

LNG: Canada's Supply Chain Opportunities

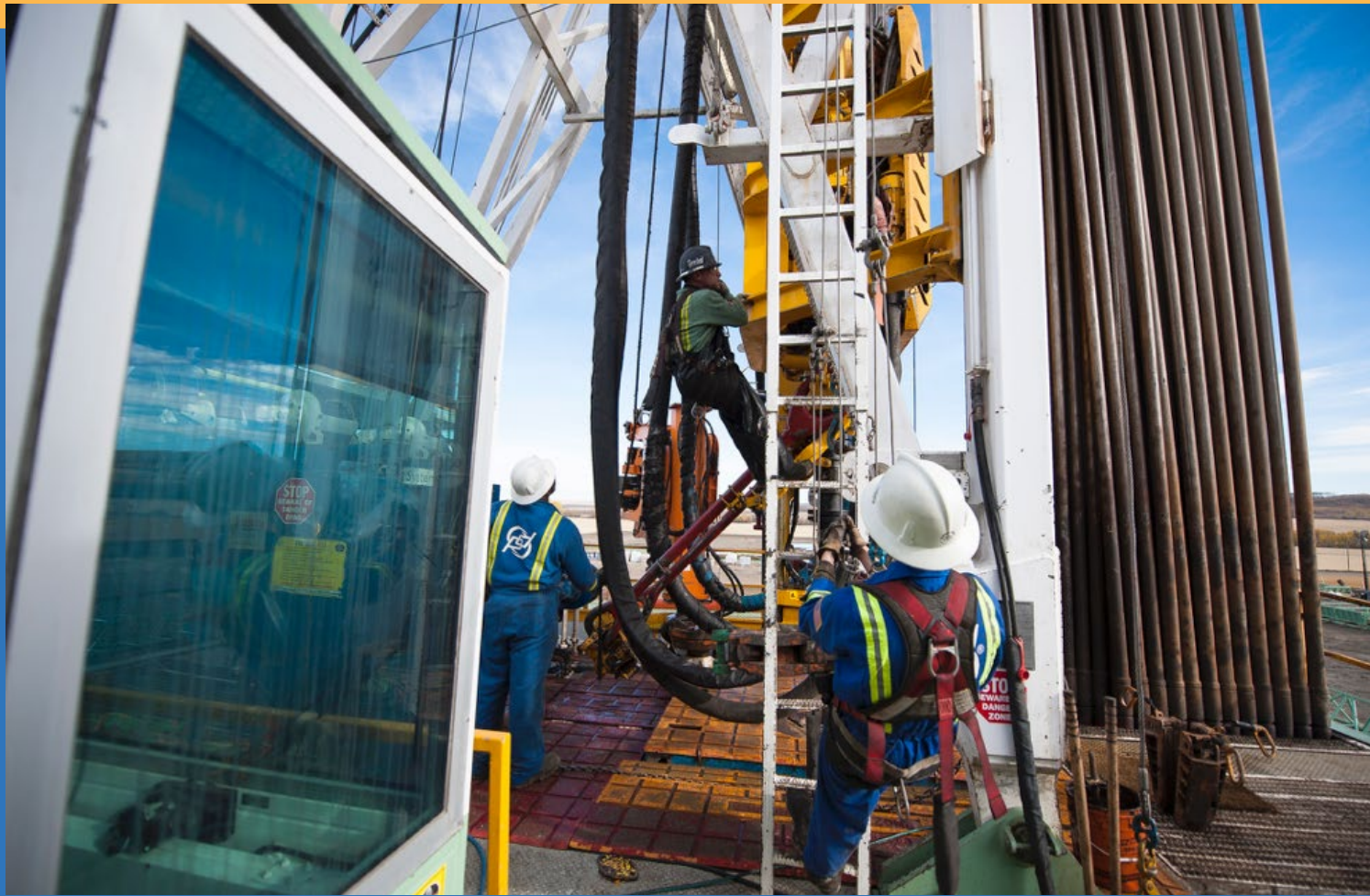
Liquefied natural gas development
a lifeline for Canada's oil and gas
supply chain



CONTENTS

03	Introduction
05	Canadian LNG Projects
07	Opportunities in the EPC and Operations Supply Chain
10	— Sidebar: Integrating Indigenous business into the LNG supply chain
11	Midstream and Upstream Supply Chain Opportunities
13	— Sidebar: Greening the upstream supply chain
14	Petrochemical Spinoffs Drive Additional Potential
17	Building the Domestic LNG Supply Chain
19	Conclusion
	Reference Material
20	Key Canadian LNG Projects
23	Glossary & Conversions
23	Web Resources

INTRODUCTION



The unconventional resource tsunami that swept across North America beginning a decade ago has washed over the Canadian oil and gas landscape, leaving behind a smaller, less secure supply chain.

A flood of U.S. tight oil production upended global oil markets, driving down prices and ending a decades-long wave of oilsands development. Market access issues added to the stress, resulting in oilsands capital expenditures declining by nearly 65% from 2014 to 2019. Operational expenditures declined by around 16% in the same timeframe. As a result, the massive supply chain built up across Canada to serve oilsands operators and to provide materials is in retreat.

A similar rush of shale gas has overwhelmed the North American market, with the U.S. — Canada's traditional export market — now becoming a competitor. Capital expenditures in conventional oil and natural gas exploration and development in Western Canada have declined by almost 60% from 2014 through 2019 as rising U.S. gas production makes headway into traditional Canadian markets.

Old business models have been swept aside as the application of extended-reach horizontal drilling and multi-stage fracturing stimulations has shifted the sector towards a manufacturing model. Development activity has headed west into the prolific Montney and

Deep Basin tight gas plays, and the supply chain has followed.

Old-style drilling rigs were retired, replaced with new high-performance rigs able to efficiently operate on multiwell pads. Fleets of fracturing equipment were built as demand skyrocketed, creating a major shift in the upstream natural gas supply chain. Much of this equipment is now sitting on the fence awaiting a revival in investment.

It hasn't been all bad news. Natural gas liquids production from tight gas plays has enabled some operators to grow revenues and this has kept many in the supply chain working. Petrochemical expansion has provided opportunity for engineering, procurement and construction (EPC) companies.

