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RESEARCH REPORT

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Managing Expectations

Assessing the Potential of BC's Liquid Natural Gas Industry

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CENTRE FOR NATURAL RESOURCES POLICY

The Centre for Natural Resources Policy focuses on the economic importance of natural resources to Canada's current and future prosperity and challenges industry to be world leaders in environmental performance and innovation.

EXECUTIVE SUMMARY

The emerging LNG industry in British Columbia presents a substantial growth opportunity. However, the province and the industry must move nimbly and quickly to beat out the competition and capture market share in Asia. Expectations of just a year ago may be tough to deliver. This report explains why.

British Columbia faces an unprecedented opportunity to develop its shale gas resources, build natural gas pipelines and construct liquefaction facilities to reach world markets. However, multiple factors may lead to intense competition for BC in Asian markets. This means that:

- The BC government and industry need to move fast to out-maneuver their competitors.
- The BC government should be prepared for a more modest natural gas boom in the event that projected production and revenues build more slowly.
- Continued attention needs to be paid to the risks facing the industry to ensure that price competiveness is maintained.
- Notwithstanding the economic boost expected from natural gas production, efforts to grow the natural gas industry should not crowd out other natural resource opportunities.

Natural gas remains a growth industry with great potential, but realistic expectations regarding the pace of development and fiscal impacts are required.

Managing Expectations examines how much competition BC will face in Asian natural gas markets. Our finding is that a shorter list of projects will proceed to construction, based on the following considerations:

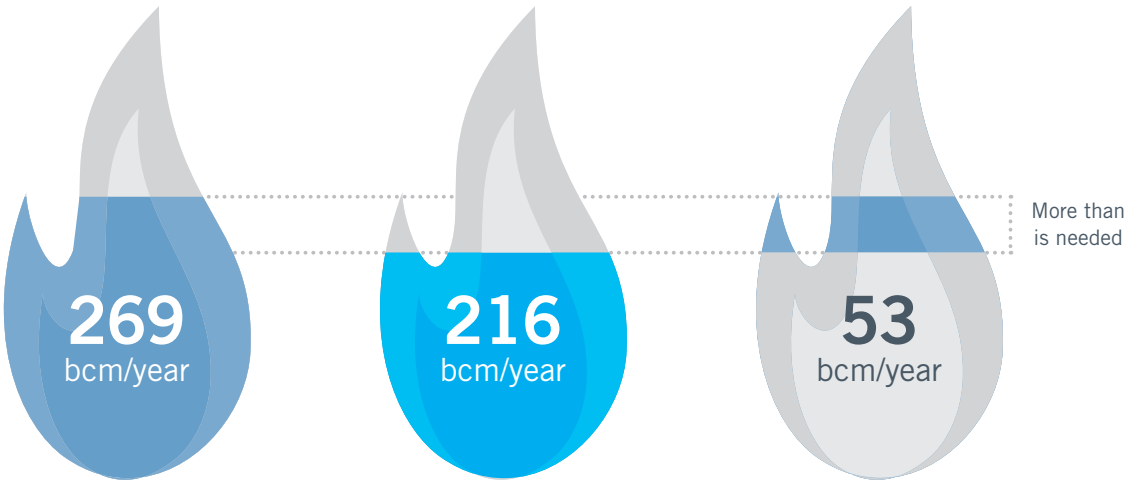
- **BC is coming late to the party**. Between 2013 and 2025, Asian natural gas demand is projected to increase by 216 billion cubic metres per year (bcm/year). Traditional LNG suppliers to Asia currently have 96.9 bcm/year of capacity under construction, 90.1 bcm/year of capacity that has completed Front-End Engineering and Design (FEED), and 81.9 bcm/year of capacity that has been announced. If all of this proceeds, it adds up to 268.9 bcm/year – 52.9 bcm/year more than anticipated market growth in Asia. The most advanced BC projects are at the early FEED stages.
- **Most of the growth in Asian natural gas demand is in China, and China has lower cost or more strategic alternatives to LNG**. Although China's conventional natural gas production is declining, unconventional gas supply and pipeline imports

are expected to see strong growth. Conventional supply will decline from 93.5 bcm in 2013 to 80 bcm in 2025 (a net loss of 13.5 bcm). China has the largest shale gas resource in the world and plans to increase unconventional gas production by 78 bcm/year (from 16 bcm in 2013 to 94 bcm in 2025). Pipeline imports from Russia, Central Asia, and Burma will increase by 37 bcm/year based on projects currently under construction, and by an additional 68 bcm/year (105 bcm/year total growth) if the projects in planning all proceed.

- **Supply costs matter**. British Columbia will rely on shale gas development to supply LNG exports. The combination of supply costs, transport to tidewater, liquefaction costs and tanker transport must be carefully managed to remain competitive with Australia and Qatar.
- **Pricing is a key potential advantage**. North American natural gas prices are currently well below world levels. Asian purchasers are working to ensure that LNG from North American suppliers is based on North American wellhead prices, plus allowances for transport and liquefaction. This provides them with lower cost supplies, as well as a negotiating position with other suppliers. Should existing suppliers choose to aggressively defend market share, this could lead to destructive competition. Such competition would disadvantage BC natural gas producers, whose supply costs are high relative to many competitors.

Taking into account all of these factors, the opportunity for BC to supply Asian markets with LNG is solid, *but not guaranteed*. Projects will face competition from each other, from domestic production in China, and from pipeline imports to China. LNG suppliers have faced similar competitive situations in the past, and should be well prepared. Competition, however, puts downward pressure on revenues and on the number of projects that can successfully move forward.

TOO MUCH GAS



Source: Canada West Foundation

British Columbia is Canada's second largest natural gas producer. Recent shale gas discoveries and plans to produce natural gas for export as LNG have the potential to greatly expand natural gas production and establish the province as a global natural gas supplier. These developments will require capital investments in British Columbia's natural gas sector that will dwarf historical spending, and may even rival investments in Alberta's natural gas industry.

Shale gas and liquefied natural gas (LNG) projects are expected to create thousands of jobs during both the construction and operations phase. Due to the sheer size of incremental spending and its compressed time frame, the economic and social impacts of an emerging LNG industry on BC's northern communities will require careful assessment and management.

Earlier market potential studies by the BC government focused on two cases: 80 million tonnes per annum (mtpa) and 120 mtpa (or between 3.84 and 5.76 trillion cubic feet). The current project list identifies a potential 87.4 mtpa (4.2 tcf) if all projects proceed as announced.

British Columbia LNG projects will primarily target consumers in Asia, one of the world's largest and fastest growing markets, including both Japan and Korea – the world's largest current LNG consumers.

