

McCULLOUGH RESEARCH

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PRINCIPAL

Date: September 29, 2017

To: British Columbia Utilities Commission

From: Robert McCullough

Subject: Question 16: LNG Prospects

Question 16: With regard to BC Hydro's forecast for LNG load, please provide a more detailed justification for why it considers it appropriate to continue to include each of the three LNG projects (i.e. FortisBC Tilbury LNG Phase 2, Woodfibre LNG and LNG Canada) in its load forecast.

Answer: Tilbury is likely in a different market than the larger LNG export terminals planned for British Columbia and Oregon. Extensive evidence exists that British Columbia and Oregon will continue to fall behind Cheniere in the race for firm contracts. Woodfibre and LNG Canada face very uncertain futures.

The basic problem is that Oregon and British Columbia are at a considerable disadvantage to an existing competitor – Cheniere. Cheniere has the largest base of existing export contracts to Asia. Their lead is expanding due to several strategic factors:

1. Cheniere is very close to natural gas sources in Texas and Louisiana;
2. Cheniere can rely on existing infrastructure in terms of pipelines and access to the electric grid.
3. Cheniere is expanding existing brownfield facilities utilizing nearby skilled labor and engineering support.

Industry press puts Cheniere's expansion cost per MTPA at between US\$500/mtpa and US\$600/mtpa.^{1,2} Similar estimates for British Columbia place the cost of natural gas at C\$1,300/mtpa.³ This is roughly twice as high.

¹ MTPA stands for million tonnes (of LNG) per annum.

² CHENIERE ENERGY, INC. BARCLAYS CEO ENERGY-POWER CONFERENCE, September 2017, page 11.

³ Liquefied Natural Gas: The Next Leg of Canada's Energy Boom?, TD Economics, May 29, 2014, page

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West coast projects have found it difficult to meet this challenge. For example, Jordan Cove's FERC filing last week reports a cost per mtpa of US\$1,282.⁴

After price spikes in 2008, twenty LNG export facilities were announced for British Columbia as well as two for Oregon. As of this date, only one very small project (Woodfibre) has reached a final investment decision. None have gone into operation. The market reality is that facilities based on brownfield sites and close proximity to natural gas production have set a price level that facilities within the Northwest Power Pool have not been able to match. Simply stated Cheniere has set a capital cost standard that NWPP competitors have not been able to match – a \$5.60/million tons per year (MTPA).⁵

Cheniere has two operating LNG terminals: one at Corpus Christi, Texas and one at Sabine Pass, Louisiana. As of yearend 2016, each terminal has an extensive portfolio of ongoing long-term export contracts:

Louisiana:

	BG Gulf Coast LNG, LLC	Gas Natural Fenosa LNG GOM, Limited	Korea Gas Corporation	GAIL (India) Limited	Total Gas & Power North America, Inc. ("Total")	Centrica plc
Annual contract quantity of LNG (in million MMBtu)	286.50 (1) (2)	182.50 (3)	182.50	182.50	104.75	91.25
Annual contract quantity of LNG (mtpa)	5.5	3.5	3.5	3.5	2.0	1.75
Expected annual fixed fees (in millions)	\$723 (1)	\$454	\$548	\$548	\$314	\$274
Fixed fees \$/MMBtu	\$2.25 - \$3.00 (1)	\$2.49	\$3.00	\$3.00	\$3.00	\$3.00
Variable fee per MMBtu	115% of Henry Hub	115% of Henry Hub	115% of Henry Hub	115% of Henry Hub	115% of Henry Hub	115% of Henry Hub
Contract start (date of first commercial delivery for applicable Train)	Train 1 (1)	Train 2	Train 3	Train 4	Train 5	Train 5
Guarantor	BG Energy Holdings Limited	Gas Natural SDG S.A.	N/A	N/A	Total S.A.	N/A
Principal place of business of customer	United States	Republic of Ireland	Republic of Korea	India	United States	England and Wales

Figure 1: Statistics of Cheniere's Louisiana Terminal⁶

⁴ Veresen submits new application for Oregon LNG terminal, BNN, September 22, 2017, page 6.

⁵ See, for example, Cheniere Energy INC Corporate Presentation, June 2017, page 9.

⁶ Cheniere 2016 Annual Report, page 4.

