	3,679	9,228	**24,259**	**144**
Alberta	4,167	4,519	4,154	**12,841**	**180**
Saskatchewan	279	121	323	**723**	**115**
Manitoba	464	159	1,273	**1,897**	**90**
Ontario	24,953	7,113	18,222	**50,288**	**88**
Quebec	1,862	679	1,088	**3,629**	**163**
New Brunswick	26	8	20	**54**	**7**
Newfoundland & Labrador	21	6	19	**46**	-
Nova Scotia	172	48	101	**320**	**2**
Prince Edward Island	-	9	-	**9**	**2**
Territories	n.a.	n.a.	n.a.	n.a.	**5**
Total Canada	**43,295**	**16,341**	**34,429**	**94,065**	**796**

Source: The Conference Board of Canada; Natural Resources Canada (CEUD)

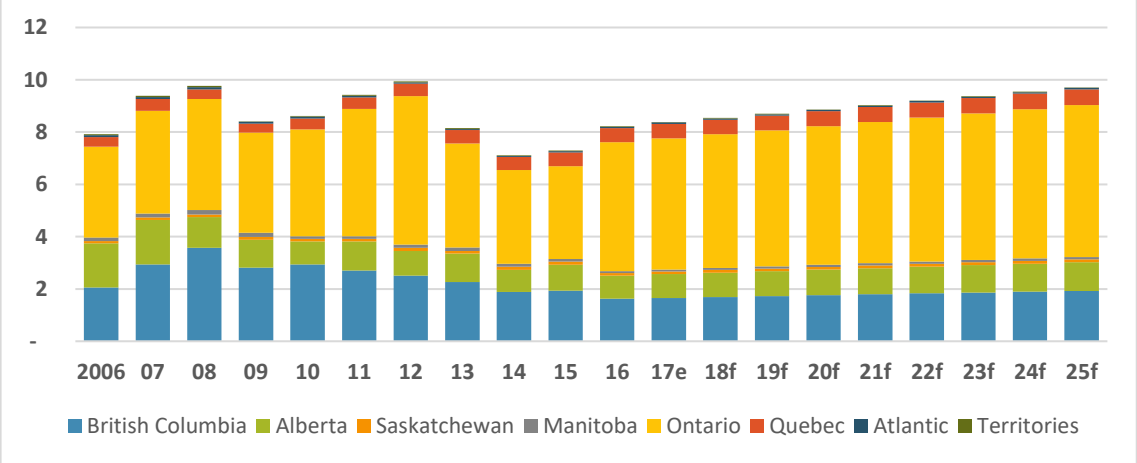
For our outlook, transportation propane demand follows the classification used by Statistics Canada in energy demand data reporting. As such, vehicles owned by companies in the commercial sector or by non-transportation industrial companies are included in the industrial sector (including forklifts used in warehousing). Thus, the road transportation sector considered here includes fleets whose primary purpose is to move people or goods for hire.

[49] (World LPG Association 2018)

Back in 2006, Ontario consumed 44 per cent of road transportation propane and British Columbia 26 per cent - for a combined 70 per cent of the total between the two provinces. By 2016, British Columbia's share had fallen below 20 per cent as consumption declined rapidly. On the other hand, Ontario's share of the national total had risen to 60 per cent, as consumption continued to grow faster than in other provinces. By 2016, the two provinces (combined) accounted for just under 80 per cent of road transportation propane consumption.

Over the outlook period, road transportation demand for propane is expected to rise at two per cent annually - almost double the rate anticipated across the industrial, commercial, and residential sectors. In fact, we anticipate road transportation will be the second fastest growing demand sector for propane, only behind petrochemical feedstock consumption. (See Figure 23)

Figure 23: Transportation propane demand by region, kb/d



e= estimate; f= forecast

Source: The Conference Board of Canada

Propane consumption in road transportation is centered on freight trucks and passenger transportation fleets. Meanwhile, medium-duty freight trucks have been the fastest growing segment of Canada's vehicle stock, and the trend is expected to continue through and beyond the outlook period. What is more, a growing population of consumers relying increasingly on online shopping will reinforce the need for light and medium-duty trucks to deliver packages to our doorsteps. For light-duty vehicles in this sector, propane is expected to maintain and potentially moderately increase its market share.

Electric vehicles are not expected to displace propane vehicles given their very different costs and use characteristics. Although the trend toward electric vehicles is expected to create competition for gasoline and diesel vehicles, propane trucks are a more niche fleet and are not expected to be broadly replaced by electric vehicles. As such, we anticipate the growth in demand for transportation services to boost the continued need for propane powered delivery vehicles, faster than competition from electric vehicles could reduce it.

Agriculture Propane Demand

Propane's share of the Canadian agriculture sector's total fuel demand was estimated at just over 3 per cent in 2015. This is the second highest share for propane use across all the end-use energy demand sectors – only behind the commercial sector.

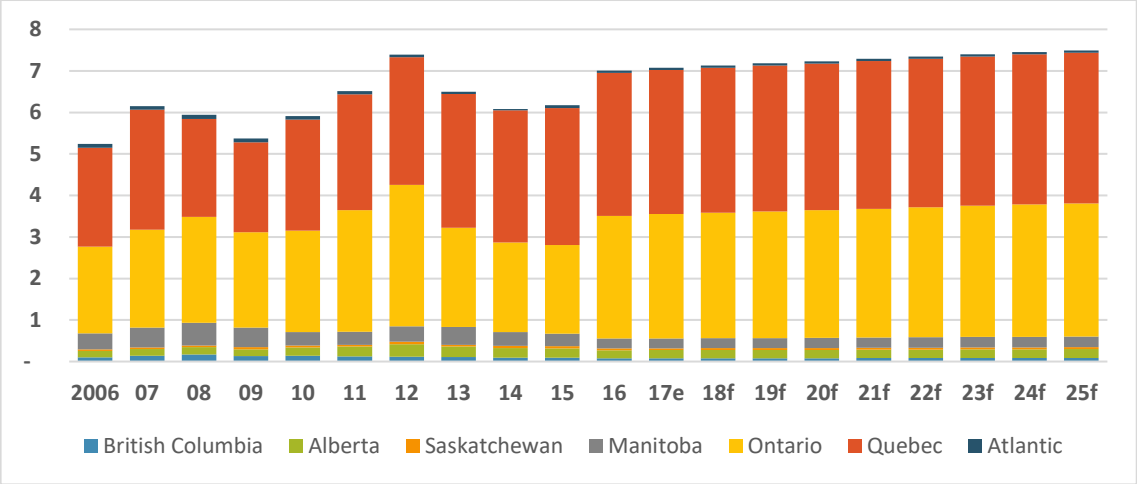
Canada's agricultural sector main energy use is for motive uses (two-thirds of total demand), followed by space heating and other applications (or non-motive uses). Diesel and gasoline dominate the fuel mix for motive uses, while propane use in the sector accounts for about 10 per cent of non-motive fuel demand. Heating livestock buildings, drying crops, and heating greenhouses are examples of propane used as a heating source in the agriculture sector. Natural gas, electricity, and heavy fuel oil (combined) account for close to 90 per cent of non-motive energy demand in the sector, making these fuels propane's largest competitors.

Propane and fuel oil have the advantage over natural gas and electricity because they can be delivered to remote locations by truck and stored onsite. This can reduce the delivery cost, making these fuels more attractive. For space-heating applications, propane and natural gas are very substitutable, requiring only minor modifications to the furnace or boiler. This means that relative prices can drive the economic decision. The situation for crop drying is very similar. Remote locations may find the cost of natural gas delivery infrastructure prohibitive and may rely on propane for that reason.

For irrigation, the primary requirement is to provide energy to drive pumps. This can be done with either diesel or propane engines. Propane engines produce fewer emissions than diesel which may act as a significant advantage in the future. As the focus on reducing GHG emissions continues to increase, farmers may benefit from a growing fuel price advantage (at least as far as carbon prices are concerned) and may also find opportunities to sell offsets by permanently switching from diesel or heating oil to propane.

The outlook for agricultural propane demand by province is shown in Figure 24. (See Figure 24)

Figure 24: Agriculture propane demand by region, kb/d



e= estimate; f= forecast

Source: The Conference Board of Canada

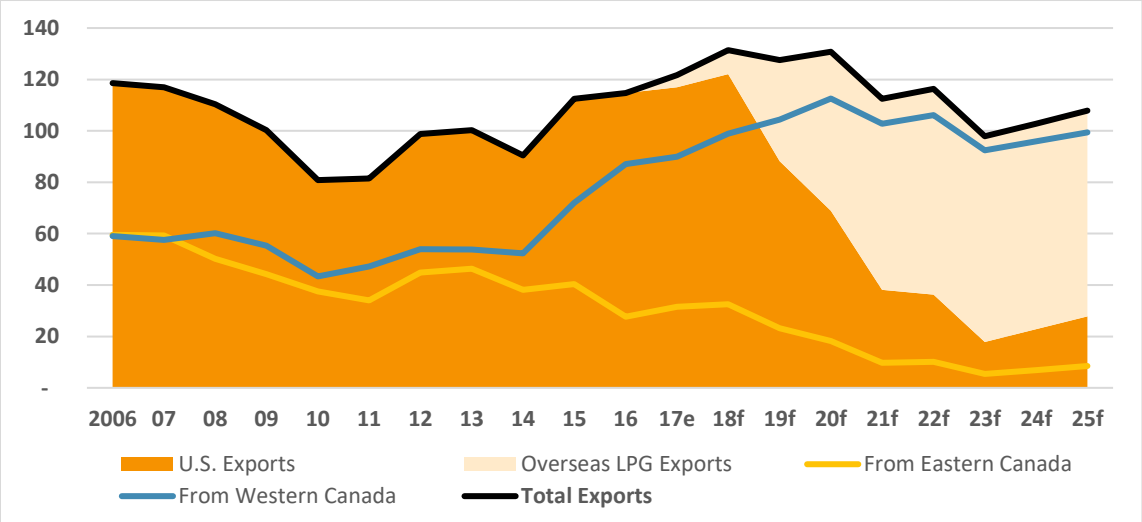
Ontario and Quebec account for just under 40 per cent of Canada's agricultural sector GDP, but together they account more than 90 per cent of total agricultural propane demand, and this share has been rising. Manitoba and Alberta are the next largest consumers of agricultural propane at around 3 per cent (each) of Canada's total.

Growth in propane demand over the outlook is primarily driven by expectations about the sector's economic output. However, as it has been observed in the previous decade, ongoing improvements in energy-efficiency in the sector will limit the growth in demand for propane over the outlook.

Exports

Exports of Canadian propane are estimated to decline in net between 2016 and 2025. However, during this timeframe, exports will fluctuate considerably – ranging from as little as under 100 kb/d, to more than 130 kb/d. This will be driven by the availability of Canadian propane vis-a-vis domestic demand requirements, while the regional composition of Canadian propane exports - by source and by destination - is expected to continue to change considerably over the outlook. (See Figure 25).

Figure 25: Canadian propane exports, by regional source and destination, kb/d



e= estimate; f= forecast

Source: The Conference Board of Canada

Given the rapid increase in Canadian propane production levels anticipated for the next couple of years, but a moderate growth in domestic demand (prior to 2021), export levels are expected to increase rapidly in the 2018-21 timeframe – peaking at around 130 kb/d. Thereafter, export levels are anticipated to decline quickly and move toward the 100 kb/d mark - remaining around that level until the end of the outlook. During this latter timeframe, although we anticipate LNG exports out of British Columbia to boost propane production levels, the sizeable increase in petrochemical feedstock demand in Alberta will inevitably result in lower export volumes.

Meanwhile, Canadian propane exports are expected to continue their westward pivot, with international LPG exports out of British Columbia and the U.S. West Coast expected to peak at about 80 kb/d by 2022 (remaining at that level to the end of the outlook). This will be possible due to the construction of 65 kb/d of LPG export capacity in British Columbia's northern coast - in addition to continued to access to Petrogas' Ferndale LPG export terminal in Washington state.

Altagas is expected to complete construction of its 40 kb/d Ridley Island Propane Export Terminal (RIPET) by early to mid-2019, while Pembina's recently announced FID on its Prince Rupert Export terminal will see another 25 kb/d of LPG export capacity added in British Columbia's coast by the early 2020's. Completion of these facilities will further open the doors to overseas LPG markets for Canadian producers over the outlook.

Given that North America's propane market is expected to continue to remain oversupplied for the near future, we believe that access to the pacific-basin market and higher prices (relative to U.S. markets), will provide Canadian propane exporters with enough incentive to continue their

shift towards overseas markets. As for the balance of exports – i.e., U.S. exports, we anticipate most of those will continue to flow into the U.S. Midwest market, although we also expect to see more volumes going into the U.S. Gulf Coast (and further on to Mexico) – as per recently observed trends.

By the end of the outlook, U.S. exports are expected to be around the 20 kb/d mark – a far cry from the average 100 kb/d registered in the past decade, and a sign of increasing market tightness and diminished surplus availability for Canada's propane - after accounting for the buildout of new petrochemical and LPG export facilities.

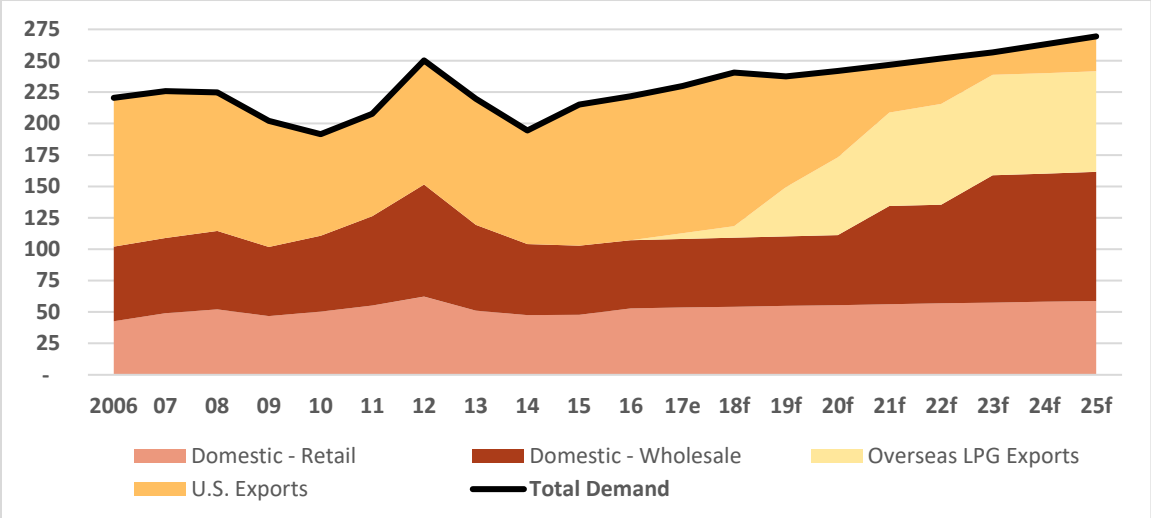
This ongoing westward shift in exports will also mean that by the end of the outlook, most exports of propane will come out of Western Canada – via rail and LPG tankers. Declines in Eastern Canada's exports will be driven by lower import needs in the U.S. East Coast market, but also, increases in fractionation capacity at Fort Saskatchewan and Empress, leaving fewer volumes of Western Canada's extracted and unfractionated propane flowing from West to East.

Total Demand

Consistent with higher production and supply levels, total Canadian propane disposition is expected to increase considerably over the outlook – growing by close to 50 kb/d by 2025, relative to 2016's levels (or an increase of more than 20 per cent). (See Figure 26)

Beyond the headline numbers, some seismic shifts in the composition of Canada's propane disposition will take place over the outlook. Chiefly, an increase in domestic petrochemical feedstock demand and a westward shift in exports – moving away from U.S. markets towards overseas LPG markets.

Figure 26: Total Canadian propane disposition, by domestic end-use and export destination, kb/d



e= estimate; f= forecast

Source: The Conference Board of Canada

Domestic demand will account for most of the increases on the disposition side, with over 80 per cent of the net increase in domestic demand coming from new petrochemical plants in Alberta. Increases across all other domestic demand sectors will remain moderate – at about 1 per cent per year – and will be driven by population and economic growth trends, but limited by energy-efficiency improvements and competition from other fuels.

Despite the significant anticipated increase in domestic demand levels, by 2025, domestic demand will account for 60 per cent of total disposition (compared to 48 per cent in 2016) – thus, exports will continue to be a significant marketing outlet for Canada's propane.

Export levels are expected to fluctuate over the forecast, increasing rapidly by 2020 and declining thereafter - coinciding with large increases in petrochemical feedstock demand in Alberta. Behind the overall volumes of exports, the source of and market destinations for Canadian propane will change considerably. By the end of the outlook, we anticipate most propane exports to come out of Western Canada, with overseas LPG exports accounting for close to three-quarters of total Canadian exports, and the difference going to U.S. markets.

With a thorough and clear understanding of the current and anticipated state of Canadian propane markets, we can estimate the value of propane output and sales, and the impact of the industry across the Canadian economy. Thus, the economic footprint of Canada's propane industry is presented in the following chapter.

Chapter 3
Economic Footprint of Canada's Propane Industry

Chapter Summary

- **Canadian propane sales are estimated at $4 billion for 2016 and are expected to increase to $7.4 billion by 2025 – supported by higher prices and volumes.**

- **In price-adjusted terms ($2016), Canadian propane sales are estimated to average $4.4 billion annually between 2017 and 2025 - compared to $4 billion in 2016. Price-adjusted sales are used to estimate the footprint of the propane industry across Canada's economy.**

- **For 2016, Canadian propane sales are estimated to result in $3.5 billion in economic activity (gross domestic product (GDP)) across Canada, supporting over 17,000 jobs across the economy, and generating over $900 million in government revenues in the form of taxes and royalties.**

- **For the outlook timeframe (2017 and 2025), the industry's footprint expands to $4.4 billion in GDP per year, close to 21,000 jobs per year, and over $1.1 billion per year in government revenues.**

Estimated Value of Canadian Propane Sales

To quantify the economic footprint of Canada's propane industry, the monetary value of propane (derived from volumes and prices) through the entire supply-chain must be estimated. This estimate can be completed from a supply or a demand-side perspective. Yet, the total estimated dollar value of propane in Canada in any given year should be the same using either approach. That is, the value of supply (i.e., production from gas plants and refineries, imports, and supply adjustments) equals the value of demand (i.e., domestic demand and exports).

From a **supply-side perspective**, this estimate would involve calculating the value of the propane extracted at the field level (e.g., using production volumes and spot prices net of fractionation, storage, and transportation costs), the costs of transporting the NGL-mix from the field to a fractionation facility (mainly via pipeline), the cost of fractionating the propane, and the costs of storing the propane at the main marketing hubs (i.e., Edmonton and Sarnia). Then, the costs of delivering the spec product (mainly via rail, pipelines, and trucks) from the main trading hubs to wholesale and retail distributors, and from distributors to end-users across provincial and territorial markets, as well as to export markets, would also need to be estimated.