Strong future growth is also anticipated in China and India. The competition to serve these markets is intense and includes new projects from Asia's current pipeline and LNG suppliers, as well as competition from US projects.

This briefing reviews world LNG supply and demand projections, then provides a more detailed look at natural gas markets in Asia, including LNG. Future market growth is compared to the supply options to shed light on the competition BC LNG projects will face.

The Historical Context

In 2011, BC natural gas production was 1.28 tcf and total Canadian natural gas production was 5.23 tcf. (CAPP 2013).

World LNG Demand

The global market for LNG dates back to the 1960s. Although the liquefaction process is energy-intensive, when methane is cooled to approximately 160 degrees below zero °C, it shrinks by a factor of almost 600, making long distance marine transport possible.

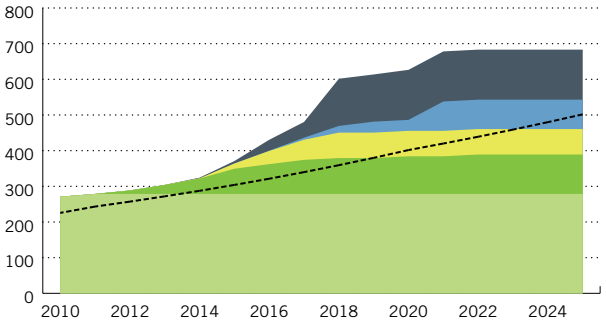
How Much is a Million Tonnes of LNG?

Natural gas in its liquid form is measured in million tonnes (weight), but as a gas it is measured in billion cubic metres or billion cubic feet (volume). To convert million tonnes to billion cubic metres, multiply by 1.36. To convert million tonnes to billion cubic feet, multiply by 48.

The first step in considering British Columbia's future position in world LNG markets is to review the current and anticipated future state of the global LNG industry. As energy demand rises in developing countries and as environmental pressures favour natural gas consumption over refined products, LNG demand worldwide is experiencing renewed growth (see Figure 1).

World LNG demand[1] is predicted to surpass 400 mtpa by 2021, when all of BC's terminals are scheduled to be in operation, and 500 mtpa by 2025.[2] Over the past decade, world LNG demand has grown at more than 7.5% per year whereas world natural gas demand has increased at less than half the pace. World natural gas markets have primarily been continental in *scope*, with pipelines linking supplies to market *within* each continental market. LNG provides links *between* markets wherever the incremental cost of liquefaction and regasification can be recovered. World LNG demand is dominated by Asian markets, with Japan, Korea and Taiwan accounting for more than half of world consumption. These countries have no or very limited domestic energy sources, and import LNG

F1: WORLD LNG MARKETS FACE POTENTIAL OVER-SUPPLY
(million tonnes per annum)



Note: There are terminals with a combined capacity of 22.5 mtpa that have FEED completed and no predicted start dates. Also, there is 129.9 mtpa of capacity planned with no start date.

- World LNG terminals announced
- British Columbian LNG terminals planned
- World LNG terminals with FEED completed
- World LNG terminals currently under construction
- World operating liquefication capacity (pre-2012)
- World LNG demand (Stinis 2012)

Sources: International Gas Union 2012b, Stinis 2012, A Barrel Full website, Canada West Foundation
See appendix for list of projects and regional summaries

[1] This paper uses both billion cubic meters and million tonnes as units for natural gas. Billion cubic meters is the more familiar unit for natural gas pipeline flows and demand. Where only LNG capacities and trade are shown, million tonnes per annum (mtpa) is used. One billion cubic meters is equivalent to 0.74 million tonnes.

[2] The LNG demand outlook shown here is relatively aggressive. More conservative forecasts show LNG demand reaching 500 mtpa in 2030, with relatively slower growth of 3% per year or less post-2020.

for regasification to produce electricity and to supply town gas systems for heating. More recently, China has become an important LNG market, with India expected to follow.

Looking forward, LNG demand in China is expected to grow more rapidly even as domestic conventional and unconventional natural gas supplies grow and pipeline imports increase. Elsewhere in Asia and around the world, a near term expansion of LNG demand is expected as the role of nuclear electricity generation is re-evaluated. The demand outlook presented in this paper is thus subject to uncertainty based on the future contribution of nuclear energy, economic growth in China and the availability of alternative natural gas supplies.

Figure 1 shows that if all liquefaction capacity for which in-service dates have been announced is actually built, the capacity would approach 700 mtpa. An additional 171 mtpa could come from projects that have been announced, but for which no timing has been identified. Of course, as with all major planned projects, many of these may not be built. LNG demand forecasts to 2020 and beyond predict a burgeoning demand from both Europe and fast-growing Asian economies (Stinis 2012). However, BC plans to export primarily to the latter market. Although it is typical for project lists to exceed market requirements, Figure 1 indicates the extent of rationalization in LNG supplies that may be required over the coming decade.

Africa (22%), Australia (19%) and North America (39%) account collectively for 80% of the future projects shown (the total less capacity in operation at the end of 2011). However, the vast majority of African and North American projects are only announced, while most of Australia's future capacity is already under construction. Despite the current large amount of exports from the Middle East, less than 30 mtpa of future capacity is predicted to be built in this region.

Natural Gas
Demand in Asia

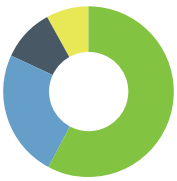
Given that Asia is the primary target market for BC LNG exports, a broad understanding of Asian natural gas markets is important to understanding LNG potential. Historically, Japan and Korea have been the two largest importers of natural gas in Asia and their imports have been entirely satisfied by LNG. In 2012, Japan purchased 87.9 mt, Korea 36.8 mt, Taiwan 12.5 mt, and China 14.8 mt (BP 2013). Figure 2 shows Japanese purchases to be the lion's share of Asia's LNG imports. Of these countries, China is the only one with significant domestic production and pipeline imports. Natural gas consumption forecasts for Japan, Korea and Taiwan estimate annual growth rates of 1.4%, 0.9% and 4.3%, respectively (Matsuo 2011).

Until 2011, Japan had steady but low growth of natural gas consumption. In 2011, the Fukushima nuclear disaster struck Japan and LNG imports jumped by 12% to 78.8 mt, and again by 11.5% to 87.9 mt in 2012 (BP 2013). It is unknown if Japan will continue replacing nuclear power with natural gas, or if this trend will return to a lower, more historical growth. The Institute of Energy Economics in Japan projects a 1.4% annual growth rate, predicting that Fukushima will cause delays in nuclear power development rather than a cessation (Matsuo 2012).

