Appendix 6.1
Liquefied Natural Gas: Potential Supply Options

Introduction

In May, 2016, as inputs to the pending 2016 Resource Plan, YEC undertook a 20 year forecast of future Liquefied Natural Gas (LNG) prices. This forecast included conservative assumptions with respect to the non-commodity components of delivered LNG. That is, the forecast assumed that the source of, and transportation routes of its LNG feedstock would remain relatively unchanged.

To augment the May work, YEC has now reviewed other possible LNG delivery options, which may achieve costs savings relative to the current forecast assumptions.

The approximate current $22/GJ cost of LNG delivered to YEC (Whitehorse) can be broken down as follows[1]:

LNG Cost Component

Transportation and Tanker Charge:	62%
Commodity Charge:	16%
Gas Charge:	22%
Total:	100%

These cost categories are detailed as follows:

- Transportation: this covers the cost of LNG delivery, from liquefaction plant to YEC, including the Tanker Charge, which is the rental fee for the LNG shipping vessel.
- Commodity Charge: This is the charge to convert natural gas to LNG using a refrigeration/liquefaction process; and
- Gas Charge: is the cost of the natural gas that is the LNG feedstock.

In estimating a possible future change in the above costs, YEC has reviewed potential options in each of the cost categories above.

Transportation Charge

The Transportation Charge should be highly correlated to the distance travelled, as it is composed of cost of labour (driver), the rental time for the vehicle, and the cost of the vehicle fuel (diesel). Larger loads and shorter distances should result in savings. Distances, driving time and status can be seen below in Table 1.

[1] This breakdown was obtained from delivered LNG invoices (2015- early 2016); the source data is commercially sensitive.

Table 1. Existing and Potential Sources of LNG

Location	Distance	Driving time	Status
Dawson Creek, BC (AltaGas)	1,460 km	16 hours	Existing
Delta, BC (Tilbury Island)	2,390 km	25 hours	Existing
Fort Nelson, BC (KT Energy)	988 km	11 hours	Potential

YEC's current source of LNG is Delta British Columbia (Tilbury Island). Dawson Creek is the location of the existing AltaGas LNG facility, which has announced plans to expand by over 30% to over 100 m^3/d. Dawson Creek is located in the heart of the Montney gas field, one of the largest, most prolific and most cost-competitive gas plays in North America. There is currently no LNG Facility in Fort Nelson, but in early 2016 KT Energy announced the potential for smaller-scale modular facilities in the region. Fort Nelson is situated in the Horn River gas supply basin, a major current and potential source of natural gas supply.

As transportation costs are highly correlated with the distance travelled, a more northerly LNG supply source should result in significant savings. Larger shipments than the current $60m^3$ volume should result in cost savings. A number of different delivery options was reviewed, up to $90m^3$ per load, a 50% increase in delivered LNG per shipment.

Commodity Charge

The two largest cost components for LNG production are capital cost recovery for the liquefaction plant, and the fuel cost for undertaking the chilling/liquefaction process. Natural gas is almost always used as the energy source for the LNG process, with approximately 7% of the input gas being consumed in the process. This is in large, efficient plants, with a higher percentage of gas consumed as fuel in smaller facilities. A very limited number of liquefaction plants use electricity to run the refrigeration process, but electricity is generally a more expensive source of energy than natural gas. The commodity charge is highly related to the efficiency of the liquefaction plant, with the cost of gas to LNG conversion being equivalent to $4/GJ and above. YEC has no information to indicate that with respect to this charge category, the Dawson Creek or a Fort Nelson LNG facility would be more efficient and more cost effective than its current supplier. Generally, the larger and older (depreciated) the LNG facility, the lower the liquefaction cost.

Gas Charge

Typically, the closer to the wellhead the natural gas supply, the less expensive, due to lower pipeline tolls. This makes North Eastern British Columbia sourced natural gas inherently less expensive that gas sourced further south. An analysis of natural gas prices at the Station 2 and Sumas market hubs indicates an approximate $0.50/GJ difference, with the northern hub having a lower average price. This differential is consistent with the transportation cost between the markets (pipeline tolls). Logistically and economically it would make more sense to produce LNG in the north, as opposed to shipping the gas to the south and then trucking LNG north, thereby incurring transportation charges in both directions. The "Optimized Supply" LNG price scenario described following assumes that natural gas is sourced at Station 2, taking advantage of the lower cost of gas closer to the supply in northeast BC.

