



Schedule "B"

Woodfibre LNG Export Pte. Ltd. Application for a licence to export liquefied natural gas for a term of 40 years: Gas Supplies, Requirements, Implications and Surplus Assessment Report

Abstract

This Report describes the gas Supplies expected to be available to the Canadian market, the expected gas Requirements for Canada, in each case with statements of underlying assumptions, and discusses the Implications of the proposed export volumes on the ability of Canadians to meet their gas requirements over the requested licence term. It concludes that the National Energy Board can satisfy itself that the quantity of gas to be exported does not exceed the Surplus remaining after due allowance has been made for the reasonably foreseeable requirements for use in Canada, having regard to the trends in the discovery of gas in Canada.

Contents

1.	Summary	3
2.	This Report is responsive to the NEB Act, Part VI Regulations and Filing Manual	7
	A. Further guidance.....	7
	B. The design of this Report	7
	C. Arrangement of material	8
	D. Quantities and time horizon	8
	E. Consideration of potential Information Requests	8
3.	Canadian natural gas requirements are met within a North American integrated market.....	10
	A. The context in which Canadian natural gas requirements are met is free trade within a North American energy market	10
	B. The North American gas market is physically integrated	10
	C. Physical interconnections produce market hubs where gas prices are formed and market liquidity is created	11
	D. Industry facilitates commercial integration by standardization of market transactions	11
	E. Some corporate activities are organized on a continental basis	11
	F. International data corroborate the integration.....	12
	G. Conclusion.....	12
4.	Depending on regional characteristics, exports and imports contribute to either gas supply or gas demand.....	14
	A. Canadian gas exports and imports	14
	B. Conclusion as to pipeline exports and imports	17
	C. U.S. gas production, exports, imports and apparent supply	17
	D. Mexico Gas Consumption, Imports and Production.....	19
	E. Conclusion.....	21
5.	The gas resource base in Canada, as well as North America overall, is large.....	22
	A. Gas Resources	22
	B. Gas reserves.....	23
	C. Roll-up of North American gas reserves and resources	24
	D. Conclusion as to trends in the discovery of gas.....	24
	E. Overall conclusion as to Canadian and North American gas resources	25
6.	The resource base can accommodate reasonably foreseeable Canadian demand, the LNG exports proposed in this Application, and a plausible potential increase in demand	26
	A. Approach to assessment of Canadian gas requirements (demand).....	26

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

B.	A description of expected gas requirements for Canada over the requested licence term through 2067 including underlying assumptions	26
C.	A description of gas supplies expected to be available over the requested licence term through 2067 including underlying assumptions	29
D.	A discussion of the economics and market factors affecting current and future LNG development in Canada that may limit volumes of Canadian LNG exports	32
E.	Conclusion: The resource base can accommodate reasonably foreseeable Canadian demand	32
7.	The incremental cost of adding new production to supply any exported LNG or to satisfy a plausible demand increase is low	34
A.	Supply cost reductions and outlook	34
B.	AEO 2016 projects dramatically lower gas prices than AEO 2015.....	34
C.	Market prices in relation to supply costs.....	35
D.	Conclusion.....	36
8.	The North American Gas Market	37
A.	A mature marketplace	37
B.	A large number of buyers and sellers	37
C.	An extensive and growing pipeline and storage network	37
D.	A sophisticated commercial structure	38
E.	Conclusion.....	39
9.	Gas markets in North America have functioned efficiently and there is no evidence to suggest that they will not continue to do so in the future	40
A.	Efficient market functioning	40
B.	Evidence for continued efficient market functioning.....	40
C.	No reason to consider that Woodfibre LNG Export’s shipments will impair efficient market functioning.....	42
D.	Conclusion.....	43
10.	The evidence in this Application is generally consistent with the Board’s own market monitoring.....	44
A.	The Board’s market monitoring.....	44
B.	Consistency with the Board’s market-monitoring.....	44
C.	Conclusion.....	46
11.	Conclusion as to the outlook for market fundamentals through 2067:	47
A.	Policy and regulation	47
B.	Industry structure and behaviour	49
C.	Conclusion as to market fundamentals	49
D.	Overall conclusion as to Characteristics and Functioning of the Gas Sector from which Canadians are able to meet their gas requirements.....	49

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

12.	Conclusion as to the ability of Canadians to meet their gas requirements:.....	51
A.	Conditions under which Canadians are currently able to meet their gas requirements:	51
B.	Reasonable expectations as to the ability of Canadians to meet their gas requirements in the presence of the applied-for export quantities and during the requested term	51
C.	Conclusion as to Implications	52
13.	Conclusion as to Surplus pursuant to s.118 of the NEB Act.....	53
D.	The criterion.....	53
E.	Allowance for reasonably foreseeable requirements for use in Canada	53
F.	Having regard to trends in the discovery of gas in Canada	53
G.	The Conclusion of this Report regarding the Surplus Criterion	53
	Annex 1: Projected Canadian Gas Supplies and Requirements (Bcf/d) Annually 2015-2067 (expansion of Table 4 in the main text)	55
	Annex 2: Technological improvements in Canadian gas resource assessments	58
	Annex 3: The reasons why this Report discards any attempt to provide a detailed description of 50-year Canadian gas requirements.....	60
	Annex 4: Some further considerations relating to Canadian gas requirements.....	62
	Annex 5: A Discussion of the economics and market factors affecting current and future LNG development in Canada that may limit volumes of Canadian LNG exports to about 6.0 Bcf/d, including Woodfibre LNG Export’s requested quantity of 0.32 Bcf/d	64

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

List of Acronyms and Abbreviations

AECO	A pipeline and storage hub, originally developed by the Alberta Energy Company, now operated by Niska Gas Storage, commercially a term of art for a leading Canadian price-setting benchmark
AEO 2016	Annual Energy Outlook (of the U.S. EIA) 2016, dated August 2016
AER	Alberta Energy Regulator (formerly: Energy Resources Conservation Board)
BC	British Columbia
Bcf	Billion cubic feet
Bcf/d	Billion cubic feet per day
Board	National Energy Board
CGPC	Canadian Gas Potential Committee
CPA	Canadian Petroleum Association
DOE	Department of Energy of the U.S.
DOE/FE	Department of Energy/Office of Fossil Energy
EIA	Energy Information Administration
EBN	Energy Briefing Note (of the NEB)
EJ	Exajoule (approximately 0.95 Tcf)
EMA	Energy Market Assessment (of the NEB)
EMR	(Department of) Energy Mines and Resources
FERC	Federal Energy Regulatory Commission
FID	Final Investment Decision
FTA	Free Trade Area
GHG	Greenhouse Gas
GSC	Geological Survey of Canada
Guide Q	NEB Filing Manual, Guide Q
ICE	Intercontinental (Commodities) Exchange
IEA	International Energy Agency
ISPG	Institute of Sedimentary and Petroleum Geology (of the GSC)
LDC	Local (Gas) Distribution Company
LNG Canada	LNG Canada Development Inc.
LNG	Liquefied natural gas
MBP	Market-Based Procedure
MMBtu	Million British thermal units
MMcf/d	Million cubic feet per day
MT	Million tonnes (of LNG)
Mtpa	Million tonnes per annum
NAFTA	North American Free Trade Area
NEB	National Energy Board
p.a.	per annum

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

PJ	petajoules
PNW LNG	Pacific NorthWest LNG Ltd.
R/P	Reserves to Production Ratio
Report	Report on Gas Supplies, Requirements, Export Implications and Surplus Assessment
SOEP	Sable Offshore Energy Project
Tcf	Trillion cubic feet
2013 Application	Woodfibre LNG Export's licence Application dated July 23, 2013
U.S.	United States of America
WCC	WCC LNG Ltd.
WCSB	Western Canadian Sedimentary Basin
WEO	World Energy Outlook (of the IEA)
Woodfibre LNG Export	Woodfibre LNG Export Pte. Ltd.
Woodside	Woodside Energy Holdings Pty.

1. Summary

This Report responds to three of the Board's four Filing Requirements in Guide Q--Export and Import Authorizations (Part VI of the *NEB Act* and Part VI Regulations) by providing: (regarding #2) a description of gas supplies available to the Canadian market over the requested licence term; (#3) a description of expected gas requirements similarly; and (#4) the implications of the proposed export volumes on the ability of Canadians to meet their gas requirements. The remaining requirement (#1), namely the source and volume of gas to be exported, is addressed in Woodfibre LNG Export's application document under Part F thereof. The Report deals with these three requirements principally by inquiring whether the conditions previously identified by the Board, and which led to its 16 December 2013 decision to issue a 25-year licence to Woodfibre LNG Export,¹ are likely to prevail in the period through December 31, 2067. The Report steps through each of the salient Views typically expressed by the Board in its relevant Letter Decisions, and in approximately the same order as the Board has them.

(Section 2, pages 7-9)

Canadian gas requirements are met within an integrated North American market. The physical integration features market hubs where gas prices are formed and market liquidity is created. The industry is commercially integrated and has common standards for market transactions. Some corporate activities are organized on a continental basis. International commentaries and data corroborate this integration. As to the perspective through the mid-2060s and beyond, the physical-infrastructure, trade-policy, national-policy, national-regulatory and commercial underpinnings of the integrated North American market will remain and, if anything, will tend to strengthen.

(Section 3, pages 10-13)

Depending on regional characteristics, exports and imports of gas contribute to Canadian gas supply or gas demand. In terms of pipeline trade, the outlook is for Canadian exports, increasingly concentrated in the west, to continue to decline and imports to Central and eastern Canada to increase, leading eventually to a situation of modest net pipeline exports from the 2040s. Reliance is placed on NEB projections of this trade to 2040, extrapolated through 2067. The decline in pipeline exports will be compensated by a substantial net export trade in LNG from the 2020s, including the exports in this Application, which Canadian supply can adequately support. In this perspective, net gas exports—LNG plus pipeline—would not regain the levels of the early 2000s during the forecast period.

(Section 4, pages 14-21)

The gas resource base in Canada as well as North America is large. Assessments of gas resources continue to increase as do continental proven gas reserves. Some major gas plays await comprehensive assessment. As this is done, it will add to the size of the estimated resource. Future trends in the discovery of gas, to which the Board is required to have regard, must be assessed as favourable in view

¹ Issuance was of course subject to Governor in Council approval which was granted on 31 March 2014.

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

of the size of the resources from which they will be developed and of recent experience in terms of growing proven gas reserves in Canada and North America. Contrasting work put before the Board by the petroleum industry in 1969 with current assessments of the NEB and provincial agencies, there has been enormous sophistication in the technology of gas resource assessment.

(Section 5, pages 22-25)

The resource base can accommodate reasonably foreseeable Canadian demand, including Woodfibre LNG Export's proposed exports, and a plausible potential increase in demand. This Report adopts and then extrapolates the Board's *Energy Future 2016* reference case projection of Canadian demand plus a potential 20%-plus sensitivity case. The assumption underlying the projections of Canadian gas supply and requirements in this Report--that demand will drive production rather than that production will be constrained by the resource--is made essentially because of the great size and early stage of exploitation of the WCSB's unconventional gas resource. This is similar to the findings of current American studies: gas demand for new LNG exports will be met out of increased production, and will not be at the expense of reduced supply to domestic consumers. Moreover, it is considered that the resource base is so large that it can satisfy projected Canadian requirements including those of Woodfibre LNG Export through 2067 and beyond, even were the acknowledged forecasting risks to result in a significant error on the upside regarding those requirements, which is considered unlikely.

(Section 6, pages 26-33)

Not all LNG export licences will be used or used to the full allowance. This Report therefore adopts the NEB high case projection of LNG exports from the Board's *Energy Future 2016*. The exports proposed by Woodfibre LNG Export are considered as part of the projected total. Annex 5 to this Report discusses the economic and market factors affecting current and future LNG development in Canada that may limit volumes of Canadian LNG exports.

(Section 6, at pages 26-33, Annex 5 at pages 64-67)

Costs of incrementing gas production from unconventional resources seem to be falling, largely due to continuing industry efficiencies. It appears that the marginal cost of adding new production to supply exported LNG or to satisfy a plausible domestic demand increase is low and will remain so for a foreseeable future. However, market gas prices reflect the interplay of demand and supply forces and will not necessarily track supply-cost trends. Should market prices rise as a result of accelerated gas production to supply the Woodfibre LNG Export project through 2067, the proportionate effect on Canadian consumer prices is likely to be minor: for residential users, the gas commodity cost is less than half of the total per unit gas bill. Moreover, it seems not to be the purpose of export licensing to protect domestic consumers from price increases that might be associated with exports, whether pipeline or LNG. Indeed, from a policy standpoint, higher rather than lower prices may be preferable for a non-renewable resource of which Canada will remain a net exporter.

(Section 7, pages 34-36)

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

The gas marketplace in Canada and North America is characterized by a large number of buyers and sellers, an extensive and growing infrastructure and a sophisticated commercial structure. The vigorously competitive pipeline and storage sector is constantly seeking out new investment opportunities, and a sophisticated commercial structure. It is entirely reasonable to consider that these characteristics will continue and even be enhanced in a 50-year perspective and in the presence of Woodfibre LNG Export's applied-for gas exports.

(Section 8, pages 37-39)

Gas markets in Canada and North America function efficiently and there is no evidence to suggest they will not continue to do so. North American gas markets approach the conditions of perfect competition: prices continuously equilibrate supply and demand, there are neither shortages nor surpluses at market prices, and abundant mechanisms ensure transparency and market operability. The market is large, open, growing, transparent, liquid, integrated, efficient, flexible and price- responsive. There is no reason to think that these conditions will be significantly different over a 50-year time horizon than over the 25-year term of Woodfibre LNG Export's existing licence plus its 10-year sunset provision.

(Section 9, pages 40-43)

The evidence in this Application is generally consistent with the Board's own published market monitoring. This can be traced since Woodfibre LNG Export's 25-year licence application was approved by the Board's 16 December 2013 Letter Decision. Thus, in its *Annual Reports*, *Market Snapshots* and *Energy Market Assessments*, the Board's monitoring corroborates this Report in relation for example to: gas resources; industry competition; international gas trade; the rising importance and influence for Canada of U.S. resources such as the Marcellus; limitations on potential Canadian LNG exports; and the favourable gas market behaviours observed in the 30 years since Canadian commodity market deregulation.

(Section 10, pages 44-46)

Sound gas market fundamentals are strongly underpinned. There is no reason to expect that over the coming 50 years, and with Woodfibre LNG Export's shipments taking place during 40 of those years, today's sound market fundamentals will be impaired. The policy, regulatory and commercial underpinnings of those fundamentals in both countries are sound and can reasonably be expected to endure, indeed to be enhanced.

(Section 11, pages 47-50)

The Implications component of this Report considers that Canadians have for 30 years been able to meet their gas requirements easily, adequately, cost competitively and securely. The overall conclusion is that they will be able to continue doing so in the presence of the applied-for export quantities. Gas resources and supplies drawn from those resources are more than adequate to meet all foreseeable requirements for combined Canadian use, a 20% upside sensitivity in that use, pipeline and LNG exports,

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

including Woodfibre LNG Export's shipments, in the context of a fully functioning, integrated North American market.

(Section 12, pages 51-52)

The Surplus Assessment component of this Report finds that the natural gas proposed to be exported by Woodfibre LNG Export satisfies the Surplus Criterion as expressed in s.118 of the NEB Act. True, there is uncertainty in projecting reasonably foreseeable requirements fifty years out. But trends in the discovery of gas have been and look to be favourable. And the gas resource base in Canada, as well as North America is large in relation to requirements no matter how they are assessed. Indeed, the capability of the resource will not be the limiting factor on the supply of gas in the period through 2067 and beyond. On the contrary, the limitation on gas supply will continue to be the availability of economic markets available to Canadian gas producers. Woodfibre LNG Export's intended shipments constitute one of those markets.

(Section 13, page 53)

Annex 1 at pages 55-57 presents *Projected Canada Gas Supplies and Requirements (Bcf/d) Annually 2015-2067* in tabular and graph form.

Annex 2 at pages 58-59 discusses technical progress in Canadian gas resource assessments in four historical phases.

Annex 3 at pages 60-61 presents reasons why this Report does not purport to provide a detailed description of Canadian gas requirements 50-years out.

Annex 4 at pages 62-63 draws on the work of an exponent of the scenario approach to consider possible implications for Canada's energy future of global outlooks at mid-century and beyond.

Annex 5 at pages 64-67 is a discussion of the economics and market factors affecting current and future LNG development in Canada that may limit volumes of Canadian LNG exports. The discussion is arranged in relation to project-specific factors and global considerations.

2. This Report is responsive to the NEB Act, Part VI Regulations and Filing Manual

This Report is to assist and enable the National Energy Board (“Board” or “NEB”) to fulfill its mandate, pursuant to s.118 of its Act, to assess whether the natural gas proposed to be exported by Woodfibre LNG Export does not exceed the surplus remaining after due allowance has been made for the reasonably foreseeable requirements for use in Canada, having regard to trends in the discovery of natural gas in Canada. This is termed by the Board “the Surplus Criterion”.

The Report assists the Board in two ways.

First, by describing over the requested licence term, expected Canadian gas supplies and requirements, including underlying assumptions, and the Implications of the proposed export volumes on the ability of Canadians to meet their gas requirements (“**the Supplies, Requirements and Implications component**” which is Sections 3 through 12).

Second, by submitting a surplus Assessment (“**the surplus Assessment component**” which is Section 13) based on those descriptions and Implications.

This Report therefore responds to the Board’s Filing Manual, Guide Q – Export and Import Authorizations (Part VI of NEB Act and Part VI Regulations) dated 28 August 2013, Release 2013-3 and to the *Filing Requirements* stated therein, specifically page 5Q-1, item 4 (“The implications of the proposed export volumes...”) with reference also to items 2 (“A description of gas supplies...”) and item 3 (“A description of expected gas requirements...”). The matter of item 1 “The source and volume of gas to be exported” is addressed in the Application document under Part F.

A. Further guidance

The Report also responds to the optional invitation in Guide Q under *Further Guidance* to consider trends in Canadian gas demand and supply and the availability of sources of gas to Canadians (under Section 6.), availability of gas supply from the United States (“U.S.”) and other global sources (under Section 4.), past trends in gas discoveries and whether they can be extrapolated (under heading 5.b.) and technological improvements in resource assessments (also under heading 5.b.).

B. The design of this Report

This Report is framed in relation to the salient elements of the evidence supporting Woodfibre LNG Export’s 23 July 2013 Application (“2013 Application”) for a 25-year gas export licence that the Board found persuasive in its Letter Decision of 16 December 2013 and Views expressed therein. Also, as suggested by the Board in Guide Q, it has sought additional guidance from the Board’s Reasons for Decision in LNG Canada Development Inc.’s application for a licence which was issued 4 February 2013. It provides evidence, analysis and reaches conclusions as to whether the conditions that persuaded the Board in applications for 25-year licences in respect of the period through about 2050 are likely to prevail at least through December 31, 2067 in respect of the current Application.

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

Additionally, the content of this Report also has regard to the *Views* expressed by the Board in its most recent decision on an application for a 40-year LNG export licence (Pacific NorthWest LNG Ltd. (“PNW LNG”) NEB Reasons for Decision, 13 October 2016) as well as its penultimate similar decision (WCC LNG Ltd (“WCC”), 28 July 2016). For example, comments are included on the matter of North American free trade (page 10), uncertainties in resource assessments (page 22) and limitations on the global market for LNG (page 62).