As for Korea and Taiwan, Korea's growth rate is small, and while Taiwan's growth rate seems significant, it imported only 12.5 mt in 2012. It is important to note that although recent consumption growth has been stronger than the rates used to project future growth, much of this may be attributed to recovering energy demand after the recession that started in late 2008. In the future, however, the main driver of Asia's growth in natural gas demand is expected to be China.

The sections that follow focus primarily on capturing a share of incremental markets in Asia, which means primarily incremental markets in China. There is also potential to capture a share of existing markets by displacing current suppliers based on supply diversity or price discounts. Japan and Korea have long been focused on supply diversity and many would argue that they have achieved that objective. Their primary interest might be lower prices from North American natural gas as compared to current LNG prices based on crude oil. Price competition is discussed below, but aggressive price discounts could place an undue burden on the economics of a new and capital-intensive BC industry. A comparison of the 87.4 mtpa list of projects being discussed in BC to the existing 152 mtpa LNG market in Asia suggests that if BC LNG suppliers choose to compete solely for existing markets they would need to displace more than half of the existing supply – an unlikely scenario. The most probable path would be a combination of sales to existing regasification terminals and sales to new or expanded receiving terminals, with the latter providing the better opportunity.

F2: LNG IMPORTS TO ASIA



8% Taiwan
10% China
24% Korea
58% Japan

Source: BP 2013

COUNTRY	LNG IMPORTS, 2012 (MTPA)
Japan	87.9
Korea	36.8
Taiwan	12.5
China	14.8
Total	**152**

Natural Gas
Demand in China

With a compound annual growth rate of 6.7% (International Gas Union 2012a) for its natural gas consumption, China's demand is predicted to increase dramatically. Unlike the other three major Asian importers, China has a large domestic gas production industry. In 2012, China consumed 143.8 bcm of natural gas (BP 2013). Of this, an estimated 107.2 bcm were produced domestically, 2.8 bcm of which were exported. Another 21.4 bcm were imported via pipeline from Central Asia and 20.0 bcm were imported as LNG. Figure 3 shows the various sources of Chinese supply and projected demand, from 2010 until 2025.

Figure 3 also shows the amount of LNG that may be available to China based on the current set of projects proposed by Asia's current primary suppliers. Figure 3 illustrates only a subset of the supplies that could be available to China. LNG imports from countries not currently serving that market (including Canada and the US) are not shown. Note that, as with the other area-graphs, supply sources are stacked according to certainty with highest certainty supplies shown at the bottom: LNG terminals that are merely planned are shown above those that have Front-End Engineering Design (FEED) completed, which are above those that are currently under construction.

Table 1 shows the pipeline projects that comprise the pipeline segment in Figure 3.

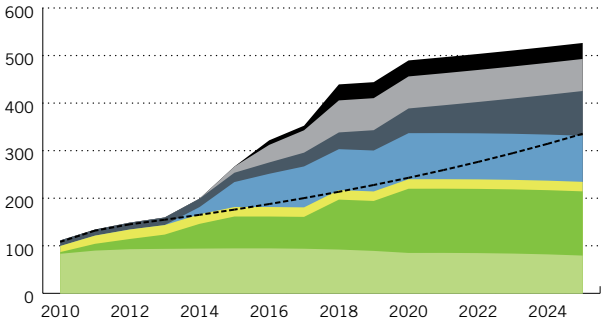
T1: FUTURE PIPELINE GAS SUPPLY TO CHINA

PIPELINES TO CHINA	**CAPACITY** (bcm)	**YEAR**
Current capacity	30	2013
Burma-China pipeline	12	2014
Central Asian pipeline expansion	10	2014
Central Asian pipeline expansion	15	2015
Far Eastern Route	38	2018
Western Altai	30	2020
Total	**135**	

Sources: BP 2013, BP 2012, BP 2011, Canada West Foundation

The Burma-China pipeline is ready for testing as of June 2013, but security issues are causing delay (The Irish Times 2013). The Central Asian pipeline is projected to reach its 55 bcm capacity by 2015 (Jarosiewicz 2012). The Far Eastern Route is scheduled

F3: CHINA'S NATURAL GAS SUPPLY OPTIONS GREATLY EXCEED MARKET REQUIREMENTS
(billion cubic meters)



Note: Pipeline imports rather than capacity are shown from 2010 to 2012.

- Major suppliers' LNG terminals planned
- Major suppliers' LNG terminals with FEED completed
- Unconventional NG production
- Major suppliers' LNG terminals under construction
- LNG imports at 2012 level
- Total pipeline import capacity* into China
- Conventional NG production
- Chinese demand

Sources: US Energy Information Administration 2011, International Energy Agency 2012, International Gas Union 2012b, BP 2013, International Energy Agency 2012, Canada West Foundation

to come online in late 2017 (Gazprom n.d.), and China has contracted for 38 bcm of annual gas imports from Russia beginning in 2018 (Lelyveld 2013). Design of the Western Altai pipeline has been put on hold until at least 2014 (RIA Novosti 2013). Hence, the pipeline will be commissioned in 2019 or 2020 at the earliest.

As with all long-term projections, many variables within Figure 3 are far from certain. One of the largest uncertainties is how much unconventional gas China will produce. In November 2012, China's Ministry of Land and Resources raised the annual domestic gas production estimate for 2030 from 300 bcm to 450 bcm (Chatham House 2012). A large part of this is based on successful and rapid development of China's vast shale gas resources, estimated to be between 30 and 36 tcm (Doshi 2012). However, this optimistic prediction may turn out to be much lower for the following reasons:

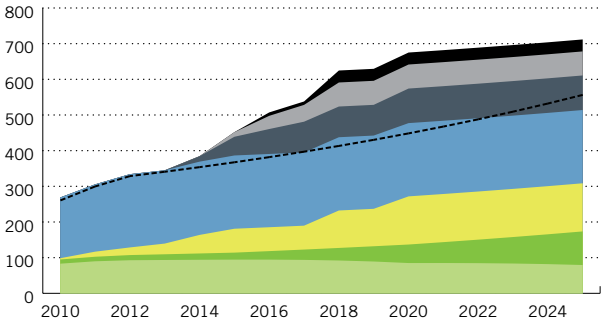
- Shale resource numbers are by no means certain and could be lower than estimated.
- There may be insufficient domestic extraction capabilities and/or investment appetite for extraction projects that will require sophisticated technologies.
- Some of China's shale gas resources are remote, or are located in areas where there may not be sufficient water available for reservoir fracturing.