These estimates would be further complicated by the need to evaluate these costs across every producing and end-use region - thus varying by distance and mode of transport. As such, detailed data on inter-regional flows, as well as on processing and transportation costs, are required to accurately estimate propane's monetary value along the industry's supply-chain from a supply-side perspective.[50] Since detailed regional-flow data is not publicly-available for Canada's propane market, in addition to having to make several assumptions on processing and transportation costs (varying by location), we believe that a supply-side approach to estimating the value of propane and the industry's economic footprint has considerable reliability risks given the potential room for misestimation and uncertainty on both volumes and on prices.

Meanwhile, from a **demand-side perspective**, estimating the value of propane across the supply-chain involves determining the value of domestic sales across each region and end-use sector, as well as the value of exports originating from each region in Canada. Given that we have robust volume data on domestic end-uses and exports as well as on export prices (by region), estimating propane's value across the supply-chain from a demand-side perspective mainly requires making assumptions about domestic retail and wholesale-level prices.[51]

As such, based on publicly available data, we can minimize the number of unknowns and required assumptions (limited to wholesale and retail-level prices) by using a demand-side (or final sales) approach to estimate the propane industry's economic footprint. Thus, providing a more accurate and reliable measure of the industry's contribution to the Canadian economy.

[50] A previous version of the CPA's market study employed a supply-side approach to derive the value of propane in Canada and then used generic multipliers to measure the industry's economic contribution.
[51] For a discussion of how wholesale and retail prices were derived see Appendix A.

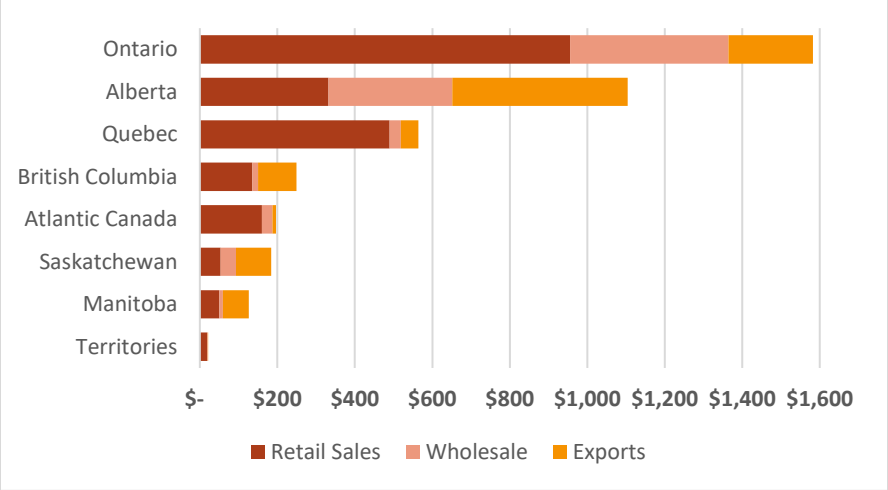
Nominal Value of Sales

Total Canadian propane sales, including domestic and export sales, were estimated at just over $4 billion in 2016.[52] Regionally, Eastern Canada's sales accounted for close to 60 per cent of the total, with Ontario accounting for over two-thirds of those – at close to $1.6 billion. Meanwhile, Alberta's sales – estimated at just over $1.1 billion, accounted for close to 30 per cent of the total. Combined, the top four markets (Ontario, Alberta, Quebec, and British Columbia, in that order) accounted for close to 90 per cent of Canada's propane sales in 2016.

By end-use, commercial sector sales accounted for over one-quarter of the $4 billion in total Canadian propane sales in 2016 – or just over $1 billion; followed by export sales (one-quarter of total sales as well), residential (13 per cent), and industrial sales (at 12 per cent). Meanwhile, transportation, agriculture, non-energy use (petrochemical feedstock), and producers' own-use sales, each accounted for less than ten per cent of total Canadian propane sales in that year.[53]

Figure 27 displays our estimate for Canadian propane sales for 2016, by region, and by end-use. For reference purposes, retail sales include the sum of agriculture, commercial, residential, and transportation sales. Wholesale-level sales include industrial sales, petrochemical feedstock sales (non-energy uses), and producer own-consumption sales. (See Figure 27).

Figure 27: Canadian propane sales in 2016, by region and end-use, millions of dollars ($MM)



Source: The Conference Board of Canada, Statistics Canada (CANSIM Table 131-0002)

[52] Note that the final propane domestic sales values as presented in this chapter include retail-level fuel/excise and sales taxes across each province and territory as per: (Natural Resources Canada 2017)

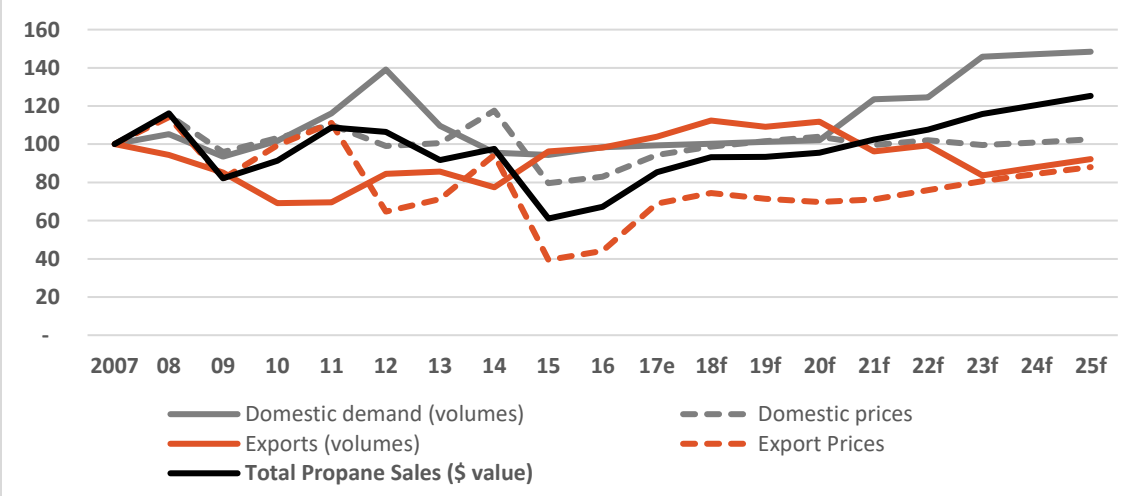
[53] Note that the difference in the end-use sector/regional distributions of demand versus sales is attributed to differences in prices. For example, in 2016, total demand in Alberta (including domestic demand and exports) was 40 per cent higher than in Ontario, but Ontario's sales were 40 per cent higher than Alberta's. This is because higher-priced retail-level sales in Ontario account for a significant share of the province's total, while wholesale and export prices in Ontario are also higher than in Alberta.

Note that although domestic propane uses only accounted for one-half of total demand in volume terms in 2016, they accounted for over three-quarters of total sales that same year. This is because domestic end-use prices – a combination of retail and wholesale-level prices – are much higher than export prices are (which tend to reflect lower spot-level propane market prices at the U.S.' Conway and Mont Belvieu NGL trading hubs).

In the decade prior to 2017, the total volume of propane demand remained relatively unchanged, with a net increase in domestic demand offsetting and almost equal net decline in export volumes. Yet, by 2016, the value of total Canadian propane sales had declined by almost one-third – or by $2 billion – from 2007's levels (when sales were estimated at the $6 billion mark). This indicates that lower prices have been primarily to blame for lower sales in the past decade. In fact, the decline in export sales accounted for two-thirds of the decline in total Canadian propane sales in that timeframe, with export prices declining by close to 60 per cent over the past decade - compared to a less than 20 per cent decline in domestic prices.

However, price levels – for both domestic sales and exports – are expected to increase going forward, boosting Canadian propane sales. (See Figure 28) Indeed, prices are estimated to recover significantly in 2017, allowing the value of propane sales to jump to $5.1 billion in 2017 - a 30 per cent improvement over 2016. By 2025, sales are expected to reach over $7.3 billion.

Figure 28: Total Canadian propane sales, domestic and export demand volumes and price trends, 2007 = 100



e= estimate; f= forecast

Source: The Conference Board of Canada; NEB; Statistics Canada (CANSIM Table 131-0002)

We estimate about two-thirds of the net increase in forecasted sales can be explained by higher prices, with the remaining one-third being driven by higher volumes (mainly in the domestic market). While sale prices are expected to increase by 50 per cent between 2016 and 2025, close to one-half of this anticipated increase in prices is estimated to take place in 2017, driven by a significant rebound in export prices – as per a rebound in U.S. benchmark spot prices.

Increases in domestic sales over the outlook are anticipated to account for most of the anticipated increases in total Canadian propane sales. Higher volumes, rather than prices, will account for the bulk of the increase in domestic sales, although rising prices will certainly contribute to increased domestic propane sales in Canada over the forecast.

On a regional basis, Alberta and Ontario (combined) will account for close to 90 per cent of the total increase in domestic sales, with growth in sales across the rest of Canada remaining moderate, but steady. Petrochemical feedstock (non-energy) sales, will account for over 40 per cent of the increase in domestic sales over the outlook. This will be the result of two new PDH facilities in Alberta that will (combined) use about 45 kb/d of propane by 2025 to produce propylene and polypropylene. Meanwhile, industrial and commercial end-use sales, combined, will account for over one-third of the increase in total domestic sales over the outlook, with growth across all other domestic end-use sales (including residential, transportation, producers' own-use, and agriculture sales, in that order) remaining more moderate.

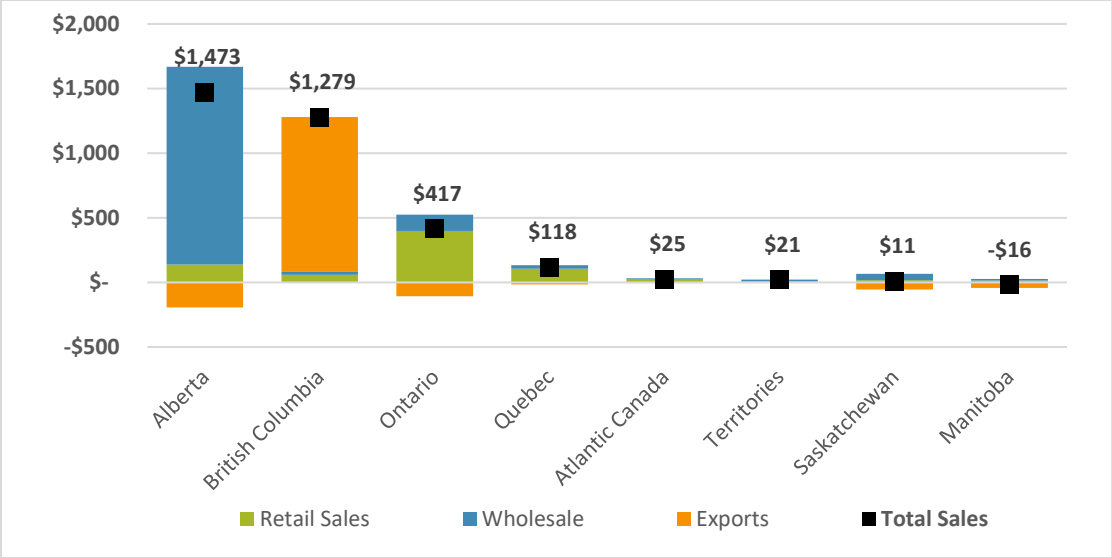
Export volumes are expected to decline slightly over the outlook as the pace of domestic demand growth outpaces that of production – leaving less volumes available for the export market. However, the value of export sales is expected to almost double between 2016 and 2025, driven by higher export prices for Canadian propane. These will be supported by rising North American spot propane prices, but more importantly, higher-value global LPG prices.

The latter will increasingly influence export prices for Canadian propane, as we anticipate that by the end of the outlook, about three-quarters of Canadian propane exports would go to overseas markets. This will be supported by LPG export capacity at two terminals (totaling 65 kb/d of capacity) in British Columbia's coast, in addition to Canadian producer's continued ability to access the Ferndale LPG export terminal in Washington state.

Figure 29 summarizes the anticipated (net) changes in Canadian propane sales between 2016 and 2025 – an increase worth a total of $3.3 billion across Canada. This figure illustrates the seismic shifts that are anticipated to materialize in Canadian propane markets over the outlook. (See Figure 29)

In summary, on the domestic front, the net increase in petrochemical feedstock sales in Alberta will be larger than the combined increase in domestic sales across all other end-use sectors in the rest of the country. Meanwhile, although overall export volumes are expected to decline, the value of export sales will increase substantially due to higher prices for Canadian propane exports. A westward shift in the export market will see the bulk of Canadian exports diverted from U.S. to overseas LPG markets over the forecast, via British Columbia – explaining the decline in export sales across other Canadian jurisdictions. These are, without a doubt, the two key developments that will shape Canadian propane markets – and by extent, propane sales - in the coming years.

Figure 29: Net change in Canadian propane sales between 2017 and 2025, by region and end-use, $MM



Source: The Conference Board of Canada

Real or Price-Adjusted ($2016) Value of Sales

Nominal sales estimates provide an important view of Canada's propane industry from a business perspective and allow us to identify the impacts of the interactions between volumes and prices. However, price-adjusted (or real) sales are needed to estimate the level of economic activity supported by Canada's propane industry over the outlook.

This is because the level of economic activity spurred by the industry - be it GDP, employment, or government revenues – is generally determined by the *level* of industry activity or output (i.e., volumes), rather than prices.[54] Simply put, adjusting for price levels improves the estimate of the economic footprint over the outlook timeframe.

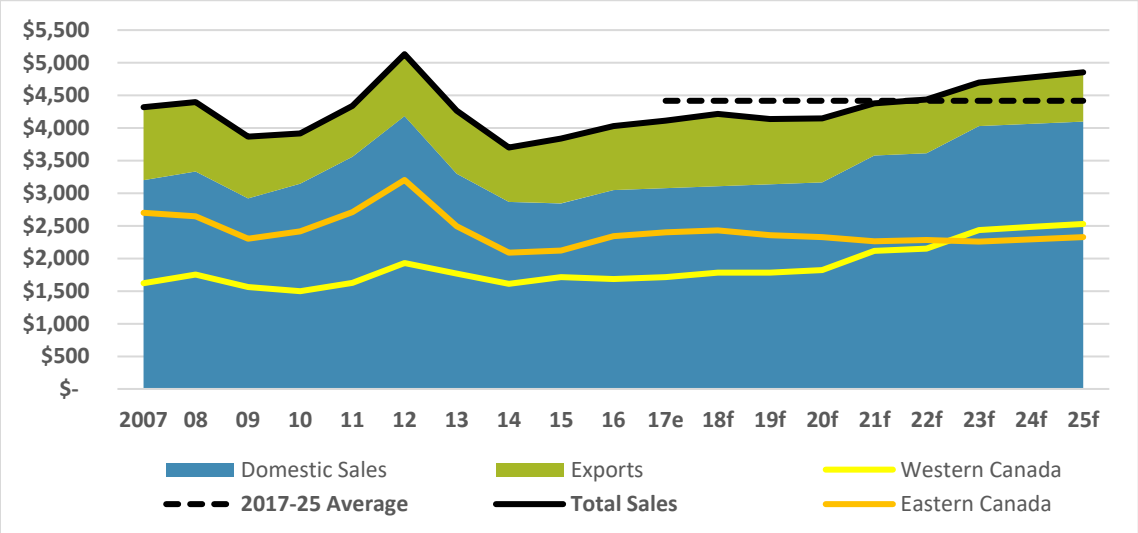
Meanwhile, the fact that we are holding prices constant at 2016's levels, means that the real value of total sales is driven by changes in the levels and mix of sales in volume terms. Thus, helping us measure the level of economic activity in the industry, irrespective of price changes.

Real or price-adjusted propane sales are estimated to increase from $4 billion ($2016) in 2016 to close to $4.9 billion by 2025,[55] averaging $4.4 billion per year between 2017 and 2025. This average annual estimate for the outlook timeframe represents a 10 per cent increase relative to 2016's levels, and is our basis for estimating the industry's footprint over the forecast.

[54] However, the changing mix of wholesale/retail domestic sales versus export sales impacts the real value of total sales over the forecast - because of price differences across these sub-segments in 2016's terms.
[55] This represents a 21 per cent increase – equivalent to the increase in total volume sales – compared to an over 85 per cent increase in nominal sales, again, indicating that a significant driver of propane sales over the forecast is increasing prices (both domestically and at the export level).

As with the case for nominal sales, total Canadian propane sales in real terms are expected to increase primarily across Alberta and British Columbia, driven by domestic petrochemical feedstock demand, and LPG exports to overseas markets, respectively. (See Figure 30)

Figure 30: Total (price-adjusted) Canadian propane sales, by segment and by region, millions of $2016



e= estimate; f= forecast

Source: The Conference Board of Canada

Canadian Propane Industry's Economic Footprint in 2016 and 2017-25

Key Definitions and Brief Methodology

Although propane accounts for a small share of energy production and demand in Canada, the propane industry is an important contributor to the Canadian economy. Part of the industry's strength is its depth and diversity. A wide variety of activities comprise the industry's supply-chain, including: propane extraction from natural gas; propane production as part of petroleum manufacturing, but also; transportation, wholesaling, and fuel distribution activities (See Box 6)

As imported volumes (part of the product sold in Canada) account for a very small share of total propane supply,[56] our $4.4 billion average annual final propane sales estimate for 2017-25 is a sound measure of the level of economic activity that can be attributed to Canada's propane industry and its supply-chain. That is the case because the estimated value of final propane sales accounts for all the costs and margins associated with producing, transporting, marketing, and distributing Canadian propane to domestic and export users.

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[56] Three per cent in 2016 (by volume), and an average of two per cent over the forecast.

Box 6. Propane's supply-chain across Canada

Several industries are involved in the production, transportation, and delivery of propane across Canada. From a statistical standpoint, these can be identified as a combination of industries based on the North American Industrial Classification System (NAICS), including:

- Businesses primarily engaged in the extraction of natural gas and by-products such as NGLs (a subset of NAICS 211), but also, those producing propane as LPG at crude oil refineries (a subset of NAICS 324).
- Businesses involved in the distribution of propane (a subset of NAICS 221), the transportation of propane via pipelines, railways, and trucks (a subset of NAICS 482, 484, and 486).
- Businesses involved in the wholesale and retail distribution of propane (a subset of NAICS 412, 447, and 454).

More detailed descriptions for each industry can be found at: (Statistics Canada 2017)

It is also important to note that the economic contribution of any given industry is much larger than its day-to-day activities. As industries are linked with each other via complex supply-chains, economic activity in one industry triggers an economic response in another.

For example, oil and gas extraction firms use services and inputs from various other businesses such as drilling services or professional services (including lawyers, accountants, etc.). Thus, to estimate the full contribution of Canada's propane industry, we must also include its secondary impacts. (See Box 7)

Box 7. Key Economic Footprint Definitions

When assessing the economic footprint of an industry there are different types of economic activities that can be considered. In this report we include **four *types of economic impacts*** associated with the Canadian propane industry's footprint, including:

- ***Gross domestic product (GDP) impacts*:** referring to the level of economic activity or value-added supported by propane sales across the country. GDP impacts are presented at the basic-price level, thus excluding the value of taxes and subsidies on products.
- ***Labour income impacts:*** are a portion of the overall GDP impacts and refer to the income (wages, salaries, and employers' social contributions) that is generated across the economy because of Canadian propane sales.
- ***Employment impacts:*** refer to the levels of employment that are estimated to be supported by the economic activity resulting from propane sales across Canada. Employment impacts presented in this report include the sum of full-time, part-time, and temporary workers, inclusive of employees and self-employed workers.