C. Arrangement of material

The Report steps through each of the salient *Views* typically expressed by the Board in its relevant Letter Decisions, and generally in the same order. It does so in regard to such matters as the integrated North American gas market (Section 3), the role of exports and imports in Canadian gas supply and demand (Section 4), the adequacy of the resource base (Section 5), reasonably foreseeable Canadian gas requirements (Section 6), the incremental cost of adding new production (Section 7), marketplace characteristics (Section 8), efficiency in market functioning (Section 9), findings of the Board’s own monitoring (Section 10) and the continuity of market functioning (Section 11). The Implications for Canadians of the applied-for export quantities are dealt with in Section 12 and the surplus assessment is presented in Section 13.

D. Quantities and time horizon

The examination of Implications and the Assessment of Surplus in this Report is based on the maximum annual quantity ($3.34 \times 10^9 \text{ m}^3$) and the maximum term quantity ($133.6 \times 10^9 \text{ m}^3$) of gas, both including the requested 15% tolerance, applied to be exported by Woodfibre LNG Export under a licence expiring 10 years after issuance, if exports have not by then commenced. If the applied-for licence were to be issued in 2017 and if unforeseen circumstances were to result in the full operation of the requested “sunset provision”, some of the exports could occur as late as 2067 and the Gas Supplies, Requirements, Implications and Surplus Assessment Report therefore deals with the period through 2067 and indeed beyond that year. The requested annual quantity, including tolerance, is expressed in imperial units for purposes of comparison as 0.32 Bcf/d.

E. Consideration of potential Information Requests

The Report seeks to anticipate information requests which have been put to previous applicants, including such matters as:

- Assessment period in relation to the requested licence term and expiration date (see immediately preceding paragraph).
- Estimate of remaining marketable natural gas resources in Canada in Tcf and exajoules (“EJ”) and the values of technically recoverable natural gas resources, in Tcf and EJ, for all North America (page 24).
- A detailed quantitative projection of Canadian natural gas production and Canadian requirements, on an annual basis to the year 2067, in tabular and graph form, including the 20% demand sensitivity and the corresponding production to meet the projected demand

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

growth, the underlying assumptions supporting both projections, and the natural gas prices that the projections are based upon (Section 6, pages 26-33 and Annex 1).

- Projected net gas exports by pipeline and in the form of LNG (data are presented quantitatively on an annual basis in Table 1 on page 15).
- Projected demand sensitivity and other projected supply and demand parameters (data are presented on the same basis in Table 4 on page 26).
- Availability of third party studies of gas supplies and requirements through 2067 and beyond (page 29).
- Risk factors in projecting gas requirements and supply (page 53).
- Factors that may limit Canadian LNG exports (discussed in **Annex 5**, pages 64-67).

3. Canadian natural gas requirements are met within a North American integrated market

A. The context in which Canadian natural gas requirements are met is free trade within a North American energy market

This Report defines the term “North America” as Canada, Mexico and the United States.

The 1992 North American Free Trade Agreement (“NAFTA”, “the Agreement”) is the foundation for continental natural gas trade free trade. Chapter Six of the NAFTA, *Energy and Basic Petrochemicals*, provides the specifics for trade in such goods. True, a party may withdraw from the Agreement on six months’ notice (Article 2205). However, the cost of dismantling the economic integration (for example: to the automotive manufacturing industry) created by the NAFTA would be so great that dissolution appears unthinkable. And the physical infrastructure for a continentally-integrated gas market will clearly be maintained and expanded.

B. The North American gas market is physically integrated

The North American pipeline “grid” covers essentially the whole of the continent. The only large proven gas reserves that are not connected to it are those of the Alaska North Slope and the three major gas fields in the Mackenzie Delta. The Government of Alaska is currently examining options to commercialize North Slope gas. There were at the end of 2008 about 31 pipeline connections of varying sizes between Canada and the U.S. and 18 between the U.S. and Mexico.²

The international, interprovincial and interstate gas transmission system comprises “open-season open-access” pipelines which offer non-discriminatory service, subject of course to predefined, regulator-approved general terms and conditions.

Not only is the physical infrastructure of pipelines and storage facilities large and interconnected, it is also growing. Many new pipeline projects are in the phase of commercial development and regulatory application in Canada and the U.S. The Board has commented on this in the following terms under the caption *Natural Gas: North American Trends: Supply on Eastern Canada’s Doorstep* in its February 2016 report *Canadian Energy Dynamics: Highlights of 2015 - Energy Market Analysis*.³

To enable delivery of U.S.-produced natural gas into eastern Canada and to meet growing demand in that market, new pipeline infrastructure is being built and existing infrastructure is being expanded. For example, Niagara, historically an export point, was reversed in late 2012 to enable the import of approximately 400 million cubic feet per day (MMcf/d) from the U.S. into eastern Ontario. In the last quarter of 2015, capacity at Niagara was further expanded and the point saw imports increase to

²U.S. Department of Energy, Energy Information Administration (“EIA”): *US Natural Gas Import/Export Locations, as of the end of 2008* (these data have not been updated in the past seven years), online: http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/impex_map.html

³ Online: <https://www.neb-one.gc.ca/nrg/ntgrtd/mrkt/dnmc/2015/index-eng.html#s9>

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

approximately 600 MMcf/d. Also in late 2015, the Chippawa export point was reversed to allow for the import of approximately 150 MMcf/d into Ontario.

C. Physical interconnections produce market hubs where gas prices are formed and market liquidity is created

The North American pipeline system incorporates pipeline connections and storage facilities which constitute “hubs” where the physical conditions exist for sales and purchases to take place, prices to be formed and market data reported publicly. Well known examples of such hubs are the AECO Hub in Alberta⁴, Henry Hub in Louisiana⁵ and the Dawn Hub in Ontario⁶. There are some two dozen hubs in North America and as many as 90 geographical points where gas prices are formed and reported such as Spectra Westcoast Station 2 in British Columbia (“BC”).⁷

D. Industry facilitates commercial integration by standardization of market transactions

The pre-eminent institutional example of this cooperation is the North American Energy Standards Board which states its purpose as follows:

*The North American Energy Standards Board (NAESB) serves as an industry forum for the development and promotion of standards which will lead to a seamless marketplace for wholesale and retail natural gas and electricity, as recognized by its customers, business community, participants, and regulatory entities.*⁸

E. Some corporate activities are organized on a continental basis

For example, Natural Gas Exchange Inc., which is owned by the TMX Group and has operated since 1994, states that:

Natural Gas Exchange Inc. (NGX), headquartered in Calgary, Alberta, Canada, provides electronic trading, central counterparty clearing and

⁴ See *Niska Gas Storage, Our Business*, online: <http://www.niskapartners.com/our-business/natural-gas-storage/aeco-hub/>

⁵ For price data see CME Group, *Henry Hub Natural Gas Futures Quotes*, online: http://www.cmegroup.com/trading/energy/natural-gas/natural-gas_quotes_volume_voi.html?0.6952843843731924=

⁶ For information about storage, pipeline connections and services see Union Gas, *About Dawn*, online: <https://www.uniongas.com/storage-and-transportation/about-dawn>

⁷ For illustrative information regarding prices etc. at Westcoast Station 2, online: http://www.naturalgasintel.com/data/data_products/daily?region_id=canada&location_id=CDNWST2?region_id=canada&location_id=CDNWST2

⁸ North American Energy Standards Board, *About NAESB*, online: <http://www.naesb.org/aboutus.asp>

Gas Supplies, Requirements, Implications and Surplus Assessment

Shell Energy North America has this to say about its trading activities:

F. International data corroborate the integration

G. Conclusion

12

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

North American rather than on a national geographical basis. There is a huge volume of intra- and international gas trade and a high degree of transparency in terms of commercial, governmental and regulatory information. In this latter connection, the Board's 2015 annual report states that one of its outputs with respect to market information is the publication of energy data and studies on specific energy issues. These products, the Board notes, offer neutral, independent, fact-based energy information that supports the Board's status as an expert tribunal, increases the transparency of Canadian energy markets and supports energy literacy.¹³

This then is the free-trading, integrated North American market within which Canadians' gas requirements are met.

As to the perspective through the late-2060s, the physical-infrastructure, trade-policy, national-policy, national-regulatory and commercial underpinnings of that integrated market will likely remain and, if anything, will tend to strengthen. Worldwide trends are clearly towards freer trade (example: the Trans-Pacific Partnership, the World Trade Organization).

The policy, regulatory and commercial contexts in which Canadians' gas requirements are met are integrated, international and continental rather than national. Canadians have access to American and Mexican gas resources and vice-versa. The only plausible assumption for purposes of this Report is that these conditions within which Canadians' gas requirements are met likely will remain for an indefinite future.

¹³ NEB, *Annual Report 2015*, page 30, *Energy Markets in 2015*.

4. Depending on regional characteristics, exports and imports contribute to either gas supply or gas demand

Regarding the Further Guidance portion of Guide Q, this section of the Report addresses the availability of gas supply from the U.S. and other global sources, specifically LNG imported to Canada.

A. Canadian gas exports and imports

Based on data published by the Board entitled *2015 Natural Gas Exports and Imports Summary*¹⁴ exports currently contribute about 7.5 Bcf/d to Canadian gas demand and imports, including LNG imports, add about 1.9 Bcf/d to Canadian gas supply for a net draw on Canadian gas supply, that is exports minus imports, of about 5.5 Bcf/d (this net number is slightly different from the one used in Table 1 which is based on data from the NEB Report *Canada's Energy Future 2016: Energy Supply and Demand Projections to 2040*, released January 27, 2016 [*"Energy Future 2016"*] Table 6.5, and may be different again from data included in the Board's *Canadian Energy Dynamics: Highlights of 2015* released February 12, 2016. These differences are trivial in relation to the overall numbers examined and conclusion drawn from them in this Report). Exports have declined from about 8.9 Bcf/d in 2010 and imports which registered about 2.2 Bcf/d in 2010, reached 3.0 Bcf/d in the two succeeding years and then fell back.¹⁵

The principal consideration affecting both Canadian pipeline gas exports and Canadian pipeline and LNG imports is the enormous size of the U.S. unconventional gas resource, the vigour of its exploitation, the seeming continuous increases in well productivity and decline in unit costs. The largest resource, as presently assessed, is located in the northeastern region of the U.S. comprising mainly gas from the Marcellus and Utica formations where production now exceeds that of the whole Western Canadian Sedimentary Basin ("WCSB") and is still growing. These gas formations are the principal sources challenging western Canadian gas in Central Canada markets. The Canadian pipeline industry may seek to meet this challenge by adjusting its rates: TransCanada PipeLines is reported in July 2016 to be discussing the potential for new 10-year transportation contracts from Alberta to Ontario that would cost 40 to 50 percent less than a current comparable toll. If an open season process moves forward as planned, shipments under the new rates could start in late 2017. Such rates would of course require the Board's approval.¹⁶

Production from the Marcellus and Utica, which was less than 2.0 Bcf/d in 2010, is currently of the order of 22 Bcf/d and is forecasted to reach 34 Bcf/d by 2025. The Marcellus and Utica formations are among the world's largest natural gas plays. They have accounted for 85% of the growth in U.S. shale gas

¹⁴ Online: <https://www.neb-one.gc.ca/nrg/sttstc/ntrlgs/rprt/ntrlgssmmr/2015/smmry2015-eng.html>

¹⁵ Source: NEB, *2014 Natural Gas Imports and Exports Summary*. Online: <https://www.neb-one.gc.ca/nrg/sttstc/ntrlgs/rprt/ntrlgssmmr/2014/smmry2014-eng.html>

¹⁶ Source: Bloomberg News, online: <http://www.bloomberg.com/news/articles/2016-07-21/transcanada-prepares-to-court-bids-for-cheaper-mainline-gas-toll>

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

production January 2012-June 2015¹⁷ and Pennsylvania, the heart of the Marcellus play, led the U.S. in terms of 2014 gas reserves additions at 10.4 trillion cubic feet (“Tcf”).¹⁸ The NEB has commented that the Marcellus region added “a Canada’s worth” of production to the North American integrated gas market in just six years.¹⁹

This Report’s projection of gas exports and imports is presented in Table 1:

Table 1: Contribution of Exports and Imports to Gas Requirements for Canada (Billion cubic feet daily - Bcf/d)

		2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2067
1	+Net Pipeline Exports	5.2	3.6	2.4	1.2	0.7	0.2	0.2	0.2	0.2	0.2	0.2
2	+ Net LNG Exports	--	1.9	4.7	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9
3	=Net Exports	5.2	5.5	7.1	7.1	6.6	6.1	6.1	6.1	6.1	6.1	6.1

The assumptions underlying this projection are as follows:

Line 1: net pipeline exports, through 2040, are derived from *Energy Future 2016* the Board’s net exports data minus the Board’s reference case projection of LNG exports. The outlook for net pipeline exports to diminish to about 0.2 Bcf/d by 2040 was reiterated by the Board in a June 2016 *Market Snapshot* which stated: *net exports of natural gas by pipeline to the U.S. decline from 5.1 Bcf/d in 2015 to 0.2 Bcf/d in 2040.*²⁰ It is not possible or necessary to reconcile this projection with that of the U.S. Energy Information Administration’s (“EIA”) *Annual Energy Outlook 2016*²¹ (“AEO”) in Table 2 below. For 2040 AEO 2016 projects net imports from Canada at 1.6 Bcf/d²² (exports from Canada 3.64 and imports to Canada 2.05 Bcf/d). In the broad scheme of things, this difference is inconsequential.

Net pipeline exports beyond 2040 are assumed to average about 0.2 Bcf/d. This is a notional number. There is no calculus to support this assumption. Canadian pipeline exports after 2040

¹⁷ EIA, *Marcellus, Utica provide 85% of U.S. shale gas production growth since 2012*, July 28, 2015. Online: <https://www.eia.gov/todayinenergy/detail.cfm?id=22252>

¹⁸ EIA, *U.S. Crude Oil and Natural Gas Reserves*, release November 23, 2015. Online: <https://www.eia.gov/naturalgas/crudeoilreserves/>

¹⁹ NEB, *Canadian Energy Dynamics Highlights of 2015*, 12 February 2016, section heading *Supply on Eastern Canada’s Doorstep*.

²⁰ *Market Snapshot: Even with LNG, net pipeline exports of natural gas expected to decline*, published 2016-06-15. Online: <https://www.neb-one.gc.ca/nrg/ntgrtd/mrkt/snpst/2016/06-03ntpplnxprt-eng.html>

²¹ Complete report, dated August 2016 and released September 15, 2016. Online: [http://www.eia.gov/forecasts/aeo/pdf/0383\(2016\).pdf](http://www.eia.gov/forecasts/aeo/pdf/0383(2016).pdf) The data used in this Report are taken from the separately published *Projections Tables by Case*, subsection *Petroleum, natural gas, coal, and macroeconomic* (tables 59-74), see footnote 22. The data that are summarized in the full AEO 2015 Report released September 15, 2016 are fully consistent with the tabular Early Release material which is used in this Report, see next footnote.

²² AEO 2016, Table 62: *Natural Gas Imports and Exports*. Online: https://www.eia.gov/forecasts/aeo/tables_ref.cfm

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

are likely to be concentrated in the mid-western and western U.S. states. Canadian gas markets east of Manitoba, including the Maritimes, are likely to be largely or even entirely supplied by imports of gas from the U.S.

Line 2: net LNG exports, this Report adopts the NEB's high case projection of LNG exports at 6 Bcf/d through 2040 (*Energy Future 2016*, page 103, Figure 11.1 and related text) and continues it through 2067 at the same rate. It assumes that during their 40-year term, whenever that occurs, Woodfibre LNG's Export's shipments, including the 15% tolerance, at 0.32 Bcf/d are part of that 6 Bcf/d total. The 6 Bcf/d number is consistent with the longstanding objective of the Government of BC to have three liquefaction and export projects in operation by the early 2020s.²³ The Government of BC in July 2016 states: *Five larger LNG plants are expected to require 4.2 tcf per year for production.*²⁴ This is equivalent to some 11.5 Bcf/d. The high case in *Energy Future 2016* is consistent with the expert evidence cited by the Board in its Letter Decision of 13 August 2015 in relation to the application by Bear Head LNG Corporation, with projections falling within the range of 1.3 to 10.3 Bcf/d (of which 1.6 Bcf/d in Eastern Canada) low and high case projections.²⁵

LNG exports from eastern Canada: with *Energy Future 2016* at page 106, this Report does not find it necessary to project this element. It is assumed that the feedgas for projects in the Maritimes will almost certainly be drawn from U.S. sources.²⁶ This is because local onshore sources are under *de facto* moratoria, existing pipeline-connected offshore sources are expected to be exhausted by the 2020s and prices available for exported LNG are unlikely to be sufficient to justify commercial development of new offshore gas resources. Under this assumption, imports of pipeline gas from the U.S. would balance exports of LNG from Canadian Maritimes projects. It is of course recognized that the provision of U.S. gas to the Maritimes by new and reversed pipelines is subject to uncertainties related to such matters as financeability, long-term shipper commitments, regulatory and environmental approvals.

LNG imports: this Report assumes that only the existing Repsol/Irving LNG import facility having a capacity of some 1.0 Bcf/d is operational during the projection period. It is further assumed that the existing Maritimes and Northeast Pipeline will be reversed by about 2020 to flow U.S. gas northeastwards and that, because of the abundance of U.S. onshore supply, the Repsol/Irving import facility will only be used seasonally to supply some of winter peak requirements in the Maritimes and, by displacement, in New England. The assumed average

²³ Ministry of Energy and Mines, *British Columbia's Natural Gas Strategy* (undated), pages 1 and 2. Online: <https://www.neb-one.gc.ca/nrg/sttstc/ntrlgs/rprt/ntrlgssmmr/2014/smmry2014-eng.html>

²⁴ FACTSHEET: *Facts about LNG in British Columbia*, dated July 6, 2016. Online: <https://news.gov.bc.ca/factsheets/factsheet-facts-about-lng-in-british-columbia>

²⁵ NEB, Letter Decision, *Bear Head LNG Corporation*, page 3, last paragraph.

²⁶ Two of the Canadian Maritimes LNG projects on February 5, 2016 received Orders of the U.S. Department of Energy, Fossil Energy ("DOE/FE"), for the export of feedgas from the U.S. and the export both to Free Trade Area ("FTA") and non-FTA countries of LNG processed from that feedgas. Bear Head LNG Corporation received Order No. 3770 and Pieridae Energy was granted Order No. 3768.

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

annual rate of 0.1 Bcf/d is not material for purposes of this Report (the 2015 LNG import rate was about 30 MMcf/d). If facilities to allow a significant inflow of gas from the U.S. to the Canadian Maritimes are not created, then larger LNG imports would likely take place.

B. Conclusion as to pipeline exports and imports

Some of Canada's gas requirements are and will continue to be met from imports in the period through 2067 and beyond. Pipeline exports will probably continue to decline in the face of strong competition from prolific, favourably located U.S. supplies and then stabilize. The expectation of only a small positive balance—about 200 million cubic feet daily—in Canada's net pipeline exports from 2040 onwards is not unreasonable.

C. U.S. gas production, exports, imports and apparent supply

This Report's projection of U.S. lower 48 states' gas production, exports and imports through 2040 is derived from the reference case²⁷ *AEO 2016* and is extrapolated from those data through 2067 and is presented in Table 2 below.