There is a large discrepancy between our demand forecast and that of Chinese government plans. China's most recent [12th] Five Year Plan sets natural gas consumption at 8.3% of total energy consumption, or 260 bcm by 2015 (Doshi 2012). Our projection shows only a level of consumption near 175 bcm for that year. Although the Chinese government's plan may inspire optimism for a higher LNG demand in the future, it should be noted that the Chinese government is also predicting an increased production of shale gas to meet this demand, compared to our more conservative forecast (Doshi 2012).

China's future natural gas supplies will come from three main sources: increased domestic production (including shale gas), increased pipeline imports, and increased LNG imports. Each supply faces its own set of uncertainties. Domestic production growth will depend critically on the level of investment China makes in unconventional natural gas development. Pipeline imports are uncertain because of the combination of investment, potential suppliers, and price negotiations. LNG imports will hinge on the cost and availability of domestic gas or pipeline imports, as well as the rate at which import terminals are built and supply contracts negotiated. Based on current information, it is reasonable to conclude that either pipeline imports or LNG imports will become the marginal supplier to China's growing natural gas market.

By 2020, all the liquefaction capacity required to meet Asia's 2025 demand at the higher growth rate, will be online (see Figure 4).

F4: LNG WILL COMPETE IN ASIA WITH SHALE GAS AND PIPELINES FROM RUSSIA
(billion cubic meters)



Note: There are 22.7 and 44.3 bcm of capacity for terminals with FEED completed and planned terminals, respectively, that have no predicted start dates. These are not shown on the graph.

- Major suppliers' LNG terminals planned
- Major suppliers' LNG terminals with FEED completed
- Major suppliers' LNG terminals under construction
- Asia LNG imports at 2011 level
- China pipeline imports
- China unconventional NG production
- China conventional NG production
- Asian demand

Sources: International Gas Union 2012b, BP 2013, International Energy Agency 2012, Canada West Foundation

The BC LNG Industry

This discussion of BC's future LNG industry focuses primarily on the proposed projects and potential Asian markets. It does not deal with the impacts of the required natural gas supply development, pipeline construction, or liquefaction plant construction on communities in northeast BC. It also abstracts from the environmental impacts, including GHG emissions. With 87.4 million tonnes of liquefaction capacity proposed, there is a potential requirement for BC natural gas production to rise from its 2011 level of 1.4 tcf/year to 5.6 tcf/year over just a decade. Although some of the proposed projects may be delayed or cancelled as the market evolves, BC faces significant growth in natural gas production as the industry unfolds. The impacts on northern communities and the resulting social, economic and environmental pressures have not been examined in the preparation of this report.

As of June 2013, plans for five liquefaction terminals have progressed beyond feasibility studies. Table 2 shows each terminal's expected completion date and estimated liquefaction capacity.

The Douglas Channel Energy Partnership is sponsored by the Haisla Nation, LNG Partners and, more recently, Golar LNG (Hamilton 2013). The latter two companies have also made sales agreements to buy 0.7 mtpa (Reuters 2013). Gas will be supplied by the Pacific Northern Gas pipeline (Douglas Channel Energy Partnership n.d.). A final investment decision is expected in late 2013 (Hamilton 2013).

T2: PROPOSED NATURAL GAS LIQUEFACTION PROJECTS IN BC

BRITISH COLUMBIA PLANNED TERMINALS	**YEAR EXPECTED TO COME ONLINE**	**LIQUEFACTION CAPACITY** (MTPA)
Douglas Channel Energy Partnership (Train 1)	2016*	0.9
Kitimat LNG	2017	10**
Pacific Northwest LNG	2018	12
Douglas Channel Energy Partnership (Train 2)	2018	0.9
LNG Canada	2019	12
Western Canada LNG	2021	21.6
Imperial and ExxonMobil Canada project	2021	30
Total		**87.4**

Sources: Various BC and federal government websites, Canada West Foundation

* Initial starting year of 2014 pushed back by 2 years: project itinerary on website was aligned with project status as of 2013.

** Current FEED study indicates an initial train of 5 mtpa with a second train based on market conditions.

Kitimat LNG is sponsored by Apache Canada and Chevron Canada. Each owns a 50% share (Kitimat LNG n.d.). Chevron will operate the terminal and pipeline assets of Pacific Trail Pipelines supplying gas from the Horn River and Liard basins, where Apache will operate upstream assets (Apache Corporation 2012). FEED is currently being conducted, and a final investment decision is expected to follow (Kitimat LNG n.d.).

Pacific Northwest LNG is sponsored by PETRONAS and Japex who own 90% and 10% shares, respectively (The Star Online 2013). A final investment decision is expected by end of 2014 (Pacific NorthWest LNG n.d.). The Prince Rupert Gas Transmission Project, to be built by TransCanada, will supply gas from the Montney region (Japex n.d.). A FEED contract was awarded in May 2013 (KBR 2013).

As for LNG Canada, Shell Canada owns a 40% share, with Kogas, Mitsubishi and CNPC each owning 20% (Mitsubishi 2012). An export license has been issued and federal and provincial environmental review submissions were made in April 2013 (Financial Post 2013). Shell has contracted TransCanada to build the Coastal Gas Link Pipeline to supply gas from the Montney region (TransCanada 2012).

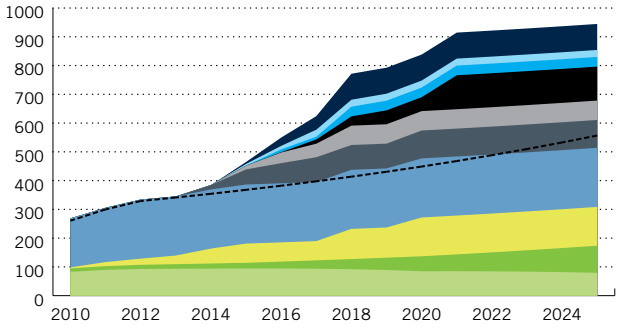
Western Canada LNG is sponsored by BG Group, with Spectra Energy building a pipeline originating from gas suppliers not yet named (Spectra Energy 2012). A final investment decision is not expected until 2016, with BG looking for investment partners to lower its share from current full ownership to below 50% (Lewis 2013).

Finally, Imperial and ExxonMobil Canada applied for an export licence for 30 mtpa (Kolenko 2013). A site has not been chosen and a final investment decision has not been signed. The project may be online as early as some time between 2021 and 2023. Gas will be supplied from fields owned by Imperial and ExxonMobil (Lewis 2013).

Figure 5 shows BC's addition (the aggregate capacity of the above five projects) to the Asian market's supply and demand forecast, as well as the potential US projects listed below.

Although BC terminals are graphed above the future terminals of Asia's current major suppliers, BC may displace at least some of the more advanced competing projects.