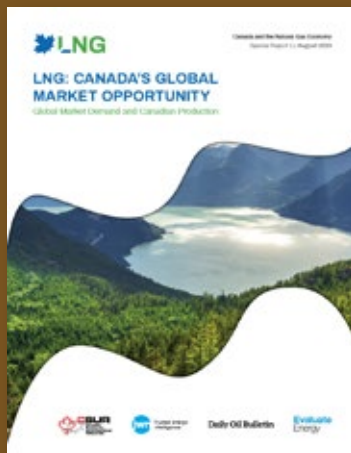
But most companies in the supply chain see the development of liquefied natural gas (LNG) facilities as key to their survival and future growth.

In this special report, we examine how Canadian LNG facilities — as they move forward — are expected to generate opportunities in construction and operations, new pipeline and midstream construction and operations, as well as in upstream exploration and development.

We look at:

- Spinoff opportunities in new petrochemical facilities, and in an emerging domestic distributed supply chain serving remote communities, industrial operations and transportation with LNG;
- The potential for LNG development to be a major driver of jobs in B.C., and even more so in Alberta; and,
- The benefits of integrating Indigenous communities into the LNG supply chain, with a look at how involvement of some bands in Alberta's oilsands can be used as a model of success.

RELATED LNG REPORTS



LNG: Canada's Global Market Opportunity



Canada's Green LNG Advantage



Building Trust: Canadian LNG Developers & First Nations

Canadian LNG Projects

Global demand for cleaner-burning natural gas has created a once-in-a-generation opportunity for Canada to develop an LNG industry.

Canada is the world's fifth largest producer of natural gas, with an estimated 1,225 trillion cubic feet (tcf) of remaining natural gas resources.¹ Alberta and British Columbia, in particular, have vast reserves of natural gas. As of year-end 2018, Alberta had 27.72 tcf of remaining established reserves of marketable natural gas, while B.C. had 41.03 tcf.² At current rates of consumption, however, Canada has sufficient natural gas in the Western Canadian Sedimentary Basin to meet the country's needs for 300 years, with enough remaining for export.³

LNG Canada, backed by Royal Dutch Shell, announced a positive final investment decision (FID) in October 2018 for an export project in Kitimat, British Columbia. Importantly, both LNG Canada and Pacific Oil & Gas' smaller Woodfibre LNG project in Squamish, B.C., have secured long-term buyers.

Both are well placed to serve growing Asian demand for cleaner natural gas to replace coal and are expected to be in operation within this coming decade.

Kitimat LNG is located just down the road from the LNG Canada project. Its operator, Chevron Canada, announced in December 2019 that it plans to exit its entire 50% working interest as part of the global

Canada's LNG Opportunity – Key Projects



¹ National Energy Board (NEB), 2017

² Canadian Association of Petroleum Producers; effective 2010, CAPP Reserves are based on provincial and NEB data.

³ Canadian Association of Petroleum Producers

portfolio optimization effort of parent Chevron Corporation. (See the Reference Material section at the back of this report for updated LNG project details.)

At the other end of the country, Pieridae Energy has proposed an LNG plant at Goldboro, Nova Scotia. The Goldboro project also has a committed buyer. Pieridae would source its natural gas from the Western Canadian Sedimentary Basin via the TC Energy Corporation (formerly TransCanada) mainline pipeline. Two other projects in Eastern Canada are the Bear Head LNG project, also in Nova Scotia, as well as Quebec's Énergie Saguenay project.

In the short-term, all project developers — including those in Canada — are focused one thing: impacts from the coronavirus pandemic. LNG Canada announced in mid-March a temporary reduction of 50% in its workforce of more than 1,000 construction workers in order to “flatten the curve” to deal with a possible outbreak on the site.

In late March, Woodfibre LNG announced a one-year delay on construction of the facility, which was to start this summer. And Pieridae said in mid-April that its FID for the Goldboro project will be delayed beyond Sept. 30, 2020, as a result of a depressed market and COVID-19 impacts.

Selected Key LNG Projects in Western Canada

Project	Owner(s)	Capacity	Capital Cost (billions)	Status
LNG Canada	Shell, PETRONAS, PetroChina, Mitsubishi Corporation, KOGAS	14-28 mtpa 1.9-3.7 bcf/d	\$40	Under construction; completion expected by 2025
Kitimat LNG	Chevron, Woodside Energy	10 mtpa 1.3 bcf/d	N/A	Chevron to exit the project; Woodside seeking to reduce stake
Woodfibre LNG	Pacific Oil & Gas	2.1 mtpa 0.3 bcf/d	\$1.6	Construction delayed to 2021

Selected Key LNG Projects in Eastern Canada

Project	Owner(s)	Capacity	Capital Cost (billions)	Status
Goldboro LNG (Nova Scotia)	Pieridae Energy	5-10 mtpa 0.7-1.3 bcf/d	\$8.3	FID delayed beyond Sept. 30, 2020
Bear Head LNG (Nova Scotia)	LNG Limited	8-12 mtpa 1.1-1.6 bcf/d	\$6	
Énergie Saguenay (Quebec)	GNL Quebec	11 mtpa 1.5 bcf/d	\$7	FID expected in 2020; completion in 2025