For this Report, the EIA projection through 2040 serves two purposes:

- It provides U.S. net pipeline imports from Canada for comparison with the net pipeline exports from Canada in Table 1, line 1 above, although this Report relies on *Energy Future 2016* for all its Canadian supply and requirements data.
- It provides total U.S. gas production which reflects the EIA's expectations regarding the potential for the U.S. gas resource and reserves to support that production.

Projected beyond 2040 these data are order of magnitude in nature and are provided essentially to give a perspective on the Canadian data and projections which are presented in Section 6. In this Report, "gas supply" on a national basis is always treated as "production plus imports minus exports" and does not include any provision for annual change in inventories.

²⁷ Regarding its projections and the reference case, the EIA states as follows: *Projections are not statements of what will happen but of what might happen given the assumption and methodologies used for any particular case. The Reference case projection is a business-as-usual trend estimate reflecting current laws and regulations, known technology, and technological and demographic trends.* Source: *AEO 2016 Early Release Presentation*. Online: [https://www.eia.gov/forecasts/aeo/er/pdf/0383er\(2016\).pdf](https://www.eia.gov/forecasts/aeo/er/pdf/0383er(2016).pdf)

Table 2: U.S. Lower-48 Gas Production, Net Imports and Apparent Supply 2013-2067 (Bcf/d)

		2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2067
1	Production of Dry Gas	73.7	82.8	94.6	102.7	108.6	114.6	119.0	123.2	127.6	132.2	137.0
2	+Net Exports	2.5	(7.9)	(14.6)	(16.5)	(19.7)	(20.7)	(21.0)	(21.0)	(21.0)	(21.0)	(21.0)
3	(of which imports from Canada)	5.3	3.6	2.8	2.0	1.6	1.6					
4	=Apparent Gross Supply	76.2	74.9	80.0	86.2	88.9	93.9	98.0	102.2	106.6	111.2	116.0

(Numbers may not sum because of rounding)

The assumptions underlying this projection are as follows:

Through 2040

- The data in Table 2 through 2040 are taken from *AEO 2016*, Reference Case:
 - **Line 1:** Table 61: *Lower 48 Natural Gas Production and Supply Prices by Supply Region*;
 - **Lines 2 and 3:** Table 62: *Natural Gas Imports and Exports*;
 - **Line 4:** The sum of lines 1 and 2. These numbers check roughly against Table 1: *Total Energy Supply, Disposition and Price Summary*, Consumption, Natural Gas, Reference Case (quads) for 2040 which is 35.39, adjusted by Table 73: *Conversion Factors* (1,031 Btu/cu ft.) =approximately 94.1 Bcf/d for total U.S.
- The data in Table 2 beyond 2040 are derived as follows:
 - **Line 4:** projected at 0.85% annual compound increase, which is the rate projected in AEO 2016 for Reference Case *Total U.S. gas consumption* in AEO 2016 Table 1.
 - **Line 2:** Net imports held constant at negative 21 Bcf/d.
 - **Line 1:** Apparent Gross Supply as a rough proxy for consumption plus net exports (treated as a positive) to yield required production. This assumes that production is not constrained by the natural gas resource but in effect tracks requirements for Consumption plus Exports.
- The assumptions underlying the *AEO 2016* reference case are summarized in Appendix E thereof (pages E-1 to E-12),²⁸ they include general features of the model structure, assumptions

²⁸ Online: [http://www.eia.gov/forecasts/aeo/pdf/0383\(2016\).pdf](http://www.eia.gov/forecasts/aeo/pdf/0383(2016).pdf)

concerning energy markets, and the key input data and parameters that are the most significant in formulating the model results. Detailed documentation of the NEMS is available in a set of 14 documentation reports.²⁹

- The use of *AEO 2016* for relevant portions of this Report is justifiable: it is the gold standard for long-term U.S. energy and natural gas projections and in terms of accumulated experience (more than 35 years) and the human and technical resources embodied in it, it cannot be surpassed by similar private or governmental work.

D. Mexico Gas Consumption, Imports and Production

It is appropriate briefly to consider the outlook for gas in Mexico because that country is part of the integrated North American gas sector. Mexico's gas requirements and production have an important but marginal effect on demand for U.S. gas production because presently and foreseeably it will pose a significant draw on U.S. gas supply, but has gas resources presently assessed to be about two-thirds as large as those of the WCSB (see under Section 5.a. below). The projection of these elements of Mexican gas are presented in Table 3:

Table 3: Mexico Gas Consumption, Imports and Required Production, 2015-2067 (Bcf/d)

		2015 ³⁰	2020	2025	2030	2035	2040	2045	2050	2055	2060	2067
1	Demand	8.0	10.1	13.5	16.0	17.7	19.5	20.5	21.5	22.6	23.8	25.3
2	Imports, pipeline	2.8	5.0	4.8	4.7	4.3	4.1	4.0	4.0	4.0	4.0	4.0
3	Imports, LNG	0.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	Required production	4.6	4.1	7.7	10.3	12.4	14.4	15.5	16.5	17.3	18.8	20.3

The assumptions underlying this projection are as follows:

The data in Table 3 are intended to serve the same perspective purpose as those in Table 2. They are derived as follows:

- Demand, **Line 1:**
 - Through 2040: projected at 3.6% per annum, with the quinquennial growth rate falling to 2.0% per annum by 2040. This is more rapid than the growth foreseen in the Mexican

²⁹ Online: <http://www.eia.gov/reports/index.cfm#/KNEMS Documentation.pdf>

³⁰ A supply/demand balance in Bcf/d for 2015, based on *BP Review of World Energy* is as follows: demand 8.0; pipeline imports 1.9 (the EIA states 2.9 Bcf/d); LNG imports 0.9; production 5.1. The BP Review may have overstated production and understated pipeline imports by 1.0 Bcf/d. By contrast, a proprietary trade source reports first half 2016 in Bcf/d as follows: production 3.7, imports from the U.S. 3.5, LNG sendout 0.5, total supply 7.7 of which about 3.7 is used for electricity generation.

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

Energy Secretary's current forecast through 2029 which is for demand to increase from about 7.2 Bcf/d in 2014 to about 9.0 Bcf/d in 2016 and then to rise slowly to some 10.4 Bcf/d by 2029.³¹ ³² If the demand projection is too high, the excess of say 5.0 Bcf/d in 2030 might be notionally distributed to reductions in required production of 3.0 Bcf/d and of pipeline imports of 2.0 Bcf/d and the elimination of LNG imports.

- 2040-2067: a growth rate of 1.0% per annum is projected. Mexico's population at about 125 million is three and a half times as large as Canada's. The country is quickly industrializing partly as a result of opportunities created by continental free trade. Rapidly growing electricity needs are being met predominantly by gas-fired generation accounting for more than 50% of consumption through the 2020s.³³ A domestic gas market (21.5 Bcf/d) one third larger than Canada's (16.0 Bcf/d) by mid-century seems a not unreasonable expectation.
- Pipeline imports, **Line 2**:
 - Through 2040 are taken from *AEO 2016*, table 62, *Natural Gas Imports and Exports* as used in Table 2. Some Mexican sources have posited imports at higher rates in the 2020s.³⁴ Indeed by 2020 capacity for pipeline imports from the U.S. to Mexico may approach 8 Bcf/d.
 - 2040-2067: a levelling-off of imports from the U.S. after 2040 with domestic production increasing by 1.0 to 1.5 Bcf/d per quinquennium taking care of the slowing growth in demand appears reasonable.
- LNG imports, **Line 3**, are assumed at 1.0 Bcf/d. This is probably an optimistic assumption; the three operating Mexican LNG terminals have never reached that total to date. True, LNG imports are currently surging, but that has more to do with inadequate domestic pipeline infrastructure than with the economics of LNG imports which appear to be poor compared to imports of pipeline gas from the U.S. As in the case of Canada, LNG imports in the medium and longer term are likely to experience severe competition from U.S. pipeline gas.

³¹ Mexico: Secretaria de Energia ("SENER"), *Prospectiva de Gas Natural 2015-2029*, 2015, page 67, Figura 2.19, *Demanda Nacional de Gas Natural*, 2004-2029. Online: http://www.gob.mx/cms/uploads/attachment/file/44326/Prospectiva_Gas_Natural_y_Gas_LP.pdf

³² Expectations recently expressed by SENER in respect only of gas imports from the U.S. appear to reflect either much higher Mexican demand or much lower production. SENER is reported to have stated on 14 October 2015 that Mexico aims to import 9 Bcf/d of gas from the U.S. under a five-year plan 2015-2019. Online: <http://www.platts.com/latest-news/natural-gas/mexicocity/mexico-to-import-9-bcfd-of-natural-gas-from-us-21293378> and <http://www.economiahoy.mx/economia-eAm-mexico/noticias/7076228/10/15/El-consumo-de-gas-natural-rebasa-a-Pemex-la-Sener-advierde-la-necesidad-importar-GNL.html>

³³ Ibid, page 68, Figura 2.20, *Demanda de Gas Natural por Sector*, 2014-2029

³⁴ EIA, *Mexico's Energy Ministry Projects rapid near-term growth of natural gas imports from the U.S.*, May 29, 2014. That source projected U.S. imports at 5.0 Bcf/d in 2020 and nearly 6.0 Bcf/d in 2025. Online: <https://www.eia.gov/todayinenergy/detail.cfm?id=16471>

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

- Required production, **Line 4**, falls out from the projection of demand Line 1 minus imports Lines 2 and 3. The EIA states that Mexico has one of the world's largest shale gas resource bases which could support increased natural gas reserves and production.³⁵ According to the EIA's assessment of world shale gas resources, Mexico has an estimated 545 Tcf of technically recoverable shale gas resources—the sixth largest of any country examined in the study. The production rate posited for the 2060s is low in relation to gas resources as presently assessed.

E. Conclusion

The North American conventional and unconventional gas resource, discussed in Section 5.a. below, is enormous. The industry which exploits it demonstrates technical and entrepreneurial virtuosity. It is entirely reasonable to adopt the *AEO 2016* projections through 2040 and extend them for a further 27 years in respect of U.S. gas production, imports and exports and to do similarly in Section 6 below in respect of the outlook for the Canadian gas sector as addressed in the Board's report *Energy Future 2016*. Mexico appears to have major gas resources which are presently underutilized in relation to rapidly growing requirements. Large gas imports look to be a continuing, even growing, contribution to meeting Mexico's gas requirements until the effects of the energy reforms enacted in 2014-15 begin to be felt in terms of much greater domestic resource development. Exports will support increased U.S. gas production over the long term. And having regard to the geographical distribution of continental resources, Canada will find that gas imports contribute the bulk of the needed gas supply to regions east of Manitoba while gas exports will increasingly be of LNG from the west coast and pipeline exports to the American mid- and far-West will in the long term not much more than balance pipeline imports to Central and eastern Canada.

³⁵ EIA, *Mexico, Full Report*, Updated to September 21, 2015, *Natural Gas*, pages 7-8 of 14. Online: https://www.eia.gov/beta/international/analysis_includes/countries_long/Mexico/mexico.pdf

5. The gas resource base in Canada, as well as North America overall, is large

Government authorities, regulators, consultants, industry and industry associations and committees produce estimates of the gas resource base in the countries of North America. This Report adopts data produced by governmental authorities. It recognizes that different and in some cases higher estimates have been put before the Board. Whatever may be the differences, there is unanimity that the continent's currently-assessed natural gas resources are very large in relation to potential requirements.

A. Gas Resources

Canada: The NEB states in *Energy Future 2016* at page 61 that the remaining marketable natural gas resources in Canada are 1,087 Tcf and in the WCSB 855 Tcf. Different numbers have been, and no doubt will continue to be, put before the Board. This Report prefers the Board's authoritative assessment.

In addressing with provincial counterparts the gas potential of one major formation, the Montney, the Board observed that resource estimates could grow as other large unconventional plays in western Canada such as the Liard Basin shales of British Columbia and the Duvernay shale of Alberta, are assessed.³⁶ Other evidence filed with the Board in recent gas export licence and pipeline certificate cases have put larger numbers on the remaining recoverable gas resource in the WCSB.

The Government of British Columbia currently claims that the province's total natural gas resource base is over 3,400 Tcf. It considers that 4.2 Tcf per year (11.5 Bcf/d) may be needed to support five LNG export facilities. On this basis, it states that with a 15% extraction rate the resource would amount to 510 Tcf which is equivalent to 120+ years' supply for five LNG projects, with a 20% extraction rate and approximately 680 Tcf of gas available, the coverage is 160+ years and with a 25% rate, 850 Tcf and 200+ years of supply.³⁷

While large scale gas development in Canada's frontier areas may not take place for a decade or more because of the abundance of supply from Canadian and U.S. producing areas that are already pipeline connected, it cannot be excluded that some of the 20% of the presently-identified national gas resource will be developed later in the period through 2067.

³⁶ NEB, Frequently Asked Questions - *An assessment of the unconventional petroleum resources in the Montney Formation, West-Central Alberta and East-Central British Columbia*, as modified 2015-10-16, online: <https://www.neb-one.gc.ca/nrg/sttstc/ntrlgs/rprt/lmtptntlmntnyfrmtn2013/lmtptntlmntnyfrmtn2013fq-eng.html>

³⁷ *BC's Natural Gas Resource*. Release by the Ministry of Natural Gas Development, based on the most recent assessments conducted by that Ministry. Online: https://news.gov.bc.ca/files/Natural_Gas_Resource_Assessment.pdf

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

United States: The oil and gas module of the EIA's AEO 2015 dated September 2015 contains a table *Technically Recoverable Dry Natural Gas Resources as of January 1, 2013*.³⁸ The total in that table is 2,276.5 Tcf.

Mexico: As already noted above, the EIA states that Mexico has an estimated 545 Tcf of technically recoverable shale gas resources, the sixth largest of any country examined in its study. Additionally, Mexico has considerable resources of gas from conventional accumulations.

Uncertainties in resource estimates:

Like the Board in WCC, this Report acknowledges that resource estimates are typically based on assumptions which carry some uncertainties. However, it is noted that the assessments of Canadian and North American gas resources have grown in the past decade, as confidence has grown in the resource base of unconventional gas, both in terms of its size and of the industry's ability to exploit it in an efficient and environmentally-acceptable manner. As the Board observes, there are large Canadian unconventional plays that are yet to be assessed. The experience of gas production from the discovered resources and the progress of geological and engineering science relating to unconventional gas is likely to result in a continuing increase in the size of assessed resources.

Conclusion as to the resource base:

The presently-assessed resource, Canadian and North American, from which Canadians' gas requirements will be met during the licence term and for the quantities applied-for by Woodfibre LNG Export is enormous.

B. Gas reserves

Regarding the *Further Guidance* portion of Guide Q, the following paragraphs address past trends in gas discoveries and whether these trends can be extrapolated into the future and why. They also touch on technological improvements in resource assessment and innovations.

For North American countries, citing for consistency the EIA, estimated proven gas reserves for 2014 (2004 proven reserves in brackets), expressed in Tcf are: Canada 67 (59); Mexico 17 (15); the U.S. 338 (189) for a North American total of 422 (263).³⁹ Clearly, the trend in gas discoveries, as reflected in the striking increases in proven reserves since the period before the unconventional gas revolution, has been very favourable. It is of course mainly because of the cost of drilling to prove up reserves that at any one time only a small fraction of the resource exists as proven reserves. The continental ratio of reserves to production ("R/P") was about 13 in 2014. In 2004 it was 10. While this may be an

³⁸ Online: <http://www.eia.gov/forecasts/aeo/assumptions/pdf/oilgas.pdf>

³⁹ EIA, *International Energy Statistics*. Online: <https://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=3&pid=3&aid=6&cid=regions&syid=2004&eyid=2015&unit=TCF>

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

unfavourable trend viewed from a strictly commercial perspective, for the regulator concerned with adequacy of gas supply it is reassuring.

C. Roll-up of North American gas reserves and resources

Authoritative sources compile the following values for technically recoverable natural gas resources for all of North America (defined as Canada, Mexico and the USA):

	Tcf	Exajoules⁴⁰
Canada ⁴¹	885–1 566	934-1 652
U.S.A.	2 431	2 565
Mexico ⁴²	600	633
All of North America	3 916-4 597	4 132-4 851

D. Conclusion as to trends in the discovery of gas

The NEB Act s.118 requires the Board to have regard to the trends in the discovery of oil or gas in Canada when dealing with an application for a licence to export oil or gas.

From a review of salient licensing decisions taken during the era 1959-87 when various quantitative methodologies were used to determine surplus, it is clear that the Board always interpreted the requirement as to “trends in the discovery of...gas” to relate to future trends and not to the past. Thus the Board in its first gas export licensing decision:

Having regard to the evidence before it, the advice of its staff and its own knowledge, and assuming that there will be incentive to exploration

⁴⁰ Assuming that the heat content of this natural gas is one million British Thermal Units (“MMBtu”) per thousand cubic feet and applying the conversion factor of 1.0 Gigajoule (“GJ”) equal to 0.9478 MMBtu, see *Energy Conversion Tables—Energy Terms* from the National Energy Board’s (“NEB”, “the Board”) website,

⁴¹ Canada and U.S.A.: Natural Resources Canada (“NRCAN”), *Energy Market Fact Book 2014-2015*, page 39, *Technically recoverable resources: gas estimated to be recoverable as drilling and infrastructure expands*, online: http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/files/pdf/2014/14-0173EnergyMarketFacts_e.pdf. The sources used by NRCAN include the NEB, the U.S. Energy Information Administration (“EIA”) and the Potential Gas Committee (“PGC”). The NEB source is stated to be *Energy Future 2013*. It is noted that EF 2016 at page 61 states that: [r]emaining marketable Canadian natural gas resources as of December 2014 were...slightly less than reported in EF 2013. Neither EF 2013 nor EF 2016 deal with technically recoverable natural gas resources.

⁴² Mexico: Technically recoverable shale gas resources of 545 Tcf (EIA, *2013 World Shale Gas Study*, online: <http://www.eia.gov/analysis/studies/worldshalegas/>) plus 55 Tcf of conventional gas being the sum of proved, probable and possible reserves (“3P” in the SPE (*Society of Petroleum Engineers*) *Petroleum Resources Management System Guide for Non-Technical Users* online: http://www.spe.org/industry/docs/PRMS_guide_non_tech.pdf) as presented in the Annual Report of Petroleos Mexicanos (Pemex) Hydrocarbon Reserves as of January 1, 2015 at page 3/21. Online: http://www.pemex.com/en/investors/publications/Reservas%20de%20Hidrocarburos%20Archivos/Reservas_2015_i.pdf

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

sufficient to result in the drilling of some 360 to 400 wildcat wells per year, the Board believes that the development of further established reserves can be expected at an average rate of some 2.5 trillion cubic feet per annum for at least the next ten years, and thereafter on a somewhat decreasing scale. The initial disposable reserves of 30.3 trillion cubic feet established at the end of 1959 are expected to increase to approximately 92 trillion cubic feet by 1989.^{43]}

In today's economic environment it is not possible to project the rate of gas drilling expectable in the WCSB over a 40-year period. What can be said today is that assessed gas resources have increased rapidly over the past 5-10 years in Canada and North America. This increase is attributable in large part to the revolutionary development of unconventional gas, based on the innovative technologies of horizontal drilling and multi-stage fracturing of mainly shale formations. As a result of exploration and development drilling, the industry has turned some of these newly discovered resources into proven reserves in Canada and North America: proven gas reserves in Canada are now approaching 70 Tcf relative to an annual production of about 5.5 Tcf giving an R/P ratio of about 13. As the unconventional gas resources become better known and understood, they also will continue to increase. And to the extent that economic conditions in terms of prices and markets, including LNG market opportunities, enable and encourage further exploration and development, this will undoubtedly lead to rising future trends in the discovery of gas in Canada.