Summary

The transportation charge represents the significant potential source of future cost savings, due to the potential for economies of scale (larger delivery vessels), and shorter delivery distances between Whitehorse and the source of the natural gas feedstock. YEC is conservative with respect to estimating cost savings due to larger vessels, as it has not fully reviewed the challenges in single larger LNG shipments. Before deliveries from larger containers should be counted on, shipping constraints (physical due to bridges and axle loadings, and local bylaws) should be thoroughly researched.

Based on currently available information, YEC estimates an $8/GJ overall LNG cost reduction due to sourcing LNG from Dawson Creek. This saving assumption is mostly due to reduced shipping distances, but also due to larger (80m^3) shipping vessels.

YEC recommends that it initiate negotiations with alternative suppliers of LNG, in order to firm-up these price estimates, and potentially realize these savings.

Figure 1 following shows a breakdown of forecast LNG costs in the key scenarios studied, for the first year of delivery. Fuel cost refers to the cost of the natural gas feedstock at the LNG liquefaction plant. Table 2 shows the content of Figure 1 as numerical values.

Figure 2 following shows the cost of LNG under the "Status Quo" assumptions, specifically current 60m^3 LNG shipments, sourced from Tilbury Island - for each of the three underlying natural gas scenarios: Base, Low and High. The "Optimized Supply" scenarios are based on larger 80m^3 shipments and LNG sourced from Dawson Creek - for each of the same 3 underlying natural gas price forecasts. Table 3 shows the content of Figure 2 as numerical values.

Figure 3 is a simplification of Figure 2, in that only the three LNG price scenarios that are used in further analysis are shown: the Base, High and Optimized scenarios. The Base scenario assumes Status Quo shipment volumes and the current Tilbury Island LNG source. The High scenario includes the same Status Quo assumptions as the Base scenario, but with the high gas price forecast. The Optimized Supply scenario selected assumes the Base gas price forecast but with 80m^3 shipments and LNG sourced from Dawson Creek. These 3 selected forecasts were used as LNG fuel input costs in YEC's portfolio analysis, as discussed in Chapter 8. Table 4 shows the content of Figure 3 as numerical values.

Figure 1: Delivered LNG Price for Different Trailer Size and Fuel Source (2016 $CA/GJ)