F5: FUTURE NATURAL GAS SUPPLY AND DEMAND IN ASIA
(billion cubic meters)



Sources: International Gas Union 2012b, BP 2013, International Energy Agency 2012, Canada West Foundation

Note: There are 22.7 and 44.3 bcm that have no predicted start dates. These are for terminals from traditional suppliers to Asia with FEED completed and planned terminals, respectively. Also, there is 34.6 bcm of capacity planned for the US with no start date.

- US LNG terminals planned
- US LNG terminals with FEED finished
- Major suppliers' LNG terminals planned
- British Columbian LNG terminals planned
- Major suppliers' LNG terminals with FEED completed
- Major suppliers' LNG terminals under construction
- Asia LNG imports at 2011 level
- China pipeline imports
- China unconventional NG production
- China conventional NG production
- Asian Demand

The US LNG Industry

Figure 5 also includes future US LNG terminals. All but two of these terminals (Warrenton and Jordan Cove) would be located on the Gulf Coast which is much closer to European markets than Asian; Houston to Tokyo is about 15,000 km while Kitimat to Tokyo is just under 6,500 km. Table 3 shows the individual projects that will add 122.9 mt to US capacity. Despite this large future capacity, the US may be more likely to sell to the EU rather than Asia since LNG transport from Houston, even with Panama Canal expansion, could be as much as double the cost from Kitimat to Tokyo.

By 2021, when BC's projects are scheduled to be finished, the province will face competition in Asia from current LNG suppliers, future LNG projects, pipeline imports, and from growth in domestic Chinese gas production.

T3: PROPOSED NATURAL GAS LIQUEFACTION PROJECTS IN THE US

US TERMINALS	YEAR	LIQUEFACTION CAPACITY (MTPA)
*Sabine Pass LNG T1	2015	4.5
*Sabine Pass LNG T2	2016	4.5
*Sabine Pass LNG T3 + T4	2017	9
Cameron LNG Export Terminal Project	2016	12
CE FLNG Project	2018	8
Corpus Christi LNG Export Terminal Project	2017	13.5
Dominion Cove Point LNG Export Terminal	2015	5
Elba Island Terminal	201?	4
Freeport LNG Export Terminal Project	2016	4.4
Golden Pass LNG Export Terminal Project	201?	15.6
Jordan Cove LNG Export Terminal Project	201?	6
Lavaca Bay LNG Project	2018	4.4
Magnolia LNG Export Terminal Project	201?	n/a
South Texas LNG Export Terminal Project	2018	8
Trunkline Lake Charles LNG Export Terminal Project	2018	15
Warrenton Oregon LNG Export Terminal	2018	9
Total		**122.9**

*FEED completed

Sources: International Gas Union 2012b, A Barrel Full website, Canada West Foundation

LNG Pricing & Revenue Streams

World LNG markets have traditionally been based on long-term contracts with pricing terms linked to crude oil prices. Over the past decade, spot LNG cargoes have become more common and can be priced using a variety of formulas. This analysis is based on long-term pricing since new projects will seek long-term certainty as a priority to attract both equity partners and lenders.

Long-term LNG contracts in Asia differ across transactions based on market conditions and the timing of contract negotiations. However, most long-term contracts are linked to the Japan Crude Cocktail (JCC) which is a basket of crudes imported to Japan. Over 2012, JCC traded at an average premium over West Texas Intermediate of about $20/barrel. LNG price formulas are set as a proportion of the energy-equivalent value of JCC. The proportion is allowed to vary within a band that is based on the level of JCC prices. When crude oil is priced below a level specified in the contract, the LNG price ratio is allowed to rise so that LNG prices do not fall as rapidly as crude prices. This provides the LNG supplier with an assurance that the LNG price will be sufficient to recover infrastructure investments. Symmetrically, when oil prices rise above a level specified in the contract, the LNG price ratio is adjusted so that the LNG price rises less rapidly than JCC, providing the LNG purchaser with a measure of price relief. The exact terms of each contract are not divulged.

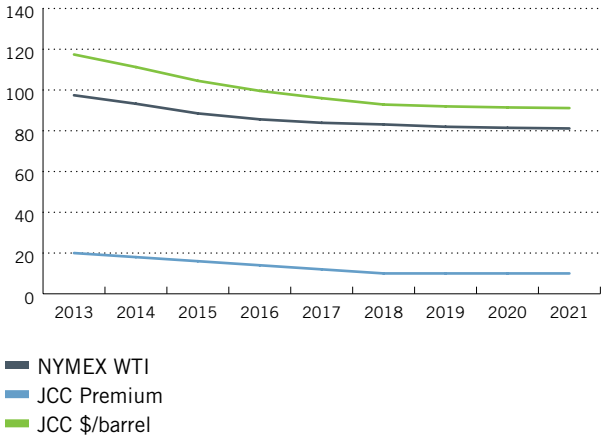
In 2012, JCC averaged $114.77 per barrel. Converting this to $/MMBtu would yield an average of approximately $20.68/MMBtu.[3] The gap between the energy-equivalent price of JCC and the 2012 average of $2.75/MMBtu for spot natural gas at Henry Hub demonstrates clearly the mutual attraction between Asian LNG markets and potential North American LNG suppliers. Somewhere between $20.68 and $2.75 there will be a price that makes the market work for all, even with upstream transport, liquefaction and LNG transport included.

Figure 6 shows a projection of JCC and WTI prices. As transportation bottlenecks are resolved, the recent premium of $20/barrel for JCC is projected to decline to $10/barrel. Both crudes are expected to decrease in value over the coming years, with world crude prices falling more rapidly than WTI. The price for WTI shown in Figure 6 is based on futures prices settled in mid-June 2013. Because JCC is not traded on futures markets, the JCC curve is based on WTI plus an assumed differential.

The data presented in Figures 6 and 7 should not be considered a forecast of crude oil and natural gas prices, since they are based on forward prices on the NYMEX exchange. However, they do represent a measure of the expectations that the market currently has with respect to both crude oil and natural gas prices. The important message is that the market currently expects a modest narrowing of the current gap between the price of crude oil and the price of natural gas within North America.