Regarding consideration of technological improvements in resource assessment and innovations as mentioned in Guide Q, it is reasonable to expect continuing steady gains. In what areas of assessment such technical progress can be expected is beyond the scope of this Report. Some elements of the progress that has been made are summarized in **Annex 2**.

E. Overall conclusion as to Canadian and North American gas resources

The finding that the Board made in December 2013 in Woodfibre LNG Export that the gas resource base in Canada as well as North America is large can be applied with even greater confidence just over two years later. Resource assessments continue to grow and resources available to meet Canadian gas requirements will be adequate to 2067 and beyond. The ratio of resources to current national production levels is strikingly high: WCSB 155; total Canada 197; U.S. 85; Mexico (shale gas only): 267; total North America including Mexico: about 120. These ratios, which are necessarily approximations, suggest that Canadian gas resources are somewhat underutilized relative to those of the U.S. This is explained in the case of some WCSB resources such as Horn River, by remoteness from market and in the case of Canadian northern frontier resources by the absence of pipeline connections to market.

⁴³ NEB, RfD, GH-1-59, page 12-2, *Trends in Discovery of Gas*.

6. The resource base can accommodate reasonably foreseeable Canadian demand, the LNG exports proposed in this Application, and a plausible potential increase in demand

Regarding the *Further Guidance* portion of Guide Q, the following paragraphs address trends in Canadian gas demand and supply and the availability of sources of gas to Canadians. They are additional to the previous paragraphs which discussed the availability of imported gas to meet Canadian requirements.

A. Approach to assessment of Canadian gas requirements (demand)

This Report takes a “high level” approach to a description of requirements over the requested licence term. It does so because of what it considers to be the impossibility of credibly projecting, much less “forecasting” requirements 50-years out. The reasons for this position are set out in **Annex 3**.

B. A description of expected gas requirements for Canada over the requested licence term through 2067 including underlying assumptions

The 2015 base

Table 4 establishes a base 2015 gas requirements (Demand) for Canada. It uses the most recent data to draw up a simple gas supply balance which admittedly neglects inventory changes. The requirements (demand) number is approximately 10.0 Bcf/d (line 1).

Table 4: Projected Canada Gas Supplies and Requirements 2015-2067 (Bcf/d)

		2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2067
1	Demand	10.0	11.4	12.8	13.9	14.6	15.1	15.5	16.0	16.5	17.0	17.5
2	+20% sensitivity	--	2.3	2.6	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5
3	Liquefaction energy	--	0.2	0.4	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
4	Net LNG exports	--	1.9	4.7	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9
5	Net pipeline exports	5.5	3.6	2.4	1.2	0.7	0.2	0.2	0.2	0.2	0.2	0.2
6	Required production	15.5	19.4	22.9	24.4	24.7	24.8	25.3	25.9	26.5	27.1	27.7

The data in Table 4 are intended to serve the same perspective purpose as those in Table 2. They are derived through 2040 from the reference case in *Energy Future 2016*, Figure 6.5, *Supply and Demand Balance, Natural Gas*, supporting data and beyond 2040 are simple, conservative projections of those data, specifically the demand data.

The data in Table 4 are tabulated on an annual basis in **Annex 1** which also presents this data in graph form. They are placed first in the numbering of annexes because of their importance in this Report.

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

The term “conservative” is used in this context to characterize projections which deliberately err on the high side for purposes of quantifying the demands that would be placed on the resource base in assessing the matter of “surplus”. Comparison of these projections with those in the Board’s report *Canada’s Energy Future 2016 Update* (“Update 2016”), released October 26, 2016 confirms their conservatism. Thus, Key Finding Number 2 of Update 2016 is that energy use, including energy derived from fossil fuels, increases but at a slower pace compared to EF 2016. And while natural gas production in the Update 2016 reference case is stated to be less than one per cent lower compared to EF 2016 by 2040, in all three production cases examined (reference, high and low price cases) LNG exports are assumed to start in 2021 (rather than 2019) and increase by 0.5 Bcf/d per year to reach 2.5 Bcf/d by 2025 (rather than 6.0 Bcf/d by 2030 in the High LNG Case of EF 2016)."

The assumptions underlying this projection are as follows:

Demand, **Line 1**, through 2040, *Energy Future 2016, Canadian Demand. 2040-2067*, Figure 6.5, beyond the 2040 base at 15.1 Bcf/d is projected at a quinquennial increase of 0.5 Bcf/d. The annual average increase per quinquennium being as follows: 0.5%; 0.6%; 0.6%; 0.6%; and for 2060-2067 is 0.5%. These increases approximate the projection of U.S. gas consumption in Table 2.

20% demand sensitivity, **Line 2**, is applied to Line 1 through 2067, as requested/presented in successive previous supply and requirements forecasts put before the Board in LNG export licence cases. This may be a generous provision against error on the low side in the demand projection of Line 1.

The Canadian natural gas demand projection including the 20 percent increase in Canadian demand growth sensitivity is given by the sum of Lines 1 and 2. The projection of Canadian natural gas production in Line 6 includes the provision for 20% demand sensitivity.

The conclusions of this Report regarding the matter of implications of the applied-for exports on the ability of Canadians to meet their gas requirements (Section 12 below) and on the matter of “surplus” in relation to Section 118 of the NEB Act (Section 13 below) therefore take full account of the 20% demand sensitivity because it is built into the projection of Canadian gas production.

Liquefaction energy, **Line 3**, *Energy Future 2016, Primary Energy Demand in B.C.*, Figure 11.4, the difference between the reference case and the high LNG case, converted from petajoules (“PJ”) to Bcf/d, is added to account for incremental natural gas consumption for liquefaction and other additional uses in the high LNG case and is projected at the 2040 rate (225PJ=approximately 586 MMcf/d rounded to 0.6 Bcf/d) through 2067. *Energy Future 2016* states that the liquefaction process is largely powered by a portion of the facilities’ natural gas supply. Auxiliary power requirements, such as for lighting and non-cooling equipment, are met by grid-purchased electricity. The provision in Line 3 may be over-generous, not least because in the next half century energy sources other than natural gas (hydro, nuclear, possibly wind) might contribute a significant proportion of the incremental energy in the high LNG case.

Net LNG exports, **Line 4**, is the NEB LNG exports high case *Energy Future 2016* pages 102-103 and Figure 11.1 *Assumed LNG Export Volumes, Reference, High and No LNG Cases* minus assumed LNG imports at a notional 0.1 Bcf/d projected through 2067.

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

This Report's choice of the NEB LNG exports high case reflects a generous projection of requirements for this demand. The total quantities of gas licensed for export in the form of LNG of course exceed the high case in *Energy Future 2016*. The NEB has recognized that LNG export licence applications before it represent a significant volume of LNG exports from Canada. However, it has stated that all of these LNG ventures are competing for a limited global market and face numerous development and construction challenges. The Board will not predict which licences will be used or used to the full allowance and, therefore, the Board evaluates each application based on the merit of its own evidence.⁴⁴ **Annex 5** presents a discussion of the economics and market factors affecting current and future LNG development in Canada that may limit gross volumes of Canadian LNG exports to about 6.0 Bcf/d, including Woodfibre LNG Export's requested quantity of 0.32 Bcf/d

Canadian LNG import capacity is approximately 1.0 Bcf/d and no increase in that capacity is assumed to take place during the projection period through 2067. As noted, 2015 LNG imports were approximately 30 MMcf/d.

Net pipeline exports, **Line 5**, is sourced as Line 1, *Net Exports (less LNG exports)* through 2040 with the 2040 NEB projected net number carried through 2067. A June 2016 NEB Market Snapshot, referred-to above in connection with Table 1, stated that net pipeline exports of natural gas from Canada could decline to essentially zero by 2040.⁴⁵ A companion Market Snapshot highlighted the huge growth of U.S. Appalachian gas production and pointed out that several new pipeline projects are already under development to transport growing Appalachian Basin gas production to markets. As these projects come into service, it stated, they will allow more Appalachian production to move into traditional markets for Canadian gas in both the U.S. and Canada.⁴⁶

Required production, **Line 6**, is the sum of **Lines 1 to 5**, and is therefore the supply needed to balance total demand. This assumes that production is not constrained by the natural gas resource but in effect tracks requirements for Canadian demand, plus the 20% sensitivity, plus liquefaction energy associated with high-case net LNG exports, plus those LNG exports net of LNG imports, plus net pipeline exports.

Assumptions from *Energy Future 2016*

In that these data are derived from *Energy Future 2016*, the underlying assumptions are the same as those of the relevant portions of that work and are adopted as part of this Evidence. It is unnecessary to enumerate those assumptions here, but they include ones relating to such disparate matters as: economic activity; natural gas and oil prices; government policy and programs; technology; market functioning; and availability of energy export markets. The demand (requirements) projections in this Report are a composite of those in *Energy Future 2016* because they combine the Board's high LNG

⁴⁴ Summarized from the Board's Reasons for Decision in PNW LNG's application for a 40-year licence to export natural gas as LNG, page 4, last paragraph.

⁴⁵ Online: <http://www.neb-one.gc.ca/nrg/ntgrtd/mrkt/snpsh/2016/06-03ntpplnxprt-eng.html>

⁴⁶ Market Snapshot 2016-06-08: *Northeast U.S. pipeline expansions continue to impact Canadian natural gas exports*. Online: <https://www.neb-one.gc.ca/nrg/ntgrtd/mrkt/snpsh/2016/06-02pplnxpsn-eng.html>

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

exports case and associated additional liquefaction energy requirements with the Board's reference case Canadian demand to which has been added the 20% for demand sensitivity.

This Report's use of *Energy Future 2016*

The use of *Energy Future 2016* for relevant portions of this Report hardly needs justification: it is the gold standard for long-term Canadian energy and natural gas projections. It embodies five decades of experience, large expert human resources, thoroughness of approach and the results of extensive cross-country and cross-sector consultation which helped to shape the key assumptions and final projections. It cannot be surpassed by private or other governmental work in this field. Private sector projections are therefore unlikely to credibly challenge or corroborate those in *Energy Future 2016*. Such projections are therefore not attempted for purposes of this Report.

Studies through 2067 and beyond

The writer is not aware of studies, forecasts, reports or sources, other than reports filed with the Board in support of applications for LNG export licences, that consider gas supplies expected to be available to the Canadian market and the expected gas requirements for Canada until 2067 and beyond.

C. A description of gas supplies expected to be available over the requested licence term through 2067 including underlying assumptions

Quantitative

The assumption underlying the description of gas supplies from Canadian production (Table 4, Line 6) is that now⁴⁷ and throughout the forecast period, the rate of production of gas from the WCSB is and will be determined by the availability of economically-viable markets, that is markets that return prices at which the industry is prepared to produce, and not by the adequacy of the gas resource which is being exploited. By contrast, the rate of production of gas from the Sable Offshore Energy Project ("SOEP"), the Deep Panuke field and the very modest onshore Maritimes gas resources is and in all probability will continue to be determined by the sufficiency of the gas resource which now appears small in relation to the size of the pipeline-connected market and its sustainable productive capacity. However, Maritimes' local supplies are not a material consideration in relation to the gas requirements in Table 4, Line 6.

This assumption tends to be supported by a recent study for the EIA which was primarily to assess the impact of U.S. LNG exports rising above 12 Bcf/d in circumstances where international demand is sufficient to support exports of 20 Bcf/d. The study found that the majority of the increase in LNG

⁴⁷ The Board's June 2016 report *Short-term Canadian Natural Gas Deliverability 2016-2018 – Energy Market Assessment* states that the North American gas market continues to be oversupplied and considers that the factors that will influence future Canadian natural gas deliverability relate essentially to markets, costs and prices. These factors include: the development of LNG markets; the development of oil sands demand; coal to gas switching in electricity generation; improved economics of gas production; and the potential for increased deliverability of low-cost Montney gas. This report is online at: <https://www.neb-one.gc.ca/nrg/sttstc/ntrlgs/rprt/2016-2018ntrlgsdlvrblty/index-eng.html>

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

exports is accommodated by expanded domestic production rather than reductions in domestic demand, a result that reflects the very elastic long-run supply curve in North America. Greater LNG exports effectively serve as additional demand for U.S. natural gas, which facilitates expansion in the domestic upstream sector.⁴⁸

This phenomenon might be termed the “induced exploration effect” of increased exports. It was discussed by several applicants for NEB licences in the late 1980s.⁴⁹ Applicants at that time estimated that this effect would result in the replacement of 50-75% of the exported quantities, a number similar to that of the U.S. EIA’s 2014 study.⁵⁰

The assumption underlying the projections of Canadian gas supply and requirements in this Report—that demand will drive production rather than that production will be constrained by the resource—is made essentially because of the great size and early stage of exploitation of the WCSB’s unconventional gas resource.

To place these numbers of required Canadian production in an authoritative American perspective, it is noted that the EIA has no difficulty in its *AEO 2016* Reference Case to project 2040 gas production of 42.12Tcf (115.4 Bcf/d total U.S. while the 114.6 Bcf/d from Table 2, line 1 is U.S. Lower-48 only) against a resource of 2,431 Tcf (currently-assessed resource to future production ratio of ~58). The NEB’s current assessment for the WCSB resource, namely 855 Tcf (*Energy Future 2016*, Table 6.1), is in a ratio of ~94 to projected 2040 required production of some 9.1 Tcf (24.8 Bcf/d from Table 4, Line 6).

The assumption underlying this Report regarding gas supplies expected to be available to the Canadian market through 2067 parallels the finding in the Board’s Letter Decision in Woodfibre LNG Export, namely that the gas resource base in Canada, as well as North America, is large and can accommodate reasonably foreseeable Canadian demand, the proposed LNG exports, and a plausible potential increase

⁴⁸ Oxford Economics and the Center for Energy Studies of Rice University, prepared by Leonardo Technologies Inc. for the Department of Energy (U.S.), *The Macroeconomic Impact of Increasing U.S. LNG Exports*, October 29, 2015, pages 11-12. Online:

http://energy.gov/sites/prod/files/2015/12/f27/20151113_macro_impact_of_lng_exports_0.pdf

⁴⁹ The Export Impact Assessment (“EIA”) submitted pursuant to the 1987 Market-Based Gas Export Procedure on behalf of Canterra, Norcen, Poco, Shell and Western Gas in GH-8-88 (January 1989) found the induced exploration effect to replace 50-65% of the gas exported. The similar submission for Progas and Western Gas in GH-7-88 (December 1988) considered that the effect would result in the replacement of 75% of the exported gas. An EIA was prepared for Esso Resources and Shell Canada by DataMetrics Limited in connection with GH-10-88 (August 1989). The EIA seems ultimately not to have been relied-upon by the applicants. However, the authors presented on page 23, Table II-2 Estimates of Natural Gas Related Supply Elasticities taken from research studies undertaken over the previous decade or so. The range of the long-run elasticity of the supply of gas to its price was from 0.83 to 1.25.

⁵⁰ U.S. EIA for U.S. DOE, *The Effect of Increased Levels of LNG Exports on U.S. Energy Markets*, October 2014, at page 12, which stated *Natural gas markets in the United States balance in response to increased LNG exports mainly through increased natural gas production. Across the different export scenarios and baselines, higher natural gas production satisfies about 61% to 84% of the increase in natural gas demand from LNG exports, with a minor additional contribution from increased imports from Canada.* Online:

<https://www.eia.gov/analysis/requests/fe/pdf/lng.pdf>

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

in demand (Views of the Board at page 4). This Report interprets the Board to mean that, for the period through 2046 being the term of the natural gas supply and demand forecast filed as evidence in 2013, the gas resource base in Canada can accommodate gas supplies adequate for the Canadian market and export demand and in North America adequate for the import component of Canadian gas supply. The Board reached the same determination in its Reasons for Decision in respect of PNW LNG's application for a 40-year licence.

Qualitative

The growth of Canadian gas requirements, apart from LNG exports, is likely to be very modest. By mid-century could even be negative (negative growth that is) as a result of slow population growth, a changing age-structure, a likely shrinking labour-force, continued weak labour productivity growth, increasingly a post-industrial service economy, a probable cap on energy use in oil sands⁵¹, commercialization of renewable energies supported by new technologies such as economic storage of electric energy, enhanced energy efficiency/reduced energy intensity in every producing and consuming sector, and, perhaps most important, policies directed at decarbonization of the energy economy. These factors will likely all start to bend the curve of fossil energy use, including gas use, in a downwards direction. This would be a development outside of Canada's historical experience. It is of course recognized that natural gas is a low-carbon fuel capable of being used very efficiently, for example in combined-cycle electricity generation. Some further considerations bearing on the potential growth of Canadian gas requirements are presented in **Annex 4**.

Risks in the projection of gas requirements and supply 50-years out

There is a risk of significant error in providing a description of expected gas requirements (demand) for Canada over the 40-year licence term requested by Woodfibre LNG Export plus the requested 10-year sunset clause. The uncertainties inherent in any demand projection are well known to practitioners such as the Board. Thus, the text of *Energy Future 2016* uses the word "uncertain" and variants on it more than 100 times and the NEB Chair's observations on the release of that report January 27, 2016 were similarly qualified. The Canadian Energy Research Institute's 2013 study *Natural Gas Pathways* is replete with references to what it terms critical uncertainties. The most important of these it considers to be LNG exports and natural gas fired power generation.⁵² Clearly, the longer the term of the required projection, the greater will be the uncertainties attending it.⁵³

In this Report, the projection of gas supplies available to the Canadian market is driven essentially from the projection of expected gas requirements whose necessary uncertainties therefore play into the

⁵¹ Energy (natural gas) use in oil sands has in recent years been the main driver of Canadian gas requirements.

⁵² CERl, *North American Natural Gas Pathways*, August 2013. Online: http://www.atlanticaenergy.org/pdfs/natural_gas/Community/CERI_Study138_North_American_Natural_Gas_Pathways_2013.pdf (this study is not now directly available from the CERl website)

⁵³ A discussion, which need not be repeated here, of forecast risks is found in LNG Canada's Response to NEB IR No.2.1, online: https://docs.neb-one.gc.ca/ll-eng/llisapi.dll/fetch/2000/90466/94153/552726/834773/2797784/2855988/A73916-2_LNG_Canada_IR_Response_No._2_-_A4V3X6.pdf?nodeid=2855989&vernum=-2

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

projection of gas supplies. However, the adequacy of gas resources and reserves in Canada, and those available from the U.S. to Canada regionally by way of imports, is such that the risk of supplies being inadequate to meet expected gas requirements for Canada, including the *Energy Future 2016* high case of LNG exports must be assessed as small.

Risk that requirements beyond 2040 will be overstated

There is a plausible Canadian energy future for the period beyond 2040, for which current projections will tend to overstate Canadian gas requirements and perhaps net Canadian pipeline exports too. This is a future determined by the social (population), economic (productivity and structure), technical (renewables, energy storage), sectoral (oil sands) and policy (“decarbonization”) trends which have been emerging in the first two decades of the century, and by the middle decades of the century may be dominant factors in the Canadian energy matrix.