- ***Fiscal impacts:*** refer to the federal, provincial, and municipal levels of government revenues that are collected across Canada due to propane sales and the resulting economic activity. These include corporate income taxes, indirect taxes, payroll taxes, and personal income taxes. For this analysis we also include estimates of royalties collected by provincial governments from propane extraction from natural gas production, and an estimate of carbon taxes paid on domestic propane sales as part of the total fiscal impacts.

In addition to the different types of economic impacts presented in this report, there are ***four levels of impacts*** that can be identified when discussing the economic footprint of Canada's propane industry, including:

- ***Direct impacts*****:** which include the economic impacts associated with the day-to-day activities of the propane industry.[57]
- ***Indirect impacts:*** which are the supply-chain impacts associated with sales of propane (or the industry's economic output). In general, these impacts capture the purchases of goods and services by the propane industry itself - such as financial services or professional services – as required for the industry's day-to-day operations.[58]
- ***Induced impacts***: are the impacts resulting from income expenditures derived from both direct and indirect impacts. As such, these impacts capture the spending of income across the economy from propane industry workers, but also, from workers in the industries that provide goods and services to Canada's propane industry.
- ***Total impacts:*** are the sum of direct, indirect, and induced impacts, and are the focus of our discussion in this report (unless otherwise specified).

To determine the level of economic activity that is incurred because of propane sales in Canada, we use Statistics Canada's Interprovincial Input-Output (IO) model. This model provides an estimate of the economic footprint for the industry across Canada – including gross domestic product, labour income, and employment impacts. We then use Statistics Canada's results, together with The Conference Board of Canada's proprietary macroeconomic and fiscal databases, to estimate the levels of government revenues generated by Canada's propane industry's activities.[59]

[57] Note however that since the footprint for Canada's propane industry is calculated based on the end-use value of propane sales, in Statistics Canada's Input-Output (IO) framework the direct impact is only considered for propane sales as a *final good* (i.e., the equivalent of exports and domestic sales only), while excluding the direct impact of propane sales as an *intermediate good* (all other domestic propane sales - excluding residential sales). As such, the direct impact of propane sales as an *intermediate input* is captured at the indirect level – a key reason to focus on ***total impacts*** in our discussion and analysis**.**

[58] In our case, based on Statistics Canada's IO framework, these impacts also capture the direct impact of *intermediate input* propane sales (domestic sales excluding residential sales).

[59] More details on the methodology for estimating the industry's footprint are provided in Appendix A.

Main Results

At the national level, $4 billion worth of propane sales in 2016 meant that Canada's propane industry supported $3.5 billion in GDP in that same year.[60] This included labour income of $1.3 billion, supporting close to 17,200 jobs across the economy. What is more, over $900 million in government revenues are estimated to have been generated by this level of economic activity. (See Table 8)

Over the outlook timeframe (2017-25), the industry's price-adjusted sales are expected to average $4.4 billion per year. This will support $4.4 billion in GDP, close to 21,000 jobs, and contribute over $1.1 billion in revenues to all levels of government across Canada (on an annual basis).

As such, we can estimate that every million dollars of Canadian propane sales supports the following levels of economic activity across Canada (for 2016 and over the outlook (2017-25), respectively), including:[61]

- $0.9 and $1.0 million in GDP across Canada
- 4.3 and 4.8 jobs across the Canadian economy
- $0.2 and $0.3 million in various types and levels of government revenues across the country

Beyond the headline numbers, the propane industry's economic footprint is estimated to extend across all of Canada's regions and sectors of the economy. (See Table 8 and Figure 31)

Regional-Level Impacts

On a regional basis, Canada's propane industry economic footprint is the biggest across Alberta – which accounts for two-thirds of all GDP impacts, and over one-half of total employment and government revenue impacts. Although propane sales in the provinces are less than a third of Canada's total, the oversized footprint of the industry on the province relates to the fact that the oil and gas extraction industry (largely based in Alberta) accounts for a significant share of the industry's activities (see Figure 31).

Despite this, all regions across Canada see some benefit from the industry's economic activities. In fact, Ontario and British Columbia, combined, account for about a third of the industry's economic footprint in both timeframes. Meanwhile, Quebec and Saskatchewan account for about five per cent of the industry's footprint each, with smaller share of the industry's economic footprint registered across Atlantic Canada, Manitoba, and Canada's northern Territories.

[60] All dollar values in this section of the report refer to $2016.

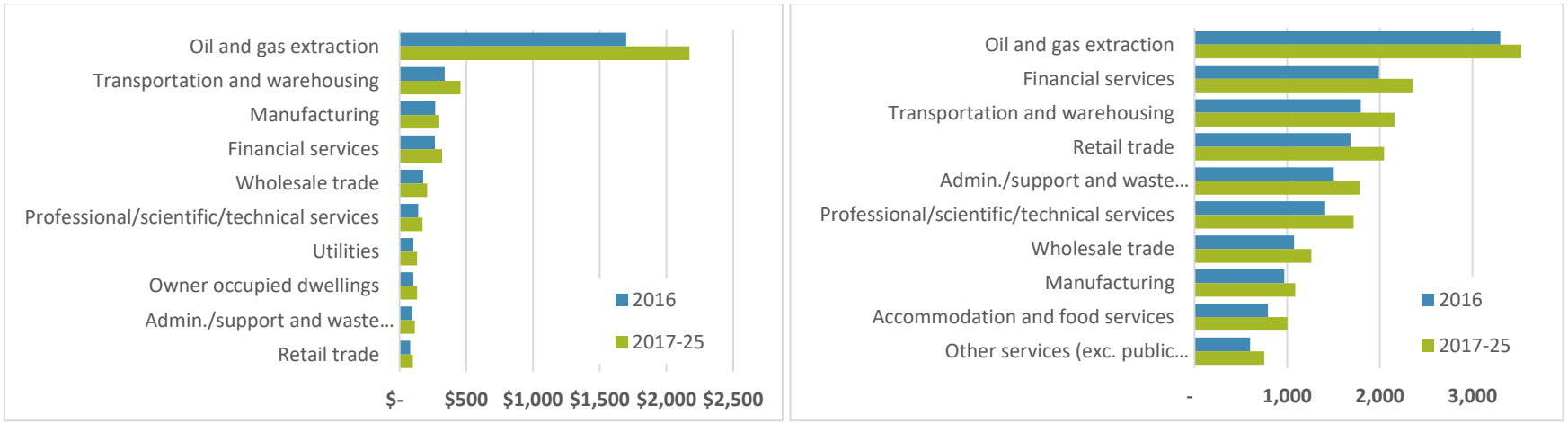
[61] These are known as the industry's economic multipliers. Note that changes in multipliers across the two timeframes are the result of changes in the sales-mix across Canada.

Table 8: Canadian propane industry's economic footprint by region in 2016 and over the 2017-25 outlook timeframe

	2016					2017-2025 (Annual Average)				
	Sales ($MM 2016)	**GDP ($2016 MM)**	*of which: Labour Income ($2016 MM)*	**Employment**	**Government Revenues ($2016 MM)**	**Sales ($MM 2016)**	**GDP ($2016 MM)**	*of which: Labour Income ($2016 MM)*	**Employment**	**Government Revenues ($2016 MM)**
British Columbia	$ 250	$ 275	*$ 93*	1,653	$ 84	$ 562	$ 584	*$ 186*	3,273	$ 171
Alberta	$ 1,104	$ 2,308	*$ 879*	8,963	$ 507	$ 1,277	$ 2,989	*$ 1,139*	11,594	$ 594
Saskatchewan	$ 184	$ 238	*$ 47*	706	$ 37	$ 140	$ 190	*$ 39*	600	$ 32
Manitoba	$ 127	$ 63	*$ 19*	352	$ 14	$ 89	$ 56	*$ 17*	325	$ 11
Ontario	$ 1,583	$ 412	*$ 210*	3,649	$ 174	$ 1,562	$ 378	*$ 197*	3,439	$ 222
Quebec	$ 564	$ 134	*$ 67*	1,286	$ 68	$ 571	$ 127	*$ 64*	1,244	$ 69
Atlantic Canada	$ 196	$ 64	*$ 29*	569	$ 20	$ 193	$ 58	*$ 26*	493	$ 23
Territories	$ 21	$ 5	*$ 1*	18	$ 1	$ 23	$ 5	*$ 1*	19	$ 2
Total Canada	**$ 4,029**	**$ 3,498**	*$ 1,344*	**17,196**	**$ 905**	**$ 4,417**	**$ 4,386**	*$ 1,670*	**20,987**	**$ 1,125**
Multiplier (per $MM of Sales)	***n.a.***	***0.9***	*0.3*	***4.3***	***0.2***	***n.a.***	***1.0***	*0.4*	***4.8***	***0.3***

Source: The Conference Board of Canada; Statistics Canada

Figure 31: Economic footprint by industry segment (top 10 only), GDP in millions of $2016 (left), and employment in number of workers (right)



Source: Source: The Conference Board of Canada; Statistics Canada

Industry-Level Impacts

Activities from the propane industry – measured here as the value of output or sales – have an impact on businesses beyond those directly involved in propane's supply (i.e., those in the business of producing, transporting, and distributing propane). This is the case as various businesses provide goods and services to companies across the propane supply-chain. For example, drilling services are needed to produce natural gas, while natural gas producers also make use of various other services from lawyers, accountants, etc. What is more, the industry's economic footprint also measures the economic impact of income spending from propane industry workers, but also, from incomes spent by workers in businesses that provide goods and services to propane companies.

As seen in Figure 31, on a GDP basis, the industry's economic footprint is the largest across the oil and gas extraction segment of the economy (including support activities such as drilling services), followed by transportation and warehousing (including transportation services via railways, pipelines, and trucks), manufacturing (of petroleum products mainly, as per refinery LPG production), but also, the financial services and wholesale industries. The financial services industry being a large part of the propane industry's economic footprint might not seem intuitive at first. However, the oil and gas industry is capital intensive and relies extensively on the use of financial services - illustrating the complex supply-chain interactions captured in the indirect component of our footprint estimates.

In terms of GDP impacts, the top five industries (as listed above) account for about 80 per cent of the industry's footprint, indicating that the GDP impacts are mainly concentrated across a handful of industries. In fact, the oil and gas extraction industry alone accounts for one-half of the industry's total footprint – as measured by the GDP impacts. Notwithstanding this fact, this also means that one-half of the GDP impacts associated with the industry's economic footprint are allocated across all other sectors of the economy – beyond oil and gas production.

From an employment perspective, the benefits of Canada's propane industry are much more evenly spread across the economy. In fact, the top five industries for employment impacts account for 60 per cent of the industry's footprint - compared to 80 per cent of the GDP impacts. The oil and gas extraction sector accounts for 20 per cent of the employment impacts – compared to one-half of the GDP impacts. Meanwhile, the retail industry sees about two per cent of the industry's footprint on a GDP basis, but accounts for a full one-tenth of the employment impacts. These differences in employment and GDP impact distributions can in turn be explained by differences in wages and productivity across industries.

Aside from the oil and gas and retail sectors, other industries across the Canadian economy account for a significant portion of the broader employment footprint of Canada's propane industry. These include financial services, transportation and warehousing, administrative support and waste management and remediation services, and the professional services industries – each accounting for around 10 per cent of the employment impacts.

Fiscal Impacts

The level of economic activity attributed to the industry - including sales, gross domestic product, and employment – can in turn be estimated to generate a significant amount of tax revenues to different levels of government across Canada. These occur in the form of indirect taxes (such as sales taxes), personal income taxes, corporate income taxes, and other (payroll) taxes. Meanwhile propane extraction from natural gas generates royalty revenues for provincial governments, while carbon taxes are also charged across Canada on propane sales. (See Table 9)

Table 9: Government revenues by type of tax and by jurisdiction, $MM 2016[62]

	2016				2017-25 (Annual Average)			
	Municipal	Provincial	Federal	Total	Municipal	Provincial	Federal	Total
Indirect Taxes	$ 87	$ 156	$ 67	**$ 309**	$ 103	$ 176	$ 76	**$ 355**
Personal Income Taxes	$ -	$ 96	$ 189	**$ 285**	$ -	$ 112	$ 224	**$ 336**
Corporate Income Taxes	$ -	$ 61	$ 99	**$ 160**	$ -	$ 72	$ 120	**$ 192**
Other Taxes	$ -	$ 10	$ 27	**$ 37**	$ -	$ 12	$ 32	**$ 43**
Royalties	$ -	$ 83	$ -	**$ 83**	$ -	$ 99	$ -	**$ 99**
Carbon Taxes	$ -	$ 30	$ -	**$ 30**	$ -	$ 99	$ -	**$ 99**
TOTAL TAXES & ROYALTIES	**$ 87**	**$ 436**	**$ 382**	**$ 905**	**$ 103**	**$ 571**	**$ 451**	**$ 1,125**

Source: The Conference Board of Canada; Statistics Canada

By type of tax, indirect taxes and personal income taxes each account for over 30 cents of every dollar generated in tax revenues from the industry's activities. This is followed by corporate income taxes (at under 20 per cent of the total), resource extraction royalties (around 10 per cent), and carbon taxes and other payroll taxes (at less than 10 per cent each).

By jurisdiction, government revenues collected at the provincial level account for around 50 cents out of every dollar of fiscal impacts generated by the industry. This is followed by revenues collected by the federal government (at around 40 per cent of the total), and municipal governments (at around 10 per cent).

Indirect taxes are mainly collected in the form of sales taxes and fuel taxes, and largely by provincial levels of government. These types of taxes also include taxes on production at the municipal level (primarily in Alberta), as well as federal custom import duties. The latter are paid for by companies along the supply-chain for their business inputs – not on propane imports. Indirect taxes are in turn the largest form of revenues for municipal and provincial governments in our footprint estimates.

[62] Note that appendix B includes a more detailed breakdown of government revenues by region. However, the distribution of total government revenues by region across Canada is presented in Table 8.

Personal income taxes and "other" (mainly payroll) taxes are collected in the form of taxes on labour income from employees along the supply-chain. These are the largest sources of government revenues for the federal government in our footprint estimates, which are in turn, much higher than the estimated levels collected at the provincial level (double, in fact). This is because federal income tax rates tend to be higher than provincial ones, specially than those in Alberta.

Corporate income taxes are generated from business profits that occur as part of the propane industry's economic activities. This type of taxes represents the second-largest source of government revenues at the federal level but are less significant at the provincial level. Just as in the case with personal income taxes, higher tax rates at the federal level help explain the larger amounts collected by the federal government (relative to provincial governments) when it comes to corporate taxes.

Royalties account for less than 20 per cent of provincial-level government revenues and are mainly collected in Western Canada – where most propane is extracted from. In fact, we estimate about 90 per cent of the total royalty revenues from propane are collected in Alberta.

Carbon taxes are a small but growing source for government revenues. Note that between the two timeframes presented (2016 and 2017-25), the increase in taxes is the highest in both absolute ($) and relative (per cent) terms for carbon taxes. In fact, in price-adjusted terms, carbon taxes triple between these two timeframes.

This is the result of higher domestic propane sales and broader application of carbon taxes across the country as of 2019. Considering that carbon prices are expected to increase rapidly over the outlook timeframe (at least until 2022), this implies that in nominal (or dollar of the day) terms, carbon tax revenues tied to propane sales would more than triple in the coming years (more on this in the next section of the report).

Without a question, Canada's propane industry's economic footprint is significant – including GDP and employment impacts across the country and different segments of the economy, and high levels of government tax revenues. And although the outlook for Canadian propane markets (and by extension, Canada's propane industry) is generally favourable, some opportunities, challenges, and policy considerations for the coming years are worth keeping in mind. These are discussed next.

Chapter 4
The Way Forward: Key Issues and Opportunities for Propane in Canada's Transition to A Low-Carbon Economy

Chapter Summary

- **Rising diesel and gasoline fuel costs, increasing energy demand, innovations in technology, and environmental issues relating to air quality and GHG emissions, suggest propane can offer value in end-use market sectors such as automotive fleet and power generation.**

- **Innovations in propane-solar hybrid technologies can support sustainable power generation in remote communities.**

- **In a future low-carbon economy, propane market penetration will most likely be shaped by its price competitiveness and lower comparative emissions relative to other fossil fuels. This will have positive impact on the economy, while helping to reduce Canada's emissions.**

Key Opportunities and Issues Facing the Propane Industry in Canada

The findings and forecasts in the previous chapters provide an important quantification of the positive outlook for Canada's propane industry. To put things in perspective, production is expected to increase; domestic propane feedstocks are expected to support a resurgent petrochemical sector; while exports are expected to move away from the U.S. toward high demand overseas LPG markets. These trends show that propane will continue to play a key role, both as a product and feedstock, in various sectors of the Canadian economy.

In this concluding chapter, we discuss the role of propane in Canada's energy mix as it transitions to a low-carbon economy. First, we review the key issues and trends through a Strengths, Weaknesses, Opportunities and Threats (SWOT) lens.

Strengths

- **Access to a large resource base**: Canada has vast and diverse natural gas and NGLs resources and is one of the largest producers of natural gas and NGLs on a global scale. This large resource base has provided Canada's propane industry with a substantial competitive advantage in world markets.

- **Versatility**: Propane is the most versatile of the NGLs, both as product and feedstock. This suggests commercial and industrial propane demand will continue to grow as new end-uses and products are discovered.

- **Low carbon attributes**: Comparative analyses of GHG emissions across fuels and in different applications show propane has lower carbon emissions per unit of energy output.[63]

- **Locational advantages**: In Canada, propane is produced, transported, and distributed across a wide-reaching supply chain, thus enabling access to different markets and supply routes.

Opportunities

- **Increasing availability of propane:** Canada has a large surplus of low cost propane, and this presents a significant opportunity for the propane industry to diversify to new markets.
- **Petrochemicals and government incentives:** Recently announced government incentives, grants and loan guarantees provide supply and growth opportunities for the propane industry. Alberta's Petrochemicals Diversification Program (PDP)[64] and

[63] Energy Information Administration, 'How Much Carbon Dioxide Is Produced When Different Fuels Are Burned?'.
[64] Government of Alberta, 'Petrochemicals Diversification Program'.

Petrochemicals Feedstock Infrastructure Program[65] are examples of financial incentives that support construction of upstream and midstream facilities for conversion of propane into value added products. Ontario[66] and Quebec[67] also offer similar financial incentives to petrochemical investors.