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Texas:

	Endesa S.A.	Iberdrola S.A.	Gas Natural Fenosa LNG GOM, Limited	Woodside Energy Trading Singapore Pte Ltd	PT Pertamina (Persero)	Électricité de France, S.A.	EDP Energias de Portugal S.A
Annual contract quantity of LNG (in million MMBtu)	117.32	39.68 (1)	78.22	44.12	79.36 (2)	40.00	40.00
Annual contract quantity of LNG (mtpa)	2.25	0.76	1.50	0.85	1.52	0.77	0.77
Expected annual fixed fees (in millions)	\$411	\$139	\$274	\$154	\$278 (2)	\$140	\$140
Fixed fees \$/MMBtu	\$3.50	\$3.50	\$3.50	\$3.50	\$3.50	\$3.50	\$3.50
Variable fee per MMBtu	115% of Henry Hub	115% of Henry Hub	115% of Henry Hub	115% of Henry Hub	115% of Henry Hub	115% of Henry Hub	115% of Henry Hub
Contract start (date of first commercial delivery for applicable Train)	Train 1	Train 2	Train 2	Train 2	Train 1/ Train 2	Train 2	Train 3
Guarantor	N/A	N/A	Gas Natural SDG, S.A.	Woodside Petroleum, LTD	N/A	N/A	N/A
Principal place of business of customer	Spain	Spain	Republic of Ireland	Singapore	Indonesia	France	Portugal

Figure 2: Statistics of Cheniere's Texas Terminal⁷

Cheniere's description of their market advantage matches contemporary research at Wall Street and the natural gas industry:



Figure 3: Price comparison of LNG terminals⁸

⁷ Cheniere 2016 Annual Report, page 7.

⁸ CHENIERE ENERGY, INC. J.P. MORGAN INAUGURAL ENERGY EQUITY June 2016, page 26.

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Cheniere's estimate for British Columbia (highlighted in yellow) indicates a \$4.30/mmbtu cost disadvantage.

Cheniere is adding more capacity continuously. Two new trains – completed liquefaction installations – are under construction in Louisiana.

Sabine Pass Liquefaction Construction Progress

Trains 1, 2, and 3 in Operation, Train 4 Expected 2H 2017, Train 5 Expected 2019

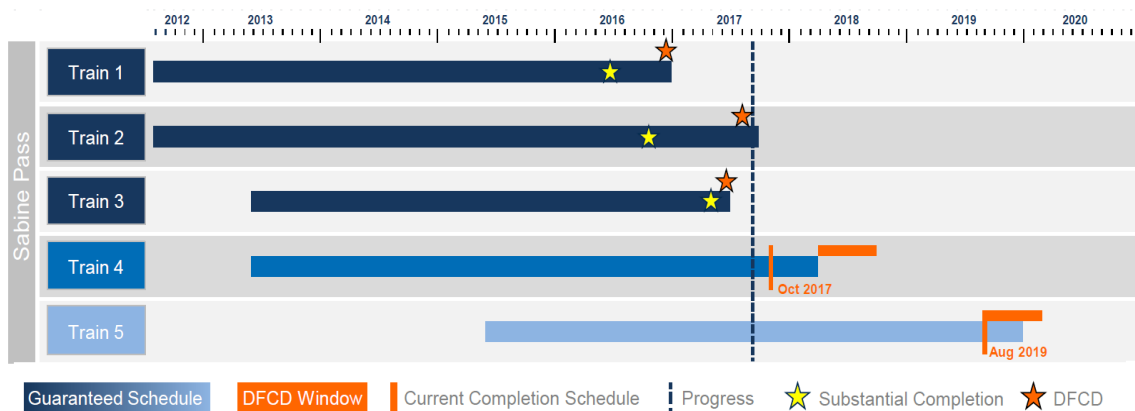


Figure 4: Construction progress at Sabine Pass⁹

In addition, two more trains are under construction in Texas.

Trains 1 & 2 Expected Completion 2019

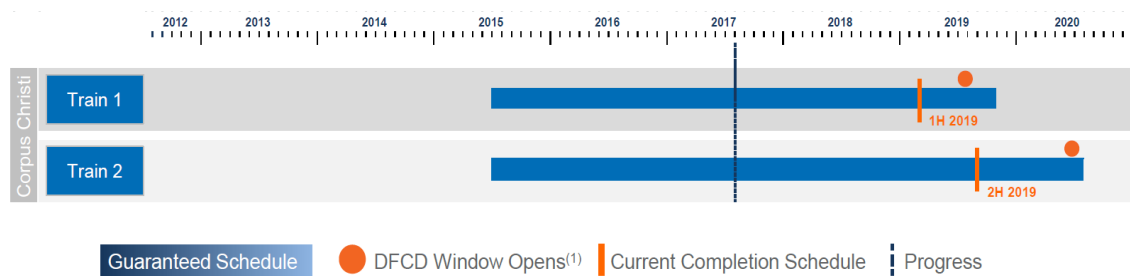


Figure 5: Train completion schedule¹⁰

⁹ CHENIERE ENERGY, INC. BARCLAYS CEO ENERGY-POWER CONFERENCE | September 2017, page 5.