D. A discussion of the economics and market factors affecting current and future LNG development in Canada that may limit volumes of Canadian LNG exports

Annex 5 to this Report provides an extensive discussion of the factors, some of which are highly speculative, that could limit the volume of LNG exports from Canada. This discussion responds to a previously identified area of interest for the Board. It must not be read as a critique of the Woodfibre LNG Export’s project. As set out in Part D of the Application, Woodfibre LNG Export is a part of the Pacific Oil & Gas Limited (“PO&G”) group of companies which already participates in and develops projects throughout the energy supply chain. PO&G owns a thirty-five per cent interest in the large Jiangsu Rudong LNG Receiving Terminal in China. PO&G is presently one of only two foreign-owned companies permitted to invest in domestic LNG receiving terminals by the Chinese Government. Following completion of its second phase, the Jiangsu Rudong Terminal will be capable of processing 6,500,000 tonnes of LNG annually. Woodfibre LNG Export in 2016 entered into Heads of Agreement with the Guangzhou Gas Group concerning the sale of one million tonnes of LNG annually for 25 years starting in 2020. As stated in the Application Part C, a 40-year licence will strengthen the global competitiveness of Woodfibre LNG Export’s contemplated project.

E. Conclusion: The resource base can accommodate reasonably foreseeable Canadian demand

The enormous resource base discussed in Section 5 above can accommodate reasonably foreseeable Canadian demand, a plausible potential increase in that demand, the exports applied-for by Woodfibre LNG Export and a reasonable expectation as to Canadian pipeline and LNG exports in the period through at least 2067 and indeed beyond that date. Whatever may be the risks in assessment of Canadian gas requirements, and they are considerable, the resource base discussed here and a reasonable expectation of the productive capability and gas supply out of that resource can certainly accommodate any reasonably foreseeable total demand for domestic and export requirements that may be put on that resource base. The forecasting risk in that calculus must be assessed as small.

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

The identified Canadian gas resource base in the WCSB alone at 855 Tcf is about 1.7 times as large as the cumulative total of those projected requirements over the period 2015-2067 of approximately 500 Tcf. As already noted under heading 5.a. *Gas Resources Canada*, other evidence filed with the Board in recent cases has put larger numbers on the remaining recoverable gas resource in the WCSB than the 855 Tcf cited here. The resource base is so large that it can accommodate projected requirements even were the acknowledged forecasting risks to result in a significant error on the upside.

An admitted conceptual inconsistency arises when the resource base is expressed as a ratio to projected requirements. The resource base represents an assessed “stock” of gas, existing at an historical point in time. The projected gas requirements are the sum of a series of “flows” over a lengthy period of time, in this case some 50 years. The resource base will be continuously reassessed as time goes on and the likelihood is that it will increase as a result of operational experience and of the progress of the relevant geological and engineering sciences. The result is that the ratio of presently assessed gas resources to projected gas requirements almost certainly understates the degree to which Canada’s gas resources can accommodate her reasonably foreseeable future requirements.

7. The incremental cost of adding new production to supply any exported LNG or to satisfy a plausible demand increase is low

The Board has repeatedly received evidence to this effect in the course of dealing with LNG export licence applications. The Board specifically accepted this view in its Letter Decision in Woodfibre LNG Export's application for a 25-year licence (*Views of the Board*, page 4, first paragraph). However, in its recent LNG decisions, the Board has not expressed Views on future Canadian and North American natural gas costs, prices or on the impact on gas prices of particular LNG export projects and higher demand scenarios.

A. Supply cost reductions and outlook

The "shale gas revolution" brought about a step change downwards in the supply cost of Canadian and North American natural gas. Remarkable cost reductions continue to be made in the U.S. shale gas sector: trade sources report increases in drilling rig productivity and in initial well production and the Board's report *Energy Future 2016* bears that out for Canada, providing data and discussion under the caption *Drilling Activity and Natural Gas Well Productivity* at pages 62-67. It is entirely reasonable to expect that the technology which achieves those reductions will transfer to Canada as demand increases for gas to supply any exported LNG.

The commercial phase of the shale gas revolution is less than a decade old and it does not appear prudent to project that short cost experience over the next 50 years, although major operators appear to report continuous improvements in drilling and well productivity resulting in lower costs.⁵⁴ Perhaps the most that can be said is that technical progress will go on yielding cost reductions. The functioning market will exert continuous pressure to reduce costs and will weed out high cost producers and producing areas. Numerous studies and evidence placed before the Board suggest that the natural gas supply-cost curve, which may currently have a negative slope, is rather flat over a very large production volume

B. AEO 2016 projects dramatically lower gas prices than AEO 2015

To the extent that Canadian gas prices are driven off U.S. Henry Hub prices, it is instructive to note that, despite much higher U.S. production exports and consumption of natural gas, *AEO 2016* Table 61: *Lower 48 Natural Gas Production and Supply Prices by Supply Region* projects dramatically lower prices in the 2025-2040 period than did *AEO 2015*. Henry Hub prices, expressed in 2015 U.S. dollars per million BTU, are projected in *AEO 2016* to rise from \$.2.62 in 2015 to \$5.12 in 2025 and then to decline marginally but continuously to \$4.86 in 2040. By contrast, *AEO 2015* projected 2040 Henry Hub prices in 2013 U.S.

⁵⁴ See for example Chesapeake Energy Corporation second quarter results under the caption *Operations Update*, online: <http://www.chk.com/media/news/press-releases/Chesapeake+Energy+Corporation+Reports+2016+Second+Quarter+Financial+And+Operational+Results+8+4+2016+>

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

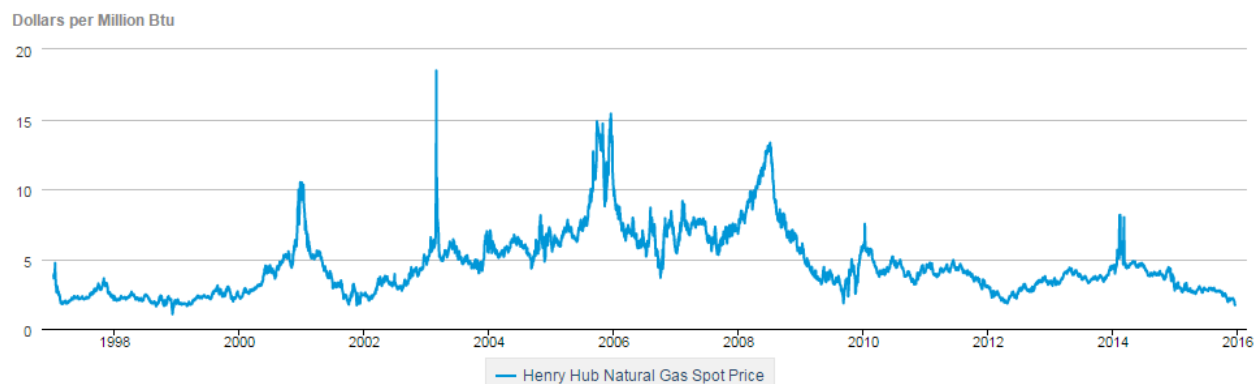
dollars at \$7.85 in Appendix B, Table B1. Total Energy Supply, Disposition and Price Summary.⁵⁵ The May 17, 2016 AEO 2016 Early Release Presentation at slide 50 states:

Over 2020-40, production, end-use consumption in the industrial and electric power sectors, and exports of LNG are projected to increase. However, technology improvements, which result in drilling cost declines and increased recovery rates, allow productive capacity to keep pace with demand, resulting in stable prices throughout much of the projection.⁵⁶

C. Market prices in relation to supply costs

As to the market gas prices that eventuate, they will be determined on a day to day basis and will be those that are required to balance supply and demand. The following chart suggests those prices may or may not reflect supply-costs, short- or long-run, marginal or full. Parenthetically, it is noted that since the shale gas revolution (since, say, 2010) gas prices have become less volatile.

Chart 1: Henry Hub Daily Spot Prices: 1997-2016⁵⁷



As to the possible effect of the exports proposed by Woodfibre LNG Export on the costs and prices of Canadian gas, the Board in its Letter Decision of 16 December 2013 at page 4 accepted that the incremental cost of adding new production to supply any exported LNG or to satisfy a plausible demand increase is low. The Canadian and North American industry cost experience since that time confirms this view.

As to the potential impact of gas supply costs on gas prices, the Board in the past took the position that the Export Impact Assessment component of the now superseded Market Based Gas Export Procedure was not intended to be used to protect Canadians from rising energy prices.⁵⁸ And the Board has stated that it considers that it is in the public interest to maximize the prices received for western Canadian

⁵⁵ Online at page 51/154: [http://www.eia.gov/forecasts/aeo/pdf/0383\(2015\).pdf](http://www.eia.gov/forecasts/aeo/pdf/0383(2015).pdf)

⁵⁶ Online: [https://www.eia.gov/forecasts/aeo/er/pdf/0383er\(2016\).pdf](https://www.eia.gov/forecasts/aeo/er/pdf/0383er(2016).pdf)

⁵⁷ EIA, *Natural Gas*. Data, Online: <http://www.eia.gov/dnav/ng/hist/rngwhhdd.htm>

⁵⁸ NEB, RfD, *Alberta & Southern Gas Company Limited*, GH-5-88, page 8 of 30, 2.1 Export Impact Assessment.

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

crude oil, a non-renewable resource.⁵⁹ It would be reasonable were the Board to take the same position on natural gas of which Canada is and will remain a net exporter.

Note that Canadian gas buyers have for many years enjoyed large “consumer rents” by virtue of the fact that gas prices have been far below those of competing fuels such as light fuel oil, propane or electricity for household use.⁶⁰ The Canadian Gas Association estimated the annual cost of water- and space-heating for the average household in 2014 to have been \$1,390 for natural gas, \$3,039 for propane, \$3,585 for electricity and \$4,495 for heating oil.⁶¹ Since then, the prices of propane and heating oil have tended downwards and electricity upwards, but significant consumer rents remain in favour of natural gas users.

AEO 2016 projects that the difference between U.S. natural gas and crude oil prices will grow dramatically compared to recent experience.⁶² Expressing both energy forms’ prices in dollars U.S. per million BTU, they are projected to increase from a ratio of 2.5 in 2016 to 4.9 in 2040. This difference in the costs of natural gas and oil fuels’ “raw material” will be reflected in somewhat similar differentials in prices of final consumption fuels, both in the U.S. and Canada.

D. Conclusion

To the extent that gas prices to Canadians reflect supply costs—which may or may not be the case—in the presence of the applied-for exports, those prices might be marginally higher than otherwise. How much higher is impossible to say in respect of Woodfibre LNG Export’s small portion of the total market. Including intercontinental exports, that market at mid-life of the 0.32 Bcf/d export project, say in 2040, will average some 155 Bcf/d and could be as much as 185 Bcf/d in 2067 (the aggregates of the production of the three North American countries in those years from Tables 2, 3 and 4 above). However that might be, it is arguably in the public interest to maximize the prices received by producers and royalty owners for Canadian gas. Canadian gas consumers are likely to be affected only marginally, if at all.

⁵⁹ Joint Review Panel, Enbridge Northern Gateway, *Considerations*, page 332, column 2

⁶⁰ “Consumer rent” or “Consumer surplus” means the difference between what a consumer would be willing to pay for a good or service and what that consumer actually has to pay. In a competitive market for substitutable fuels, residential space and water heating for example, the consumer would be willing to pay for one fuel (gas, let us say) up to what he would have to pay for its substitute (heating oil or electricity).

⁶¹ Canadian Gas Association, *Natural Gas Pre Heating Season Update, 2015: Residential Heating Costs*. Online: http://www.cga.ca/wp-content/uploads/2015/10/CGA_bulletin_Pre-Heating_-EN.pdf

⁶² Early Release Presentation, May 17, 2016, slide 51. Online: [https://www.eia.gov/forecasts/aeo/er/pdf/0383er\(2016\).pdf](https://www.eia.gov/forecasts/aeo/er/pdf/0383er(2016).pdf)

8. The North American Gas Market

The North American gas market is a mature marketplace characterized by a large number of buyers and sellers, an extensive and growing pipeline and storage network and a sophisticated commercial structure.

A. A mature marketplace

This Report defines a mature marketplace as one which is fully developed and continuously equilibrates supply and demand through the free working of the price mechanism. It exhibits features such as ease of price discovery, transparency of all other important market conditions, and offers a variety of options for sellers and buyers such as futures contracts and the ability to lock-in supplies and prices. In a mature marketplace, buyers and sellers tend to express their confidence by their willingness to rely principally on market functioning to secure supplies of a given commodity and find markets for it.

B. A large number of buyers and sellers

The continental marketplace includes producer-sellers (in Canada several hundred, in the U.S. several thousand), intermediaries such as agents, brokers and marketers (in the first quarter of 2016, the top 24 marketers traded in total more than 116 Bcf/d in North America⁶³), buyers of gas for own consumption (in Canada they may be exemplified by the 20 major industrial buyers grouped in the Industrial Gas Users Association and 10 who belong to the Industrial Gas Consumers Association of Alberta) and buyers for resale under regulated conditions (the local distribution companies—“LDCs”).

Gas prices are formed by the interaction of these buyers and sellers and intermediaries. The marketplace is large and liquid and the volume of paper transactions healthily exceeds the volume of physicals. Facilities such as hedging and the use of derivatives are available to adjust market participants’ exposure to price fluctuations.

C. An extensive and growing pipeline and storage network

Pipeline gas is available in the major population centres of all provinces except Newfoundland and Prince Edward Island and all the mainland states of the U.S. The spread of distribution networks is taking place only slowly in New Brunswick and Nova Scotia where pipeline gas has only been available for about 15 years. There are extensive gas storage facilities, principally in Alberta, BC and Ontario, which appear adequate to provide for gas trading needs, assist in security of supply and adjust pipeline load utilization responsive to temperature sensitive demands of consuming areas.

The pipeline network is growing. The Canadian pipeline industry responds vigorously to the needs of producers, exporters, marketers and LDCs. At any one time, the NEB and provincial regulators may be dealing with a dozen major projects. At the time of writing this, the NEB has before it Nova Gas Transmission Ltd.’s 2017 System Expansion, Merrick Mainline, the North Montney detailed route hearing and the Towerbirch expansion and TransCanada PipeLines’ Eastern Mainline Project. The BC Oil

⁶³ Online: http://www.naturalgasintel.com/marketer_rankings/2016Q1

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

and Gas Commission lists four major transmission projects before it: Coastal Gas Link, Pacific Trails Pipeline, Prince Rupert Gas Transmission and Westcoast Connector Gas Transmission, as well as several smaller ones.⁶⁴

The situation is similar in the U.S. with its 220,000 miles of interstate and international transmission pipelines. The industry is providing increased capacity to move Marcellus and Utica gas both west and east in the U.S. and into southern Ontario. The U.S. Northeast Gas Association lists from public sources about 15 projects intended mainly to deliver new gas supplies to that area of the U.S. and to Canada, including reversal of pipelines such as Maritimes and Northeast, Iroquois and Portland Natural Gas Transmission.⁶⁵

To enable delivery of U.S.-produced natural gas into eastern Canada and to meet growing demand in that market, new pipeline infrastructure is being built and existing infrastructure is being expanded. For example, Niagara, historically an export point, was reversed in late 2012 to enable the import of approximately 400 million cubic feet per day (MMcf/d) from the U.S. into eastern Ontario. In the last quarter of 2015, capacity at Niagara was further expanded and the point saw imports increase to approximately 600 MMcf/d. Also in late 2015, the Chippawa export point was reversed to allow for the import of approximately 150 MMcf/d into Ontario.⁶⁶ Canadian pipelines are reportedly responding to the challenge of imports, particularly to Central Canada by offering reduced transmission rates between Alberta and Ontario.

The Canadian interprovincial and international gas transmission sector has developed over a period of about 60 years from the construction of the initial lines of pipe of the TransCanada and Westcoast Energy (Spectra Energy) systems. More companies have since entered the sector (Alliance, Foothills, Maritimes and Northeast) with major long-distance facilities.

There is no reason to think that the fundamental market structure which has evolved to its present condition over the past 60 years will change over the coming 40-50 years. It can confidently be expected that entrepreneurship will bring positive change to ways of doing business. The pipeline and storage industry will continue to search out and act on investment opportunities such as bringing more U.S. gas to Central Canada and to the Maritime provinces and providing pipeline connections needed to link WCSB gas resources to West Coast liquefaction plants.

D. A sophisticated commercial structure

The Canadian and North American gas market structure and transactions display sophistications that generate efficiencies. These sophistications include: the presence of intermediaries (agents, brokers and marketers); instant price discovery at trading hubs; the availability of electronic trading; futures markets; price-hedging and other financial tools; the provision by transmission and distribution businesses of a variety of non-traditional services; and the existence of secondary markets for

⁶⁴ Online: <https://www.bcogc.ca/public-zone/major-projects-centre>

⁶⁵ Online: http://www.northeastgas.org/pdf/system_enhance1215.pdf

⁶⁶ Cited from NEB, *Canadian Energy Dynamics, Highlights of 2015*, op.cit.

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

transmission capacity. Since gas commodity deregulation was initiated in 1985, Canadians have been able to meet their gas requirements in full at prices determined by this increasingly sophisticated functioning market.

E. Conclusion

Canadians' gas requirements will be met by a competitive market structure and by vigorous entrepreneurial gas producing, midstream, transmission, intermediary and distribution businesses. Canadians, it is concluded, have an assured, adequate, competitively priced supply of gas. The Canadian gas marketplace is clearly "fit for purpose". Its existence and operation is in no way controversial. The most reasonable presumption is that this condition will prevail for an indefinite future, and almost certainly into the 2060s.

9. Gas markets in North America have functioned efficiently and there is no evidence to suggest that they will not continue to do so in the future

A. Efficient market functioning

This Report considers that Canadian gas markets are part of one North American gas commodity market which cannot be differentiated by jurisdiction (national, provincial or state) and in which prices are networked reflecting only differences in transmission prices in all but the rare situations where pipeline transmission capacity is a constraining influence (example: the Canadian Maritimes and parts of New England, mainly in the heating season, a matter which is discussed in *Energy Future 2016* at page 29 under the caption *The Nova Scotia and New Brunswick Natural Gas Market*).

Conditions in the pipeline-connected Canadian and North American gas market approach those associated with perfect competition in which every buyer and seller is a price-taker. Thus: there are large numbers of buyers and sellers; adequate decision-taking information is equally available to all participants; in particular, price-discovery is easily and continuously achieved; there are no dominant positions in buying or selling; conversely, no participants have market power; and transmission and distribution capacity and storage is generally available when and where required (an exception is noted in the previous paragraph).

The result of these conditions is that the gas market functions efficiently. Prices continuously reflect the availability of sufficient and accurate market information. Willing sellers and buyers are able to interact and dispose of or acquire all the gas they wish to at current market prices. The market clears continuously. There are neither seller surpluses nor buyer shortages.

Multiple mechanisms enable efficient market functioning. In the commodity market, there is a vast amount of relevant information available from such sources as the Intercontinental Exchange (“ICE”)⁶⁷ and from trade sources print and electronic. Prices are instantly and continuously available. Contracts are available for a variety of terms. Prices can be hedged and risks mitigated. In the gas transmission market, pipelines operate open-season open-access, there is a market for capacity offered by third parties who have contracted pipeline and storage services, and electronic bulletin boards help to keep all parties informed. Market participants can also find information in regulatory filings and from sources such as the NEB’s market snapshots and the US EIA’s market comments.

B. Evidence for continued efficient market functioning

The functioning Canadian and North American gas market has developed essentially as a result of the abandonment of government-regulated gas pricing in Canada under the “Halloween Agreement” of October 31, 1985 and the Board’s decision shortly after that to order TransCanada Pipelines to transport gas for third parties. Open-access to transmission was formally instituted within a year in Canada and in the U.S. by the early 1990s.