- **Technology innovation and propylene demand**: Propylene is a versatile building block used in a variety of applications. High domestic consumption and export-based demand for propylene has created a significant opportunity for Canada's propane industry.[68] [69] This opportunity is boosted by recent technological innovations that aid "on-purpose" propane-propylene separation in a cost-effective and energy-efficient manner.[70] [71]
- **Relative increase in transport sector propane demand**: Growing demand for transportation services in Canada has contributed to a rise in propane demand for freight and passenger vehicles. The low cost of adapting existing internal combustion engine power trains to alternative fuels like propane and potential application to transport fleets, presents additional opportunity to increase propane demand as an automotive fuel.
- **Increasing energy demand in remote areas**: Rising and unpredictable fuel costs, increasing energy demand and environmental issues relating to GHG emissions, suggest that low-cost, portable, low-emissions, efficient and abundant propane can become an alternative energy solution needed to reduce and replace diesel consumption in nearly 300 remote communities spread across Canada.
- **New export terminal and markets:** Growing supply surplus, lower prices and the lower political risk associated with Canadian propane has attracted countries like Japan, South Korea and China to source propane from Canada. These countries have high demand for propane and have encouraged investments like the Ridley Island Propane Export Terminal (RIPET) and Prince Rupert LPG Export Terminal in British Columbia. With new export capacity being brought on-line and Chinese buyers reducing U.S. propane imports due to trade war concerns,[72] the potential to reach new markets in the Asia-Pacific region will increase.

[65] Government of Alberta, 'Petrochemical Feedstock Infrastructure'.
[66] McIntosh, 'Ontario Government Gives $100 Million to Alberta Petrochemical Company under Investigation'.
[67] Communauté métropolitaine de Montréal, 'Petrochemicals-Chemical-Plastics Clusters'.
[68] Khalil, 'Propylene in Demand: Roadblocks and Opportunities'.
[69] Economic Plant, 'Increasing Global Demand for On-Purpose Production of Propylene - Economic Plant'.
[70] IHS Markit, 'New Technology for On-Purpose Production of Propylene Critical to Meet Demand for Plastics Production'.
[71] Stephan, 'The Rise of On-Purpose Propylene'.
[72] Hussain and Salazar, 'Chinese LPG Buyers Reduce US-Origin Propane Imports on Trade War Concerns'.

Weaknesses

- **Sensitivity to natural gas dynamics**: Propane is a by-product of oil and gas but is generally more susceptible to natural gas production and supply trends.
- **Variability in NGL resource content:** NGL content varies between geological formations, the mix of natural gas sources also has an impact on future propane supply.
- **Market economics creates uncertainty for NGL production**: Prolonged low crude oil prices cause delays to new projects and expansions in the oil sands which reduces demand for liquid propane diluent.
- **Infrastructure projects under construction**: Uncertainty regarding the timing and magnitude of West Coast LNG projects will affect western Canadian natural gas production, and thus NGL production. PDH Development is still in the design and constructions phases, slowing propane demand.
- **Inadequate propane storage facilities in remote communities**: Large volumes of propane need to be barged to remote communities for propane to be cost-effective. Few remote communities have facilities that can handle large propane tanks. In addition, barge loading and unloading facilities in many of the communities are generally inadequate or non-existent.[73]

Threats

- **Weakened U.S. export potential**: Rapidly increasing propane production in the U.S. is leading to decreased supply from Canada.
- **Carbon pricing**: Carbon pricing regimes being implemented across Canada and/or the proposed Federal backstop represent a threat to the propane market, impacting both production and demand.
- **Electricity:** Loss of market share to electricity grid providers in warmer regions of Canada continues to present the largest risk to propane markets. This is compounded by improvements in electric-based technologies and appliances.
- **Decline in residential housing markets**: Propane market share for space heating slipped between 2005 and 2015. This indicates that the residential sector is a more competitive market relative to electricity and natural gas prices.
- **Decline in the use of propane for urban transit bus fleets**: Demand for propane in urban mass transit bus fleets has declined rapidly in recent years. This may point to a lack of understanding and knowledge on how propane compares with other fleet fuels, from emissions and economic perspectives.
- **Vulnerability to seasonal changes:** Propane markets are vulnerable to seasonal factors. Changes in weather and demand patterns cause prices to fluctuate.

[73] Englishoe, 'Benefits of Propane for Rural Alaska'.

- **Competition with other fuel sources:** An ongoing challenge for the Canadian propane industry is to find new markets for growing propane supplies in the face of stiff competition from other competing low-cost fuels such as fuel oil, diesel, and natural gas.[74] The potential for demand growth is limited by the increasing availability and technological advances of zero carbon and renewable sources like wind and solar energy.[75,76]
- **Dealing with diesel fuel subsidies in remote communities**: The continued use of diesel in remote communities is supported by regulations providing subsidies to diesel fuel and investment grants to diesel power plants. This has created an uneven marketplace for propane to compete.

Scenarios for the Future

A SWOT analysis of the propane value chain provides a breakdown of the strengths, weaknesses, opportunities and threats facing the industry. While many issues have resulted in increased challenges for propane supply and demand, they have also created new opportunities for the propane industry to be competitive in Canada's transition to a low-carbon economy.

In the future, we anticipate domestic propane demand to evolve through the gradual expansion of diversified, multi-user sectors. For example, in the residential, commercial, agriculture, and transportation sectors. This expansion will be driven by population and economic growth, energy-efficiency improvements, and low-carbon government policies. Within this segment, propane will compete with other fuels based on security of supply, end-use technology options, cost advantages, and low-emissions impact.

This backdrop informs the analyses on market opportunities, such as automotive fleet and power generation in remote communities, where the evidence suggests that propane can satisfy the needs of consumers in a low-carbon economy.

Propane as an Automotive Fuel

Propane has a long history as a vehicle fuel. It is considered the most universally used alternative vehicle fuel. In Canada, automotive propane fuel is usually referred to as "auto propane". Outside of Canada, propane is commonly referred to as liquefied petroleum gas (LPG) or "auto gas" when used as automotive fuel.

Experiments using propane began around 1910, and by 1920, some fleets in California were reportedly using propane.[77] In 1934, Imperial Oil built the first refinery to produce propane on a

[74] Goobie, 'Canadian Propane Supply and Demand through 2050'.
[75] Farchy and Gilblom, 'What If Big Oil's Bet on Gas Is Wrong?'
[76] Levenson-Falk, 'Propane Conversion Strategies: Energy Alternatives for Minnesota Users of Propane Gas'.
[77] M Werpy, Burnham, and Betram, 'Propane Vehicles: Status, Challenges, and Opportunities'.

commercial scale in Montreal, Canada.[78] Since its first utilization in the early 1900s, the application of propane has continued to grow across Canada and around the world. On a global level, about 25 million propane-powered vehicles ply the roads, with over 70,000 refueling sites around the world.[79] In 2016 Canadians used more than 240 million liters of propane for on-road vehicle applications.[80] According to Natural Resources Canada, propane fueled more than 94,000 on-road vehicles in 2015. This trend has occurred primarily in passenger cars, light duty trucks, and medium duty freight trucks, which are relatively suitable for propane application.

Fleet Perspectives

The fleet industry is an attractive market sector for the propane industry. For fleet operators, choosing a fuel is a decision that impacts an organization's long-term costs, emissions footprint, performance, and public perception. Many considerations for assessing fuel choices are qualities synonymous with propane. Below are some of the drivers that make the use of propane in fleets a prudent choice for a low-carbon economy in Canada:

- Propane has a long history of use in light-duty and medium-duty vehicles and is particularly popular for school buses, making this a relatively mature and available technology.
- There are nearly 70,000 businesses in Canada whose primary activity is truck fleet transportation.[81] Truck fleets include many small for-hire carriers and owner-operators, and some medium and large for-hire companies that operate fleets and offer logistic services. Together, they provide a consistent conduit of moving goods across Canada.
- Approximately 1,500 bus service fleet operators currently exist in Canada.[82] These include: urban transit systems; inter-city and rural buses; school and employee buses; charter buses; shuttles; and scenic or sightseeing transportation. Targeting decision makers of these bus fleets is an efficient way of getting more vehicles to use propane.
- Most fleet vehicles tend to have fixed daily routes and are refueled at central locations. This arrangement makes it easier to develop and maintain propane supply networks.
- Early adopters of alternative fuels are usually companies and institutions with large fleets of vehicles. These fleets often operate in urban areas where emission reductions are most needed.
- A considerable number of fleet vehicle purchases are owned by government agencies or regulated companies which are more compliant to the Alternative Fuel Act, which requires government departments to make use of low carbon fuels like propane when

[78] Canadian Propane Association, 'Propane Quick Facts'.
[79] World LPG Association, 'Autogas Incentive Policies: A Country-by-Country Analysis of Why and How Governments Encourage Autogas and What Works'.
[80] Statistics Canada, 'Sales of Fuel Used for Road Motor Vehicles, Annual (x 1,000)'.
[81] Transport Canada, 'Transportation in Canada 2017'.
[82] Group, 'Transportation in Canada 2011'.

it is economically and operationally feasible. These organizations like to demonstrate practical applications for low carbon fuels.

These factors demonstrate that opportunities exist for the propane industry to retain, recapture, and expand propane's share of the automotive fleet fuel market. Looking ahead, we anticipate that Canadian governments and stakeholders will continuously adapt the transportation system to lower emissions fuels.

Value Analysis for the Fleet Industry

Auto propane is promoted in Canada primarily for its ability to reduce greenhouse gas emissions and fuel consumption costs in the transportation sector.

In this section, we provide impact outcomes that can help fleet operators make the switch to propane. The value analysis looks at gasoline and diesel fuel comparisons and focuses on key economic and emissions issues.

For the analyses in this section, we assume the primary goals of fleet operators and managers are to comply with Environment and Climate Change Canada emissions standards pursuant to the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations under the Canadian Environmental Protection Act, 1999,[83] and that they want to reduce maintenance and fuel consumption costs for their fleets. This assumption is reasonable since: 1) Environment and Climate Change Canada tracks average greenhouse gas emission performance of Canadian fleets of passenger cars and light trucks; 2) fleet managers understand the direct relationship between vehicle emissions and climate change, and 3) fleet managers are interested in the impact fleet fuel has on the climate and their operational costs.

Environmental Emissions

In 2016, the transportation sector was the second largest source of GHG emissions, accounting for 25 per cent (173 Mt CO_2 eq) of total national emissions.[84] Between 1990 and 2016, GHG emissions from the transportation sector grew by 42 per cent.[85] The bulk of emissions were mostly from light duty trucks, cars, heavy duty trucks, and medium duty trucks (see figure 10).[86] Canada's road transportation sector depends on petroleum-based fuels. However, with the sector's well-documented contribution to climate change, Canada has moved to encourage the use of low carbon alternative fuels in vehicles in the last few years. In 2017, the federal government continued its efforts to lower emissions in the transportation sector through different measures including: the development of a Canada-wide strategy for zero-emission vehicles in collaboration with provincial and territorial governments; the publication of draft

[83] Consolidated federal laws of canada, Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations.
[84] Environment and Climate Change Canada, 'Canadian Environmental Sustainability Indicators: Greenhouse Gas Emissions'.
[85] Ibid.
[86] Natural Resources Canada, 'Transportation Sector – GHG Emissions'.

greenhouse gases (GHG) regulations for heavy duty road vehicles; and the development of the Locomotive Emission Regulations.[87]

Vehicle markets are highly dynamic, and consumers historically have focused on price, service characteristics, convenience in operations, features, style, fuel economy, and maintenance costs when choosing a vehicle. Of these factors, only fuel economy relates directly to emissions. Subsidies for electric vehicle (EV) purchases have addressed the price premium that currently exists for EVs and are designed to increase adoption and reduce emissions. The emissions reduction achieved, however, depends on whether life-cycle emissions are considered.

Lower emissions arising from low-carbon fuel vehicles are an important consideration for fleet operators. There is evidence that propane-fueled vehicles can make an immediate contribution in reducing emission levels from the transport sector.

Box 8: Types of Emissions

For environmental safety, the following emissions are monitored:

- Carbon dioxide (CO_2) — Colourless, odourless, non-combustible greenhouse gas that contributes to global warming. Formed by complete combustion of fossil fuels.
- Carbon Monoxide (CO) – Colorless, odorless, toxic gas produced from incomplete burning of fossil fuels.
- Nitrogen Oxides (NOx) – Occurs naturally because of bacterial process, biological growth, decay, lightning, forest fires and burning of fossil fuels. Colorless non-toxic gas (referred to as laughing gas).
- Hydrocarbons (HC) – Organic chemical compounds that consist entirely of carbon and hydrogen. They range from simple molecules such as methane to polymers such as polystyrene.
- Particulate Matter (PM) – The sum of all solid and liquid particles suspended in the air.

[87] Transport Canada, 'Transportation in Canada 2017'.

Table 10. On-Road Transportation Sector – GHG Emissions (millions of tonnes – Mt)

Year	1995	2005	2015
GHG Emissions by Transport (Mt)			
Passenger Transportation	83.5	93.4	92.6
Freight Transportation	54.9	74.4	81.8
GHG Emissions by Vehicle type (Mt)			
Cars	47.5	43.0	35.7
Light Trucks	27.6	40.0	47.6
Medium Trucks	10.1	14.5	21.3
Heavy Trucks	22.4	32.3	34.8
Motorcycles	0.1	0.2	0.4
School Buses	1.1	0.9	0.9
Urban Transit	1.8	2.4	2.5
Inter-City Buses	0.6	0.5	0.4

Source: Natural Resources Canada (NEUD)

GHG Emissions (CO_2 Indicator)

The principal emissions from motor vehicles are greenhouse gases, which contribute to climate change. Carbon dioxide (CO_2) is the principal greenhouse gas produced by motor vehicles. Carbon dioxide traps additional heat from the sun in the earth's atmosphere, causing the 'greenhouse effect' and climate change.

As part of its ongoing work to reduce GHG emissions, the Ministry of Environment in British Columbia tracks and reports the amount of greenhouse gases vehicles in its fleet emit when using equal amounts of different fuels. According to the latest data published by the ministry, propane reduces CO_2 emissions in fleet vehicles by more than 30 per cent compared to gasoline.[88] Compared to diesel, propane produces 40 per cent less carbon dioxide emissions in both trucks and cars (See Table 11). These values resonate with test results from earlier experimental work conducted by the Argonne National Laboratory, which found that light-duty propane vehicles produce 21 per cent to 24 per cent less GHG than gasoline vehicles.[89]

[88] British Columbia Ministry of Environment, 'B.C. Public Sector Greenhouse Gas Emissions'.
[89] Wang and Huang, 'A Full Fuel-Cycle Analysis of Energy and Emissions Impacts of Transportation Fuels Produced from Natural Gas'.

Table 11. Fleet Fuel Emissions

Transport Mode	Fuel Type	Emission Factor	
		CO_2 (kg/L)	NO_X (kg/L)
Light-duty Vehicle	Gasoline	2.175	0.00047
	Diesel	2.556	0.00022
	Propane	1.510	0.000028
Light-duty Truck (includes SUV and Minivan)	Gasoline	2.175	0.00058
	Diesel	2.556	0.00022
	Propane	1.510	0.000028
Heavy-duty	Gasoline	2.175	0.00020
	Diesel	2.556	0.000151
	Propane	-	-

Source: British Columbia Ministry of Environment Public Sector Emissions, 2011

Regulated emissions (NO_X Indicator)

Nitrogen oxides (NO_X) are formed in internal combustion engines and are also considered measures of air quality. In 2015, transportation was a major source of NO_X representing 44 per cent (825 kilotonnes) of emissions.[90] NO_X generally include emissions of nitric oxide (NO), nitrous oxide (N_2O) and nitrogen dioxide (NO_2). NO_2 can have adverse effects on human health and the environment. The emissions also contribute to acid rain, which can lead to the acidification of aquatic and terrestrial ecosystems.

Propane offers opportunities for significant reductions in NOx emissions. As the numbers from the B.C. Ministry of Environment in Table 11 illustrate, light-duty vehicles and trucks running on propane generally emitted over 94 per cent less NO_x than gasoline and 87 per cent less NO_x than diesel.[91] When considered along with the CO_2 emissions, propane-fueled vehicle emissions are below those of the equivalent class of vehicles that use conventional fuels like diesel and gasoline.

Economic Competitiveness

A survey of over 2,700 light-duty vehicle fleets in California identified vehicle purchasing and operating costs as principal factors that influence the decision to switch to principal alternative fuels like propane.[92] When the cost of gasoline and diesel fuels increase rapidly many fleet

[90] Environment and Climate Change Canada, 'Canadian Environmental Sustainability Indicators: Air Pollutant Emissions'.
[91] British Columbia Ministry of Environment, 'B.C. Public Sector Greenhouse Gas Emissions'.
[92] Miaou, Hu, and Young, 'FLEET VEHICLES IN THE UNITED STATES'.

operators seek more efficient, less expensive fuel options to reduce operating and maintenance costs. Recent data indicates propane can become an important alternative fuel with its economic advantages over gasoline and diesel.

Economic impacts that need to be considered when switching automotive fleets from diesel or gasoline into vehicle fleets include costs associated with vehicle purchase, vehicle conversions, vehicle operation, and the alternative fuel price. Propane fuel-switching in vehicle fleets depends on how propane compares to traditional fuels on fuel costs and tax subsidies.

Box 9: Case Study of Regina School Propane Bus Fleet

In 2016, LP3 Transportation Solutions, a school bus company, collaborated with École St. Mary, Regina Catholic School Division (RCSD), to provide 89 Blue Bird propane school buses for students in Regina.

The aim was to help reduce emissions from the existing school bus fleet. According to Blue Bird officials, the fleet of propane buses is the largest in Saskatchewan that are equipped with a 6.8L V10 Ford engine and powered by a ROUSH CleanTech propane fuel system. Internal test results show that the buses emit about 80 per cent fewer hydrocarbons and particulate matter when compared with diesel-powered buses.

"Our new fleet of school buses fueled by propane means cleaner air around our students and drivers, and within our community," said Domenic Scuglia, RCSD's director of education. "At Regina Catholic Schools, we always consider our students' needs first when we make any decision inside and outside of the classroom."

In addition to the environmental benefits, the new buses have the capacity to start in freezing conditions. The buses also have excellent heat retention capacity and have about 50 per cent lower noise levels compared with diesel-fuelled buses.
Source: Alternative Fuels—School Bus Fleet.[93]

Fuel Consumption Costs

Fuel cost is a major operating cost for fleet operators. Fuel costs are usually determined by the distance traveled, vehicle fuel consumption, and fuel price. Using August 2017 as a baseline, average retail fuel prices in Canada for gasoline increased 21.5 cents per litre over a one-year period in August 2018.[94] In the same period, the average price per litre of diesel increased by 23.3 cents. During the same period the price of auto propane increased by 7.7 cents (see table 12). While the price of propane is subject to substantial seasonal variation, the average propane price has been lower by several cents per litre in comparison with gasoline and diesel in the past few years.

[93] School Bus Fleet, "Canada District Switches Entire School Bus Fleet to Propane."
[94] Natural Resources Canada, 'Average Retail Fuel Prices in Canada'.

Table 12. Comparison of Average Retail Fuel Prices in Canada from 2017

	Cents per Litre	
Product	**August 2018**	**Change from 2017**
Regular Gasoline	134.1	21.5
Mid-Grade Gasoline	147.4	21.5
Premium Gasoline	152.3	22.0
Diesel	128.5	23.3
Auto Propane	88.8	7.7

Source: Natural Resources Canada[95]

Market penetration of propane will most likely be influenced by its price competitiveness with diesel and gasoline. Evaluation of the high-level impact of the price differentials shows the value proposition for propane is stronger than for a comparable diesel or gasoline fleet. But price competitiveness may not be the only factor that drives propane demand in the fleet market sector. While propane has less energy content by volume than gasoline and diesel (it takes about 1.4 litres of propane to travel the same distance as one litre of gasoline), it is less expensive than gasoline on an energy content adjusted basis.[96] Based on fuel price, the evidence suggests current propane-fueled vehicles are an economical fuel choice for fleets.