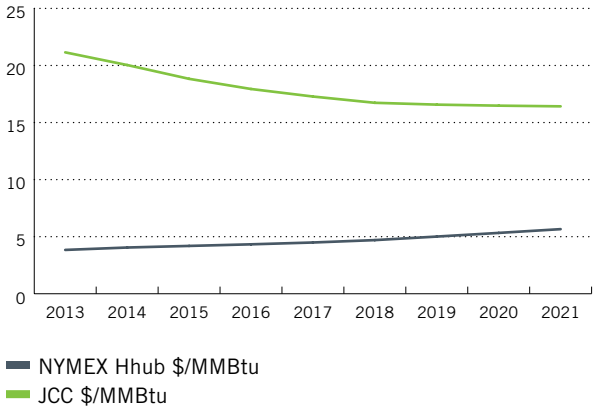
[3] This conversion is done from a barrel of oil equivalent to MMBtu. An exact conversion would be based on the actual energy content of JCC which changes depending on the particular crudes being imported.

F6: JCC AND WTI FORWARD PRICES – THE PRICE GAP UNDERPINNING LNG FROM NORTH AMERICA
(US $ per barrel)



Sources: NYMEX, Canada West Foundation

F7: THE PRICE GAP WILL NARROW BUT NOT CLOSE
(US $ per barrel)



Sources: NYMEX, Canada West Foundation

Figure 7 compares the JCC price outlook (shown in $/MMBtu) to the forward curve for natural gas at Henry Hub (as traded on NYMEX). This chart shows an expected narrowing of the differential as Henry Hub natural gas prices rise slowly through time and world crude oil prices soften. British Columbia's LNG projects are currently scheduled to begin in 2017 at the earliest, suggesting they will experience a continued differential of more than $10/MMBtu in their early years. Unless this differential closes more rapidly than expected, the price negotiations between North American LNG suppliers and Asian purchasers promise to be challenging. Note that if the Henry Hub price shown in Figure 7 can be considered to reflect natural gas supply costs, liquefaction and transport costs would absorb $3 - $5/MMBtu of the price differential shown.

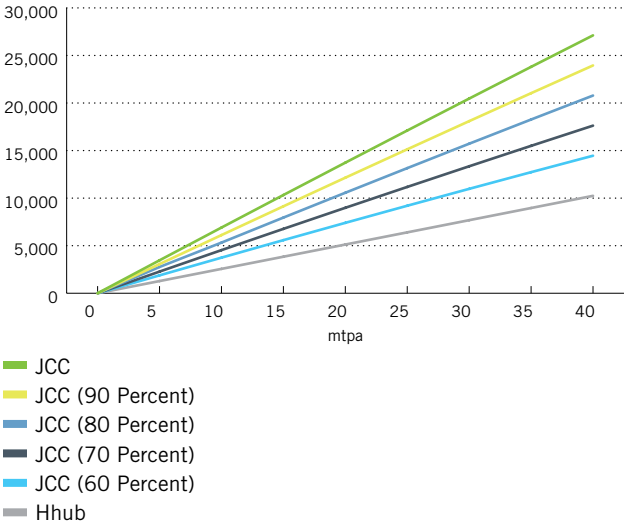
Figure 7 shows clearly that crude prices in Asia and natural gas prices in North America follow different fundamental paths, and that the current market expectation is for only a very gradual narrowing of the differential. Due to the very limited LNG export/import capacity and overall supply self-sufficiency for natural gas in North America, continental natural gas prices follow their own set of market fundamentals. The Henry Hub natural gas price is a common reference point for wholesale natural gas prices in most regions of North America. For most of the period since LNG markets began to emerge around the world (since the 1960s), natural gas prices in North America have been too low for LNG imports to be economically attractive, and natural gas supplies within North America have found continental markets. With the recent rapid expansion of shale gas production in the United States, continental natural gas prices have fallen and are expected to remain low. LNG exports from North America are now attractive because the wholesale price of gas plus transport, liquefaction and tanker fees is substantially lower than current LNG import prices in Asia. Prices based on Henry Hub pricing plus LNG related costs would be very attractive to Asian LNG customers. Similarly, prices based on current Asian LNG contracts less LNG related costs would be very attractive by comparison to current wholesale natural gas prices in North America. The market landing is likely between the two options.

Figure 8 presents a basic sensitivity analysis for LNG revenues at the export terminals on the British Columbia coast. The vertical axis measures the gross revenue from LNG loaded onto tankers, and the vertical axis measures the volume of LNG loaded

in million tonnes per annum. Each line represents a particular price relationship, measured in 2020. The line showing JCC represents point of export revenues vs. LNG volumes shipped based on energy parity with the projected value of JCC. Given that LNG pricing formulas typically include discounts to that value, lines have been added to show revenues based on 90, 80, 70, and 60 percent of the JCC price. For all of the lines based on JCC pricing, there is an assumption that the LNG is actually sold in Asia, with transport costs (approximately $2/MMBtu projected for 2020) deducted to determine revenues at Prince Rupert. For the Henry Hub price, the LNG is assumed to be purchased in British Columbia, with the customer paying transport to market. As the chart shows, the anticipated Henry Hub price for 2020 would be less than 50% of the energy-equivalent value of JCC, a point with underscores the importance of the price negotiation.

The data shown in Figure 8 represent the value of the LNG only. There may be additional revenue that arises from the sale of natural gas liquids extracted from the natural gas stream. Some of the shale gas that is expected to be developed for LNG projects has above average natural gas liquids content. These liquids may be extracted at upstream processing plants, or left in the natural gas stream and delivered to the LNG liquefaction plants. The eventual disposition will depend on the volume of liquids present, the extent of upstream processing, and the characteristics of the natural gas transmission pipelines. If the natural gas liquids are left in the natural gas stream, the liquefaction process will cause them to condense out. Depending on market conditions and relative prices, the liquids may be purified and sold separately, or simply injected back into the LNG prior to shipment. The point relative to LNG markets is simply that the presence or absence of significant liquids volumes can influence the energy content (hence market value) of the LNG as well as the economics of the LNG project itself.

F8: LNG REVENUE SENSITIVITY ANALYSIS
(Million $US per year)



Source: Canada West Foundation

CONCLUSION

British Columbia faces an unprecedented opportunity to develop its shale gas resources for export to Asian markets in the form of liquefied natural gas. The proposed investments in natural gas field development, pipeline transport, liquefaction and shipping would be much larger than the natural gas industry's historical investments. Although many of the companies vying for market share are already active participants in global LNG markets, this represents a new market for British Columbia resources. Future success is likely to hinge on several key issues:

- **Timing**. Australian projects, although higher cost than originally projected, are much closer to completion than the BC projects. There will also be competition from Africa, the US, and potentially South American and Middle Eastern projects. There is market pressure to move forward with project development, including acquiring land for LNG terminals, progressing through approval processes and securing natural gas supplies and markets.
- **Pricing**. North American projects have a potential advantage to the extent that they are willing to consider pricing that is at least partially indexed to North American natural gas prices. The first such commitment has already been made by Cheniere, and BC projects will face pressure to follow the precedent.
- **Cost**. Shale gas is expensive to develop, and BC's natural gas production will require new pipeline investments to reach tidewater. It will be critical to keep these costs under control, particularly if US projects compete aggressively for the market.
- **China**. Alternative sources of natural gas supply and growth in China's natural gas demand may prove to be the most important issue the BC projects face. China has immense shale gas resources of its own and a commitment to develop them. Over the past 20 years, China has also contracted for large volume, long distance pipeline supplies. Pipeline imports are expected to continue to grow. China's existing LNG suppliers are expanding their capacity and looking to expand trade with China. BC projects will be relative newcomers to the market and will face pressure to price their LNG to penetrate balanced (or even oversupplied) markets.