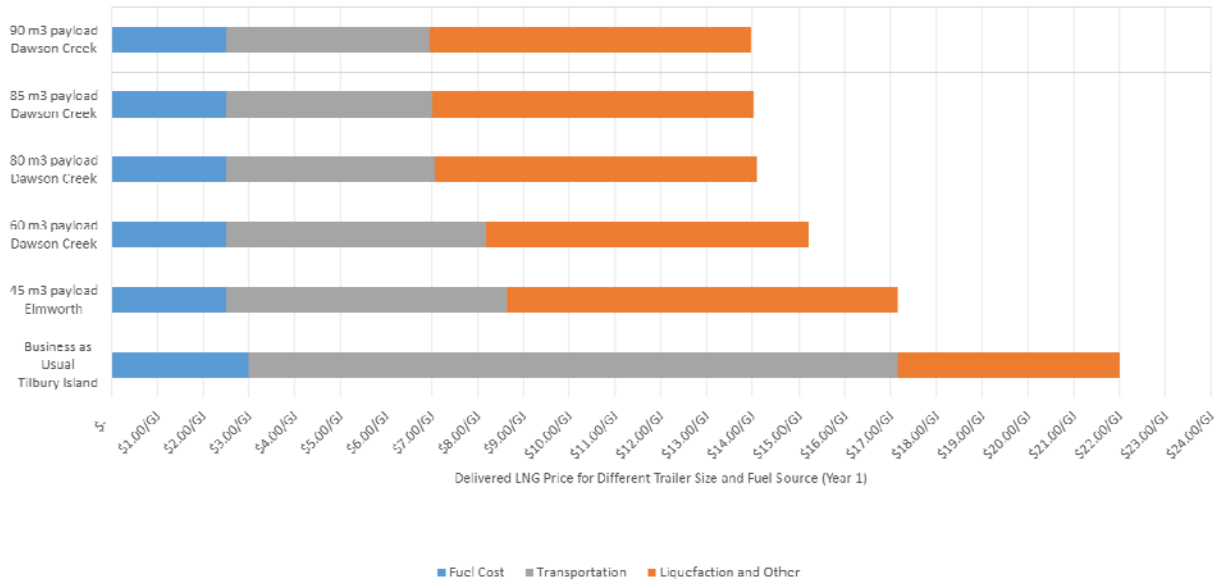

Table 2: Delivered LNG Price for different Trailer Size and Fuel Source (2016 $CA/GJ)

Scenario	Transportation	Liquefaction and Other	Fuel Cost
Business as Usual Tilbury Island	$14.15/GJ	$4.85/GJ	$3.00/GJ
45 m^3 payload Elmworth	$6.15/GJ	$8.50/GJ	$2.50/GJ
60 m^3 payload Dawson Creek	$5.68/GJ	$7.03/GJ	$2.50/GJ
80 m^3 payload Dawson Creek	$4.57/GJ	$7.03/GJ	$2.50/GJ
85 m^3 payload Dawson Creek	$4.50/GJ	$7.03/GJ	$2.50/GJ
90 m^3 payload Dawson Creek	$4.45/GJ	$7.03/GJ	$2.50/GJ

Figure 2: LNG Price Forecast with Alternative Supply and Shipping Options (Real $CA/GJ)