Opportunities in the EPC and Operations Supply Chain

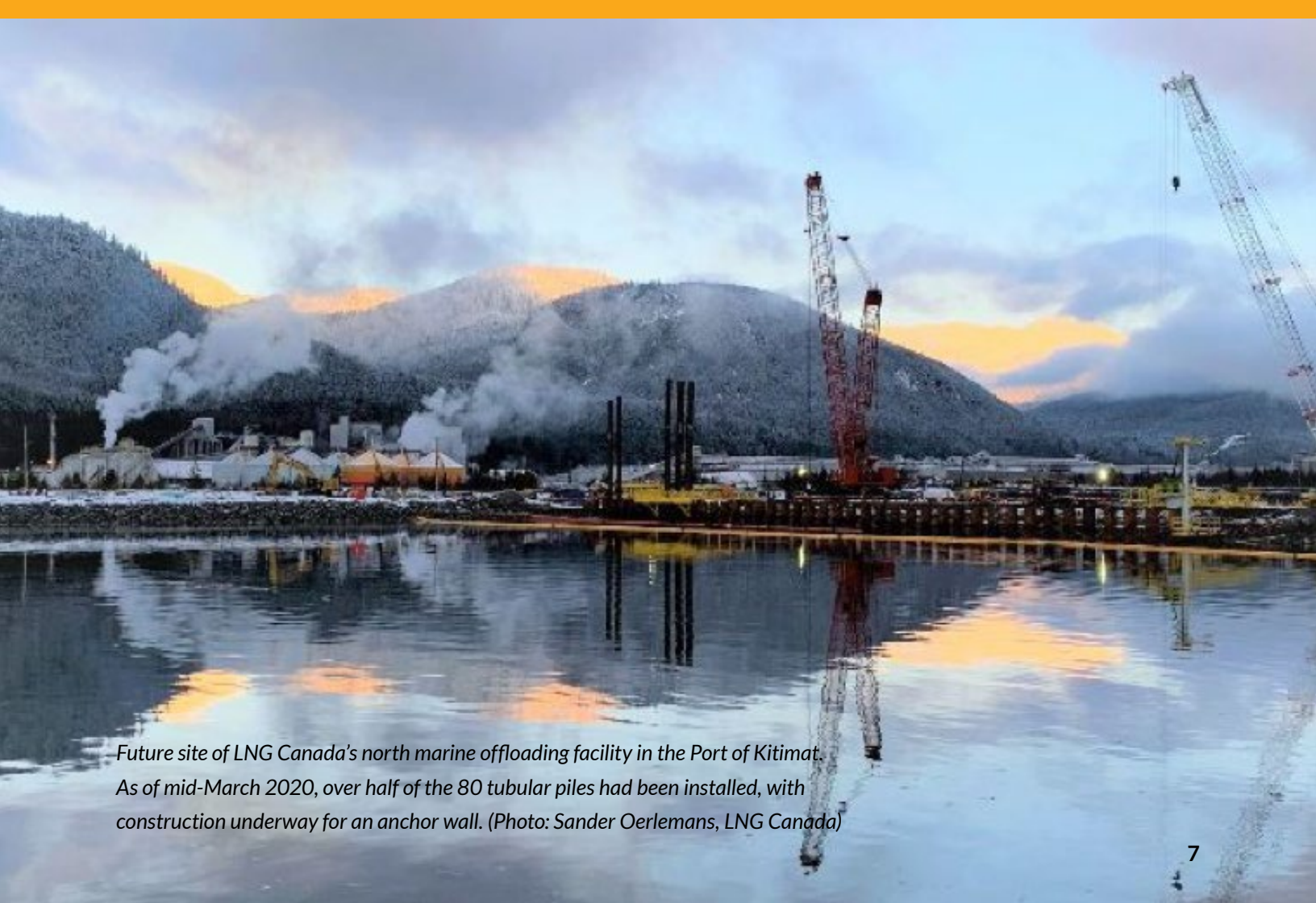
The ongoing construction of the LNG Canada export facility at Kitimat on the B.C. coast and the accompanying Coastal GasLink pipeline project are already providing supply chain opportunities across Canada. But for the supply chain to stabilize and grow in the longer term more facilities are needed.

The estimated cost of construction of Phase 1 of LNG Canada's Kitimat facility, consisting of LNG trains 1 and 2, the marine terminal and port works, is between \$12.9 billion and \$20.6 billion over approximately five years. Add in the expected subsequent two trains and the total

construction cost of full build-out of all four LNG trains would be between \$22.6 billion and \$36 billion.

In its project filings, LNG Canada said it expects between \$10.4 and \$16.6 billion of direct capital expenditures to take place in Canada, representing 46 per cent of total capital costs.

At full build-out, spending on goods and services during construction in Canada is projected to range from \$6.2 billion to \$9.9 billion.



Future site of LNG Canada's north marine offloading facility in the Port of Kitimat. As of mid-March 2020, over half of the 80 tubular piles had been installed, with construction underway for an anchor wall. (Photo: Sander Oerlemans, LNG Canada)

	Trains 1 and 2		Trains 1, 2, 3 and 4	
	Low Cost (\$ millions)	High Cost (\$ millions)	Low Cost (\$ millions)	High Cost (\$ millions)
Direct Labour	1,170	1,820	2,040	3,180
Services	1,870	2,980	3,280	5,220
Goods	1,650	2,650	2,880	4,640

The LNG Canada export facility is expected to operate for more than 25 years. During operation, annual spending on labour, goods and services (other than natural gas) is expected to range from \$548 million to \$791 million. Purchased utilities and repair and maintenance are the two largest costs associated with operation.

LNG Canada is the only large-scale LNG export terminal under construction on the West Coast but other facilities are working their way through the planning and regulatory process towards an FID. These include the proposed Rockies LNG Partnership facility, a future project by Pembina Pipeline Corporation, and smaller

projects including an expansion of the FortisBC Tilbury facility and construction of the Woodfibre LNG facility. At least one of these larger facilities and one smaller facility would need to be built to ensure the long-term sustainability of the construction supply chain.

Three years ago the Conference Board of Canada looked at the investment benefits if two large facilities and one small facility on the West Coast were built that used around five billion cubic feet per day (bcf/d) of gas. It forecast total capital spending on LNG export facilities to come in at over \$50 billion. Annual expenditures would average around \$1.65 billion over the life of the three projects.

PIPELINES PROVIDING OPPORTUNITY

Construction of TC Energy's Coastal GasLink pipeline is also providing ongoing supply chain opportunities. While four large contractors have been hired for the bulk of the work, the \$6.6-billion pipeline running from northeastern B.C. to Kitimat is expected to provide \$1 billion in employment and contracting opportunities to local communities and spend around \$42 million annually in operating costs in local and regional markets.

Meanwhile, Enbridge Inc. also expects to spend heavily in upcoming years if future LNG terminals are built, providing more opportunity in the pipeline supply chain. Enbridge has more than doubled its investment in Westcoast's T-North and T-South lines over the last several years and expects expansions to continue for years to come.

"Our T-North and T-South pipelines are playing a really significant role already by providing upstream transportation for LNG Canada and Woodfibre Squamish," Bill Yardley, executive vice-president and president of gas transmission and midstream, told the company's investor day. "A world-class gas supply and proximity to Asia makes Western Canada ideal for LNG export projects."

Enbridge recently received Canada Energy Regulator (CER) approval for the \$1-billion T-South reliability and expansion project.

"This is a great investment on T-South to serve both growing demand of domestic needs in Vancouver and the Pacific Northwest but also an LNG export market, all under a cost-of-service framework," he said.

“A world-class gas supply and proximity to Asia makes Western Canada ideal for LNG export projects.”

— Bill Yardley, Enbridge

The project is expected to come into service in 2021, about the same time as its \$500-million Spruce Ridge project in T-North, which provides needed access for Montney producers trying to reach export markets, said Yardley.

