

Galicia Spirit, one of a fleet of LNG carriers owned by Canada-based Teekay Shipping, would be used for LNG export facilities on British Columbia's remote north coast.



MOVING TARGET

LNG prospects in Canada as
developers look to open new markets

By K. Joseph Spears and Marcel LaRoche



Modern shipping carries 90% of world trade. Some 10% of global natural gas, in the form of liquefied natural gas (LNG), is moved by sea, and this will increase as new export markets develop. Canada, a major natural gas producer, is poised to be an LNG exporter as it seeks to develop large reserves of unconventional natural gas through new technologies. These involve both horizontal drilling and fracking, a technique using liquids and a proprietary mix of chemicals to release natural gas in tight sedimentary formations that previously were not commercially feasible to recover. These new extraction methods, along with a robust approach to risks taken by exploration companies, have increased the recoverable supply of natural gas in Canada and the United States.

With these increased natural gas reserves, the U.S., Canada's traditional export market, has less appetite for Canada's abundant energy exports. These new unconventional hydrocarbon reserves

in the U.S. have impacted both oil sands development and the natural gas sector. Previously, the U.S. was seen as the sole export market well into this century. Decreased U.S. demand, among other factors, has had Canadian gas producers looking closely at the development of overseas export markets, mostly in the Indo-Pacific (India, China, Japan, Taiwan, and Korea). Presently, a higher price can be obtained in these new markets than in the existing continental North American energy market, where natural gas sells for C\$3 (US\$2.75) per MBtu (one thousand British Thermal Units), compared to C\$18 (US\$16.50) per MBtu in the Indo-Pacific market, a \$15 price spread.

The Indo-Pacific market requires specialized LNG carriers in the transportation chain. In the case of Japan and Korea, there is no overland pipeline and the LNG carrier is the only means to move the commodity. In many cases, Canadian producers have partnered with major global energy firms and natural gas companies to move these proposed projects forward. Individual project capitalization can exceed C\$36 billion (US\$33 billion) per project. Presently, Canada has no existing marine natural gas export facilities and does not export LNG by sea. Our goal here is to provide marine design professionals with an overview of this dynamic and changing opportunity in Canada's LNG sector, which is being impacted by a variety of global factors at this early phase of project development. There are many pressures, and this new sector has the opportunity to create marine design challenges and opportunities.

Predicting the future of Canada's LNG projects is very much a moving target, with each individual project having many moving parts and approvals needed to bring natural gas from remote interior gas fields to tidewater liquefaction plants. As has been seen with recent geopolitical developments, trade embargos against Russia, which historically has exported natural gas to Europe, could open up natural gas export opportunities for Canada in the European Union. To say the LNG market is in a state of flux is an understatement. Any export from continental North America would involve the liquefaction of the natural gas to LNG at a marine terminal and transport in dedicated LNG carriers. LNG carriers are complex vessels and are an integral part of the supply chain of new Canadian natural gas export development. Presently, there are 75 new builds on the order book for 2017 for LNG carriers.

Natural gas has been produced in Canada for decades. Historically, most of Canada's production went to the United States via overland pipelines (which don't require liquefaction of the natural gas) from the western sedimentary basin that encompasses Alberta, Northern British Columbia, and Saskatchewan to markets throughout continental North America (including both Eastern Canada and the United States). The development of new, unconventional natural gas reserves has greatly altered Canada's existing export opportunities in a few short years. The U.S. now has ample energy reserves; therefore, there is less demand for Canada's energy exports, which was the foundation on which Canadian producers relied.

The U.S. is no longer a net energy importer. It is now an energy exporter. Canada's natural gas in the continental North American market has sold well below global rates, which have been pegged to world oil prices, thus presenting another reason to seek new export markets and a higher price for the commodity. But even that price spread has been shifting downward as new global supply sources come online, with increased supply lowering long-term prices in the Indo-Pacific market.

Liquefaction need

Traditional pipelines cannot be used to supply markets around the Indo-Pacific, so natural gas must be liquefied into LNG for marine shipment, which decreases the volume approximately 600-fold. The natural gas is cooled to a liquid state for shipment, which involves a great deal of energy to cool it down to -162°C . Normally this liquefaction process is done using energy-intensive natural gas powered electrical plants. In the case of British Columbia, one thought is to make use of abundant hydroelectric power to cool the gas into a liquid form. The use of renewable hydro energy is seen as a selling point for sustainable energy for "green gas." The natural gas in liquid form is then delivered using specialized LNG gas carriers employing sophisticated insulated containment and gas management systems to keep the gas cool. It then enters the landward distribution system at the final destination.