⁶⁷ Online: http://www.ngx.com/?page_id=2

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

Open-access created the key condition for a functioning gas commodity market and over the next 30 years released a flood of entrepreneurship on the part of both existing industry players—producers, pipelines and distributors—and market entrants providing a variety of new services. The market has grown in sophistication and efficiency. Its functioning has never been called into question by governments, regulators or by the competition authorities. It is endorsed by all sectors of the industry, both companies and their associations, including some which in the era of regulation were occasionally at loggerheads. There is no evidence to suggest that efficient gas market functioning will not continue for an indefinite future, extending at least to 2067.

The North American gas sector presents in every way a functioning market, the largest and best-operating in the world.^{68 69} It does not distinguish national from international transactions: national borders are not now commercially important. The effects of fluctuations in supply and demand variables are therefore similar across all participants—suppliers, buyers and intermediaries—in the integrated continental market which has the following characteristics:

Size: the combined Canada, Mexico, U.S. gas market is by far the largest barrier-free gas trading zone in the world with open-season open-access inter-jurisdictional transmission pipelines, currently aggregating some 95 Bcf/d in 2015;⁷⁰

Openness: there are thousands of market participants and no identified dominant positions or other non-economic non-technical barriers that would distort the market by preventing entry by new producers, processors, pipelines, sellers, buyers, importers, exporters or intermediaries;

Growth: is steady and driven mainly by demand for power generation, oil sands and, prospectively, LNG exports;

Integration: is physical, commercial, regulatory and, frequently, corporate; it enjoys strong longstanding policy underpinnings including, fundamentally, the relevant provisions of the North American Free Trade Agreement;

⁶⁸ The IEA *Review of United States Energy* published in 2007, stated at page 22: *The United States oil markets are fully open to competition, and the country's natural gas market is a regulatory model within the IEA for what liberalization can achieve.* Exactly the same comment could appropriately be applied to Canada. Online: <http://www.iea.org/publications/freepublications/publication/us2007.pdf>

⁶⁹ The IEA *Review of Canadian Energy* published in 2009, stated at page 32: *The natural gas market in Canada is resource-rich, efficient, competitive and diversified, and the present structure of the natural gas market provides a high degree of energy security.* Online: <http://www.iea.org/publications/freepublications/publication/canada2009.pdf>

⁷⁰ For perspective, in 2014 North American gas consumption was about 92 Bcf/d (*BP Review of World Energy, 2015*, excel spreadsheet *Natural Gas Consumption*) while the whole of Europe and Eurasia, therefore including the former Soviet Bloc, 31 countries in all, tallied 97.7 Bcf/d. In regard only to the European Union, Makhholm, J.D., in *The Political Economy of Pipelines* (Chicago: University of Chicago Press, 2012) states at page 165 *The continent almost certainly has the supply diversity and the pipeline hardware necessary to create a competitive gas market. But the EU has yet to achieve any noteworthy movement in that direction.*

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

Transparency: is assured by very large public and private information flows including readily-available sources for comprehensive price discovery at many locations;

Efficiency: the gas market is efficient essentially because it is highly competitive and because the prices which transmit signals to market participants fully reflect the breadth of information available as a result of the transparency characteristic;

Liquidity: is reflected in a huge daily volume of transactions with “paper” transactions far exceeding “physicals” and in the market’s confidence in and therefore preference for short-term transactions;

Flexibility: is demonstrated by the industry’s ability to continuously connect supplies to markets and vice-versa, to meet seasonal and exceptional fluctuations in supply and demand and to seek out and invest in new pipeline, processing and marketing opportunities such as LNG exports; and

Price responsiveness: is demonstrated by the fact that the market clears continuously on an hourly and daily basis as price signals flow through to all market actors—gas production is apparently never involuntarily shut-in and there are never reports of gas consumers being unable to purchase the commodity at market prices.

The foregoing characteristics have of course long been identified in the Board’s own market monitoring and are commented-on in the *Views* it has expressed in numerous decisions respecting applications for liquefied natural gas exports. This then is the Canadian and North American market from which Canadians are able to meet their gas requirements.

C. No reason to consider that Woodfibre LNG Export’s shipments will impair efficient market functioning

As regards the exports proposed by Woodfibre LNG Export, the significance of the foregoing analysis is as follows:

- The Implications on the ability of Canadians to meet their gas requirements are not significantly different as between exports of LNG by Woodfibre LNG Export from Canada to the Pacific Rim or by others to the Atlantic Basin or exports of LNG from the U.S. to overseas markets or the long-term surge in continental gas demand which is occurring and expected to continue as older coal-fired electric generating plants are retired and partly replaced by new combined cycle gas units;
- The surplus Assessment required under section 118 of the NEB Act respecting the exports proposed by Woodfibre LNG Export, while necessarily focusing on foreseeable Canadian gas requirements and trends in the discovery of gas in Canada must be informed also by consideration of the broad background of the integrated North American market; and
- The market structure, characteristics and functioning identified particularly in section b. above cannot be adversely affected by the exports proposed by Woodfibre LNG Export

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

which are small in proportion to the aggregate supply available during their term. Indeed, to the extent that Woodfibre LNG Export's activities result in a larger than otherwise gas market, they would tend to contribute marginally but favourably to that efficient market functioning.

D. Conclusion

The functioning gas market has and will continue to greatly benefit Canadians as they meet their gas requirements. This gas market prevails on a continent-wide scale and within it gas flows across national boundaries are unimpeded. In the last analysis, this is the market from which Canadian gas requirements are met. Efficiently functioning Canadian and North American markets enable Canadians to meet their gas requirements under conditions that will not be changed by the exports proposed by Woodfibre LNG Export. This finding applies just as much to the period through 2067, and indeed beyond, as it did in 2014 for the term through 2049.

10. The evidence in this Application is generally consistent with the Board's own market monitoring

A. The Board's market monitoring

The Board has exercised this function pursuant to Part II of its Act since its inception in 1959. In its decision regarding the Market-Based Gas Export Procedure, the Board stated that one of the ways in which it would act to ensure that gas licensed to be exported is surplus to Canadian requirements will be by monitoring Canadian energy markets on an ongoing basis.⁷¹ And the Board's 2015 Annual Report, at page 30 under *Energy Markets 2015*, advises that as part of its regulatory mandate, it monitors the integrated North American energy markets, to track and understand ongoing changes in the relationships between supply, infrastructure, demand and prices, and to stay current on the conditions in a quickly evolving energy market.

It is entirely reasonable to expect that, if things should in future change in such a way as to have implications for the ability of Canadians to meet their gas requirements, the Board will be the first to identify changes, signal to market participants and encourage any required adjustments, as well as taking appropriate actions itself.

B. Consistency with the Board's market-monitoring

This Report's analysis which addresses prospectively the Implications of the export volumes proposed in this Application is consistent with what the Board has identified by way of gas resource development, industry competition, industry cost experience, gas trade, pipeline industry activity, limitations on Canadian LNG exports and long-term policy on gas market functioning since December 2013 when the Board's Letter Decision in Woodfibre LNG Export was released. By way of example, in the following bullet points, selected statements in this Report are matched with corroborating material from the Board's own post-2014 market monitoring.

- **Gas resources:** This increase (in assessed gas resources) is attributable in large part to the revolutionary development of unconventional gas based on the innovative technologies of horizontal drilling. The Board's Market Snapshot: *Increased horizontal drilling in western Canada* June 24, 2015 stated: *Since 2010, horizontal well drilling activity has dominated and now accounts for the vast majority of drilling activity in the WCSB...The average cost of drilling, completing and producing from new horizontal wells is below the cost of doing the same from new vertical wells in the WCSB.*
- **Industry competition:** The Market Snapshot titled *Large Mid-Size Companies Rival Major Producers in Share of Tight Gas Production from Western Canada*, October 8, 2015, stated: *In that same period (2006 to 2014), the share of "operated"⁷² tight gas produced by majors*

⁷¹ GHR-1-87, op.cit., page 36, *The Market-Based Procedure*.

⁷² Operated production is the wellhead gas production assigned to the company who is responsible for maintaining it (the operator), and differs from "net" production.

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

decreased while large mid-sized producers' share increased, such that both groups produced 44 per cent each in 2014... Like the majors, large mid-sized producers also possess the size, scale and land to attract investment capital and access debt markets. Further, the large mid-sized producers generally have more local or regionally focused asset bases and expertise. This has enabled them to lead all producer groups in Canadian tight gas production growth since 2006.

- **Industry cost experience:** Remarkable cost reductions continue to be made in the U.S. shale gas sector: trade sources report continuing increases in drilling rig productivity and in initial well production. The Market Snapshot: *Average Initial Production Rates of Natural Gas Wells in Western Canada at a 14-year High*, July 22, 2015 stated: *Technology improvements encouraging drilling activity to concentrate on deep tight and shale formations, has led to the highest average initial production rates for natural gas wells in the WCSB since 2000.*
- **Canadian gas trade:** The principal consideration affecting both Canadian pipeline gas exports and Canadian pipeline and LNG imports is the enormous size of the U.S. unconventional gas resource. The Market Snapshot: *Decreasing Canadian Natural Gas Exports to the U.S. Midwest and East Regions*, September 16, 2015, contained the following: *Rapid development of unconventional gas projects has increased U.S. natural gas production. For example, from 2007 to 2015, natural gas production from the Marcellus region increased from less than two billion cubic feet per day to over 16 Bcf/d. As a result, natural gas exports from Canada to the U.S. have been decreasing. Between 2007 and 2014, Canadian exports to the U.S. East region decreased by over 65 per cent, from 2.82 Bcf/d to 0.95 Bcf/d. Exports from Canada to the U.S. Midwest region have also decreased, from 5.05 Bcf/d in 2011 to 3.90 Bcf/d in 2014. Increased natural gas production in the U.S. has also led to pipeline modifications that have affected Canadian exports.*
- **Changing gas flows:** The Board's Energy Market Assessment ("EMA") *Canadian Energy Market Dynamics, Review of 2014* published in February 2015 observed under the caption *Gas Flows Continue Changing in Ontario and Quebec: Historically, Eastern Canada has received most of its natural gas from Western Canada. Natural gas from Western Canada was also exported to the northeast U.S. via several export points in Ontario and Québec. However, the rapid development of the Marcellus Shale in the northeast U.S. is changing this, as gas exports from Ontario and Québec to the U.S. dropped 12 per cent from 2013 to 2014, for a total decline of 38 per cent since 2010 as shown in Figure 12. Some former export points are now being used to both import and export natural gas. In the near future, more export points are expected to be used to import gas from the U.S., either occasionally or permanently.*
- **Pipeline industry responses:** The industry is providing increased capacity to move Marcellus and Utica gas both west and east in the U.S. and into southern Ontario. The Market Snapshot *Pipelines Transitioning to Bring More U.S. Natural Gas to Ontario and Quebec* February 5, 2015 commented: *To enable more flow of U.S. sourced natural gas into*

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

Ontario and Quebec (and even the Maritimes, through interconnecting pipelines), regional pipeline companies are in the process of expanding existing infrastructure.

- **Limitations on Canadian LNG exports:** Factors could limit the volume of LNG exports from Canada (see **Annex 5** to this Report)]. The Market Snapshot *Canadian LNG Projects Face a Competitive Global Market*, March 5, 2015, observed: *Factors influencing the competitiveness of liquefaction projects include distance to gas reserves, availability of the existing infrastructure, distance to markets, construction and labour costs, geopolitical factors, financing and timing.* Subsequently in *East Coast LNG Projects Tackle Competition and Supply Challenges*, Market Snapshot, August 27, 2015 the Board noted that: *In addition to the challenge of global competition, LNG exporters from the Maritimes face the challenge of finding long-term sources of natural gas supply... Moreover, ongoing pipeline bottlenecks in the U.S. are currently preventing U.S. Northeast supply from reaching Maritimes consumers. Should Maritimes LNG projects proceed, additional infrastructure may be required to service the LNG plants.*
- **Policy on market functioning:** The functioning Canadian and North American gas market has developed essentially as a result of the abandonment of government-regulated gas pricing in Canada under the “Halloween Agreement” of October 31, 1985: the Board on November 16, 2015 published a feature article *30th Anniversary of the Deregulation of Canada’s Natural Gas Prices* which concluded with the following statement: *Without the Western Accord and the Halloween Agreement, North American energy markets – one of the few in the world where buyers and sellers are able to freely negotiate prices – would look significantly different than they do today.*

C. Conclusion

The Board’s long-established, detailed and continuous monitoring can be counted-on to provide an early warning to all interested parties, including of course the Board itself, should the effective functioning of energy and gas markets appear to be at risk as a result of presently unforeseeable circumstances. The evidence presented in this Report is consistent with the market monitoring of recent years, as illustrated by examples provided. As well, that market monitoring confirms, within an admittedly short span of time, the market behaviours projected in the evidence submitted by Woodfibre LNG Export in support of its 23 July 2013 application for a 25-year licence.

11. Conclusion as to the outlook for market fundamentals through 2067:

There is no reason to anticipate any major change through 2067 in the fundamentals that led the Board to make its Surplus finding in respect of Woodfibre LNG Export's 2013 Application.

A. Policy and regulation

Canada policy

The Government of Canada's policy of allowing and encouraging energy and natural gas markets to work, initiated by the 1985 Western Accord, was followed by the seven succeeding federal administrations up to the October 2015 change of federal administration. The present administration has not indicated any intention to change policy in this respect.

Canada's energy policy is clearly understood internationally in terms of a market-oriented framework. The following statement is from a review by the IEA:

*Canadian energy policy relies on competitive markets to determine supply, demand, prices and trade.*⁷³

Canada regulation

The NEB's strategic plan states that one of its four goals is that Canadians benefit from efficient energy infrastructure and markets.⁷⁴ Market efficiency which has already been discussed above is, of course, secured by encouraging competition and by allowing prices to equilibrate supply and demand to the greatest extent possible.

U.S. Policy

The U.S. Government has pursued essentially similar policies for an even longer period. The interventionist policies of the Nixon and Carter administrations in respect of crude oil and petroleum

⁷³ The Executive Summary of the International Energy Agency's 2010 Review of Canada (see also footnote 47) reads in part as follows:

Three key underlying principles of Canadian energy policy are: market orientation; respect for jurisdictional authority and the role of the provinces; and, where necessary, intervention in markets to achieve specific policy objectives. Canadian energy policy relies on competitive markets to determine supply, demand, prices, and trade, and is guided by a drive for cleaner production and use of energy. The government of Canada seeks to achieve a balance between the environmentally responsible production and use of energy, the growth and competitiveness of the economy, and secure and competitively priced energy and infrastructure. (pages 9 and 10)

<http://www.iea.org/Textbase/npsum/canada2009SUM.pdf>

⁷⁴ Undated. Online: <https://www.neb-one.gc.ca/bts/whwr/gvrnnc/strtgcpIn-eng.html>

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

products were dismantled early in the first Reagan administration (1981). However, deregulation of the U.S. natural gas commodity markets occurred later than the same process in Canada and was not achieved until the early 1990s. Comments similar to those made above relative to Canadian policy could now appropriately be applied to American policy as it relates to energy commodity markets.

With respect to natural gas markets, it is clear from the most recent applicable piece of federal legislation, the Energy Policy Act of 2005,⁷⁵ that market functionality is a continuing policy objective. This is reflected in such measures as clarification and simplification of regulation of liquefied natural gas import and export facilities (section 311), market-based pricing for gas storage (section 312), the prohibition of gas market manipulation (section 315) and natural gas market transparency rules (section 316).

The market-based approach for the U.S. natural gas and oil sectors, which has been the organizing policy principle for some 30-plus years, is not at issue between America's principal political parties.

U.S. Regulation

The Federal Energy Regulatory Commission ("FERC"), somewhat similar to the NEB, states in its Strategic Plan 2014-2018 that:

The Commission encourages the development of competitive markets by approving efficient market rules, reducing barriers to participation by all supply-side and demand-side resources, and preventing the exercise of market power.⁷⁶

North America Legislation

In respect to Canada and the U.S., the North American Free Trade Agreement of January 1994⁷⁷ solidified in law the energy policies adopted in the mid-1980s. With respect to Mexico, it should be noted that there are no restrictions in international gas trade with Mexico.⁷⁸ In the view of the Government of Canada, the NAFTA, the world's largest free trade region, has proved to be a solid foundation for building Canada's prosperity and has set a valuable example of the benefits of trade liberalization for the rest of the world.⁷⁹

⁷⁵ Public Law 109-58-Aug 8, 2005, *Energy Policy Act of 2005*, online: http://www1.eere.energy.gov/femp/pdfs/epact_2005.pdf

⁷⁶ FERC, *Strategic Plan FY 2014-2018*, March 2014, online: <http://www.ferc.gov/about/strat-docs/FY-2014-FY-2018-strat-plan.pdf>

⁷⁷ Source for text of the Agreement: <http://www.international.gc.ca/trade-agreements-accords-commerciaux/agr-acc/nafta-alena/texte/index.aspx?view=d> See Chapter Six: *Energy and Basic Chemicals*.

⁷⁸ It is sufficient to note the official Mexican statement that *Natural gas foreign trade is an unregulated activity. Importers and exporters must inform* the [Comision Reguladora de Energia] *on imports and exports*. Comision Reguladora de Energia, "Mexico", page 2, online: <http://www.cre.gob.mx/documento/ingles.pdf>

⁷⁹ Foreign Affairs, Trade and Development Canada, *North American Free Trade Agreement*, online: <http://www.international.gc.ca/trade-agreements-accords-commerciaux/agr-acc/nafta-alena/text-texte/toc-tdm.aspx?lang=eng>

B. Industry structure and behaviour

This Report has already addressed the competitive nature of the producing, transacting and consuming components of the Canadian and North American gas sector, including the large numbers of gas sector competing producer-suppliers and consumer-buyers and the structural characteristics and sophistications that generate efficiencies.

As confidence in market-working has increased, almost all transactions have become short-term. One result is that volumes of Canadian export gas moving across the border by pipeline under NEB long-term approvals, which pre-deregulation were about 100% of the total, have effectively disappeared. This has worked to increase overall liquidity because what was formerly a large gas quantity immune from trading influences (other than price tracking) has become a part of the liquid whole.

There is no significant government control of, or interference in the pricing of the major primary energy commodities—natural gas, natural gas liquids, crude oil, oil products or coal. There has been no concerted appeal for government regulation of gas commodity prices.

Natural monopolies (pipelines, gas distribution) in the natural gas and oil industries are regulated so as to prevent abuse of dominant positions and to facilitate and encourage the operation of the related commodity markets, for example, by open-season open-access to gas transmission and the provision of electronic bulletin boards for transmission information.

By conforming to the competitive model, energy and natural gas market prices are freely arrived at without pressure or obligation on either sellers or buyers and are, therefore, the fair market prices.

There are no indications from the private or governmental sectors of any desire in Canada or the U.S. to bring about fundamental change in energy markets' structure or functioning.

C. Conclusion as to market fundamentals

The market model has been successful for more than 25 years in economic and social terms. It is acceptable to the major political parties in Canada and the U.S. It can reasonably be regarded as the enduring "default setting" where policy and regulation will remain or, if disturbed, to which they will revert. Its continuance over the long term is therefore the appropriate assumption for purposes of this Report. It is entirely reasonable to expect the market model to endure through at least 2067.