Another area of focus is the potential Westcoast Gas Transmission Connector pipeline.

“It’s got a nicely-developed route to Prince Rupert, it’s scalable and cost-effective,” he said. “Any of the next phase LNG projects that have Prince Rupert in their sights are talking to us with regard to the Westcoast Connector.”

Overall, Enbridge said it has the potential to deliver around 8.4 bcf/d of capacity if warranted.



EASTERN LNG FACILITIES WOULD SPREAD SUPPLY CHAIN NATIONWIDE

There is also opportunity to grow the construction supply chain to the east if proposed LNG export facilities are built. The Pieridae Energy project, which plans to use gas production from Alberta to feed its export facility at Goldboro, N.S., has signed contracts with a German utility, although it is still working to fund

its project. The Bear Head LNG project in Nova Scotia continues to search for backing. The GNL Quebec LNG project, also projected to export Alberta gas from Saguenay, Que., to overseas markets, is also working to fund its project.

Integrating Indigenous business into the LNG supply chain



Chief Dan George

Integrating Indigenous business into the LNG supply chain is key to getting consent to build projects, and to operate projects successfully.

The oil and gas industry has proven successful in building partnerships with Indigenous companies in Alberta's oilsands region, and that success is being replicated in B.C. with the construction of LNG Canada's export terminal and TC Energy's Coastal GasLink pipeline.

Chief Dan George of the Burns Lake Band and a director of the B.C.-based First Nations LNG Alliance, told a recent National Coalition of Chiefs meeting he thinks the government and industry have learned a lot in the past 10 years and, "things are looking a lot brighter for First Nations throughout the country."

The Alliance negotiated procurement opportunities for every Nation along the Coastal GasLink line with joint venture partners, he said.

"Partnerships are like a marriage and you learn how to make things happen together," said George.

The oil and gas industry has been partnering with Indigenous communities for a long time, but the definition of this is changing, which is "a good thing," said

Chris Bloomer, chief executive officer of the Canadian Energy Pipeline Association (CEPA). "The scope has been changing, the breadth of partnerships has been changing; long-term value creation is happening."

The growing involvement of Canadian First Nations in LNG and other resource development projects is contributing to economic reconciliation, moving them from poverty in many cases to the standard of living enjoyed by a majority of Canadians, a London LNG conference was told.

"To me, that goes, and must go, hand-in-hand with reconciliation, moving Canada forward in a mutually respectful relationship between Aboriginal and non-Aboriginal groups," Karen Ogen-Toews, CEO of the First Nations LNG Alliance, told the conference.

The London event, which provided a special briefing to around 140 European energy investors and stakeholders, was supported by the Government of Alberta, and organized by Glacier Media (the parent company of the *Daily Oil Bulletin*) and the Canadian Society of Unconventional Resources.

First Nations have moved beyond merely having a say in resource projects and signing impact benefit agreements to investing in natural gas and LNG, said Ogen-Toews.

"From coast to coast to coast, First Nations and their people are becoming known as business leaders and as solid partners to non-Indigenous companies," she said. "We have become an important player in the development of natural gas, LNG and other resources in Canada."

Ogen-Toews point to the 900-member Fort McKay band in northern Alberta and its three companies working in the oilsands as a model of success.

"They call it community capitalism," she said.

Midstream and Upstream Supply Chain Opportunities

The big question with many in the oil and gas supply chain is what impact LNG development will have on exploration and development spending.

The answer is it depends on whether LNG Canada is a one-off or the start of a new industry.

Most of LNG Canada's partners already have gas production up and running, and are expected to use their own production to supply the export facility. Shell Canada, with 40% ownership in LNG Canada, has over 500 wells in production at Groundbirch in the Montney.

Shell expects it will need to drill about 20 to 30 new wells each year over two years to meet additional demand from LNG Canada and to replace production from some of the wells whose production will have declined leading up to exports from LNG Canada. From then on, the LNG Canada partners will need to drill about 200 new wells per year for the life of the LNG plant.

However, if a second large terminal and small terminal were built, the facilities would require significantly more investment and drilling, according to the Conference Board of Canada. To provide five bcf/d of gas supply, annual investment would be around \$5 billion for the first decade as the facilities came onstream. These investments would put in place the wells, gathering systems and field processing facilities, as well as the pipeline fuel required for the transmission lines. In addition, because tight gas wells show high initial production rates but very steep initial decline rates, significant long-term drilling activity will be required to maintain the targeted production level.

Expected drilling levels to support five bcf/d of liquefaction capacity are 600 wells per year for the initial phase building up to exports, followed by 510 wells per year in the longer term.

The impact on the supply chain from this increased drilling would be significant. A minimum of 44 individual and unique drilling, service and supply companies



Shell's Groundbirch operations. Image: Shell Canada

(assuming all rental equipment comes from one vendor, which is not likely to be the case) are contracted through the course of the drilling and completion process, employing personnel with 25 unique skill sets based on education, vocation and years of experience in various elements of the wellbore construction, completion and production process, according to the Petroleum Services Association of Canada's Horizontal Well Workforce Study.

Completing an LNG project would remove some of the current uncertainty in natural gas supply chain, according to Irwin Fritz, Grande Prairie district manager for Calfrac Well Services Ltd.

"It's about five years too late, but the potential for being a positive to our business as well as our community for the future will be very good," Fritz said at a recent Alberta government-supported conference in Grande Prairie. "It's a little behind schedule. That's all."

McElhanney Geomatics Engineering Ltd., which has an office in Grande Prairie, is already heavily involved in surveying, engineering and environmental work for both upstream and midstream activity. John Haggerty, senior project manager, said that additional regional natural gas projects resulting from LNG developments would have further real and direct benefits, both near-term and long-term, for his company.

"My hope is that our greatest challenge will be in finding the competent and experienced people to do the work well," he said, adding successful completion of an LNG project would support Grande Prairie specifically

(province and country more generally), starting at construction for actual LNG infrastructure, as well as the added drilling and related activities needed to supply the project with natural gas.

Midstream operators are also pinning their hopes on West Coast LNG to build out infrastructure. David Smith, president and chief executive officer of Keyera Corp., told a recent conference that LNG development on the West Coast will be a "big shot in the arm" for natural gas producers and ultimately would create opportunities upstream for natural gas processing, transportation and fractionation. Smith said he sees a

lot of opportunity in northwest Alberta and northeast B.C. over the next 10 to 15 years, in the growth in both natural gas and liquids production.