The development of the cooling facilities (called liquefaction trains) and necessary shore-side infrastructure, along with the specialized vessels, is a very costly and capital-intensive process. There are a lot of variables for an LNG project proponent in making a final investment decision. Normally, these projects proceed based upon a stable long-term supply contract given the capital investment required. This is what all projects are seeking. LNG does not normally trade on the spot market like crude oil. The price of the natural gas is a key component in this investment decision, along with any proposed tax or levy on this new activity. (British Columbia has not announced its tax regime on LNG.) What we are seeing is the commodity price outside North America coming down as new LNG supply comes on the global market. There is no longer the wide price spread that existed a few years ago. Analysts indicate that the price of LNG will continue to drop and have an impact on Canada's LNG developments,



which may not become economically feasible at this time. It is believed that most Canadian LNG projects can run on a price of C\$10 to \$13 (US\$9 to \$12) per MBtu.

Canadian producers have entered into joint venture and project partnerships and sought regulatory export approval for

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15 proposed projects on Canada's west coast. These export projects would use new unconventional natural gas reserves in the Horn River Basin, and in Cordova and Montney shale reserves in northeast British Columbia near Fort Nelson abutted against the Northwest Territories/Alberta border. Horn River, the largest shale gas field in Canada, is estimated to contain 250 trillion cubic feet. These new greenfield projects also would require pipeline infrastructure across a number of mountain ranges to link these

Carriers such as this Shell Moss type LNG carrier will become frequent visitors to Canadian waters. At present, they're seen only in east coast waters at St. John, New Brunswick and the Bay of Fundy.



remote gas fields to tidewater access with export facilities proposed at both the ports of Kitimat and Prince Rupert.

A smaller export project is proposed for Howe Sound, just north of the Port of Vancouver, using a former pulp facility, which is in close proximity to an existing natural gas pipeline. Whether all these Canadian LNG projects come to fruition remains to be seen. Some analysts indicate likely there will be two major projects on the north coast of British Columbia and a few smaller projects that are focused on fulfilling the requirements of niche markets.

In addition, on Canada's east coast, an LNG export facility is proposed at Golboro Guysborough County, Nova Scotia (where offshore Sable Island natural gas comes ashore), which has an existing natural gas pipeline. Indian interests have been pursuing an LNG export facility in Melford on the Strait of Canso, Nova Scotia. These facilities with deepwater access could service Europe and the Far East and, in particular, India. In fact, India is closer to Canada's east coast via Suez Canal than Canada's west coast, and the Suez Canal is slated for expansion. Developments in Russia also could see Canadian LNG moving to European markets given the potential trade embargo that could be imposed on Russia for its actions in the Ukraine. Canada's only LNG facility at present is the Canaport LNG terminal near Saint John, New Brunswick on the Bay of Fundy, an import facility that has been in operation since 2008.

Another major factor in the negotiation of LNG supply contracts is the security for supply for purchasers of LNG, often used in

electrical power generation by power utilities. Given the high infrastructure costs, most LNG is sold under long-term supply contracts with fixed prices over the long term. Both Malaysia and Japan are major players in the proposals that are moving forward in British Columbia. Following the 2011 Fukushima nuclear incident, Japan is reflecting seriously on its use of nuclear power as a major source of its electrical power generation, and is moving to LNG as an alternative fuel source for power generation. Petronas, the state-owned Malaysian natural gas producer, is driving one of the major projects in Prince Rupert, Pacific Northwest LNG. Petronas also is a leading player in the Horn River natural gas fields. Analysts indicate this is a leading project for development and that the final investment decision on this proposed C\$35 billion (US\$32.1 billion) project is approximately a year away.

LNG as marine fuel

In addition to export markets, there is a great deal of interest in using LNG as a marine fuel for vessels engaged in domestic trade in Canada and the U.S. LNG is considered a clean fuel and has a much lower air emission footprint; it also provides a means of complying with national and international marine environmental air emissions. The challenge remains the lack of refueling facilities. BC Ferries, one of the world's largest ferry operators, has announced the construction of new LNG-fueled ferries. (For more on the BC Ferries program, see "Strategic Adoption" beginning on page 61 in this

A joint partnership between Spain's Repsol S.A. and Irving Oil, Canaport LNG is Canada's only operating LNG import receiving and regasification facility.



issue.) Also, there is an increasing interest in using LNG as a fuel in remote locations in Canada for municipal and commercial use as an electrical power generation source.

In Canada, all of the proposed LNG projects are greenfield and require pipelines, liquefaction facilities, and infrastructure to be completed. These involve large expenditures of capital investment before the project proceeds. Given the costs of these projects and their complex nature, in Canada there are requirements for project approval from government regulatory agency agencies for the export of natural gas along with environmental approval of the various elements of the projects. In addition, communities impacted by these developments need to support this economic activity. This is becoming increasingly important in the development of energy export projects in Canada.