Motor Fuel Tax Subsidies

The case for using differential fuel taxes to achieve environmental objectives is well established, largely because of the close relationship between fuel combustion and its associated pollutants.[97] The most common approach applying differential taxation to support environmental goals was the introduction of unleaded gasoline, where lower taxes relative to leaded fuel were extremely effective in accelerating uptake.[98] In Canada, financial incentives for alternative fuels have taken the form of fuel-based tax subsidies. The federal government charges an excise tax at a flat rate of 10 cents per litre on gasoline (in effect since 1995) and 4 cents per litre on diesel (in effect since 1987).[99] Propane is exempt from the excise tax. Since differences in excise tax appear in fuel prices at the pump, the measure can be effective in

[95] Ibid.
[96] Natural Resources Canada, 'Alternative Fuels in Canada: Making Choices Today for a Better Tomorrow'.
[97] Antweiler and Gulati, 'Policy Forum: Reducing the Environmental Impact of Transportation—British Columbia's Tax Policy Initiatives'.
[98] World LPG Association, 'Autogas Incentive Policies: A Country-by-Country Analysis of Why and How Governments Encourage Autogas and What Works'.
[99] Natural Resources Canada, 'Fuel Consumption Taxes in Canada'.

raising interest of fleet owners on the potential cost savings from using auto propane. Provincial governments also collect fuel taxes, but these vary markedly from province to province.

Table 13. Federal and Provincial Consumption Taxes on Petroleum Products (In Cents/Litre or in %, as indicated)

	Gasoline	Diesel	Auto Propane
Federal Taxes			
Excise Tax	10.0	4.0	-
Goods and Services Tax	5%	5%	5%
Provincial Fuel Taxes			
Newfoundland and Labrador	33.0	21.5	7.0
Prince Edward Island	13.1	20.2	-
Nova Scotia	15.5	15.4	7.0
New Brunswick	15.5	21.5	6.7
Quebec	19.2	20.2	-
Ontario	14.7	14.3	4.3
Manitoba	14.0	14.0	3.0
Saskatchewan	15.0	15.0	9.0
Alberta	13.0	13.0	9.4
British Columbia plus Carbon Tax (1)	14.5	15.0	2.7
	6.67	7.67	4.62
Yukon	6.2	7.2	-
Northwest Territories (2)	10.7/6.4	9.1	-
Nunavut (2)	10.7/6.4	9.1	-

Source: Natural Resources Canada

Notes:

1. *British Columbia applies a carbon tax on all fuels.*
2. *In the Northwest Territories and Nunavut, gasoline is taxed at 6.4 cents per litre in communities not served by a highway system.*

Table 13 shows federal and provincial consumption taxes on petroleum products. The figures do not include carbon tax rates or in federal backstop, except in the case of British Columbia.

Provincial rates are sourced from individual provincial Fuel Acts, e.g. in Ontario[100] and Alberta,[101] where tax subsidies for propane are enacted in law.

Overall, these taxes are much lower (and sometimes non-existent) for propane compared to gasoline or diesel. In dollar terms, the lower differential taxation on federal and provincial fuel taxes contributes to making the case for propane as a lower cost fuel option for fleet operators than gasoline and diesel.

Propane for Power Generation in Remote Communities

Up to 300 remote communities spread across Canada have no connection to the North American electrical grid or its natural gas distribution pipelines. For the 200,000 people living in these off-grid communities, obtaining access to affordable electricity is a constant challenge These communities include Aboriginal and non-Aboriginal settlements, villages or cities as well as long-term commercial outposts and camps for mining, fishing and forestry activities[102]. These communities rely mostly on locally generated electricity, usually supplied by expensive and emission-intensive diesel-fuel generators (see Figure 32). The situation inhibits the economic growth of these communities and can lead to adverse environmental impacts — leaving them vulnerable to the impacts of climate change.

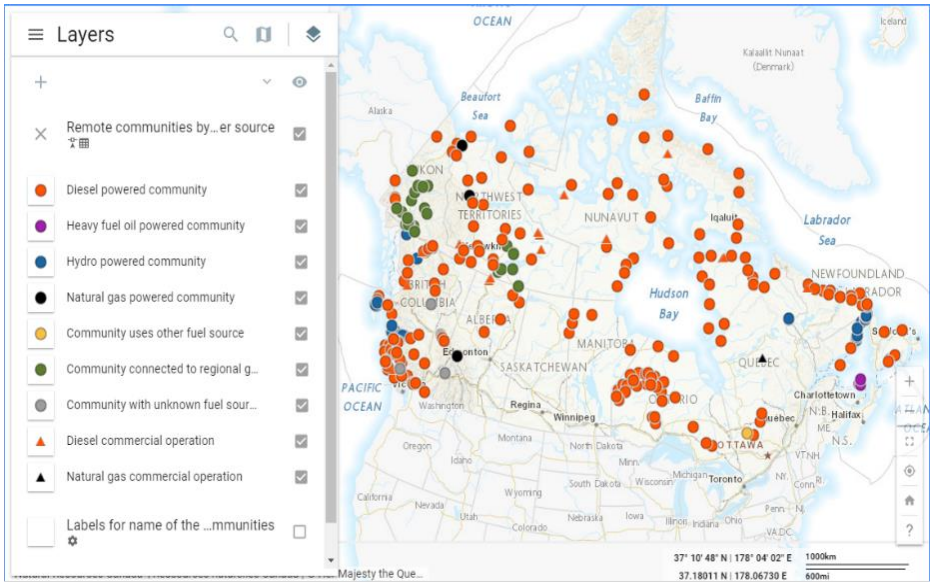


Figure 32. Remote Communities in Canada by main power source (Natural Resources Canada)

[100] Revised Statutes of Ontario, Fuel Tax Act.
[101] Statutes of Alberta, Fuel Tax Act.
[102] Royer, 'Status of Remote Off-Grid Communities in Canada'.

Recently, attempts have been made to reduce dependence of remote communities on diesel fuel.[103,104] For instance, Natural Resources Canada announced a call for proposals for the Clean Energy for Rural and Remote Communities Program.[105] The program will provide approximately $220 million in funding for initiatives to reduce reliance on diesel fuel in rural and remote communities. This program builds on $453 million provided through Indigenous and Northern Affairs Canada, and Arctic Energy Fund: funds designed to help improve energy security by replacing or upgrading aging fossil fuel energy infrastructure in remote communities.[106] While these grants are not expressly directed at the propane industry, they can motivate propane fuel expansion to such communities.

Box 10: What communities are considered 'rural' or 'remote'?

"Rural" is defined as a community with a population of fewer than 1,000 people and a population density of fewer than 400 people per square kilometer and not connected to the North American piped natural gas network.

"Remote community" refers to a community not currently connected to the North American electrical grid nor to the piped natural gas network, and which is a permanent or long-term (5 years or more) settlement with at least 10 dwellings.

Electricity Demand and Capacity in Remote Communities

The provincial level summary in Table 14 shows average electricity demand per person is higher than existing capacity in most remote communities. On an annual basis, these communities have been projected to consume up to 1,850 gigawatt hours (GW h) of electricity;[107,108] of which, about 251 communities generate 453.3 MW from their own fossil fuel power plants.

Of these, 176 are diesel-fueled, two are natural gas powered and 73 are from unknown sources but most likely diesel power plants or gasoline generators in smaller settlements. Eleven power plants are hydro based with a total generating capacity of 153.1 MW. Altogether, the strong demand coming from these areas creates an opportunity to increase the propane market share relative to other energy sources.

[103] MacKinlay, 'Reducing Diesel Reliance in Canada's Rural and Remote Communities'.
[104] Natural Resources Canada, 'Reducing Diesel Energy in Rural and Remote Communities'.
[105] Natural Resources Canada, 'Government of Canada Supports Clean Energy in Rural and Remote Communities'.
[106] Ibid.
[107] Knowles, 'Power Shift: Electricity for Canada's Remote Communities'.
[108] Natural Resources Canada, 'Remote Communities Energy Database'.

Table 14. Total Provincial Generation Capacity of Fossil Fuel Power Plants in Remote Communities, 2011

Province/Territory	Population	Total Capacity	Capacity/person (KW/P)	Demand/person
Alberta	195	1,450	7.44	12.2
British Columbia	13,962	72,400	5.18	9.9
Manitoba	2,937	7,175	2.44	4.4
Newfoundland	8,159	24,198	2.97	5.6
Northwest Territories	36,757	123,552	3.36	9.7
Nunavut	29,448	50,348	1.71	14.4
Ontario	14,618	25,730	1.76	5.8
Quebec	14,505	37,000	2.55	10.2
Saskatchewan	57	350	6.14	3.3
Yukon	25,771	117,710	4.57	10.2

Source: Natural Resources Canada

Marketplace Opportunity to Displace Diesel Fuels

A quick glance at the map in Table 15 also demonstrate the dominant role diesel currently plays in fossil fuel electricity power generation in remote communities. Table 16 provides a summary of annual fuel consumption by electric generation plants across Canada. The gap between propane and diesel indicates a market opportunity for the propane industry for diesel displacement with propane. For example, if propane gas were to replace only 10 per cent of diesel fuel used for electricity generation in 2016 (using current $/litre pricing for diesel in Table 12), that instantly creates an $18 million utility supply market opportunity for the propane industry. Higher substitution rates only increase market size and revenue opportunity for the industry. Fuel displacement also increases GHG reductions greater than the assumed 10 per cent substitution level.

The good news is diesel fuels currently used in stationary engines can be substituted with propane using new technology developed by the Gas Equipment Company, technology which allows users to displace up to 50 per cent of diesel with propane to cut fuel costs.[109] Propane dual fuel engines are modified diesel engines which use propane as the primary fuel and diesel as the secondary fuel.[110]

[109] Vogt, 'Dual-Fuel Engine Saver'.
[110] Ashok, Denis Ashok, and Ramesh Kumar, 'LPG Diesel Dual Fuel Engine – A Critical Review'.

Table 15. Total Provincial Generation Capacity of Fossil Fuel Power Plants in Remote Communities (2011)

Province or Territory	Type of Fossil Fuel (FF) Generation	Total FF Capacity (kW)	Total Number of Sites
Alberta	Diesel	1450	1
British Columbia	Diesel	70,957	15
Manitoba	Diesel	7,175	7
Newfoundland	Diesel	24293	28
Northwest Territories	Diesel Natural gas	114681	34
Nunavut	Diesel	50295	26
Ontario	Diesel	25570	38
Quebec	Diesel	106925	24
Saskatchewan	Diesel	350	1
Yukon	Diesel	51600	13

Source: Natural Resources Canada

Table 16. Annual fuel consumed by electric utility thermal plants in Canada

Fuel consumed for electric power generation (Kilolitres)	2012	2013	2014	2015	2016
Diesel	103,930	107,286	154,893	156,279	148,940
Propane	28	32	33	58	0

Source: Statistics Canada[111]

Propane-Renewable Energy Hybrid Power Application

Most remote communities are seeking alternatives to combat the prohibitive cost of electricity. Because a good proportion of these areas have renewable resources like solar and wind, renewable power generation is attracting interest.[112,113] However, well-documented obstacles — such as intermittency, reliability of supply, commercial viability, and large environmental

[111] Statistics Canada, 'Table 25-10-0017-01 Electric Power Generation, Annual Fuel Consumed by Electric Utility Thermal Plants', n.d.
[112] Natural Resources Canada, 'Clean Energy for Rural and Remote Communities'.
[113] MacKinlay, 'Reducing Diesel Reliance in Canada's Rural and Remote Communities'.

footprints — continue to limit their widespread use. New initiatives have focused on creating hybrid applications to balance different power sources which combine lower carbon fuels and renewable energy sources. Some studies have proposed the use of utility-scale or hybrid systems, running on propane for power generation in remote, off-grid communities.[114,115]

The use of different fuel sources improves system efficiency and reliability of the energy supply and reduces the energy storage requirements compared to systems comprising only of one single fuel source. With the complementary characteristics of solar energy or wind energy for certain locations, combined with propane's versatility, portability, and low-carbon qualities, suggest hybrid applications could be integrated to provide sustainable power to remote, off-grid communities with environmental and cost benefits.

Recent feasibility studies have demonstrated the possibility of using a stand-alone solar photovoltaic-propane generator hybrid power system for low-cost electricity production to satisfy energy load requirements of a typical remote community.[116] A demonstration project in the remote community of Xeni Gwet'in is currently helping residents reduce their reliance on diesel-generated power.[117] The $4.5 million solar-propane hybrid system is designed to provide electricity for 67 homes and eight community buildings.[118] It is expected to reduce diesel consumption by 143,000 litres per year which represents average yearly savings of about $150,000 to the community.

In subsequent sections, we assess the competitiveness for a propane-solar power generation system — where propane is used as primary or back up fuel – from a potential economic and environmental perspectives. In this scenario, the analysis stems from the assumptions that, for a given community, the costs of different fuel supply alternatives will vary depending on specific local conditions, such as load size and distribution, resource availability, emissions factor, fuel price and transportation network.

Economic Competitiveness

Cost and Security of Supply

Like diesel, propane is transported long distances by rail, truck or barge, on ice roads built on frozen rivers and lakes during the short winter road season, or by airplane throughout the remainder of the year. This delivery structure adds higher energy costs and creates uncertainties of supply. While the average Canadian consumer pays between 7 and 17 cents per kilowatt-hour, independent studies have shown the average unsubsidized cost of diesel-derived

[114] Adouane et al., 'Feasibility Study of a Hybrid Plants (Photovoltaic–LPG Generator) System for Rural Electrification', 2016.
[115] Englishoe, 'Benefits of Propane for Rural Alaska'.
[116] Adouane et al., 'Feasibility Study of a Hybrid Plants (Photovoltaic–LPG Generator) System for Rural Electrification', 2016.
[117] Brevifolia Consulting, 'Solar-Diesel Project Review and Oversight – Xeni Gwet'in First Nation'.
[118] BC Gov News, 'Hybrid Solar Power Burns Cleaner for Xeni Gwet'in'.

electricity production in Canada's remote communities is $1.30 per kilowatt-hour.[119,120] When multiple forms of fuel are available for the same function, price and security of supply are important points of consideration for consumer energy choices.

Onsite Bio-Propane

Propane can be produced from biomass feedstocks or waste materials as bio-propane. From a fuel product viewpoint, bio-propane has the same characteristics as traditional propane and can be utilized the same way. As a result, in situ production of bio-propane can help the propane industry be more competitive in remote communities, eliminating costs associated with transporting fuel from outside locations.

Bio-propane also has the potential to secure production and supply of propane for power generation in remote communities. Gas conversion technologies that utilize waste as feedstock can convert this waste into bio-propane creating additional environmental value in communities. According to industry experts, bio-propane allows propane retailers and distributors to provide on-site alternatives to diesel, especially in propane-renewable hybrid generator applications.

Environmental Emissions

Stationary diesel generators are used in many remote communities throughout Canada. Emissions from diesel engine exhaust has been classified as carcinogenic by the World Health Organization (WHO). The prevalent use of diesel engines in these communities affects local air quality and greenhouse gas emissions, especially in situations where engines operate 24 hours a day, often near homes and schools. Burning substantial amounts of diesel produces greenhouse gas emissions in addition to those transportation related emissions associated with delivering fuel. This contributes to climate change which negatively affects the communities.[121]

Using a hypothetical scenario, emissions profiles for a propane-solar PV hybrid power generation system were compared to a diesel-solar PV hybrid power generation system based on simulation results from a feasibility study. Both systems have solar as the secondary fuel. The environmental impacts are measured in kilograms and the categories for the measured impacts are shown in Table 17. According to simulation results, in propane versus diesel generators that have the same capacity factor, average change in emissions' reduction was about 45 per cent for the propane-solar hybrid generators

[119] Arriaga, Cañizares, and Kazerani, 'Renewable Energy Alternatives for Remote Communities in Northern Ontario, Canada - IEEE Journals & Magazine'.
[120] Wilt, 'Canada's Commitment of $220 Million to Transition Remote Communities Off Diesel a Mere "Drop in the Bucket"'.
[121] Advanced Information Centre, 'Enabling a Clean Energy Future for Canada's Remote Communities'.

Table 17. Comparison of Emissions Profiles of Propane and Diesel Hybrid Power Generators

Emissions (kg/year)			
	Diesel-solar PV hybrid	Propane-solar PV hybrid	% difference
Carbon dioxide	3679	2110	42.6
Carbon monoxide	9.08	4.42	51.3
Particulate material	0.66	0.33	50
Sulfur dioxide	7.39	4.38	40.7
Nitrogen oxides	81	39.4	41.6

Source: Adouane and others, 2016

Value-Chain Petrochemical Opportunities

Value-added and economic diversification policies are a key driver behind growing demand for propane as a petrochemical feedstock in the domestic market. The Government of Alberta's PDP program has encouraged the development of potentially two large-scale propane to polypropylene (PP) petrochemical projects in that province.

With the recent awards to Pembina and announcement of a second round of grants, there is an upside to domestic propane demand above what is currently presented in this outlook. Although government policies aim to encourage this type of project development, there is no denying that the economic case for moving propane up the value-chain to propylene and PP, makes business sense (See Table 18).

Table 18: Propane to Petrochemicals Value-Added

Product	Price (c/lb) (2013-17 avg.)	Price mutliplier over propane
Propane	19	1.0
Propylene	57	3.0
Polypropylene	92	4.8

Source: The Conference Board of Canada; Sproule and propaneresources.com (spot propane prices); Statistics Canada's International Merchandise Trade Database for propylene and polypropylene prices

As indicated, the average price for Canadian-exported propylene[122] in the last five years was three times that of the production weighted-average for Edmonton and Sarnia spot propane prices. Interestingly, the price of imported polypropylene[123] was close to five times that of Canadian-produced propane.

Overall, while government policies can have an impact on boosting demand for certain energy products in Canada – such as new petrochemical investments - value-added economics and a strong demand-outlook for petrochemicals provides strong business-case rationale for today's propane industry.

Net Impact of Domestic Market Opportunities

There exist other opportunities for incremental demand across Canada. Estimates of the associated value of sales for these opportunities and their net impact on Canada's GHGs are presented in Table 19. There are however, key assumptions and limitations behind these estimates.

Business-as-usual estimates for future propane demand and sales in Canada are already presented in Chapters 2 and 3 (respectively). Those estimates assume propane maintains its historical share of energy demand across each end-use sector, with propane demand volumes driven by rising energy demand in that sector. Sector-specific energy demand is in turn driven by population and economic activity trends but tempered by increasing energy efficiency. As such, opportunities identified in the table would be incremental to the volumes and sales estimates previously presented.