Taking into account all of these factors, the opportunity to build a successful new industry in BC is solid, *but not guaranteed*. Projects will face competition from each other, from domestic production in China and from pipeline imports to China. LNG suppliers have faced similar competitive situations in the past and should be well prepared. Competition, however, puts downward pressure on revenues and on the number of projects that can successfully move forward. The path forward should include the following steps:

- The BC government and industry need to move fast to out maneuver their competitors.
- The BC government should be prepared for a more modest natural gas boom in the event that projected production and revenues build more slowly.
- Greater attention needs to be paid to the risks facing the industry to ensure that price competiveness is maintained.
- Notwithstanding the economic boost expected from natural gas production, efforts to grow the natural gas industry should not crowd out other natural resource opportunities.

APPENDIX

This appendix summarizes the LNG projects that are currently under construction, have completed Front End Engineering and Design (FEED), or have been announced. Some projects that have been announced do not have specific timing associated with them as of the time of writing. Although every effort has been made to compile complete and accurate information, the details of many of these projects may have been revised. These lists are presented solely to provide the reader with an indication of the projects that we have included in our analysis.

REGIONAL SUMMARIES OF FUTURE LIQUEFACTION CAPACITY
(million tonnes per annum)

	AUSTRALIA	AFRICA	ASIA	EUROPE	MIDDLE EAST	NORTH AMERICA	CENTRAL & SOUTH AMERICA
Under Construction	56.9	14.4	13.4	15	10.8	0	0
Feed Completed	14.1	30.1	0	22.5	0	22.4+	3.2
Announced	35.2	80.5	9.8	2.6	26	192.9	9.2
Regional Totals	106.2	125	23.2	30.1	36.8	218.3	12.4
Total projected world liquefaction capacity: 559							

Sources: International Gas Union 2012b, A Barrel Full webite, project websites, Canada West Foundation

LIQUEFACTION PLANTS UNDER CONSTRUCTION

COUNTRY	PROJECT NAME	ANNOUNCED START YEAR	LIQUEFICATION CAPACITY (mtpa)
Algeria	Skikda – GL1K Rebuild	2012	4.5
Angola	Angola LNG T1	2012	5.2
Algeria	Arzew GL3Z (Gassi Touil)	2013	4.7
Iran	Iran Nioc LNG Terminal	2013	10.8
Australia	Gorgon LNG T1	2014	5
Indonesia	Donggi-Senoro LNG	2014	2
Papua New Guinea	PNG LNG T1	2014	3.3
Papua New Guinea	PNG LNG T2	2014	3.3
Australia	Queensland Curtis LNG T1	2014	4.3
Australia	Australia Pacific LNG T1	2015	4.5
Australia	Gladstone LNG T1	2015	3.9

Australia	Gorgon LNG T2	2015	5
Australia	Gorgon LNG T3	2015	5
Australia	Queensland Curtis LNG T2	2015	4.3
Malaysia	Malaysia LNG Terminal Train 9	2015	3.6
Malaysia	Malaysia FLNG Terminal	2015	1.2
Australia	Gladstone LNG T2	2016	3.9
Australia	Wheatstone LNG T1	2016	4.5
Australia	Wheatstone LNG T2	2016	4.5
Australia	Ichthys LNG T1	2017	4.2
Australia	Ichthys LNG T2	2017	4.2
Australia	Prelude LNG (Floating)	2017	3.6
Russia	Vladivostok LNG Terminal Project	2018	5

Sources: International Gas Union 2012b, A Barrel Full website, project websites, Canada West Foundation

LIQUEFACTION PLANTS THAT HAVE COMPLETED FEED

COUNTRY	PROJECT NAME	ANNOUNCED START YEAR	LIQUEFICATION CAPACITY (mtpa)
Colombia	Colombia LNG Export Terminal Project	2014	0.5
US	Sabine Pass LNG T1	2015	4.5
Australia	Pluto LNG T2	2015	4.3
Australia	Pluto LNG T3	2015	4.3
Australia	Newcastle LNG Terminal	2015	1
US	Sabine Pass LNG T2	2016	4.5
Australia	Australia Pacific LNG T2	2016	4.5
Nigeria	Brass LNG T1	2016	5
Nigeria	Brass LNG T2	2016	5
Eq. Guinea	EG LNG T2	2016	3.25
US	Port Lavaca Floating LNG Export Terminal Project	2018	4.4
US	Sabine Pass LNG T3	2017	4.5
US	Sabine Pass LNG T4	2017	4.5
Russia	Shtokman LNG	2017	7.5
Nigeria	NLNG T7	N/A	8.4

Nigeria	NLNG T8	N/A	8.4
Russia	Yamal LNG Terminal	2018*	15
Brazil	Santos Basin Floating LNG Terminal	n/a	2.7

Sources: International Gas Union 2012b, A Barrel Full website, project websites, Canada West Foundation

PLANNED LIQUEFACTION PLANTS

COUNTRY	PROJECT NAME	ANNOUNCED START YEAR	LIQUEFICATION CAPACITY (mtpa)
	REGION: AUSTRALIA		
Australia	Arrow Energy LNG	2020	8
Australia	Australia Pacific LNG	n/a	7
Australia	Bonaparte LNG Terminal	2018	2
Australia	Browse LNG Terminal (cancelled?)	2018	12
Australia	Crux Floating LNG Terminal	n/a	n/a
Australia	Fishermans Landing LNG Terminal	n/a	3
Australia	Gladstone LNG Terminal	n/a	2.2
Australia	Ptt Timor Sea FLNG Terminal	2016	2
Australia	Scarborough LNG Terminal	n/a	n/a
Australia	Sunrise LNG Terminal	n/a	n/a
Australia	Tassie Shoal LNG Terminal	201?	3
	REGION: AFRICA		
Mozambique	Anadarko Eni Mozambique LNG Terminal	2018	20 (final target of 10 trains at 5 mtpa each)
Cameroon	Cameroon LNG Terminal	2018	3.5
Egypt	Damietta Segas LNG Terminal Expansion	n/a	5
Eq. Guinea	ELNG IDCO LNG Terminal Expansion	n/a	n/a
Libya	Libya ENI LNG Terminal	n/a	n/a
Libya	Libya Shell LNG Terminal	n/a	n/a
Nigeria	Olokola LNG Terminal	n/a	22
Tanzania	Tanzania LNG Terminal Project	n/a	n/a
	REGION: ASIA		
Indonesia	Abadi Masela LNG Terminal	2016	2.5
Papaua New Guinea	Liquid Niugini Gulf LNG Terminal	2014	2