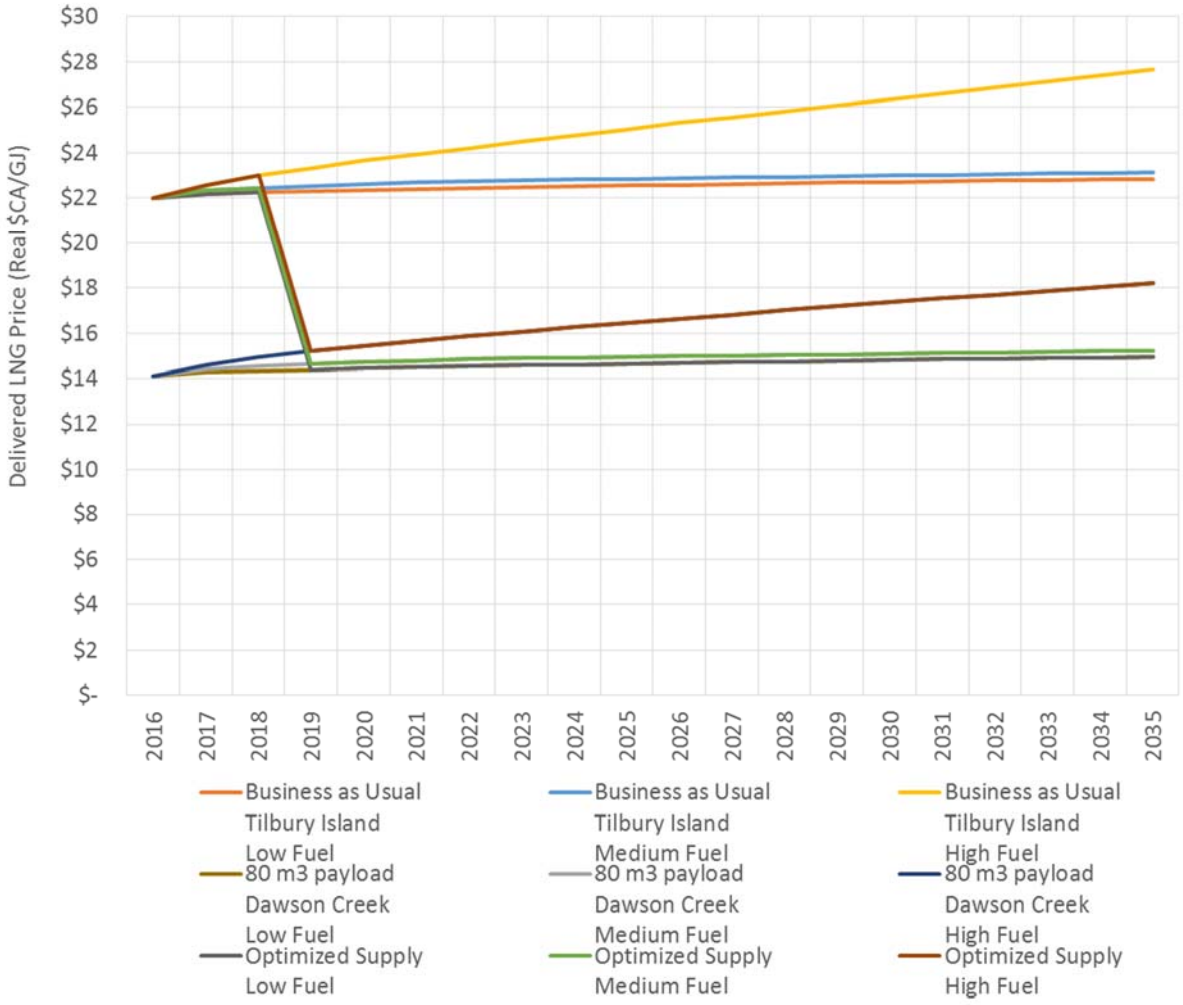

Table 3: LNG Price Forecast with Alternative Supply and Shipping Options (Real $CA/GJ)

Year	Delivered Cost (Real $CA/GJ)								
	Business as Usual Low Fuel	**Business as Usual Medium Fuel**	**Business as Usual High Fuel**	**Dawson Creek Low Fuel**	**Dawson Creek Medium Fuel**	**Dawson Creek High Fuel**	**Optimized Supply Low Fuel**	**Optimized Supply Medium Fuel**	**Optimized Supply High Fuel**
2016	$22.00	$22.00	$22.00	$14.10	$14.10	$14.10	$22.00	$22.00	$22.00
2017	$22.18	$22.33	$22.56	$14.29	$14.43	$14.59	$22.18	$22.33	$22.56
2018	$22.24	$22.44	$23.01	$14.34	$14.54	$14.97	$22.24	$22.44	$23.01
2019	$22.29	$22.53	$23.32	$14.40	$14.64	$15.20	$14.40	$14.64	$15.20
2020	$22.35	$22.61	$23.64	$14.45	$14.71	$15.44	$14.45	$14.71	$15.44
2021	$22.40	$22.68	$23.92	$14.51	$14.79	$15.65	$14.51	$14.79	$15.65
2022	$22.45	$22.74	$24.21	$14.55	$14.84	$15.86	$14.55	$14.84	$15.86
2023	$22.48	$22.79	$24.49	$14.59	$14.89	$16.06	$14.59	$14.89	$16.06
2024	$22.51	$22.82	$24.77	$14.62	$14.92	$16.26	$14.62	$14.92	$16.26
2025	$22.55	$22.84	$25.04	$14.65	$14.95	$16.45	$14.65	$14.95	$16.45
2026	$22.58	$22.87	$25.31	$14.68	$14.98	$16.64	$14.68	$14.98	$16.64
2027	$22.61	$22.90	$25.57	$14.72	$15.00	$16.82	$14.72	$15.00	$16.82
2028	$22.65	$22.93	$25.83	$14.75	$15.03	$17.00	$14.75	$15.03	$17.00
2029	$22.68	$22.96	$26.10	$14.78	$15.06	$17.18	$14.78	$15.06	$17.18
2030	$22.71	$22.98	$26.36	$14.82	$15.09	$17.36	$14.82	$15.09	$17.36
2031	$22.74	$23.01	$26.61	$14.85	$15.12	$17.52	$14.85	$15.12	$17.52
2032	$22.78	$23.04	$26.87	$14.88	$15.14	$17.69	$14.88	$15.14	$17.69
2033	$22.80	$23.07	$27.12	$14.90	$15.17	$17.86	$14.90	$15.17	$17.86
2034	$22.82	$23.10	$27.39	$14.93	$15.20	$18.04	$14.93	$15.20	$18.04
2035	$22.83	$23.13	$27.66	$14.94	$15.23	$18.23	$14.94	$15.23	$18.23
2036	$22.84	$23.15	$27.93	$14.95	$15.26	$18.41	$14.95	$15.26	$18.41
20 year Comp. growth	0.19%	0.26%	1.20%	0.29%	0.39%	1.34%	-1.91%	-1.81%	-0.89%