D. Overall conclusion as to Characteristics and Functioning of the Gas Sector from which Canadians are able to meet their gas requirements

The integrated North American gas market is well-supplied at low incremental costs from a large resource base. Supply and demand are equilibrated by constantly adjusting to market price signals. This fully-functioning gas commodity market is liquid, open and efficient. It enjoys long-established and sound policy, regulatory and commercial-structure underpinnings. Since gas commodity deregulation was initiated in 1985, Canadians have been able to meet their gas requirements in full at prices determined by this increasingly sophisticated functioning market. There is no evidence that Canadian

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

and North American gas markets will not continue to perform efficiently in a future extending into the mid-2060s and beyond.

12. Conclusion as to the ability of Canadians to meet their gas requirements:

A. Conditions under which Canadians are currently able to meet their gas requirements:

- **Easily**, because competing alternative suppliers and supplier-services are available;
- **Adequately**, because the gas resources that they can draw on from Canada and the U.S. are very large;
- **Cost-competitively**, because of supplier innovation, inter-supplier competition, highly competitive price relationships with e.g. oil fuels and electricity almost universally, and where there are competitive weaknesses e.g. Maritimes, it can be expected that the competitive instincts of industry will search out means to bring more gas and more competition; and
- **Securely**,
 - In terms of **quantity**, because supply and the supply outlook has been revolutionized since about 2008 by the technology of horizontal drilling and multi-stage fracturing;
 - In terms of **source-stability**, because almost all supplies are derived from continental sources within reliable political jurisdictions, this is the expectation for an indefinite future, therefore continuing the remarkable record of 100% supply security achieved during the 30-years of market-functioning.

B. Reasonable expectations as to the ability of Canadians to meet their gas requirements in the presence of the applied-for export quantities and during the requested term

- Alternative suppliers and supplier-services will continue to be readily available, indeed their availability will grow in an expanding total gas market, therefore Canadians will be able to meet their gas requirements **easily**;
- The outlook is for gas resources, presently assessed as very large, to grow over time and for gas requirements to be modest in relation to the size of those resources even as presently assessed, therefore the **adequacy** of gas supply for Canadians over the requested licence term is not in question;
- Supplier innovation and inter-supplier competition will continue to be a central feature of all components of the gas sector: production, processing, transmission, distribution and commodity transactions of all kinds, therefore the **cost competitiveness** of gas supply for Canadians will be maintained or enhanced in terms of both gas-on-gas competition and inter-fuel competition;

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

- The gas resources of Canada and North America are so large that supplies for the Canadian market will be almost entirely drawn from continental sources over the requested licence term and governments and industry are likely to enhance the security of critical gas supply infrastructure, therefore the **security** of Canadians' gas supply is assured for any foreseeable future.

C. Conclusion as to Implications

Canadians will be able to continue to be able to meet their gas requirements easily, adequately, cost competitively and securely in the presence of the applied-for export quantities over the requested licence term.

13. Conclusion as to Surplus pursuant to s.118 of the NEB Act

A. The criterion

The natural gas proposed to be exported does not exceed the surplus remaining after due allowance has been made for the reasonably foreseeable requirements for use in Canada, having regard to trends in the discovery of gas in Canada (see above under Section 2.).

B. Allowance for reasonably foreseeable requirements for use in Canada

This Report, see above under Sections 3., 4., 5. and 6.

C. Having regard to trends in the discovery of gas in Canada

This Report, see above under heading 5.b. and caption *Conclusion as to trends in the discovery of gas*.

D. The Conclusion of this Report regarding the Surplus Criterion

The quantity of gas proposed to be exported by Woodfibre LNG Export is surplus to Canadian needs. Just as it was in regard to Woodfibre LNG Export's 2013 Application, the Board can be satisfied on the basis of the present Report that the gas resource base in Canada, as well as North America, is large and through at least 2067 can accommodate gas quantities respecting (1) reasonably foreseeable Canadian demand, plus (2) a plausible potential increase in that demand, plus (3) the LNG exports proposed in this Application, plus (4) a reasonable expectation as to total Canadian LNG exports, and plus (5) pipeline exports as described under Section 6. Using the Board's number of 855 Tcf⁸⁰ for remaining marketable natural gas resources as of end-2014 in the Western Canada Sedimentary Basin, the ratio of resources to year 2015 production of some 5.7 Tcf is about 150. Taking the resources number of 1 087 Tcf for total Canada, the ratio to production rises to 192. Clearly, the annual Canadian gas requirement of some 10 Tcf projected in Schedule "B" for the 2060s is well within the capabilities of the resource, which by that time is likely to be assessed as even larger than today.

Canadian requirements can be met at low incremental cost (Section 7), from a sophisticated market (Section 8) working efficiently and there is no reason to expect that they will not continue to function in that manner for the long-term future through at least 2067 (Section 9).

There is some risk in projecting reasonably foreseeable requirements for use in Canada fifty years out from 2016. However, the size of the gas resource base in Canada, as well as North America, is such that the gas proposed to be exported by Woodfibre LNG Export does not exceed the surplus remaining after making due allowance for those requirements and having regard to trends in gas discovery (again, see above under Section 6.).

⁸⁰ *Energy Future 2016*, page 61, Table 6.1

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

The capability of the resource will not be the limiting factor on the supply of gas during the projection period, just as it is not now a factor. On the contrary, the limitation on gas supply will continue to be the availability of economic markets available to Canadian gas producers (see under heading 6.c.).

This conclusion is valid regardless when, in the period through the end of 2067, the export proposed by Woodfibre LNG Export take place under the applied-for 40-year licence.

R.Priddle

October, 2016

Annex 1:
Projected Canadian Gas Supplies and Requirements (Bcf/d) Annually 2015-2067 (expansion of Table 4 in the main text)

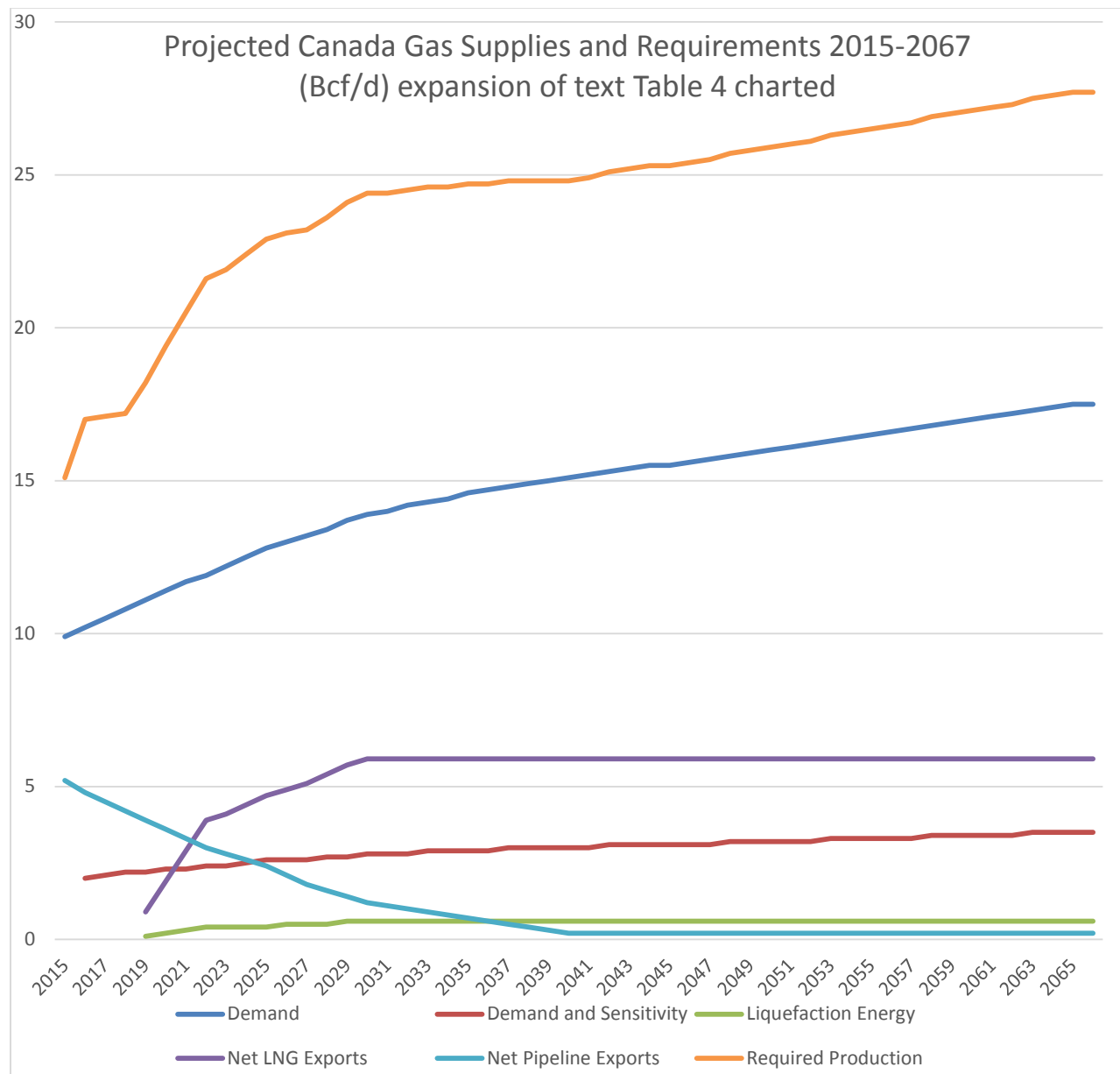
Year	Base Demand	Add for Demand Sensitivity	Plus Additional Liquefaction	Plus Net LNG Exports	Plus Net Pipeline Exports	Equals: Required Production
2015	9.9				5.2	15.1
2016	10.2	2.0			4.8	17.0
2017	10.5	2.1			4.5	17.1
2018	10.8	2.2			4.2	17.2
2019	11.1	2.2	0.1	0.9	3.9	18.2
2020	11.4	2.3	0.2	1.9	3.6	19.4
2021	11.7	2.3	0.3	2.9	3.3	20.5
2022	11.9	2.4	0.4	3.9	3.0	21.6
2023	12.2	2.4	0.4	4.1	2.8	21.9
2024	12.5	2.5	0.4	4.4	2.6	22.4
2025	12.8	2.6	0.4	4.7	2.4	22.9
2026	13.0	2.6	0.5	4.9	2.1	23.1
2027	13.2	2.6	0.5	5.1	1.8	23.2
2028	13.4	2.7	0.5	5.4	1.6	23.6
2029	13.7	2.7	0.6	5.7	1.4	24.1
2030	13.9	2.8	0.6	5.9	1.2	24.4
2031	14	2.8	0.6	5.9	1.1	24.4
2032	14.2	2.8	0.6	5.9	1	24.5
2033	14.3	2.9	0.6	5.9	0.9	24.6
2034	14.4	2.9	0.6	5.9	0.8	24.6
2035	14.6	2.9	0.6	5.9	0.7	24.7
2036	14.7	2.9	0.6	5.9	0.6	24.7
2037	14.8	3.0	0.6	5.9	0.5	24.8
2038	14.9	3.0	0.6	5.9	0.4	24.8
2039	15	3.0	0.6	5.9	0.3	24.8
2040	15.1	3.0	0.6	5.9	0.2	24.8
2041	15.2	3.0	0.6	5.9	0.2	24.9
2042	15.3	3.1	0.6	5.9	0.2	25.1
2043	15.4	3.1	0.6	5.9	0.2	25.2
2044	15.5	3.1	0.6	5.9	0.2	25.3
2045	15.5	3.1	0.6	5.9	0.2	25.3
2046	15.6	3.1	0.6	5.9	0.2	25.4
2047	15.7	3.1	0.6	5.9	0.2	25.5
2048	15.8	3.2	0.6	5.9	0.2	25.7
2049	15.9	3.2	0.6	5.9	0.2	25.8

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

Year	Base Demand	Add for Demand Sensitivity	Plus Additional Liquefaction	Plus Net LNG Exports	Plus Net Pipeline Exports	Equals: Required Production
2050	16.0	3.2	0.6	5.9	0.2	25.9
2051	16.1	3.2	0.6	5.9	0.2	26.0
2052	16.2	3.2	0.6	5.9	0.2	26.1
2053	16.3	3.3	0.6	5.9	0.2	26.3
2054	16.4	3.3	0.6	5.9	0.2	26.4
2055	16.5	3.3	0.6	5.9	0.2	26.5
2056	16.6	3.3	0.6	5.9	0.2	26.6
2057	16.7	3.3	0.6	5.9	0.2	26.7
2058	16.8	3.4	0.6	5.9	0.2	26.9
2059	16.9	3.4	0.6	5.9	0.2	27.0
2060	17.0	3.4	0.6	5.9	0.2	27.1
2061	17.1	3.4	0.6	5.9	0.2	27.2
2062	17.2	3.4	0.6	5.9	0.2	27.3
2063	17.3	3.5	0.6	5.9	0.2	27.5
2064	17.4	3.5	0.6	5.9	0.2	27.6
2065	17.5	3.5	0.6	5.9	0.2	27.7
2066	17.5	3.5	0.6	5.9	0.2	27.7
2067	17.5	3.5	0.6	5.9	0.2	27.7

Woodfibre LNG Export—40-year Licence
 Gas Supplies, Requirements, Implications and Surplus Assessment



Annex 2: Technological improvements in Canadian gas resource assessments

The following notes respond to the invitation in Guide Q under **Further Guidance**, the fourth bullet thereof, to consider the expected technological improvements in resource assessments and innovations.

Canadian gas resource assessments have gone from the relatively primitive national “volume of sediments” approach canvassed by industry in the late 1960s, to comprehensive assessments of mainly conventional resources by the Geological Survey of Canada (“GSC”) in the 1980s and by the Canadian Gas Potential Committee (“CGPC”) in the 1990s and early 2000s to the sophisticated assessment of particular formations by the Board and provincial agencies in the past five years.

Probably the first-ever oil and gas resource assessment placed before the Board was a 1969 report by the *Canadian Petroleum Association* (“CPA”), prepared by its *Committee on Geological Reserves* on the total potential reserves of gas that could be expected to be ultimately recovered in Canada using present-day technology and conventional methods of production. The CPA report was filed in connection with the Board’s omnibus gas export licensing proceeding GH-4-69. Its approach is summarized as follows at page 4-8 of the Board’s Reasons:

The estimates were made on the basis of the volumetric method which relates the volumes of sedimentary rocks expressed as cubic miles to a recovery factor which is an estimate of the number of cubic feet of gas believed to be recoverable per cubic mile of sediment.

There may have been a hiatus in resource assessment during the 1970s. In the 1980s and continuing, considerable work was done “in-house” at the Department of Energy Mines and Resources’ (“EMR”, now the Department of Natural Resources) Institute of Sedimentary and Petroleum Geology (“ISPG”) in Calgary. The results of that work were publicly exposed in numerous “open file reports” and may have influenced policy in regard to deregulation of Canadian gas commodity markets by suggesting that the WCSB remaining gas resource in particular is large.

Between 1991 and 2009 the volunteer-staffed CGPC, which enjoyed as well the support of the NEB and the Energy Resources Conservation Board of Alberta (latterly the Alberta Energy and Utilities Board), conducted assessments of potential undiscovered conventional gas resources in Canada. Reports were published in 1997, 2001 and 2006 (dated 2005 and based on year-end 2003-2004 data)⁸¹. This activity was modeled partly on the work and practices of the U.S. Potential Gas Committee which dates from about 1965.⁸² The CGPC decided in 2009 that a fourth report would have to address resources of unconventional gas⁸³ requiring a combination of geological, engineering and economics expertise. The

⁸¹ The CGPC’s final report acknowledged the financial support of the Canadian Association of Petroleum Producers, the Canadian Energy Pipeline Association, the Canadian Gas Association and Natural Resources Canada.

⁸² Online: <http://potentialgas.org/about>

⁸³ The 2005 report focussed on conventional gas resources, but contained much more discussion and data on unconventional gas than earlier CGPC reports. However, the only resource estimates for unconventional gas

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

Committee considered that, as then constituted, it did not have such expertise and disbanded leaving its archives, financial resources and ideas to others.

The progress since the “volume of sediments” approach, is strikingly reflected in the work of the NEB and sister agencies in Alberta and BC in respect of the November 2013 Energy Briefing Note (“EBN”) on *The Ultimate Potential for Unconventional Petroleum from the Montney Formation of British Columbia and Alberta*. That EBN provides an explicit description of the methodologies used and notes that, for the BC portion, the process used was similar to that for the Horn River assessment made in 2011.

In that connection, the BC Oil and Gas Commission states as one of its current objectives, to improve B.C.’s resource estimates by completing assessments, in collaboration with the Ministry of Natural Gas Development, of the Montney Play, the Liard Basin and other significant areas.⁸⁴

The Energy Resource Appraisal Group of the Alberta Energy Regulator (“AER”) provides extensive information regarding the province’s gas resource endowment.⁸⁵ This is a noteworthy contrast with the period when the AER focused its efforts essentially on assessment of reserves. The striking features of the current approach by public authorities to resource assessments are: a recognition that such assessments are important for policy purposes, perhaps more important than calculation of proven reserves; the amount of human resources being applied (11 authors in the case of AER Open File Report 2012-06); the level of detail in terms of examination of specific formations; and the careful description of the processes followed.

There have clearly been huge improvements in the practice of gas resource assessment in the past half century. It is entirely reasonable to expect further progress. A national approach such as was achieved by the CGPC for conventional resources might not be repeated in respect of unconventional gas resources. Instead, at least for the medium term future, assessments will more likely be of particular geological formations, like the Montney, carried out on a “case by case” basis.

related to natural gas from coal. An estimate was provided for methane in hydrates, which was characterized by the Committee as highly speculative and possibly misleading.

⁸⁴ BC Oil and Gas Commission, *Service Plan 2014/15-2016-17, Planned Actions*, page 15. Online: <https://www.bcogc.ca/node/11169/download>

⁸⁵ See for example, Alberta Geological Survey, Open File Report 2012-06 *Summary of Alberta’s Shale- and Siltstone-Hosted Hydrocarbon Resource Potential*. This source provides references to 16 other related reports by the AGS, which is now a department of the Alberta Energy Regulator. Online: http://www.ags.gov.ab.ca/publications/abstracts/OFR_2012_06.html

Annex 3: The reasons why this Report discards any attempt to provide a detailed description of 50-year Canadian gas requirements

1. The record of long-term energy forecasts is poor.⁸⁶ There are too many acknowledged uncertainties.⁸⁷ It is acknowledged that we are living in a time of unprecedented energy market uncertainty.⁸⁸ As forecasts go out in time, the range of uncertainties increases.⁸⁹ One authority has stated: “...managers (relying on forecasts—R.Priddle) prefer the illusion of certainty to the understanding of risks and realities.”⁹⁰
2. A more credible alternative to such “single case” forecasts might be to present “high, low and reference cases” as do authorities such as the NEB and the US EIA, however this is not useful for the “go/no-go” regulatory decision-taking required in dealing with gas licence applications.
3. Public authorities publishing in the energy field such as (alphabetically): the EIA (*Annual Energy Outlook 2016*), the European Union (*EU Energy Trends to 2030, Update 2009*), the International Energy Agency (*World Energy Outlook 2016*, for release 16 November 2016) the NEB (the Board’s *Energy Future* reports), and the World Bank (for example: *Global (Energy) Tracking Framework*, 2013⁹¹) do not now use the word “forecast”, preferring the term “projection” with its implied lesser degree of certainty.