In addition, in Canada, there is a requirement of the government of Canada to consult First Nations (various indigenous peoples in Canada) with respect to projects that may cross their

territorial lands. In a June 2014 decision, the Supreme Court of Canada held that, in the case of First Nations holding title to the lands, they need to give their approval before any project proceeds. In British Columbia at the time of Confederation, many of these First Nations did not sign treaties giving up their land rights. First Nations land claims remain live issues on project approval. This creates a further level of complexity for project approval and development for LNG projects in British Columbia. There are many steps in this complex process.

Another challenging factor in the development of LNG exports in Canada is that the remote locations of the tidewater sites where export facilities would be built have very little existing infrastructure and small populations. These projects also require skilled labor, which is in short supply at the moment. In Australia, where there are seven LNG export projects under construction, costs have been seen to double from projections because of increased labor costs and scarcity of skilled labor. An approach being



considered in Canada is the development of floating liquefaction plants that can be built in other locations and brought to the site by heavy lift vessel or floated in. Again, this creates regulatory complexity over these floating facilities.

At this time, there is no final investment decision made on any LNG project in Canada. There are 15 projects in various stages of approval by Canada's National Energy Board, the federal regulatory agency that issues export permits for the sale of natural gas. Commentators and analysts seem to indicate that there are likely at least three projects on the west coast. These include the Pacific Northwest LNG, of which Petronas is a major partner in Prince Rupert. Another facility is proposed for Kitimat, which is the closest tidewater to the natural gas fields in northeastern British Columbia and Alberta.

Shell has been leading the LNGCanada proposal in Kitimat. Given the flux in this market, gas producers need to sign long-term supply contracts guaranteeing prices, which are complicated

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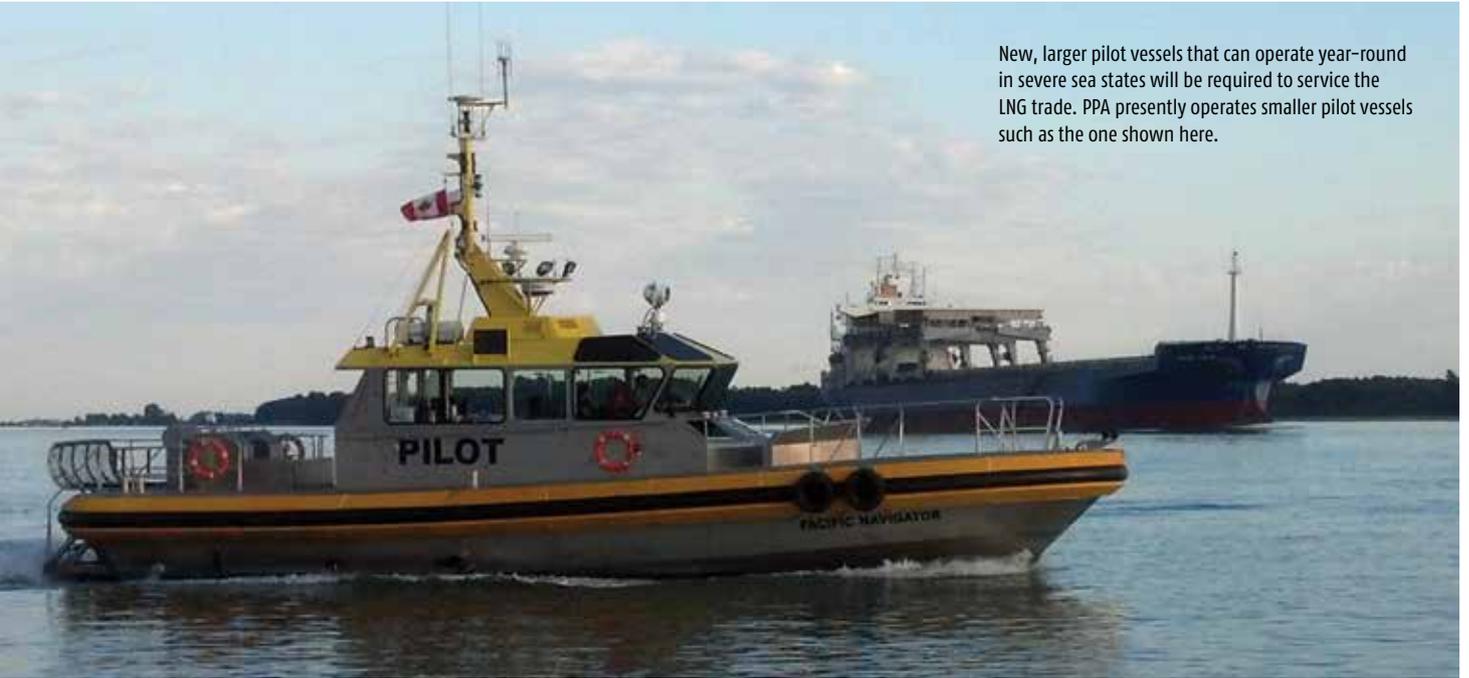
to negotiate. All of this makes for a very dynamic process. Given the lead time for the construction of both pipelines and infrastructure, any final decision on any of these projects won't see LNG moving on the British Columbia coast for at least the next 4 to 5 years if a decision is made in 2015.