Figure 3: Delivered LNG price to Whitehorse (Real $CA/GJ)

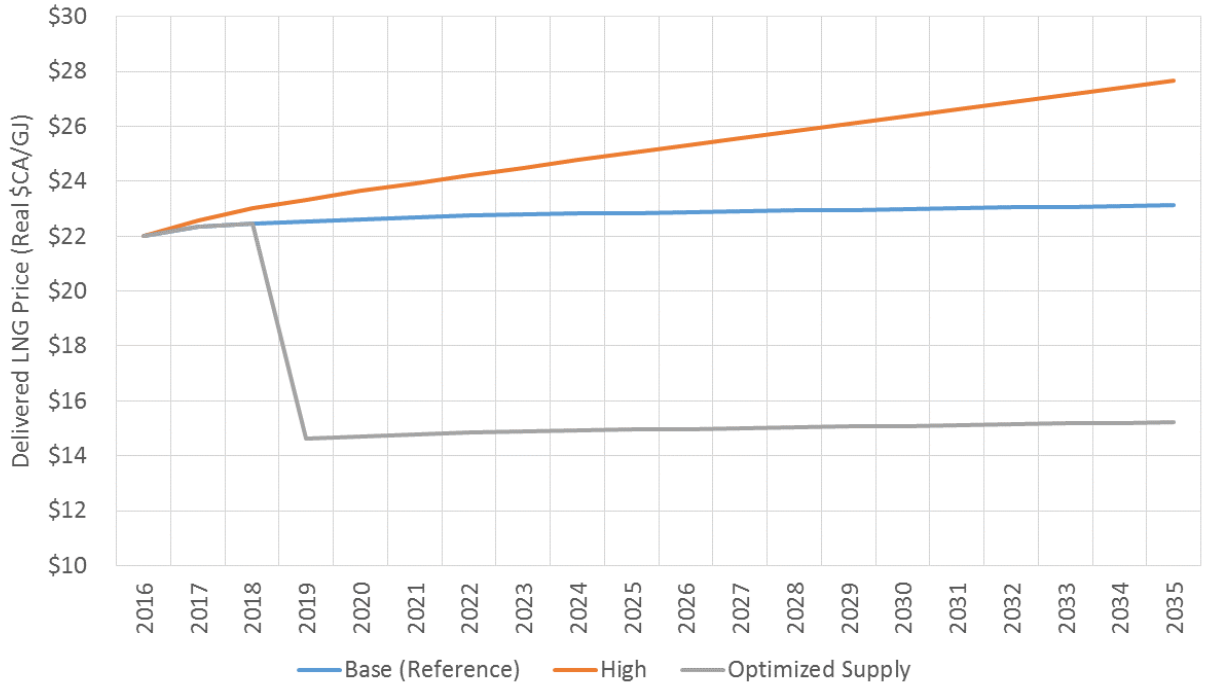

Table 4: Delivered LNG price to Whitehorse (Real $CA/GJ)

Year	Base (Reference) $CA/GJ	High $CA/GJ	Optimized Supply $CA/GJ
2016	22.00	22.00	22.00
2017	22.33	22.56	22.33
2018	22.44	23.01	22.44
2019	22.53	23.32	14.64
2020	22.61	23.64	14.71
2021	22.68	23.92	14.79
2022	22.74	24.21	14.84
2023	22.79	24.49	14.89
2024	22.82	24.77	14.92
2025	22.84	25.04	14.95
2026	22.87	25.31	14.98
2027	22.90	25.57	15.00
2028	22.93	25.83	15.03
2029	22.96	26.10	15.06
2030	22.98	26.36	15.09
2031	23.01	26.61	15.12
2032	23.04	26.87	15.14
2033	23.07	27.12	15.17
2034	23.10	27.39	15.20
2035	23.13	27.66	15.23
2036	23.15	27.93	15.26