The estimated incremental opportunities presented are best interpreted as upper-bound estimates. For most end-use sectors assessed, it is assumed that propane displaces total demand for the selected fuels in that sector. While these estimates are useful to understand the maximum potential in each end-use sector, realistically, only a fraction of these incremental demand opportunities might materialize. This emphasizes the assumption that propane can easily replace demand for other fuels (such as diesel) in an end-use sector. Any costs and physical limitations associated with repurposing existing fuel-delivery infrastructure as well as that of end-use stock equipment replacement, are not accounted for - both of which are potentially significant limiting factors.

Estimates are based on sector-specific demand levels and fuel shares for 2015 (latest comprehensive data available at the time of writing). Over time, newer data may indicate incremental market opportunities are much smaller than these estimates suggest.

With those caveats, current maximum incremental market uptake for propane demand in Canada is estimated to be 170 kb/d, or 1.6 times the level of domestic demand registered in

[122] Canada is a net exporter
[123] Canada is a net importer

2016. Qualitatively, these opportunities are driven by propane's relative competitiveness to more emissions-intensive fuels across most end-use sectors, as well as by incremental demand for propane as a competitive feedstock in the petrochemical sector. These opportunities vary by region, industry, sub-sector, and end-use application.

The equivalent value of sales for these opportunities is estimated at $5.1 billion (in $2016), 1.7 times greater than the $3 billion estimate for Canada's 2016 domestic propane sales. The impact on Canada's GHG emissions from these opportunities is estimated to be a net reduction of close to 2 million tonnes (Mt) of GHGs per year, equivalent to shutting down a 250-megawatt coal power plant for an entire year.

Table 19: Incremental domestic market opportunities for propane in Canada and net impact on GHGs

Target markets						Incremental propane demand		Estimated value of incremental propane sales	GHG emissions impact (Mt of CO2e/yr)		
Sector	**Assumption**	**Sub-sector**	**Region**	**Competitive Advantages**	**Competitive Challenges**	**PJ/yr**	**kb/d**	**$MM 2016**	Avoided GHG emissions	Propane GHG emissions	**Net emissions impact**
Non-energy use	Additional (i.e., third) PDH plant from second round of Alberta's PDP program.	Petrochemical feedstock for manufacturing polymers	Alberta (potential in Ontario, but mainly imports)	Affordability, availability, and government support in AB.	Competition with ethane and natural gas as alternative feedstocks.	33	**22**	$ **329**	0.0	0.4	**0.4**
Power generation	Replace diesel fuel oil, light fuel oil, kerosene, and heavy fuel oil use in the sector (1% of sector's fuel use in 2015).	n.a.	Atlantic Canada and Northern Territories	General fuel price advantage with and without carbon price. Reduced carbon footprint.	Delivery infrastructure availability and end-use equipment replacement. Competition for market share with natural gas and electricity.	45	**30**	$ **454**	-3.3	2.7	**-0.6**
Industrial	Replace heavy fuel oil use in the sector (1% of sector's fuel use in 2015).	Mining and construction industries.	Alberta, British Columbia, Northern Territories, Ontario and Quebec.			30	**21**	$ **308**	-2.3	1.8	**-0.4**
Commercial	Replace light fuel oil, kerosene, and heavy fuel oil use in the sector (3% of sector's fuel use in 2015).	Office buildings, health care and education facilities, retail and hospitality outlets.	Atlantic Canada, Quebec, and Ontario.			35	**24**	$ **993**	-2.5	2.2	**-0.3**
Residential	Replace heating oil use in the sector (4% of sector's fuel use in 2015).	Space and water heating	Atlantic Canada, Quebec, and Ontario.			69	**47**	$ **2,032**	-4.9	4.3	**-0.6**
Transportation	Capture 1 per cent of market share from diesel and gasoline (88% of sector's fuel use in 2015).	Road transportation	Across Canada.			23	**16**	$ **606**	-1.6	1.4	**-0.2**
Agriculture	Replace light fuel oil, kerosene, and heavy fuel oil use in the sector (16% of sector's fuel use in 2015).	Non-motive uses	Saskatchewan and Ontario.			16	**11**	$ **430**	-1.2	1.0	**-0.2**
TOTAL						**252**	**170**	$ **5,150**	**-15.8**	**13.9**	**-1.9**

Source: The Conference Board of Canada; Natural Resource Canada (CEUD)

Concluding Insights and Recommendations

As highlighted, propane markets in Canada have been influenced by the combined effects of volatile oil and gas prices, swings in economic outlook, advancements in renewable energy technologies, evolving government policies, and changes in propane supply and demand. While many of these factors have resulted in increased challenges for propane supply and demand, they have also created new opportunities for the propane industry to be competitive in Canada's transition to a low-carbon economy.

The role of propane in meeting Canada's climate change targets and energy needs in the coming decades provides opportunities to the industry. Overall, the outlook for Canada's propane industry is positive.

Building capacity and encouraging innovations that leverage the industry's strengths while minimizing weaknesses should be priority actions aimed at improving global and domestic market share for Canadian propane in the 21st century. Other recommendations include:

1) The strong global outlook for LPG and petrochemicals, presents an opportunity to expand production levels and to diversify exports towards overseas markets for these products. However, this can only be achieved by solving the key issues impacting Canada's oil and gas sector. These include market access constraints, trade negotiation risks and the potential impact of carbon prices on the upstream sector.

The propane industry should support policy initiatives that improve market access for Canada's oil and gas resources. In doing so, the industry would grow with a vibrant oil and gas sector, which is a cornerstone of propane supply and demand in Canada.

2) On the demand side, climate-change related policies will impact demand for propane via multiple and complex channels not yet fully studied or understood. At face value, carbon pricing favors propane use over other more-carbon intensive fuels across various end-use sectors. However, it may also limit propane's potential uptake opportunities in certain sectors like transportation, where biofuels, natural gas, and electricity are emerging as alternative fuels.

Future research is recommended to develop in-depth understanding of the potential impact of climate-change related policies on propane supply and demand in Canada. As well, the industry should increasingly promote the benefits of propane in the context of a transition to a low-carbon economy, based on its affordability and lower-carbon footprint attributes, while highlighting propane's contribution to the economy.

3) Policies that support the development of propane-based petrochemical projects can provide a boost to the outlook for domestic demand beyond what is currently anticipated. The business-case for these types of projects might stand on their own and may not necessarily require additional government support.

The propane industry should actively support value-added and economic diversification policies that boost demand for propane as a petrochemical feedstock. These policies could increase the value of the resource and result in additional market opportunities along the supply-chain.

4) There are incremental market uptake opportunities for propane. As per estimates supplied, these opportunities can propel demand and sales across Canada, and lead to net reduction on GHGs.

The industry should analyze potential fuel-switching opportunities across Canada. This should include a thorough assessment of infrastructure and equipment investment, programs, and financial models that can facilitate fuel switching for end-users across different sectors.

5) Hybrid solar-propane power systems are an excellent option to deliver consistent and affordable electricity to remote and rural areas, at lower economic costs and with lower environmental emissions.

The propane industry should build knowledge capacity for power generation in remote communities. The Xeni Gwet'in community demonstration model is a good example. Benefits from such projects should be communicated widely to encourage adoption in remote communities.

The insights presented in this study provide a roadmap for the industry's future, its potential challenges, and ways it can maximize opportunities across the country. Taking advantage of opportunities will require concerted action by policy makers, propane industry association and its members. The CPA's vision of a thriving propane industry that plays a vital role in Canada's energy sector and economy provides an opportunity to grow the industry.

Appendix A
Data Sources and Methodology
Chapter 2
Historical Supply and Demand Data

Unless otherwise specified, all the data listed below refers to publicly available data sources.

Data on Canada's primary energy supply and demand comes from CANSIM Table 128-0016. Gas plants' NGLs production data is sourced from CANSIM Tables 128-0012 and 131-0002. Provincial-level NGLs production data for gas plants is corroborated and augmented with data for natural gas, NGLs, and propane production from the Alberta Energy Regulator's (AER) statistical report ST3 for Alberta, by-product production statistics from the Ministry of Energy, Mines & Petroleum Resources for British Columbia, and NGLs production data from the Canadian Association of Petroleum Producers' (CAPP) Statistical Handbook for Saskatchewan and Offshore Nova Scotia. Refinery LPG production data comes from CANSIM Tables 128-0012, 128-0016, 128-0017, 134-0003, and 134-004. Off-gas liquids production data comes from the AER's ST39 report.

Natural gas exports and imports data comes from CANSIM Tables 129-0004 and 131-0004. Propane exports data including volumes, prices, transport mode, and destination come from the National Energy Board's (NEB) NGLs statistics portal. Propane import quantities and prices by year, by source, and by region are sourced from Statistics Canada's Canadian International Merchandise Trade Database (using the harmonized system (HS) commodity code 271112 for liquefied propane).

Regional and end-use level demand data for propane comes from CANSIM Table 128-0012. Data gaps were filled using deductions from statistical balances across end-uses and regions, and applying The Conference Board's best judgment on statistical adjustments. Data for the northern territories was split using Statistics Canada's purchaser prices use-level data for natural gas liquids for the individual territories from the detail-level supply and use tables for the Canadian economy for the years 2010 to 2014 (CANSIM Tables 381-0033).

Sub-sector and end-use application demand data comes from Natural Resources Canada's Comprehensive Energy Use Database (CEUD) and the Energy Use Data Handbook Tables.

Market Forecast

The Conference Board of Canada has developed in-house proprietary models for conventional crude oil, natural gas and NGLs, and oil sands production. The natural gas and NGLs model draws provincial-level trends on initial production (IP) rates, decline curves, wells drilled and completed, individual NGL-yields, and drilling costs from historical data collected from CAPP, Statistics Canada, provincial energy regulators, the NEB, and the latest version of the AER's ST98.

Commodity prices and drilling costs are a key driver of the forecast for natural gas and NGLs production, as the model is driven by-reinvestments of a share of the industry's profits, which are in turn determined by the multiple revenue streams (production times spot prices for natural gas and NGLs) against production costs (mainly, drilling costs).

Drilling costs are driven by oil and gas extraction and production and services wages, which in turn move with the level of industry activity, as well as with commodity prices. The process for forecasting spot-level commodity prices for natural gas, NGLs, and crude oil is discussed on the section on estimating propane sales, later in this appendix.

The Conference Board of Canada's resulting natural gas production forecast is checked against the latest-available versions of publicly-released natural gas production forecasts including those from the AER, CAPP, and the NEB. Meanwhile, the natural gas production forecast is also corroborated by estimating the "call" on Canadian gas, as determined by the forecast for domestic demand and the outlook for net exports. Domestic demand trends are driven by the NEB's energy demand forecast for Canada, while the imports and exports trade outlook is cross-referenced with the latest U.S. natural gas trade forecast numbers from the U.S. Energy Information Administration's (EIA) Annual Energy Outlook.

The forecast for propane production levels from the natural gas stream is the result of overall natural production levels in Canada, and evolving NGLs yields – as per the evolving composition of the natural gas, gas processing trends, infrastructure availability, etc. Gas plant propane forecast levels and yields are cross-checked against the latest-available provincial and national-level data, but also against publicly released forecast from the AER and the NEB.

Refinery LPG production of propane is forecast based on the NEB's forecast for Canadian refinery balances and split at the regional-level based on historical trends.

The forecast for domestic propane demand, by end-use sector and region, is primarily driven by population and economic growth trends as per the latest long-term forecast from The Conference Board of Canada and adjusted for energy-efficiency improvements over time. However, some sectors' demand forecast uses a more comprehensive analytical approach involving the use of comprehensive energy use and energy efficiency data and trends as published from Natural Resources Canada. Lastly, publicly available data on demand-side projects currently being built or in the planning stages – are also considered in the forecast.

The forecast for exports is determined by the volumes that are surplus to a region after accounting for the difference between local supply and demand levels. Import requirements, are determined by a cross-regional flow model that primarily estimate whether international propane imports are required in Eastern Canada, after accounting for pan-Canadian west to east flows (dependent on the supply and demand balance in Western Canada), and local demand requirements.

Export flows are determined based on the estimated availability and costs of transportation infrastructure, as well as a determination of price differences for Canadian propane exports in the U.S. market versus global LPG markets.

Chapter 3

Estimating the economic footprint of the industry is a two-step process. First an estimate of the industry's total sales – including domestic end-use sales by sector and by region – needs to be developed. Then, a price-adjusted estimate of industry sales is inputted as a demand-side or use-level shock for natural gas liquids into Statistics Canada's interprovincial input-output (IO) model to obtain regional/sector-level estimates of gross domestic product (GDP), employment, and indirect taxes – or the level of economic activity supported by estimated propane sales. Statistics Canada's IO results are then augmented by The Conference Board of Canada to include estimates of personal income taxes, corporate income taxes, and other taxes.

Historical and Forecasted Propane Sales Estimates

Canada's propane industry sales estimates are a function of volumes and prices. Given that historical and forecasted levels of propane exports and end-use domestic demand by sector and by region (as discussed above) represent the volume component; this section focusses on the data sources and methodology used to determine the different levels of propane prices (including spot, export, wholesale, and retail-level prices), historically and over the outlook.

Spot Market and Export Prices

Historical spot commodity prices for global, North American and Canadian natural gas, NGLs, and crude oil are sourced primarily from Sproule, the International Monetary Fund (IMF), the World Bank, and the U.S. Energy Information Administration. Conway and Sarnia spot propane prices were acquired from propaneprice.com. Saudi LPG contract prices were acquired from 3MCO and Gas Energy Australia.

The Conference Board of Canada uses a consensus approach to estimate the key North American benchmark prices for natural gas (Henry Hub) and light sweet crude (West Texas Intermediate). This consensus is defined as the median price over the outlook timeframe for a group of over ten external price forecasts.[124]

The Canadian natural gas price forecast for AECO is then determined by our long-term estimate for the CAD/US exchange rate, and assuming the HH to AECO basis returns to it long-term historical value of U.S.$0.7/MMbtu by the end of the outlook timeframe. The AECO price forecast is a key driver of natural gas production growth over the forecast, as well as a key determinant of NGLs-extraction economics.

[124] Including commodity price forecast from the AER, Bank of Montreal, CERI, CIBC, GLJ Petroleum Consultants, the IMF, NYMEX futures, RBC, TD Bank, Scotiabank, Sproule, the US EIA (both short-term and long-term forecasts), and the World Bank.

As with the case with all other of our price forecast series, we cross-check and compare our price levels over the forecast across a range of the most-recent publicly-available external forecasts – for accuracy and consistency purposes.

As with the illustrative case of the AECO natural gas price, we generally derive other forecasted crude oil and NGLs prices as a function of long-term location-specific price differences that may reflect transportation costs, or percentage of intra and inter-commodity benchmark prices, based on the best possible statistically-inferred relationships. For example, North Sea Brent crude oil prices are driven by a return to a long-term premium of U.S.$3/bbl to WTI over the outlook, while Edmonton light crude prices are driven by a long-term discount of U.S.$3/bbl to WTI prices.

Saudi LPG propane prices, the global benchmark, are in turn set at a range of around 65 percent to North Sea Brent's U.S.$/bbl prices - consistent with historical price relationships, and GJ/bbl energy density conversions for light sweet crude and propane. U.S. Gulf Coast propane prices at Mt. Belvieu are driven by a combination of year-over-year changes in Saudi LPG prices, and a long-term historical discount of U.S.$10/bbl to the global benchmark.

Conway spot propane prices are set to move towards a long-term trend discount of U.S.$1/bbl to the USGC's propane benchmark at Mt. Belvieu, while Edmonton propane prices are set relative to the U.S. benchmarks at Conway and Mt. Belvieu, but also, the Saudi global LPG price benchmark, and a historical ratio of Edmonton propane prices to Edmonton light crude oil prices. Similarly, the forecast for Sarnia spot propane prices are set relative to its historical relationship to other North American benchmarks at Mt. Belvieu, Conway, and Edmonton, but also the global LPG benchmark.

Lastly, provincial-level propane export prices are determined based on the historical discount of each province's propane export prices relative to the U.S. Midwest spot market benchmark at Conway, but also, each region's propane prices' long-term discount to the Saudi LPG global benchmark. The amount by which each provincial export price is affected by either the Conway or Saudi discount is in turn weighted by the anticipated level of exports from that Canadian jurisdiction to either the U.S. or global LPG markets.

Wholesale and Retail-level Prices

Canadian retail-level prices for gasoline, diesel, heating oil, and automotive propane were sourced from Kent Group Ltd. Wholesale and retail margins data for the above-mentioned fuels (excluding auto propane) were also sourced from the Kent Group.

Publicly available regulated wholesale and retail-level propane prices for 2017 were collected from FortisBC, EDPRO, New Brunswick's Energy & Utilities Board, Prince Edward Island's Regulatory & Appeals Commission, Newfoundland's Board of Commissioners of Public Utilities, and the Yukon's Department of Energy, Mines, and Resources.

Annual information forms, annual reports, financial statements, and investor presentations for the last three fiscal years for Gibson Energy, Parkland Fuel Corporation, and Superior Plus - estimated to account for between 40 and 50 percent of Canada's propane sales in 2016 (combined) – were reviewed and analyzed to estimate realized propane prices at the wholesale and retail level, where possible.

In addition to the analysis on wholesale and retail margins for other fuels, retail-level data on automotive propane prices, publicly available data on regulated wholesale and retail-level propane prices collected from the different provincial regulatory bodies, and the realized propane sales price data from Canada's largest propane wholesalers and retailers, The Conference Board of Canada conducted a couple of brief interviews – arranged by the CPA – with CPA's board members to discuss potential metrics for estimating wholesale and retail-level propane prices for the Canadian market – relative to spot market prices and the automotive propane retail benchmark.

Using a combination of these different data sources and insights, historical and forecast wholesale propane prices in Canada were determined based on a combination of: a 50 percent markup to spot prices, and; a $30/bbl (19c/liter) fixed-level markup to spot propane prices. Regional-level wholesale prices were determined using the Edmonton spot price for Western and Northern Canada, and the Sarnia spot price for Eastern Canada. Wholesale prices were used to estimate producer's own-use, petrochemical feedstock, and industrial sales.

Meanwhile, the historical regional-level automotive propane price retail benchmark is used to estimate propane sales across all other domestic end-users. This is done by applying user-specific discounts or premiums relative to the automotive retail price benchmark for agriculture (-15%), commercial (-10%), transportation (automotive propane price), and residential (+15%) end-users, and by adding regional excise/fuel taxes and sales taxes to retail-level prices. Over the forecast timeframe, these premiums and discounts are held constant, while the automotive propane retail benchmark is driven by the average increase in gasoline and diesel transportation end-use prices per the NEB's 2017 long-term *Energy Futures* projection under its reference case.

The resulting wholesale, retail-level, and average Canadian sale prices (including export prices) were cross-checked against the publicly available regulated prices, and the derived sales prices from the largest marketers' financial results for consistency and verification purposes.

To illustrate this point, consider that our weighted-average price for Canadian propane sales (including exports, and wholesale and retail-level domestic sales) for 2015, 2016, and 2017 were $47/bbl, $50/bbl, and $61/bbl (respectively), compared to an average of $47/bbl, $56/bbl, and $65/bbl for the same years for some of Canada's largest propane marketers. As such, while various assumptions go into deriving wholesale and retail-level prices for domestic Canadian propane sales in our analysis, we believe our wholesale and retail-level price estimates to present a reasonably accurate and representative view of Canadian propane market conditions.