East Coast projects will also have a major impact on upstream activity. The Pieridae project is expected to source around 800 million cubic feet per day (mmcf/d) from Alberta's conventional

gas fields to supply its Nova Scotia facility. GNL Quebec's Énergie Saguenay project will ultimately require around 1.8 bcf/d of Alberta gas. Bearhead LNG would require 1.75 bcf/d of Alberta gas.

McElhanney's Haggerty said these upstream and midstream opportunities should only be seen as a start.

"If we are really smart, we will capitalize on the potential downstream opportunities such as liquids and plastics upgrading and manufacturing," he noted. "This would be a novel move for Grande Prairie, but I have always been confident in the entrepreneurial spirit of this place."

"If we are really smart, we will capitalize on the potential downstream opportunities such as liquids and plastics upgrading and manufacturing. This would be a novel move for Grande Prairie, but I have always been confident in the entrepreneurial spirit of this place."

— John Haggerty, McElhanney

Greening the upstream supply chain

As the upstream natural gas supply chain moves towards a manufacturing process, environmental sustainability is being built into developments. This is shifting the types of services required by operators.

Tourmaline Oil Corp. provides an illustration of this shifting supply chain.

Tourmaline has designed and constructed massive water infrastructure at its vast operations in the Deep Basin and Montney natural gas plays designed to increase the amount of recycled water used in fracking, as well as to reduce and eventually eliminate the need for fresh water.

To create the water infrastructure, the company has created a supply chain to build a series of pipelines, pumps, headers, controls, filters, heaters, temporary storage, and flowback ponds that facilitate recycling over 95% of the produced and flowback water at Tourmaline. The infrastructure is now at a size that has allowed the company to recycle third-party water from other producers, with over 50,000 m³ of third-party recycling in 2019.

But it has also had impacts on the existing supply chain as it reduces the need for water disposal, and keeps thousands of water transport trucks off the roads.

Tourmaline is also working to displace the use of diesel fuel with its own natural gas in its operations, again resulting in a supply chain shift.

Tourmaline's entire fleet of 11 drilling rigs now run bi-fuel natural gas, all its boilers run natural gas, and all its frack fleets are bi-fuel natural gas. It has two completions natural gas turbines, two natural gas portable generators, one highline powered drilling rig, and it is building a highline completions transformer skid. With clean-burning natural gas electrical generation on site, it has been able to convert diesel-fired light towers, derrick lights, pumps, heaters and shacks to electric, and completely eliminated several diesel engines from some locations. The gas is supplied to drilling and completions via wellhead or bi-directional pipeline infrastructure and 15 Tourmaline-owned fuel scrubbing/gas conditioning skids. With this system it can displace over 9.8 million litres of diesel fuel annually. The system has had a significant environmental benefit through switching to lower carbon fuel and by removing over 500 fuel truck loads annually off the roads.

The company is now funding clean-tech innovation such as natural gas hybrid drilling rigs, compressed natural gas mobile power generation, natural gas light/heavy haul transportation solutions, and completions electrification.

Tourmaline has collaborated with numerous service companies including Flex Turbine, Precision Drilling, Nabors Drilling, Ensign Drilling, Zedcor Energy, Trican, Calfrac, Caterpillar and more to build this new natural gas based supply chain.



Tourmaline constructed and now operates produced water pipeline infrastructure that facilitates its extensive water recycling program. Image: Tourmaline

Petrochemical Spinoffs Drive Additional Potential



Moving the purge bin for Inter Pipeline's Heartland Petrochemical Complex. Image: Inter Pipeline

LNG exports off the West Coast could double Alberta's petrochemical output and create tens of thousands of jobs, according to an energy diversification report presented to the provincial government in 2018.

"If West Coast LNG becomes a reality, the Alberta petrochemical industry could double its output in 20 years. Without West Coast LNG, the potential for petrochemicals growth is cut in half, as the methane has to be sold into domestic markets," reads Alberta's Energy Diversification Advisory Committee report. "The committee strongly urges the Alberta government to make West Coast LNG a priority by working closely with the B.C. and Canadian governments and industry to ensure proponents and the regulatory environment are ready for the next time the global LNG window opens."

Gil McGowan, president of the Alberta Federation of Labour, was one of the committee's co-chairs. He said that over the course of 20 years, the LNG Canada

facility could create as many as 100,000 jobs.

"It'll create all sorts of jobs in B.C., but it has the potential to create more in Alberta," McGowan said.

Driving the growth in petrochemicals will be increased production natural gas liquids (NGLs) like ethane, propane and butane from the liquids-rich Montney resource play straddling the border of Alberta and B.C. as companies drill to fill the LNG export pipeline.

"And that's the link to LNG," David Chappell, senior vice-president, Petrochemical Development at Inter Pipeline Ltd., told an Alberta government-supported LNG conference in Calgary. "When you produce a lot of methane, you get a lot of NGLs so any way you can strengthen the wellhead is going to strengthen this industry."

Inter Pipeline's Heartland Petrochemical Complex — built in Strathcona County, Alta., near the company's

existing Redwater Olefinic Fractionator — will be Canada's first integrated propane dehydrogenation (PDH)-polypropylene (PP) facility. The project is designed to consume approximately 22,000 bbls/d of locally-sourced, low-cost propane to produce approximately 525 kilotonnes per annum of polypropylene, a high-value, easily transported plastic used in the manufacturing of a wide range of finished products. It will be the first petrochemical plant in North America — and possibly in the world — to take a fee-for-service type of approach, said Chappell.



Construction at Inter Pipeline's Heartland Petrochemical Complex. Image: Inter Pipeline

Most producers who produce a mixture of natural gas liquids at the well don't have their own fractionators so they look to a fractionator who turns their mixture into a pure product and sells it on the producers' behalf for the price they opt for, said Chappell. "This is the same thing but we are taking that propane one step further, turn it into polypropylene and sell it on their behalf."

What that means is the propane producer is getting a much higher value for their propane, he said. "Using historic numbers — and the forecast looks very good too — over the past five years if producers had signed up

with us, they would have more than doubled their price compared to Edmonton."

This increased cash flow could be re-invested in upstream activity.

There are a number of other products such as methanol and ethane that share similar economic characteristics as what Inter Pipeline is doing at the Heartland project, the conference heard.