Australia will be the source of the most new LNG supply entering the market over the next few years based upon the seven projects that are under construction. However, the outlook for 2020 is much more uncertain as suppliers in the U.S., Canada, Russia, and East Africa are all in competition for the same Indo Pacific market—in particular, China.

The market situation is further complicated by the fact that China is seen as a major potential market for Canada's natural gas, and China just entered into a long-term natural gas supply contract with Russia in May 2014. This will not involve LNG; rather, it will be natural gas from Siberia. This deal is worth approximately C\$400 billion (US\$367 billion) over 30 years, and it will see a pipeline built that ultimately will carry natural gas from Russia's east Siberian gas fields to customers in China. Canada was seen to be a major supplier to this Chinese market.

This is a game changer for Canadian projects, as the cost of pipeline transport of natural gas is much lower than is the case with LNG carried by sea. It has been called a gas shock. In this case, Russia will supply China with 38 billion m³ of gas per year at a rate favorable to China. There is still potential for long-term contracts to be entered into in the Chinese and other Asian markets. However, China can now use this contract as a negotiating tool with respect to long-term price with other suppliers, including Canada, and this could cause price volatility. The issue is further complicated by the fact that China, in August 2014, indicated it is going to ban coal-fired electrical power production from its cities to reduce air pollution, which may increase LNG demand.

It is important to recognize that the LNG market is a dynamic one. The United States is a market competitor to Canada; it already



New, larger pilot vessels that can operate year-round in severe sea states will be required to service the LNG trade. PPA presently operates smaller pilot vessels such as the one shown here.

has a number of liquefaction facilities in place and is eyeing the same Asian markets.

Increasing competition

The expanded and enlarged Panama Canal is set to open in January 2016, and this could impact Canada in a major way as the canal will be able to carry a good portion of the world's LNG carriers. It is estimated that up to 30% of the increased traffic of an expanded Panama Canal could enable 347 of the world fleet of 392 LNG gas carriers to transit from the U.S. Gulf Coast to Asian markets. Some 45 of the larger Q-Flex vessels would not be able to use the canal. Presently, the Panama Canal can only handle 6% of the LNG fleet. The canal fees for this commodity have not been confirmed.

In the U.S., there will be four LNG export projects under construction by early 2015. The U.S. is leading the race to supply the markets by 2020. These include the Freeport LNG project in Texas, as well as the massive Cheniere Energy's Sabine Pass LNG project (a brown-field site) and Cameron LNG, which are both in Louisiana. A fourth major project is the Dominion Cove LNG project in Maryland. At the end of the decade, the U.S. could be moving 50 million tons of LNG annually. These are brownfield sites that have existing pipeline structures and upstream markets to provide natural gas feedstock for export to new markets. Additionally, conditional approval has been given to an export facility in Oregon.

Australia has been greatly expanding its LNG export capacity to Asian markets. With its seven LNG export projects in production by the end of the decade, it is predicted that Australia will surpass Qatar as the world's major LNG exporter. Investors are looking at the Australian experience when it comes to investing and making final project decisions in British Columbia because of the cost overruns that

recent LNG projects have incurred due lack of skilled labor and remote locations.

Future LNG in Canada development presents some interesting ship design challenges. The movement of LNG carriers on the remote north British Columbia coast will require the use of larger pilot vessels that are operated by the Pacific Pilotage Authority. In addition, given the remote coastline where LNG carriers may be operating, the Pacific Pilotage Authority is examining helicopter transfer of British Columbia coast marine pilots (heliohoist) to LNG carriers. This approach comes with several unique challenges, as LNG carriers typically are not equipped and outfitted for this marine pilot transfer method.

Canada's LNG export potential is huge given the unconventional reserves and potential tidewater on two coasts (leaving the Arctic aside for now). A variety of global factors are at play, which will determine whether LNG export projects will move to completion. The marine shipping component of these LNG export projects is integral to their success. Given the remote geography of the British Columbia coastline, and the present lack of skilled workers and infrastructure, the development of floating liquefaction plants could keep costs controlled and lead to increased ship building capacity in this specialized area. It also could lead to a variety of spinoffs in the marine design field and new vessel construction for a variety of support vessels and assist tugs.

There is great pressure on project proponents to get these final investment decisions right and to create an LNG export market for Canada that is globally competitive. Marine design professionals need to keep an eye on these developments. After all, where there is LNG, ships will follow. **MT**

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