Estimating the Industry's Economic Footprint Across Canada

Statistics Canada houses the most-comprehensive and up-to-date interprovincial input-output (IO) model of the Canadian economy. Simply explained, the IO model is a set of matrices or tables that maps the flows and relationships between supply and use of close to 500 different goods and services, both as intermediate inputs across over 200 different industries, and final expenditures across close to 300 different types of business and consumer spending categories. Beyond capturing the complex interactions of goods and services used as intermediate inputs across industries and as final business and consumer expenditures, the IO model maps the flows across all of Canada's thirteen provinces and territories, while determining the impacts international trade, taxes, as well as on trade and transportation margins.

Statistics Canada's IO model, based on the inter-provincial input and output or supply and end-use tables is so robust, that it acts as the backbone of the Canadian system of national accounts – the main measure of macroeconomic data for the national economy.

Without a question, Statistics Canada's interprovincial IO model is the best available tool for estimating the impact that a given level of economic activity – in our case, propane sales – has on the overall Canadian economy. However, like any model, there are limitations to its use. First is the fact that the it takes a lot of time for the model to be up-to-date to the latest data on the most recent structural snapshot of the Canadian economy – in fact, the latest version of the model uses 2014's data. The model is also static in nature, and it gives results for a question that we might be asking about say 2016 or a year in an outlook timeframe, based on the 2014's structure of the economy. With that in mind, however, although the level of economic activity across industry does change year by year, the relationship between industries – i.e., the structure of the economy, takes a long time to change. Thus, the results obtained from the IO model are still relevant in today's context and even over an outlook timeframe, even though it is based on the 2014's structure of the Canadian economy.

The regional-level price-adjusted sales estimates for Canadian propane are fed into Statistics Canada's inter-provincial IO model as three separate demand shocks for natural gas liquids, including international exports, final consumer expenditures (residential sales), and a shock on intermediate goods (all domestic sales excluding residential sales). The model then estimates the level of economic activity generated by this level of sales is then estimated by the model, across different regions and industries, in the form of gross domestic product (GDP), employment, and indirect taxes.

Regional-level GDP results generated by Statistics Canada's model including different types of labor income and profits, are then used with The Conference Board of Canada's proprietary fiscal and macroeconomic databases, to augment the economic footprint results and generate estimates of provincial and federal-level tax revenues in the form of personal income taxes, corporate income taxes, and other payroll taxes.

Carbon taxes were estimated using sector-specific emission factors from Environment and Climate Change Canada's National Inventory Report for 2018, combined with information about carbon pricing rates collected from provincial and federal departments of finance and departments of environment.

Royalties were calculated using a combination of derived rates as per CAPP's statistical handbook data, and royalty rates published by provincial departments of energy.

Chapter 4

Results in the tables were developed using Statistics Canada data, British Columbia Ministry of Environment Public Sector Greenhouse Gas Emissions data, Natural Resources Canada's CEUD and NEUD tables, and data from Adouane and others.

Appendix B
Supplementary Regional-Level Summaries

Table 20: Canadian propane supply by source and by region, kb/d

	Gas plants			Refineries			**Total production**			Imports			Adjustments			**TOTAL SUPPLY**		
Region/Year	**2007**	**16**	**25f**	**2007**	**16**	**25f**	**2007**	**16**	**25f**	**2007**	**16**	**25f**	**2007**	**16**	**25f**	**2007**	**16**	**25f**
British Columbia	6.0	18.4	37.3	1.8	1.1	1.1	**7.8**	**19.4**	**38.4**	0.9	0.4	0.2	0.4	(0.3)	(0.3)	**9.1**	**19.5**	**38.4**
Alberta	90.7	108.6	153.4	7.0	3.1	3.2	**97.8**	**111.7**	**156.6**	0.0	0.1	0.0	4.7	(1.9)	(1.5)	**102.5**	**109.9**	**155.1**
Saskatchewan	0.7	7.3	7.9	6.2	4.1	4.2	**7.0**	**11.4**	**12.1**	0.0	0.0	0.0	0.3	(0.2)	(0.2)	**7.3**	**11.3**	**12.0**
Manitoba	-	-		-	-	-	**-**	**-**	**-**	0.0	0.0	0.0	0.0	(0.0)	(0.0)	**0.0**	**0.0**	**0.0**
Ontario	81.1	65.2	51.1	5.3	2.4	2.4	**86.4**	**67.6**	**53.5**	0.6	5.5	3.5	4.2	(1.2)	(1.0)	**91.2**	**71.9**	**56.0**
Quebec	-	-		6.4	3.4	3.4	**6.4**	**3.4**	**3.4**	0.0	0.9	0.6	0.3	(0.1)	(0.1)	**6.7**	**4.2**	**3.9**
Atlantic Canada	2.7	1.7	1.0	7.0	4.3	4.4	**9.6**	**6.0**	**5.4**	-	0.1	0.0	0.5	(0.1)	(0.1)	**10.1**	**6.0**	**5.4**
Territories	-	-		-	-	-	**-**	**-**	**-**	-	-	-	-	-	-	**-**	**-**	**-**
Canada	**181.3**	**201.2**	**250.8**	**33.7**	**18.4**	**18.6**	**215.0**	**219.6**	**269.4**	**1.5**	**7.0**	**4.4**	**10.5**	**(3.8)**	**(3.0)**	**227.0**	**222.8**	**270.8**

Source: The Conference Board of Canada; Canadian Association of Petroleum Producers (CAPP); Government of British Columbia; Statistics Canada (CANSIM Table 128-0012)

Table 21: Canadian propane demand by use and by region, kb/d

	Producer's own-use		Non-energy (feedstock)		Industrial		Commercial		Residential		Transportation		Agriculture		**Total domestic demand**		Exports		**TOTAL DISPOSTION**	
Region/Year	**2016**	**25f**	**2016**	**25f**	**2016**	**25f**	**2016**	**25f**	**2016**	**25f**	**2016**	**25f**	**2016**	**25f**	**2016**	**25f**	**2016**	**25f**	**2016**	**25f**
British Columbia	0.4	0.5	-	-	1.0	1.0	0.9	1.0	0.5	0.5	1.6	1.9	0.1	0.1	**4.5**	**5.1**	15.7	80.0	**20.2**	**85.1**
Alberta	5.5	6.0	0.8	45.3	21.9	23.9	5.3	6.1	1.0	1.2	0.9	1.1	0.2	0.2	**35.5**	**83.7**	55.6	15.8	**91.1**	**99.5**
Saskatchewan	0.2	0.2	-	-	3.2	3.4	0.6	0.6	0.2	0.2	0.1	0.1	0.0	0.0	**4.4**	**4.7**	8.6	2.1	**13.0**	**6.8**
Manitoba	-	-	-	-	0.8	0.9	0.4	0.5	0.1	0.1	0.1	0.1	0.2	0.3	**1.7**	**1.8**	7.3	1.5	**9.0**	**3.3**
Ontario	0.2	0.2	10.1	10.6	6.4	7.0	11.0	12.3	7.7	8.6	4.9	5.8	3.0	3.2	**43.3**	**47.6**	22.0	6.5	**65.3**	**54.1**
Quebec	-	-	0.5	0.5	1.3	1.4	5.3	5.7	1.1	1.2	0.5	0.6	3.4	3.6	**12.2**	**13.0**	4.7	1.8	**16.9**	**14.8**
New Brunswick	-	-	-	-	0.7	0.8	0.8	0.8	0.2	0.2	0.0	0.0	0.0	0.0	**1.7**	**1.8**	0.9	0.2	**2.7**	**2.0**
Nova Scotia	-	-	-	-	0.3	0.3	0.8	0.9	0.4	0.4	0.0	0.0	0.0	0.0	**1.6**	**1.6**	0.0	0.0	**1.6**	**1.6**
Newfoundland and Labrador	-	-	-	-	0.1	0.1	0.7	0.7	0.3	0.3	0.0	0.0	0.0	0.0	**1.0**	**1.0**	-	-	**1.0**	**1.0**
Prince Edward Island	-	-	-	-	-	-	0.1	0.1	0.0	0.0	-	-	0.0	0.0	**0.1**	**0.1**	-	-	**0.1**	**0.1**
Territories	-	-	-	-	0.5	0.6	0.2	0.3	0.1	0.2	0.0	0.0	-	-	**0.9**	**1.0**			**0.9**	**1.0**
Canada	**6.4**	**6.9**	**11.4**	**56.4**	**36.3**	**39.4**	**26.1**	**28.8**	**11.6**	**12.9**	**8.2**	**9.7**	**7.0**	**7.5**	**107.0**	**161.5**	**114.7**	**107.9**	**221.8**	**269.4**

Source: The Conference Board of Canada; Statistics Canada (CANSIM Table 128-0012)

Table 22: Canadian propane sales by use and by region, $MM

	Producer's own-use		Non-energy (feedstock)		Industrial		Commercial		Residential		Transportation		Agriculture		**Total domestic demand**		Exports		**TOTAL SALES**	
Region/Year	**2016**	**25f**	**2016**	**25f**	**2016**	**25f**	**2016**	**25f**	**2016**	**25f**	**2016**	**25f**	**2016**	**25f**	**2016**	**25f**	**2016**	**25f**	**2016**	**25f**
British Columbia	$ 4	$ 12	$ -	$ -	$ 11	$ 26	$ 40	$ 54	$ 23	$ 31	$ 70	$ 103	$ 3	$ 4	**$ 150**	**$ 231**	$ 99	$ 1,298	**$ 250**	**$ 1,529**
Alberta	$ 64	$ 147	$ -	$ 1,113	$ 255	$ 588	$ 235	$ 329	$ 49	$ 70	$ 40	$ 61	$ 8	$ 11	**$ 652**	**$ 2,319**	$ 453	$ 258	**$ 1,104**	**$ 2,578**
Saskatchewan	$ 2	$ 6	$ -	$ -	$ 38	$ 84	$ 31	$ 41	$ 14	$ 18	$ 6	$ 8	$ 2	$ 3	**$ 94**	**$ 160**	$ 91	$ 35	**$ 184**	**$ 195**
Manitoba	$ 0	$ -	$ -	$ -	$ 10	$ 22	$ 26	$ 34	$ 6	$ 8	$ 4	$ 6	$ 13	$ 17	**$ 60**	**$ 87**	$ 67	$ 24	**$ 127**	**$ 111**
Ontario	$ 5	$ 7	$ 270	$ 319	$ 134	$ 210	$ 388	$ 544	$ 300	$ 421	$ 170	$ 254	$ 98	$ 135	**$ 1,365**	**$ 1,889**	$ 218	$ 111	**$ 1,583**	**$ 1,999**
Quebec	$ 1	$ -	$ -	$ 15	$ 28	$ 42	$ 251	$ 306	$ 59	$ 72	$ 26	$ 33	$ 154	$ 184	**$ 519**	**$ 652**	$ 45	$ 30	**$ 564**	**$ 682**
New Brunswick	$ 1	$ -	$ -	$ -	$ 15	$ 23	$ 39	$ 41	$ 12	$ 12	$ 1	$ 1	$ 1	$ 1	**$ 68**	**$ 77**	$ 8	$ 4	**$ 77**	**$ 81**
Nova Scotia	$ 1	$ -	$ -	$ -	$ 8	$ 9	$ 35	$ 45	$ 18	$ 23	$ 1	$ 2	$ 1	$ 1	**$ 64**	**$ 80**	$ 1	$ 0	**$ 65**	**$ 80**
Newfoundland and Labrador	$ 1	$ -	$ -	$ -	$ 2	$ 3	$ 33	$ 36	$ 14	$ 15	$ 0	$ 0	$ 0	$ 0	**$ 49**	**$ 54**	$ -	$ -	**$ 49**	**$ 54**
Prince Edward Island	$ 0	$ -	$ -	$ -	$ -	$ -	$ 3	$ 3	$ 2	$ 2	$ -	$ -	$ 0	$ 0	**$ 6**	**$ 6**	$ -	$ -	**$ 6**	**$ 6**
Territories	$ -	$ -	$ -	$ -	$ 2	$ 15	$ 11	$ 16	$ 7	$ 10	$ 1	$ 1	$ -	$ -	**$ 21**	**$ 42**	$ 0	$ 0	**$ 21**	**$ 42**
Canada	**$ 78**	**$ 172**	**$ 270**	**$ 1,447**	**$ 503**	**$ 1,021**	**$ 1,091**	**$ 1,449**	**$ 504**	**$ 682**	**$ 319**	**$ 469**	**$ 282**	**$ 357**	$ 3,046	$ 5,598	**$ 982**	**$ 1,759**	$ 4,029	$ 7,357

Source: The Conference Board of Canada

Table 23: Fiscal impacts of Canada's propane industry economic footprint in 2016, $MM 2016

Type	Level	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	Atlantic	Territories	Canada
Indirect Taxes	Municipal	$ 8	$ 55	$ 4	$ 1	$ 13	$ 4	$ 1	$ 0	**$ 87**
	Provincial	$ 15	$ 40	$ 11	$ 4	$ 61	$ 19	$ 5	$ 0	**$ 156**
	Federal	$ 4	$ 27	$ 2	$ 1	$ 22	$ 6	$ 3	$ 0	**$ 67**
	Total	***$ 27***	***$ 122***	***$ 18***	***$ 7***	***$ 95***	***$ 29***	***$ 10***	***$ 1***	***$ 309***
Personal Income Taxes	Municipal							$ -	$ -	**$ -**
	Provincial	$ 7	$ 57	$ 4	$ 2	$ 15	$ 9	$ 3	$ 0	**$ 96**
	Federal	$ 14	$ 126	$ 6	$ 2	$ 29	$ 7	$ 3	$ 0	**$ 189**
	Total	***$ 21***	***$ 183***	***$ 10***	***$ 4***	***$ 44***	***$ 17***	***$ 6***	***$ 0***	***$ 285***
Corporate Income Taxes	Municipal							$ -	$ -	**$ -**
	Provincial	$ 5	$ 36	$ 3	$ 1	$ 11	$ 4	$ 1	$ 0	**$ 61**
	Federal	$ 11	$ 59	$ 5	$ 2	$ 17	$ 4	$ 2	$ 0	**$ 99**
	Total	***$ 16***	***$ 95***	***$ 8***	***$ 3***	***$ 28***	***$ 8***	***$ 3***	***$ 0***	***$ 160***
Other Taxes	Municipal							$ -	$ -	**$ -**
	Provincial	$ 1	$ 5	$ 0	$ 0	$ 2	$ 1	$ 0	$ 0	**$ 10**
	Federal	$ 2	$ 18	$ 1	$ 0	$ 4	$ 1	$ 1	$ 0	**$ 27**
	Total	***$ 3***	***$ 23***	***$ 1***	***$ 1***	***$ 6***	***$ 3***	***$ 1***	***$ 0***	***$ 37***
Royalties	Municipal							$ -	$ -	**$ -**
	Provincial	$ 6	$ 77	$ -	$ -	$ -	$ -	$ 0	$ -	**$ 83**
	Federal							$ -	$ -	**$ -**
	Total	***$ 6***	***$ 77***	***$ -***	***$ -***	***$ -***	***$ -***	***$ 0***	***$ -***	***$ 83***
Carbon Tax	Municipal							$ -	$ -	**$ -**
	Provincial	$ 11	$ 8	$ -	$ -	$ -	$ 12	$ -	$ -	**$ 30**
	Federal							$ -	$ -	**$ -**
	Total	***$ 11***	***$ 8***	***$ -***	***$ -***	***$ -***	***$ 12***	***$ -***	***$ -***	***$ 30***
TOTAL TAXES & ROYALTIES	Municipal	$ 8	$ 55	$ 4	$ 1	$ 13	$ 4	$ 1	$ 0	**$ 87**
	Provincial	$ 45	$ 222	$ 18	$ 7	$ 89	$ 45	$ 10	$ 0	**$ 436**
	Federal	$ 31	$ 230	$ 14	$ 5	$ 72	$ 19	$ 9	$ 1	**$ 382**
	Total	***$ 84***	***$ 507***	***$ 37***	***$ 14***	***$ 174***	***$ 68***	***$ 20***	***$ 1***	***$ 905***

Source: The Conference Board of Canada; Statistics Canada

Table 24: Fiscal impacts of Canada's propane industry economic footprint in 2017-25 (annual average), $MM 2016

Type	Level	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	Atlantic	Territories	Canada
Indirect Taxes	Municipal	$ 17	$ 63	$ 3	$ 1	$ 13	$ 4	$ 1	$ 0	**$ 103**
	Provincial	$ 35	$ 46	$ 9	$ 3	$ 60	$ 19	$ 5	$ 0	**$ 176**
	Federal	$ 10	$ 32	$ 2	$ 1	$ 22	$ 7	$ 3	$ 0	**$ 76**
	Total	***$ 61***	***$ 141***	***$ 14***	***$ 5***	***$ 94***	***$ 30***	***$ 10***	***$ 1***	***$ 355***
Personal Income Taxes	Municipal							$ -	$ -	**$ -**
	Provincial	$ 15	$ 66	$ 3	$ 1	$ 15	$ 9	$ 3	$ 0	**$ 112**
	Federal	$ 32	$ 145	$ 5	$ 2	$ 29	$ 7	$ 3	$ 0	**$ 224**
	Total	***$ 47***	***$ 212***	***$ 8***	***$ 3***	***$ 44***	***$ 17***	***$ 6***	***$ 0***	***$ 336***
Corporate Income Taxes	Municipal							$ -	$ -	**$ -**
	Provincial	$ 12	$ 42	$ 2	$ 1	$ 11	$ 4	$ 1	$ 0	**$ 72**
	Federal	$ 24	$ 68	$ 4	$ 1	$ 17	$ 4	$ 1	$ 0	**$ 120**
	Total	***$ 36***	***$ 110***	***$ 6***	***$ 2***	***$ 28***	***$ 8***	***$ 3***	***$ 0***	***$ 192***
Other Taxes	Municipal							$ -	$ -	**$ -**
	Provincial	$ 2	$ 6	$ 0	$ 0	$ 2	$ 1	$ 0	$ 0	**$ 12**
	Federal	$ 4	$ 20	$ 1	$ 0	$ 4	$ 1	$ 1	$ 0	**$ 32**
	Total	***$ 6***	***$ 26***	***$ 1***	***$ 0***	***$ 6***	***$ 3***	***$ 1***	***$ 0***	***$ 43***
Royalties	Municipal							$ -	$ -	**$ -**
	Provincial	$ 9	$ 90	$ -	$ -	$ -	$ -	$ 0	$ -	**$ 99**
	Federal							$ -	$ -	**$ -**
	Total	***$ 9***	***$ 90***	***$ -***	***$ -***	***$ -***	***$ -***	***$ 0***	***$ -***	***$ 99***
Carbon Tax	Municipal							$ -	$ -	**$ -**
	Provincial	$ 12	$ 15	$ 4	$ 1	$ 50	$ 12	$ 4	$ 1	**$ 99**
	Federal							$ -	$ -	**$ -**
	Total	***$ 12***	***$ 15***	***$ 4***	***$ 1***	***$ 50***	***$ 12***	***$ 4***	***$ 1***	***$ 99***
TOTAL TAXES & ROYALTIES	Municipal	$ 17	$ 63	$ 3	$ 1	$ 13	$ 4	$ 1	$ 0	**$ 103**
	Provincial	$ 84	$ 265	$ 18	$ 6	$ 137	$ 45	$ 14	$ 1	**$ 571**
	Federal	$ 70	$ 266	$ 11	$ 4	$ 71	$ 19	$ 9	$ 1	**$ 451**
	Total	***$ 171***	***$ 594***	***$ 32***	***$ 11***	***$ 222***	***$ 69***	***$ 23***	***$ 2***	***$ 1,125***

Source: The Conference Board of Canada; Statistics Canada

Appendix C
Bibliography

Adouane, Mabrouk, Ismail Tabet, Daoud Rezzak, Khaled Touafek, Sitayeb Abdelkader, and Houam Yahia. 'Feasibility Study of a Hybrid Plants (Photovoltaic–LPG Generator) System for Rural Electrification'. *Renewable Energy and Environmental Sustainability* 1 (2016): 15. https://doi.org/10.1051/rees/2016012.