"There's a lot of ethane in this province and we are getting gas value for it," said Chappell, who believes there's enough ethane for two more world-scale ethane crackers.

"More ethane plants and derivatives plants would be great for the province," he said.

Inter Pipeline is halfway through the construction of the Heartland project, which is scheduled to start up in late 2021 and is still on schedule and on budget. "It's a great time to be building in Alberta because there's not an awful lot being built but we made a conscious decision to build in Alberta with all the fabrication and steelwork," said Chappell.

While it looked like it was cheaper to go offshore, "we didn't do that and we are really happy about that," he said. The decision "paid off in spades" with the quality of the work and the ability to inspect, the conference heard. Inter Pipeline also will receive up to \$200 million in royalty credits under the Alberta government's Petrochemicals Diversification Program when the project is complete.

"If West Coast LNG becomes a reality, the Alberta petrochemical industry could double its output in 20 years. Without West Coast LNG, the potential for petrochemicals growth is cut in half, as the methane has to be sold into domestic markets."

— Alberta's Energy Diversification Advisory Committee report

There are a number of other projects under way to leverage increasing liquids production, although the COVID-19 pandemic is stalling progress temporarily. Pembina Pipeline is planning to expand its Prince Rupert propane export terminal to increase capacity to 40,000 bbls/d. Pembina is also working to expand its ethane extraction infrastructure to provide over 100,000 bbls/d of incremental ethane transportation to the Edmonton area, much of which may be sourced from existing or future Pembina facilities. This opportunity aligns with customers' needs and the Government of Alberta's goal to provide a made-in-Alberta petrochemical solution resulting in significant investment and long-term employment for thousands of Albertans, said the company.

AltaGas Ltd. is also expanding its propane export facilities to reach over 50,000 bbls/d, with an ultimate goal of exporting 80,000 bbls/d.

Meanwhile, in February 2020, the Alberta government signed a memorandum of understanding with Tri-Municipal Industrial Partnership in order to co-ordinate development of a new "eco-industrial area" in the Municipal District of Greenview. Serving as a "global energy and petrochemical-manufacturing hub," the district is situated on the Montney formation.

Fact box: Petrochemical Opportunities

Ethane

Alberta already has a world-class ethane-processing cluster that produces ethylene, polyethylene, linear alpha olefins and ethylene glycol. Feedstock supplies can be procured by stripping more ethane from existing natural gas exports and domestic consumption. A greenfield ethane cracker and associated derivatives facilities would cost between \$8 billion and \$12 billion, require 80,000 to 100,000 bbls/d of feedstock, and take seven to nine years to plan, permit and build. Most ethane derivatives demand is in various types of polyethylene, and this demand is expected to grow as much as 5.7% annually.

Propane

Alberta has a large surplus of cheap propane. A greenfield world-scale propane dehydrogenation facility/polymerization unit would cost \$3 billion to \$5 billion; planning, permitting and construction would take five to six years; and the facility would consume 22,000 bbls/d of propane. Most global propane demand is for the production of polypropylene, and this demand is expected to grow 4.6% annually.

Methane

A greenfield, world-scale methanol plant would cost \$900 million to \$1.5 billion and consume 0.1 bcf/d of methane. Planning, permitting and construction would take five to six years. Global methanol demand, led by China, is expected to grow at 4.5% a year. Key commercial growth opportunities in the methane space other than methanol include producing electricity, ammonia and urea.

Source: Alberta's Energy Diversification Committee Report, 2018

Building the Domestic LNG Supply Chain

While many Canadian LNG projects have focused on large-scale exports, there is also a tremendous opportunity at home for LNG to replace diesel in remote power generation and in onshore and offshore transportation.

Tom Elwell, chief executive officer of Kate Energy Holdings Inc., which invests in and operates power generation projects for industrial projects (such as mines) and remote communities in northern Canada, said the market for distributed LNG to replace diesel use in Canada is large.

Elwell noted that there are 300 remote communities in Canada that use 340 million gallons of diesel fuel annually for power generation.

Of mines proposed or in operation, 4,300 megawatts of power a day is to be generated or is being generated, which equates to about 2.1 billion gallons of diesel a year, he said. “That’s a tremendous opportunity for those who want to focus inward on distributed LNG in

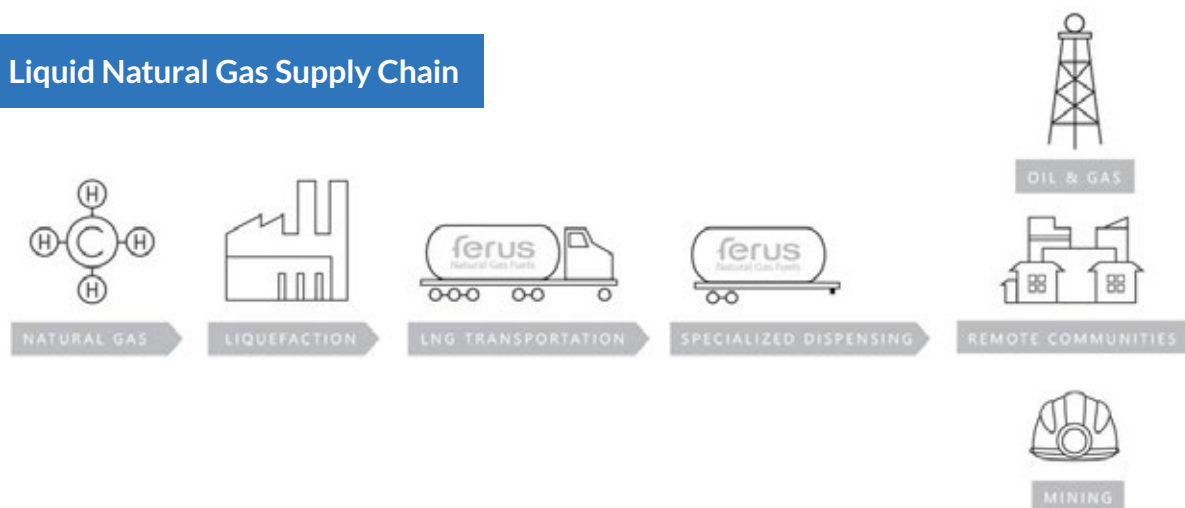
Canada for the purpose of power.”

Ferus Natural Gas Fuels and Kate Energy are building out the supply chain to meet this need in Western Canada. Ferus has two LNG plants in operation, one in Alberta and one in B.C., already supplying communities and industry.