⁸⁶ The EIA’s first AEO was published in 1978 and projected U.S. energy demand in 2020 to be about 147.6 Quadrillion BTU (“quads”) and gas demand 12.7 quads. *AEO 2016* projects U.S. energy demand in 2020 at 100.55 Quads and gas demand at 28.3 quads (source: Table 1: *Total Energy Supply, Disposition and Price Summary*). Examples could be multiplied: the U.S. National Petroleum Council’s September 2003 study carried out at the request of the U.S. Secretary for Energy, titled *Balancing Natural Gas Policy*, looked out to 2025, found that “traditional North American producing areas will provide 75% of long-term U.S. gas needs, but will be unable to meet projected demand.” This finding, the product of the best brains in the industry, completely overlooked the revolution in unconventional gas that had just started. Now, half way through the projection period, its analysis and policy prescriptions appear to be hopelessly wrong. Online: <http://www.npc.org/>

⁸⁷ The Board’s *Energy Future 2016* uses the word “uncertain” and its derivatives about 100 times.

⁸⁸ The NEB Chair addressing the *Pacific NorthWest Economic Region’s 26th Annual Summit* on July 19, 2016 stated that the past two years in energy markets has been a time of unprecedented uncertainty. Current uncertainty in energy markets clearly increases the risk in long-term energy forecasting. Online: *Canadian Energy in a Global Marketplace*; http://news.gc.ca/web/article-en.do?mthd=index&crtr.page=1&nid=1105499&_ga=1.47820007.1373902808.1458239801

⁸⁹ Population is a key uncertainty in all long term economic and energy forecasting. The range of projections of total Canadian population for 2063 is 40 million to 63.5 million. Online: <http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0520005&paSer=&pattern=&stByVal=1&p1=1&p2=31&tabMode=dataTable&csid>

⁹⁰ Schwartz, Peter. *The Art of the Long View: Planning for the Future in an Uncertain World*, New York: Currency-Doubleday 1991, 1996, page 6. Schwartz is among the acknowledged pioneers of the scenario approach to dealing with decision taking.

⁹¹ Online: <http://trackingenergy4all.worldbank.org/~media/GIAWB/GTF/Documents/GTF-2013-Full-Report.pdf>

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

4. The use even of the term “projection” is appropriately nuanced, for instance by the EIA in the *AEO 2016* which states: *Projections by EIA are not statements of what will happen but of what might happen, given the assumptions and methodologies used for any particular case.*⁹²
5. In its decisions in LNG export licence applications so far, the Board has refrained from any numerical calculus.
6. This position is consistent with the Board’s Reasons for Decision in its *Review of Natural Gas Surplus Determination Procedures*. That report repeatedly questioned the value of forecasts which give “an aura of precision”, stated that “it is not possible to forecast accurately”, considered that “once a forecast has been adopted, the procedure loses its flexibility” and, in regard to one rejected export determination procedure, noted that it “requires making assumptions about the future uncertain behaviour of supply, demand and prices”.⁹³
7. The Board in its 5 November 2015 Letter Decision in *StoltLNGaz* accepted the Applicant’s analysis of Canadian demand, which took a high level approach similar to that pursued in this Report, essentially adopting the Reference Case Canadian natural gas projections in the NEB *Energy Futures Report to 2035*, and extended them to 2040 and 2050.

It is considered that these reasons provide grounds more than sufficient to explain this Report’s choice of a high level approach to describing Canadian gas requirements. The approach is based on the use of expert reports by public authorities, having unchallengeable expertise, appropriately extrapolated beyond their terminal year of 2040

⁹² Online: [https://www.eia.gov/forecasts/aeo/er/pdf/0383er\(2016\).pdf](https://www.eia.gov/forecasts/aeo/er/pdf/0383er(2016).pdf) (admittedly, the link uses the word “forecasts”)

⁹³ NEB RfD, GHR-1-87, July 1987, at pages (v), 7, 8 and 10

Annex 4: Some further considerations relating to Canadian gas requirements

The following comments relate to work done by the Shell Group and by the staff of the California Energy Commission (“CEC”):

The **Shell Group’s** current scenarios⁹⁴ include quantification tables of global energy demand by primary energy source and by final consumption by sector through 2060.⁹⁵ This may be the only current published source of such projections. It is submitted that these data are of some relevance to the qualitative consideration of Canadian gas requirements through 2067.

The Shell scenarios are “Mountains” (in which status quo power is locked-in creating rigidities, dampening economic dynamism and stifling social mobility) and “Oceans” (in which power is devolved, market forces have freer play and there is more growth, higher energy consumption but greater use of renewable energies).

The salient features of these scenarios in terms of primary energy and, in italicised text, the possible implications for Canada, are as follows:

1. The rate of global energy growth over the 50 years to 2060, in Mountains 1.2% per annum (“p.a.”) and in Oceans 1.4%, is about half that of the 50 years to 2010 which was 2.6% p.a. *The growth of energy requirements in an economically and socially advanced country like Canada might decelerate even more than is currently foreseen by the Board.*
2. The rate of global gas growth which was 3.7% p.a. in the half century to 2010 is reduced to 1.4% p.a. in Mountains and 0.85% p.a. in Oceans over the 50 years to 2060. *Gas requirements in an almost-fully gas-serviced energy economy like Canada’s might grow even more slowly taking the half century as a whole.*
3. Primary energy continues to grow through 2060 in both scenarios, but gas peaks in 2040 in Oceans and in 2050 in Mountains. The peaking of global gas in 2040 in Oceans seems to be associated with the growth of renewables (35% of primary energy in 2060), particularly solar which nearly triples its contribution in the 20 years to 2060 when it becomes the largest single source of primary energy. In Oceans, gas growth is also constrained by the assumption that unconventional gas production outside North America does not meet initial expectations. *While solar’s potential contribution may be less in Canada than in the world as a whole, it cannot be excluded that Canada’s gas requirements will peak before 2067 and be slowly declining for a decade or more before that date. The NEB has noted in an April 2016 Market*

⁹⁴ By “scenarios” is meant “...varied stories of equally plausible futures. The stories are carefully researched, full of relevant detail, oriented toward real-life decisions and designed (one hopes) to bring forward surprises and unexpected leaps of understanding.” Source: Schwartz, op.cit., Introduction, page xiii.

⁹⁵ Source: <http://www.shell.com/energy-and-innovation/the-energy-future/shell-scenarios.html> Go to DOWNLOAD THE NEW LENS SCENARIOS. Scroll to SUMMARY QUANTIFICATION TABLES MOUNTAINS VS OCEANS.

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

Snapshot⁹⁶ that carbon pricing policies are active or proposed in provinces generating more than 80% of Canada's greenhouse gas (GHG) emissions. Alberta, accounting for 37% of Canada's 2013 GHG emissions has a Climate Leadership Plan that includes a legislated maximum oil sands emissions limit of 100 million tonnes in any year, which might spell the end of growth in natural gas demand in that sector. Ontario, responsible for 24% of national GHG emissions, has a Climate Change Strategy to reduce such emissions to 80 per cent below 1990 levels by 2050 which would certainly require negative natural gas demand growth.

4. Coal's share in primary energy remains important through 2060 in both Mountains (25%) and Oceans (19.3%). This suggests that there will be room for gas displaced by efficiencies and by renewables from the North American energy economy to find a place in the decarbonization of coal-based overseas economies, particularly in Asia. *The result would be some migration of markets for Canadian and other North American gas away from domestic use and towards overseas use by way principally of LNG: in Mountains, gas is the world's largest single source of energy in the 2040-2050 period.*

CEC: California is a bellwether jurisdiction for energy reform in the era of climate change policy. Its *Renewable Portfolio Standard* ("RPS") aims for 33% renewable energy by 2020. The *Clean Energy and Pollution Reduction Act* of 2015 codifies the current Administration's goals to procure 50 percent of the state's electricity from renewables by 2030. The staff of the CEC in its *2015 Natural Gas Outlook*, published November 2015⁹⁷ models the state's total requirements for natural gas to fall from 6.3 Bcf/d in 2015 to 5.9 Bcf/d in 2030 in its "mid demand case"⁹⁸, with demand in the power generation sector where California's the RPS has the greatest impact, falling from 2.7 Bcf/d to 1.8 Bcf/d in that period.⁹⁹ The significance of this modelling result for Canada is twofold: it points to the potential for reduction in gas requirements in an advanced service-oriented economy and it has obvious implications for the market for Canadian export gas which for half a century has been the major supply source for northern California.

⁹⁶ Online: <https://www.neb-one.gc.ca/nrg/ntgrtd/mrkt/snpst/2016/04-01crbnprcng-eng.html> The reference document includes links to relevant provincial policies and programs.

⁹⁷ Online: http://docketpublic.energy.ca.gov/PublicDocuments/15-IEPR-01/TN206579_20151110T164123_Gene_Nelson_PhD_Comments_Appendix_1_CGNP's_Recommendation_for.pdf

⁹⁸ The CEC Staff Report states at page 18: *The mid demand case can also be referred to as the "business-as-usual case" because the current observable trend of all energy policies and market practices are adopted for the duration of the forecasting period.*

⁹⁹ Report, page 31, Table 4: *Actual and Modeled Natural Gas Demand for All Sectors in California*

Annex 5:
A Discussion of the economics and market factors affecting current and future LNG development in Canada that may limit volumes of Canadian LNG exports to about 6.0 Bcf/d, including Woodfibre LNG Export's requested quantity of 0.32 Bcf/d

The Board has in the past requested gas (LNG) export licence applicants to provide an extensive discussion of the economics and market differentials as well as any other factors that may limit volumes of Canadian LNG exports. One example is the Board's Information Request No.2.2 to Woodside Energy dated 12 November 2014 which resulted in the filing on 5 December 2014 of an Information Response supported by a report prepared by Poten and Partners (Australia) Pty Ltd.

This Report accepts the Board's view as expressed in its Reasons for Decision in PNW LNG that the LNG export licence applications submitted to the Board to date represent a significant volume of LNG exports from Canada and that all these LNG ventures are competing for a limited global market and face numerous development and construction challenges. This Report also agrees with the NEB that, with LNG prices falling in conjunction with crude oil prices, and several new U.S. LNG projects either completed or under construction, Canadian LNG projects face an increasingly challenging business environment.¹⁰⁰ The Board similarly noted at page 69 of *Energy Future 2016* that the timing and volume of LNG exports from Canada are key uncertainties in the outlook. This was a consideration which led the Board to explore this uncertainty further in its two LNG export cases.

This Report also aligns with the view expressed on behalf of GNL Québec Inc in its May 8, 2015 response to the Board's Information Request No.1 that these factors are not a matter of significant disagreement by a variety of interested parties including many project proponents, relate to the various risks that are inherent in major project development and have resulted in no major Canadian project having yet made an unconditional Final Investment Decision.¹⁰¹

Similarly, the Board in its February 2015 report *Canadian Energy Dynamics: Review of 2014 – Energy Market Assessment*, under the caption *Canadian Proposals Face Challenges and Global Competition*, considers that project economics for Canadian LNG projects are affected by factors such as: remote resource locations, remote plant sites, significant environmental and regulatory requirements, and cost considerations. This Report accepts this expression of view and does not consider it necessary to provide further support by means of extensive citations from this and other Board reports and decisions.

Finally, this Report notes the following comments of the U.S. DOE/FE in an Opinion of February 5, 2016 in an application by Pieridae Energy (USA) Ltd. for the export of U.S.-sourced gas:

The Opinion Receiving a non-FTA authorization from DOE/FE does not guarantee that a particular facility would be financed and built; nor does it guarantee that, if built, market conditions would continue to favor

¹⁰⁰ Cited from NEB, *Canadian Energy Dynamics, Highlights of 2015*, op.cit., *Overview of 2015*.

¹⁰¹ Response 1.1 *Factors Limiting LNG Exports from Canada*, page 4, paragraph 1.

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

export once the facility is operational. To illustrate the point, of the more than 40 applications to build new LNG import facilities that were submitted to federal agencies between 2000 and 2010, only eight new facilities were built and those facilities have seen declining use in the past decade.¹⁰²

Project-related factors

Distance from gas supplies: projects on the north coast of BC are remote from the abundant gas resources and supplies available in northeastern BC and Alberta, necessitating the construction of pipeline connections, each of which could cost in the billions of dollars.

Gas supply infrastructure: in addition to pipeline construction, the development for LNG export purposes of available gas resources particularly in geographically remote areas of BC will require the creation of other infrastructure such as gas processing plants.

Remote greenfield sites and associated costs: most of the projects in BC which are the subject of export licence applications, whether approved or pending, are to be located in greenfield sites distant from existing large population centres and infrastructure.

Financing issues: some commentators have observed that national and international finance tends to be more readily attracted to regions and jurisdictions which have a proven track record of commercial success in a particular field.

Commercial complexity: traditionally, LNG projects involving international markets with marine shipments have been structured around a complex contractual chain of transactions from gas supply to market delivery covering some or all of the physical steps of gas production, processing, transmission, liquefaction, storage, marine shipment, regasification and delivery into consumer countries' transmission and distribution systems.

Technical risk: the technology for large-volume natural-gas liquefaction for export by marine vessel has been safely and successfully developed over the past 50 years.

Completion risk: this Report recognizes the possibility exists that for technical or market reasons, a project may reach FID, construction may be initiated but then not completed to the stage of commercial operation. This situation arose in respect of a number of North American LNG import projects as a result of the fundamental change in North American gas supply occurring in the last few years.^{103 104}

¹⁰² Online: <http://www.energy.gov/sites/prod/files/2016/02/f29/ord3768.pdf>.

¹⁰³ See CBC report of the sale of the mothballed Anadarko LNG import project to Bear Head LNG, July 28, 2014 online: <http://www.cbc.ca/news/canada/nova-scotia/proposed-bear-head-lng-plant-bought-for-11m-by-australian-company-1.2720168>

¹⁰⁴ Liquefied Natural Gas Limited, the Australian parent of Bear Head LNG, states that: *The prior owners of Bear Head LNG spent more than \$100 million to design, complete engineering work, and develop the Bear Head LNG site*

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

Commercial risk: when a project having a technical life of several decades is completed, it faces volume risk and price risk. To the extent that Canadian LNG investors are unable to satisfactorily mitigate these risks, this could limit the volume of LNG exports from Canada.

Project economics: this is essentially the question whether for any given project, investors can reasonably expect that the margin between cost of gas into the liquefaction plant and the price of LNG delivered into the marine vessel for export will cover the costs of the operation, including return on and of invested capital.

Industry consolidation: this process may reduce the number of active projects compared to the total of licence applications to the Board and therefore limit the volume of LNG exports compared to the quantities initially licensed by the Board.

Environmental and other regulatory requirements: Canadian federal and provincial environmental assessment and approval processes and other requirements such as the permitting of LNG facilities by the BC Oil and Gas Commission and the TERMPOL process of the Federal Department of Transport for review of marine pollution issues are thorough, expensive and time-consuming.

Aboriginal engagement, consultation and accommodation: the physical steps associated with an LNG project, outlined above will typically occur at least in part on Aboriginal traditional-use and occupancy lands, and affect inland and marine waters. The consultation, negotiation and accommodation of Aboriginal interests may be time-consuming.

Global Considerations

Global and regional gas demand: several authorities in recent years have expressed optimism about the market for natural gas, especially in south and east Asia and in the Middle East. Thus, a special report for the IEA's WEO 2011 answered affirmatively the question "are we entering a golden age of gas?"¹⁰⁵ The IEA's WEO 2015 which looks ahead to 2040 states that natural gas is the only fossil energy source expected to increase its overall market share in that period. Shell Global envisages a future in which natural gas becomes a backbone of the global energy system.¹⁰⁶ In assessing energy prospects to 2040, Exxon Mobil projects global demand for natural gas to rise by 65 percent from 2010 to 2040, the largest volume growth of any energy source, and expects half of that increase will come from the Asia

in the early 2000s. online: <http://www.lnglimited.com.au/irm/content/bear-head-lng.aspx?RID=331&RedirectCount=1>

¹⁰⁵ IEA, World Energy Outlook 2011, Special Report, online: <http://www.worldenergyoutlook.org/goldenageofgas/>

¹⁰⁶ Shell Global, New Lens Scenarios, online: http://s01.static-shell.com/content/dam/shell-new/local/corporate/Scenarios/Downloads/Scenarios_newdoc.pdf

Woodfibre LNG Export—40-year Licence

Gas Supplies, Requirements, Implications and Surplus Assessment

Pacific region, particularly China.¹⁰⁷ It is against this background that the following discussion of global factors that could limit the volume of LNG exports from Canada takes place.

Questions around gas market growth: the outlook for energy and gas demand in Asia Pacific markets is of course related to economic growth prospects which, particularly in China, now appear more modest than a year ago.

Alternatives to imported LNG for sourcing of market supplies: gas supplies to meet market growth may be obtained from (1) local sources in countries like China which have favourable geological prospects¹⁰⁸, (2) imported by pipeline or (3) imported as LNG.

Competition among LNG suppliers: in less than five years, the east African deep offshore in Mozambique and Tanzania has developed into a major source of potential LNG for Asian markets. Trade press reports indicate potential reserves of as much as 100 Tcf in Mozambique and 50 Tcf in Tanzania. It is unclear to what degree U.S. Gulf and East Coast LNG projects will compete directly against Canadian west coast supplies in Asian markets. This competition among world-wide LNG suppliers is a factor that could limit the volume of LNG exports from Canada.

Policy and regulatory issues in importing jurisdictions: in regard to policy, some importing countries may adopt a portfolio approach in which supply security will be one consideration. Given Canada's reputation for political and economic stability and secure trading relationships, this should not be a factor limiting the volume of its LNG exports

Conclusion: This Report adopts the Board's view, expressed in numerous decisions in LNG licence applications, that all of the LNG ventures coming before the Board are competing for a limited global market and face numerous development and construction challenges.¹⁰⁹ It notes the Board's inclusion of Reference and High LNG Cases in its *Energy Future 2016* and its comment under *Key Uncertainties* at page 107 of that report that the total volume of LNG exports in the High LNG Case could be higher than its report assumes because future global demand for LNG is uncertain. This Report considers that in the light of the economics and market factors discussed in this Annex, it is reasonable to adopt the Board's High LNG Case from *Energy Future 2016*.

¹⁰⁷ ExxonMobil, The Outlook for Energy: A View to 2040, Natural Gas Rises in Prominence, pages 51-57, online: http://cdn.exxonmobil.com/~media/global/reports/outlook-for-energy/2015/2015-outlook-for-energy_print-resolution.pdf

¹⁰⁸ BP expects shale gas to expand outside North America, most notably in Asia Pacific and particularly in China, where shale gas production reaches 13 Bcf/d by 2035. See *BP Energy Outlook 2016 Edition*, page 57. Online: <http://www.bp.com/content/dam/bp/pdf/energy-economics/energy-outlook-2016/bp-energy-outlook-2016.pdf>. Nevertheless, *BP Energy Outlook* at page 31 considers that demand for natural gas through 2035 will grow by 1.8% p.a., making it the fastest growing fossil fuel. This robust growth is helped by ample supplies and supportive environmental policies. As well, at page 35, it is stated that LNG trade grows twice as fast as consumption, with LNG's share of world demand rising from 10% in 2014 to 15% in 2035.

¹⁰⁹ NEB, Reasons for Decision, 28 July 2016, page 4, last paragraph.