Advanced Information Centre. 'Enabling a Clean Energy Future for Canada's Remote Communities'. Advanced Information Centre, 2015.

Alberta Energy Regulator. 2017. *ST98 - Glossary.* March. https://www.aer.ca/data-and-publications/statistical-reports/glossary.

—. 2018. "ST98 - Transporation and Facilities." *AER.* March. Accessed March 2018. http://www.aer.ca/data-and-publications/statistical-reports/transportation-and-facilities.

—. 2018. *ST98.* Accessed November 2018. https://www.aer.ca/data-and-publications/statistical-reports/st98.

Antweiler, Werner, and Sumeet Gulati. 'Policy Forum: Reducing the Environmental Impact of Transportation—British Columbia's Tax Policy Initiatives'. *Canadian Tax Journal* 60, no. 4 (2012): 869–79.

Arriaga, Mariano, Claudio Cañizares, and Mehrdad Kazerani. 'Renewable Energy Alternatives for Remote Communities in Northern Ontario, Canada - IEEE Journals & Magazine'. *IEEE Transactions on Sustainable Energy*, IEEE Transactions on Sustainable Energy, 4, no. 3 (2013): 661–70.

Ashok, B., S. Denis Ashok, and C. Ramesh Kumar. 'LPG Diesel Dual Fuel Engine – A Critical Review'. *Alexandria Engineering Journal* 54, no. 2 (1 June 2015): 105–26. https://doi.org/10.1016/j.aej.2015.03.002.

BC Gov News. 'Hybrid Solar Power Burns Cleaner for Xeni Gwet'in', 27 December 2017. Accessed November 2018. https://news.gov.bc.ca/releases/2017IRR0057-002106.

Brevifolia Consulting. 'Solar-Diesel Project Review and Oversight – Xeni Gwet'in First Nation', 2018. https://brevifoliaconsulting.com/projects/solar-diesel-xenigwetin-first-nation/.

British Columbia Ministry of Environment. 'B.C. Public Sector Greenhouse Gas Emissions'. Methodology for Reporting. B.C. Ministry of Environment, 2011. https://www2.gov.bc.ca/assets/gov/environment/climate-change/cng/methodology/2011-pso-methodology.pdf.

Canadian Propane Association. 'Propane Quick Facts'. *Canadian Propane Association* (blog). Accessed 24 August 2018. https://propane.ca/quick-facts/.

Chemical Market Resources Inc. and Polymer Consulting International Inc. 2015. "Sarnia-Lambton Propylene Investment Opportunity Study." *Sarnia-Lambton Economic Partnership.* Accessed March 2018. http://33sgq1wqdn71n18qv11fgblh.wpengine.netdna-cdn.com/wp-content/uploads/2016/05/Sarnia-Lambton-Propylene-Investment-Opportunity-Final-Report-E.pdf.

Communauté métropolitaine de Montréal. 'Petrochemicals-Chemical-Plastics Clusters', 2004.

Conference Board of Canada, The. "Canadian Outlook Long-Term Economic Forecast: 2018." Ottawa: CBoC, 2018.

Consolidated federal laws of canada. Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations, P.C. 2010-1162 2010-09-23 § (2010). http://laws-lois.justice.gc.ca/eng/regulations/SOR-2010-201/FullText.html.

Economic Plant. 'Increasing Global Demand for On-Purpose Production of Propylene - Economic Plant'. *Economic Plant*. Accessed 20 August 2018. https://www.economic-plant.com/18-news/70-increasing-global-demand-for-on-purpose-production-of-propylene.html.

Energy Information Administration. 'How Much Carbon Dioxide Is Produced When Different Fuels Are Burned?' U.S. Energy Information Administration, 8 June 2018. https://www.eia.gov/tools/faqs/faq.php?id=73&t=11.

Englishoe, Bartz. 'Benefits of Propane for Rural Alaska', 3, 2014.

Environment and Climate Change Canada. 'Canadian Environmental Sustainability Indicators: Air Pollutant Emissions'. Research, 2017. https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/air-pollutant-emissions/nitrogen-oxide.html.

———. 'Canadian Environmental Sustainability Indicators: Greenhouse Gas Emissions'. Research, 2018. www.canada.ca/en/environment-climate-change/services/environmentalindicators/greenhouse-gas-emissions.html.

Farchy, Jack, and Kelly Gilblom. 'What If Big Oil's Bet on Gas Is Wrong?' *Bloomberg.Com*, 17 July 2017. https://www.bloomberg.com/news/articles/2017-07-17/big-oil-sees-salvation-in-gas-but-what-if-it-s-the-wrong-bet.

Goobie, G. 'Canadian Propane Supply and Demand through 2050', 2016.

Government of Alberta. 2018. "Energy Diversification Act." *Alberta Government.* March. Accessed March 2018. https://www.alberta.ca/energy-diversification-act.aspx.

—. 2018. "Petrochemical feedstock infrastructure." *Alberta Government.* March. Accessed 2018 March. https://www.alberta.ca/assets/documents/energy-petrochemical-feedstock-factsheet.pdf.

—. 2018. "Petrochemicals Diversification Program." *Alberta Government.* March. Accessed March 2018. https://www.alberta.ca/assets/documents/energy-petrochemical-diversification-factsheet.pdf.

Government of British Columbia. 'Natural Gas & Oil Statistics'. Accessed 2 November 2018. https://www2.gov.bc.ca/gov/content/industry/natural-gas-oil/statistics.

Government of Canada; Transport Canada; Policy. 'Transportation in Canada 2011', 10 July 2012. https://www.tc.gc.ca/eng/policy/anre-menu-3021.htm.

Hussain, Ramthan, and Andrea Salazar. 'Chinese LPG Buyers Reduce US-Origin Propane Imports on Trade War Concerns'. *S&P Global Platts*, 11 July 2018. https://www.spglobal.com/platts/en/market-insights/latest-news/oil/071118-chinese-lpg-buyers-reduce-us-origin-propane-imports-on-trade-war-concerns.

ICF International. 2017. "2017 Propane Market Outlook: Current Market Conditions and the Outlook Through 2025." *ICF International.* April 21. Accessed March 2018. https://www.npgaexpo.org/files/C1_Sloan.pdf.

IHS Markit. 'New Technology for On-Purpose Production of Propylene Critical to Meet Demand for Plastics Production'. IHS Markit, July 2017. https://news.ihsmarkit.com/press-release/competitive-processes-and-cost-tracker/new-technology-purpose-production-propylene-c-0.

International Enegy Agency. 2017. "WEO-2017 Special Report: Energy Access Outlook." *IEA.* November. https://www.iea.org/publications/freepublications/publication/weo-2017-special-report-energy-access-outlook.html.

Innovation, Science, and Economic Development Canada. 2017. "Trade Data Online, HS27111, Total Exports, Top 10 Countries, 2016, Canadian Dollars." *ISED, Trade Data Online .* November. Accessed March 2018. https://www.ic.gc.ca/app/scr/tdst/tdo/crtr.html?timePeriod=%7CCustom+Years&reportType=TE&hSelectedCodes=%7C271112&searchType=BL&customYears=2016&productType=HS6&currency=CDN&countryList=TOP&runReport=true&grouped=GROUPED&toFromCountry=CDN&naArea=9999.

International Energy Agency. 2018. "Canada Balance (2015)." *IEA Sankey Diagram.* February. https://www.iea.org/Sankey/#?c=Canada&s=Balance.

—. 2017. "World Energy Outlook 2017." *IEA.* November. https://www.iea.org/weo2017/.

Kent Group Ltd. 2017. "2016 National Retail Petroleum Site Census." *Kent Group Ltd.* Accessed May 2018. https://www.kentgroupltd.com/wp-content/uploads/2015/12/Executive-Summary-2016-National-Retail-Petroleum-Site-Census.pdf.

Khalil, Yasmin. 'Propylene in Demand: Roadblocks and Opportunities'. *Engineering360*, 2015. https://insights.globalspec.com/article/473/propylene-in-demand-roadblocks-and-opportunities.

Knowles, James. 'Power Shift: Electricity for Canada's Remote Communities'. The Conference Board of Canada, 2016. https://www.conferenceboard.ca/e-library/abstract.aspx?did=8249.

Levenson-Falk, Annie. 'Propane Conversion Strategies: Energy Alternatives for Minnesota Users of Propane Gas'. Minnesota Legislative Energy Commission, 2015.

M Werpy, A Burnham, and K Betram. 'Propane Vehicles: Status, Challenges, and Opportunities'. Argonne National Laboratory, 2010.

MacKinlay, Cheri-Ann. 'Reducing Diesel Reliance in Canada's Rural and Remote Communities'. presented at the Generate 2017: First Nation's Workshop, 29 November 2017. https://www.cleanenergybc.org/wp-content/uploads/2017/12/NRCan-Generate-2017-Nov-29-2017-1.pdf.

McIntosh, Emma. 'Ontario Government Gives $100 Million to Alberta Petrochemical Company under Investigation'. *National Observer*, 11 December 2017. https://www.nationalobserver.com/2017/12/11/news/ontario-government-gives-100-million-alberta-petrochemical-company-under.

Miaou, S. P., P. S. Hu, and J. R. Young. 'Fleet Vehicles in the United States: Composition, Operating Characteristics, and Fueling Practices'. Publication. Oak Ridge National Laboratory, 1992. https://trid.trb.org/view/368161.

Murillo, Carlos A. 2014. *Natural Gas Liquids (NGLs) in North America: An Update. Part I - Upstream.* May. https://www.ceri.ca/assets/files/CERI%20Study%20139%20Part%20I%20-%20Final.pdf.

—. 2014. "Natural gas liquids (NGLs) in North America: An Update. Part II - Midstream and Downstream Infrastructure ." *Canadian Energy Research Institute (CERI).* May. Accessed March 2018. https://www.ceri.ca/assets/files/CERI%20Study%20139%20Part%20II%20-%20Final.pdf.

National Energy Board, Government of Canada. "Commodity Tracking System—Natural Gas." Database. National Energy Board, Energy Information, Statistics & Analysis, 2018. https://www.neb-one.gc.ca/nrg/sttstc/index-eng.html.

National Energy Board and Competition Bureau. 2014. *Propane Market Review - Final Report to the Minister of Natural Resources and the Minister of Industry.* April. https://www.neb-one.gc.ca/nrg/sttstc/ntrlgslqds/rprt/2014/2014prpn-eng.pdf.

National Energy Board. 2018. "Canada's Energy Future 2017 Supplement - Oil Sands." *NEB.* January. Accessed March 2018. https://www.neb-one.gc.ca/nrg/ntgrtd/ftr/2017lsnds/nrgftrs2017spplmnts2017lsnds-eng.pdf.

—. 2018. "Canadian propane exports to Mexico leap eight-fold in 2017." *Market Snapshots.* April 18. Accessed May 2018. http://www.neb-one.gc.ca/nrg/ntgrtd/mrkt/snpsht/2018/04-03cndprpn-eng.html.

—. 2018. "Canadian Refinery Overview - Energy Market Assessment." *NEB.* April. Accessed May 2018. https://www.neb-one.gc.ca/nrg/sttstc/crdlndptrlmprdct/rprt/2018rfnryrprt/2018cndnrfnrvrvw-eng.pdf.

—. 2016. *Energy Conversion Tables.* May. https://apps.neb-one.gc.ca/Conversion/conversion-tables.aspx?GoCTemplateCulture=en-CA.

—. 2017. *Energy Information, Statistics & Analysis, Natural Gas.* December. https://www.neb-one.gc.ca/nrg/sttstc/ntrlgs/index-eng.html.

—. 2018. "Growing electric vehicle incentives in Canada." *Market Snapshot.* January 17. Accessed May 2018. http://www.neb-one.gc.ca/nrg/ntgrtd/mrkt/snpsht/2018/01-03lctrcvhclncntvs-eng.html.

—. 2016. *Propane Market Review: 2016 Update.* https://www.neb-one.gc.ca/nrg/sttstc/ntrlgslqds/rprt/2016/2016prpn-eng.pdf.

Natural Resource Canada. 2012. "Survey of Commercial and Institutional Energy Use - Buildings 2009." *Natural Resources Canada, Office of Energy Efficiency.* Accessed March 2018. http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/scieu/2009/tables.cfm.

Natural Resources Canada. 2018. "Comprehensive Energy Use Database." *Office of Energy Efficiency, National Energy Use Database.* March 6. Accessed March 2018. http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive_tables/list.cfm.

—. 2018. "Electric Charging and Alternative Fuelling Stations Locator." *Personal vehicles.* January. Accessed May 2018. https://www.nrcan.gc.ca/energy/transportation/personal/20487#/find/nearest?fuel=ELEC&ev_levels=2&ev_levels=dc_fast&ev_levels=1.

—. 2017. *Fuel Consumption Taxes in Canada.* 07 24. Accessed November 2018. http://www.nrcan.gc.ca/energy/fuel-prices/18885.

—. 2018 'Average Retail Fuel Prices in Canada'. Accessed November 2018. http://www2.nrcan.gc.ca/eneene/sources/pripri/prices_byfuel_e.cfm.

—.2018 'Clean Energy for Rural and Remote Communities: BioHeat, Demonstration & Deployment Streams'. Accessed November 2018. http://www.nrcan.gc.ca/energy/science/programs-funding/20776.

—.2018 'Fuel Consumption Taxes in Canada'. Accessed November 2018. https://www.nrcan.gc.ca/energy/fuel-prices/18885.

—. 2018 'Government of Canada Supports Clean Energy in Rural and Remote Communities'. *Newswire.Ca*. Accessed November 2018. https://www.newswire.ca/news-releases/government-of-canada-supports-clean-energy-in-rural-and-remote-communities-674300013.html.

—. 2018 'Reducing Diesel Energy in Rural and Remote Communities'. Accessed November 2018. https://www.nrcan.gc.ca/energy/science/programs-funding/20542.

—.2018 'Remote Communities Energy Database'. Accessed November 2018. http://atlas.gc.ca/rced-bdece/en/index.html.

—. 2017 'Transportation Sector – GHG Emissions'. Accessed November 2018. http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=AN&sector=aaa&juris=00&rn=5&page=0.

—.2008 'Alternative Fuels in Canada: Making Choices Today for a Better Tomorrow'. Natural Resources Canada's Office of Energy Efficiency, 2008.

Natural Resources Canada, and Jimmy Royer. "Status of Remote/Off-Grid Communities in Canada." Natural Resources Canada, 2013.

Royal Dutch Shell plc. 2018. "Shell LNG Outlook 2018." Shell Global. Accessed November 2018. https://www.shell.com/energy-and-innovation/natural-gas/liquefied-natural-gas-lng/lng-outlook/_jcr_content/par/textimage_864093748.stream/1519645795451/d44f97c4d4c4b8542875204a19c0b21297786b22a900ef8c644d07d74a2f6eae/shell-lng-outlook-2018-presentation-sl.

School Bus Fleet. "Canada District Switches Entire School Bus Fleet to Propane." Accessed September 20, 2018. http://www.schoolbusfleet.com/news/714864/canada-district-switches-entire-school-bus-fleet-to-propane.

Statistics Canada. 2017. *North American Industry Classification System (NAICS) Canada 2017 Version 1.0.* 07 18. http://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVD&TVD=307532.

—. 2017. *Table 128-0016 Supply and demand of primary and secondary energy in terajoules.* November. http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=1280016&tabMode=dataTable&p1=-1&p2=9&srchLan=-1.

—. Table 25-10-0026-01 Supply and demand of natural gas liquids, annual (formerly CANSIM 128-0012). https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2510002601

—. 'Electric Power Generation, Annual Fuel Consumed by Electric Utility Thermal Plants (Table 25-10-0017-01)'. Database. Statistics Canada, 2018. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2510001701.

—. 'Sales of Fuel Used for Road Motor Vehicles, Annual (x 1,000)', 21 August 2018. Accessed November 2018. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2310006601.

Statutes of Alberta. Fuel Tax Act, Pub. L. No. Chapter F-28.1 (2006). http://www.qp.alberta.ca/documents/Acts/F28P1.pdf.

Stephan, Dominik. 'The Rise of On-Purpose Propylene: How to Supply the World's Hunger for Plastic'. *Process Worldwide*, 2015. https://www.process-worldwide.com/the-rise-of-on-purpose-propylene-how-to-supply-the-worlds-hunger-for-plastic-a-499478/.

Transport Canada. 'Transportation in Canada 2017'. Annual Report. Accessed November 2018. https://www.tc.gc.ca/eng/policy/transportation-canada-2017.html.

U.S. Energy Information Administration. 2018. *Natural Gas.* Accessed November 2018. https://www.eia.gov/naturalgas/.

Vogt, Willie. 'Dual-Fuel Engine Saver'. *Farm Industry News*, 2015. Accessed November 2018. https://www.farmindustrynews.com/bioenergy/dual-fuel-engine-saver.

Wang, M.Q., and H.S. Huang. 'A Full Fuel-Cycle Analysis of Energy and Emissions Impacts of Transportation Fuels Produced from Natural Gas'. Argonne National Laboratory, 1999. Accessed November 2018. https://doi.org/10.2172/750803.

Wilt, James. 'Canada's Commitment of $220 Million to Transition Remote Communities Off Diesel a Mere "Drop in the Bucket"'. *The Narwhal*. Accessed 26 August 2018. https://thenarwhal.ca/canada-s-commitment-220-million-transition-remote-communities-diesel-mere-drop-bucket/.

World LPG Association. 2018. "Autogas vehicles catalogue 2018." *WLPGA.* Accessed May 2018. https://auto-gas.net/wp-content/uploads/2018/04/WLPGA-LPG_Vehicle_CATALOGUE_A4_V11_pbp_SMALL-2.pdf.

commitment-220-million-transition-remote-communities-diesel-mere-drop-bucket/.

—. 2016 'Autogas Incentive Policies: A Country-by-Country Analysis of Why and How Governments Encourage Autogas and What Works'. The World LPG Association. Accessed November 2018. https://auto-gas.net/wp-content/uploads/2017/12/Autogas-Incentive-Policies-2016.pdf.

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