In Quebec, work is under way to build out a distributed LNG supply chain to meet this domestic demand. Énergir, Quebec’s main natural gas distribution company, is trucking LNG to remote industrial operations and communities, said Guillaume Brossard, director of development & LNG at a recent Alberta government-supported LNG conference in Toronto. “There’s a lot of these remote regions in the province of Quebec that are not served by our gas pipeline distribution system.”

Énergir delivers LNG by truck within a 1,500-kilometre radius of its plant, including to some power plants in the United States where LNG is used for peaking demand.

Liquid Natural Gas Supply Chain



Source: Ferus Natural Gas Fuels



Use of LNG for completions operations. Image: Ferus Natural Gas Fuels

The company recently signed a deal with Seven Generations Energy Ltd., which will supply it with 500 mmcf/d to 600 mmcf/d of “responsible” natural gas as certified by a third party.

The maritime industry also offers potential for LNG and Énergir provides LNG solutions in the ports of Montreal and Quebec. Énergir recently completed its 100th bunkering of LNG as a marine fuel replacing marine diesel. In Quebec, there currently are eight vessels — three ferries and five boat carriers — running on LNG.

“It’s a growing market; it’s not an easy market because infrastructure is a big challenge,” Brossard said.

However, LNG can be delivered closer to end users, reducing costs and emissions related to the transportation, said Stéphane Boyer, chief executive officer of Distributed Gas Solutions Canada (DGSC), and deputy director-general of Hydroméga Services Inc. of Montreal, which develops and operates clean energy projects.

Hydroméga has partnered with DGSC to build out the supply chain to bring distributed LNG or compressed natural gas (CNG) production to the Canadian market. Other partners are Quebec-based Group Desgagnés Inc., Canada’s only maritime company to use LNG for fuel, and Galileo Advanced Solutions, a United States-Argentinean partnership brought in to develop the

business model of bringing LNG, using liquefaction or compression, to deliver natural gas to end users through the distributed model.

“It’s actually a network of distributed compression and liquefaction and micro-liquefaction stations as close as possible to end users,” said Boyer. “They can be located at the end of the pipeline or on the wellhead.”

The product is then delivered to the end user by truck, pipeline, train or ship.

Potential markets include mines, LNG-capable marine vessels, heavy-duty vehicle fleets and rail locomotives as well as off-grid power generation and micro grids, he said. Distributed scaleable, pre-fabricated modular packages are easy and fast to deploy — about 18 months from the start of an environmental study to coming online, with annual production of 300 mmcf to 10 bcf.

The micro-liquefaction approach is a reliable and proven solution that Galileo has demonstrated in Argentina, Colombia, the Marcellus and North Dakota, according to Boyer.

DGSC and others in the distributed LNG market have to establish themselves as a proven and reliable solution, he said. “We are a good source of income for natural gas producers; we are a potential outcome to produce that LNG and CNG and convert end-users.”

CONCLUSION



Declines in capital investment in Canada's oil and gas industry, combined with technological changes, have had a negative impact on the oil and gas supply chain since the oil price collapse in late 2014. Opportunities for EPC companies have diminished as oilsands construction has wound down. Opportunities for oilfield services companies have also disappeared as U.S. shale gas production has taken market share, resulting in less exploration and development spending in Canada.

The development of an LNG export industry promises to reverse this trend, creating opportunities across the supply chain to put companies back to work or expand operations. There are also potential spin-off opportunities as increased demand for natural gas drives NGL production that could feed new petrochemical facilities.

An emerging domestic LNG industry is also building momentum, providing opportunities for increased

upstream activity and the development of a downstream distributed supply chain to power remote communities, remote industrial operations, and marine and heavy-duty transport vehicles.

However, with only one large LNG export facility under construction this opportunity remains limited. At least one more large facility and a smaller facility on the West Coast are needed to generate sustainable upstream activity to encourage supply chain growth and more petrochemical diversification.

Further expansion in Eastern Canada could build on this effort, providing even more upstream exploration and development opportunities.

For this to happen, however, Canada must prove it can move projects through its regulatory process and industry must prove it can compete in global markets to attract capital back to the country.

REFERENCE MATERIAL – KEY CANADIAN LNG PROJECTS

1. LNG Canada

- Location: Kitimat, B.C.
- Proponents: A joint venture comprised of Royal Dutch Shell plc, through its affiliate Shell Canada Energy (40%); PETRONAS, through its wholly-owned entity, North Montney LNG Limited Partnership (25%); PetroChina Company Limited, through its subsidiary PetroChina Canada Ltd. (15%); Mitsubishi Corporation, through its subsidiary Diamond LNG Canada Partnership (15%); and Korea Gas Corporation, through its wholly-owned subsidiary Kogas Canada LNG Ltd (5%).
- Capacity: The project will initially export 14 mtpa, the equivalent of about 1.8 bcf/d, from two processing units. At full build out, LNG Canada will have four trains or processing units, each with the capacity to process approximately 7 mtpa of LNG for export to countries in Asia and elsewhere.
- FID: A final investment decision was made for the first two trains on Oct. 1, 2018
- Anticipated onstream date: 2025
- Associated infrastructure: The 670-kilometre Coastal GasLink (CGL) pipeline will connect natural gas from northeast B.C. to the export plant.
- Regional economic benefits: 4,500 people employed at peak construction on the Kitimat site.
- Recent announcements:
 - In March 2020, due to COVID-19, LNG Canada announced it was reducing its workforce of about 1,750 at Kitimat site by about half, as it stopped using fly-in workers. It has since said its on-site workforce has been reduced by about 60 per cent.
- In December 2019, TC Energy announced an agreement to sell a 65% equity interest in the Coastal GasLink pipeline project to KKR and Alberta Investment Management Corporation (AIMCo) on behalf of certain AIMCo clients. TC Energy will hold a 35% limited partnership equity interest and will be contracted by the limited partnership to construct and operate the pipeline.
- In November 2019, TC Energy increased to estimated cost of CGL to \$6.6 billion from \$6.2 billion due to increased scope and the refinement of construction estimates.
- In September 2019, LNG Canada prime contractor JGC Fluor awarded Clough PPM the EPC for the project's loadout line trestle.
- In June 2019, the federal government said it will spend \$220 million to help fund energy-efficient gas turbines and another \$55 million to replace a bridge for the project.
- In April 2019, the LNG Canada project owners officially hand over construction management to their prime contractor, JGC Fluor.
- In January 2019, LNG Canada approved \$937 million in contracts and subcontracts to First Nations and Canadian businesses.
- More details: <https://www.lngcanada.ca/>