Malaysia	Sabah FLNG Terminal	n/a	1.5
Indonesia	Tangguh Train 3	2018	3.8
COUNTRY	**PROJECT NAME**	**ANNOUNCED START YEAR**	**LIQUEFICATION CAPACITY** (mtpa)
	REGION: EUROPE		
Russia	Baltic LNG Terminal	n/a	n/a
Georgia	Georgia LNG Export Terminal	201?	n/a
Norway	Hammerfest LNG Snohvit Expansion Project	n/a	n/a
Russia	Pechora LNG Terminal	2015/2016	2.6
	REGION: MIDDLE EAST		
Israel	Eliat LNG Terminal Project	2018	5
Iran	Pars LNG Terminal	201?	10
Iran	Persian LNG Terminal	n/a	8
Israel	Tamar Floating LNG Terminal	201?	3
	REGION: NORTH AMERICA		
Canada	Goldboro LNG Export Terminal Project	2018	10
US	Cameron LNG Export Terminal Project	2016	12
US	Corpus Christi LNG Export Terminal Project	2017	13.5
US	Dominion Cove Point LNG Export Terminal	2015	5
US	Freeport LNG Export Terminal Project	2016	4.4
US	Golden Pass LNG Export Terminal Project	201?	15.6
US	Jordan Cove LNG Export Terminal Project	201?	6
US	Magnolia LNG Export Terminal Project	201?	n/a
US	South Texas LNG Export Terminal Project	2018	8
US	Trunkline Lake Charles LNG Export Terminal Project	2018	15
US	Warrenton Oregon LNG Export Terminal	2018	9
	REGION: SOUTH & CENTRAL AMERICA		
Trinidad & Tobago	Atlantic LNG Terminal Expansion Project	n/a	n/a
Venezuela	Deltana Caribe LNG Terminal	201?	9.2
Colombia	El Viajano Altenesol LNG Terminal Project	201?	n/a
Venezuela	Gran Mariscal De Ayacucho Industrial Complex LNG Terminal	201?	n/a

Sources: International Gas Union 2012b, A Barrel Full website, project websites, Canada West Foundation

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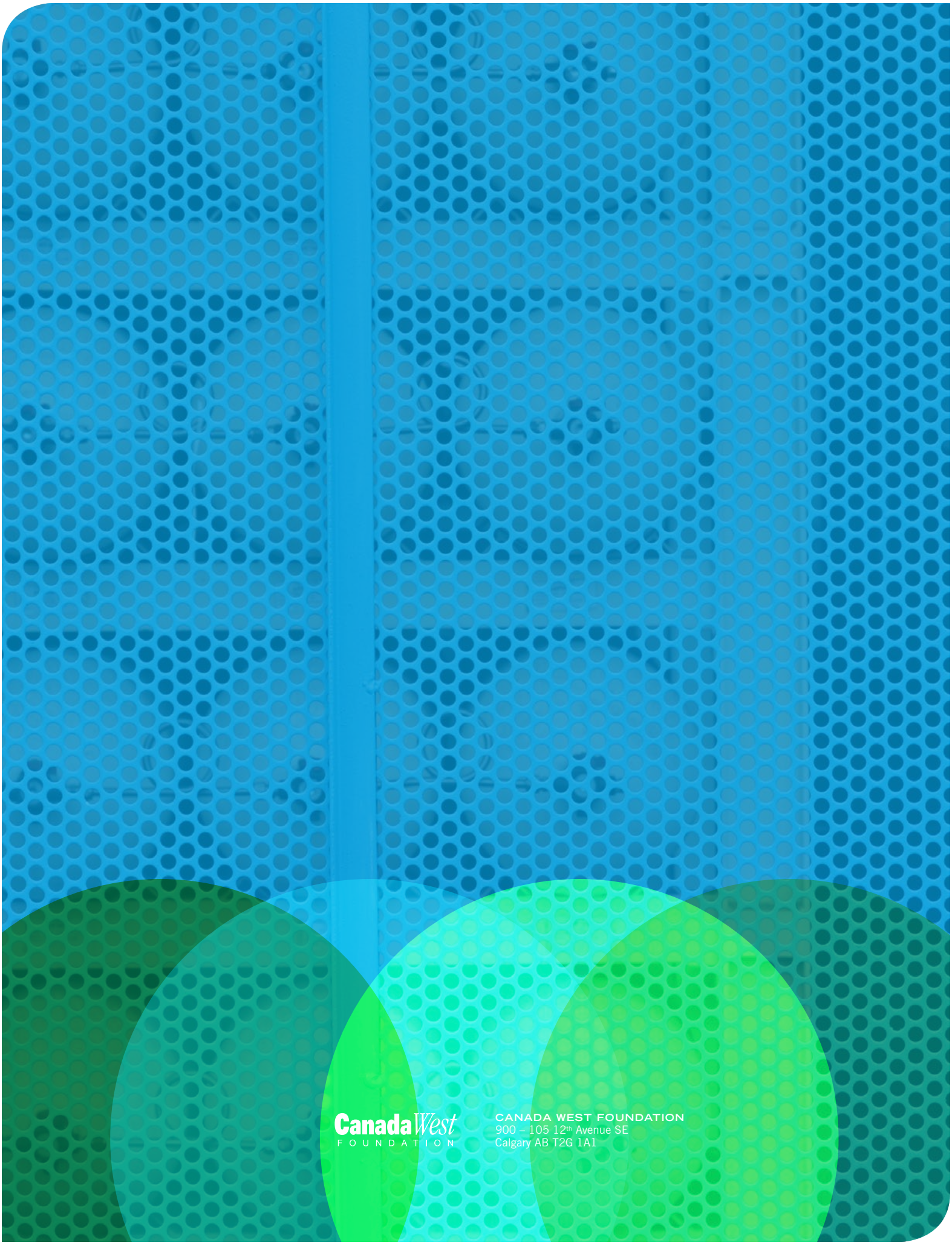

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