2. Kitimat LNG

- Location: Bish Cove, near Kitimat, B.C.
- Proponents: The proposed project is a 50/50 joint venture between Chevron Canada Limited and Woodside Energy International (Canada) Limited. Chevron is looking to sell its entire equity position; Woodside wants to reduce its stake (see below for recent announcements).
- Capacity: The Kitimat LNG plant includes up to three LNG trains totalling 18 mtpa (6.0 mtpa/train. The initial foundation project consists of two trains (12 mtpa).
- Anticipated FID: 2022 to 2023
- Construction of Phase 1: 2022/23 to 2028/29; commissioning of first LNG train begins after construction is complete; commissioning of second LNG train begins three weeks after the commissioning of the first train; construction and commissioning of the third LNG train as market conditions allow.
- Associated infrastructure: The 471-kilometre Pacific Trail Pipeline (PTP).
- Regional economic benefits: At peak construction of the LNG facility, it is estimated that more than 3,000 people would be working on the Kitimat LNG plant site with another 1,500 workers building PTP. In addition, Kitimat LNG has a benefits agreement with the Haisla Nation for the plant, which is located on Haisla Nation Reserve land, and an agreement with all 16 First Nations along the proposed PTP route through the First Nations Limited Partnership (FNLP)
- Recent announcements:
 - In December 2019, Chevron Canada announced plans to exit its entire 50% working interest, and to solicit expressions of interest for its share of the project. No timeline has been set to conclude this process.
 - In December 2019, Chevron Canada announced the successful completion of a major milestone in the Kaybob Duvernay program following the start of first production from its East Kaybob development pads in west-central Alberta. The milestone was achieved in October 2019.
 - In September 2019, Woodside said it was seeking to reduce its stake in the Kitimat LNG project to cut its capital exposure.
 - In July 2019, in an NEB filing, the proponents said supply will come from the equity gas resources of Chevron and Woodside held together in the Liard Basin, Chevron's equity gas resource in the Kaybob Duvernay resource and, if needed, from other contingent and prospective resources, and open market purchase or swaps made in WCSB market hubs.
 - In July 2019, the project proposed to become an all-electric plant that will be powered by hydroelectricity from BC Hydro. In July, the proponents also proposed a third train for the project.
- More details: <https://canada.chevron.com/our-businesses/kitimat-lng-project>

3. Woodfibre LNG

- Location: Squamish, B.C.
- Proponents: Woodfibre LNG Limited is a subsidiary of Pacific Oil & Gas Limited (PO&G), part of the Singaporean conglomerate RGE.
- Capacity: The project is licensed to export about 2.1 mtpa for 40 years.
- Anticipated FID: Projected dates will be announced after a construction agreement is finalized.
- Anticipated onstream date: TBD.
- Associated infrastructure: The project will receive natural gas from the Eagle Mountain – Woodfibre Gas Pipeline (EGP) Project.
- Regional economic benefits: 650+ jobs at peak construction; 100+ jobs at Woodfibre site; 1,410+ additional indirect or induced jobs during construction or at the site thereafter.
- Recent announcements:
 - In March 2020, Woodfibre LNG announced that uncertainty and work stoppages caused by COVID-19, such as the shutdown of a fabrication yard in China that was making product for the facility in Squamish, has forced the company to delay the construction start. Construction, expected to begin in the summer of 2020, is now expected to start in the summer of 2021.
- In October 2019, Woodfibre LNG filed a proposed amendment to the project's Environmental Assessment Approvals. The amendment seeks approval to house construction workers in a floating worker camp located just offshore at the project site. The proposed "floatel" would have the capacity to house a majority of workers during the facility's construction phase.
- In July 2019, the BC Oil and Gas Commission approved Woodfibre's permit for its export facility.
- In June 2019, Woodfibre said that BP Gas Marketing Limited had agreed to buy 0.75 mtpa of LNG for 15 years starting in 2023.
- In May 2019, PO&G said it is acquiring all of the issued and outstanding shares of privately-held Canbriam Energy Inc. and its Montney assets.
- More details: <https://www.woodfibrelng.ca/>

4. Goldboro LNG

- Location: Goldboro, N.S.
- Proponents: Pieridae Energy (Canada) Ltd.
- Capacity: up to 10 mtpa
- Anticipated FID: 2020
- Anticipated onstream date: Commercial deliveries of gas to Uniper are expected to start between Nov. 30, 2024, and May 31, 2025.
- Associated infrastructure: The facility is located adjacent to the Maritimes & Northeast Pipeline, a 1,400-kilometre transmission pipeline system built to transport natural gas between developments in Nova Scotia, Atlantic Canada and the northeastern United States.
- Regional economic benefits: Construction phase – up to 3,500 jobs at the Goldboro site; ongoing operation and maintenance – up to 200 positions.
- Recent announcements:
 - In April 2020, Pieridae announced an FID for the Goldboro project will be delayed beyond Sept. 30, 2020, as a result of a depressed market and COVID-19 impacts.
 - The company also said in April 2020 that it was in discussions with different levels of government on how the project could benefit

from infrastructure funding that might become available with the restart of the national economy after the coronavirus pandemic.

- In December 2019, Pieridae announced a pre-FID budget of \$32 million for 2020, and a development expense budget of \$16 million for Goldboro LNG.
- In October 2019, Pieridae closed its acquisition of all of Shell Canada Energy's midstream

and upstream assets in the southern Alberta Foothills for \$190 million. Pieridae signed the purchase and sale agreement with Shell Canada Energy in June 2019. Shell Canada will take an equity stake in Pieridae.

- In July 2019, Pieridae said it has negotiated extensions of the key deadlines under its 20-year agreement with German utility Uniper.
- More details: <http://goldborolng.com/>

Glossary & Conversions

mmcf/d = million cubic feet per day

bcf/d = billion cubic feet per day

tcf = trillion cubic feet

bcm = billion cubic metres

mtpa = million tonnes per annum

1 bcf/d = 7.55 mtpa

1 mmcf/d = 0.267 mtpa

1 cubic metre = 0.0007 tonnes

Web Resources

Canadian Society for Unconventional Resources

JWN Energy

Daily Oil Bulletin

Evaluate Energy

Alberta government - Natural Gas

B.C. government - Natural Gas & Oil