¹⁰ Ibid., page 6.

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Based on this data, it is very unlikely (as we can see almost certain) that the proposed export terminals in Oregon and British Columbia will be able to meet Cheniere's prices or its accelerating level of export capacity.

The prototypical British Columbia LNG facility is based on purchasing natural gas in Alberta and selling the natural gas to markets in Japan, China, and other Asian markets. Japan has little in the way of fossil fuels, so there is a potential profit in the transaction.

The most recent reports show that the Japan Liquefied Natural Gas (LNG) import price is US\$8.30/mmbtu.¹¹ The wholesale price for AECO natural gas in Alberta is US\$1.94/mmbtu.¹² The average price differential between Japanese LNG and AECO is to be \$6.03/mmbtu between September 2017 and December 2024 according to futures markets.

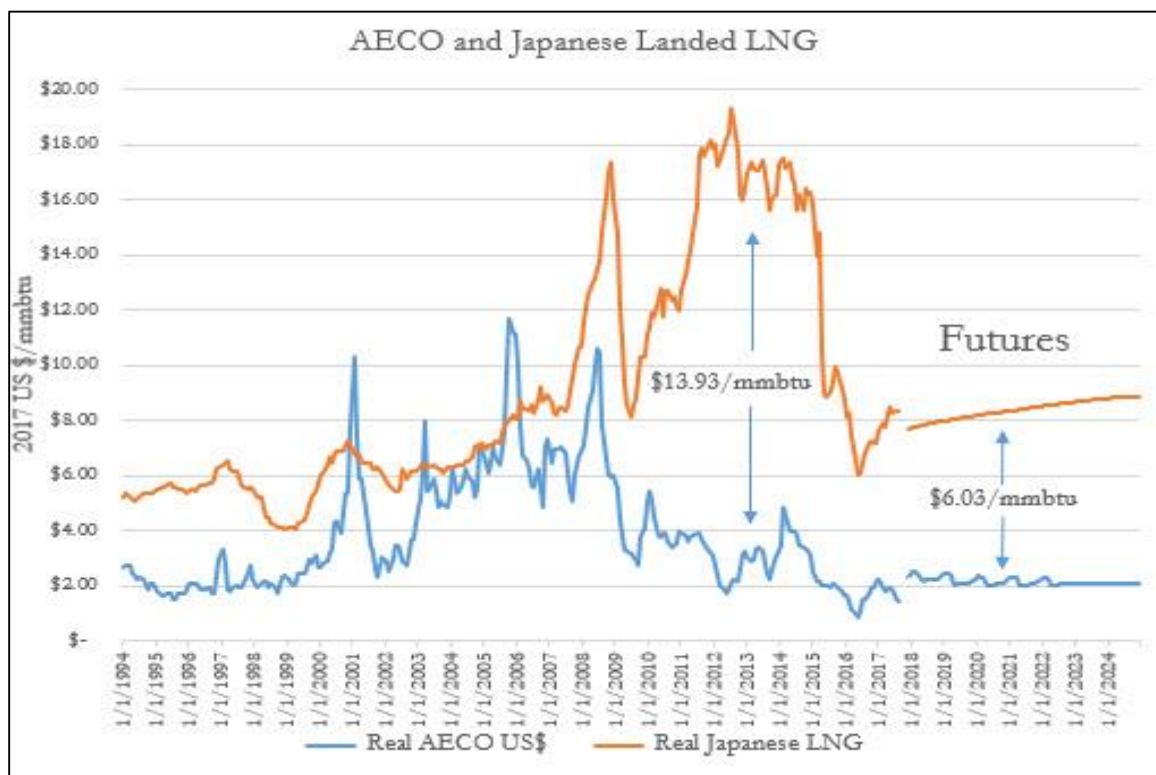


Figure 6: AECO and Japanese natural gas price comparison

¹¹ YCharts. Japan Liquefied Natural Gas Import Price. Based on World Bank data. Accessed August 27, 2017.

¹² NGX. NGX Alberta Market Price, Current Month Details, Index Calc. Accessed August 27, 2017. Market price is for August 27, 2017, the most recent available. Price is converted from C\$2.2201/GJ to US\$/mmbtu using Bank of Canada exchange rate for August 27, 2017.

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The forward markets in the chart above are for Brent crude oil and Henry Hub natural gas at the Chicago Mercantile Exchange. Henry Hub natural gas prices have historically correlated almost perfectly with AECO natural gas prices.^{13,14}

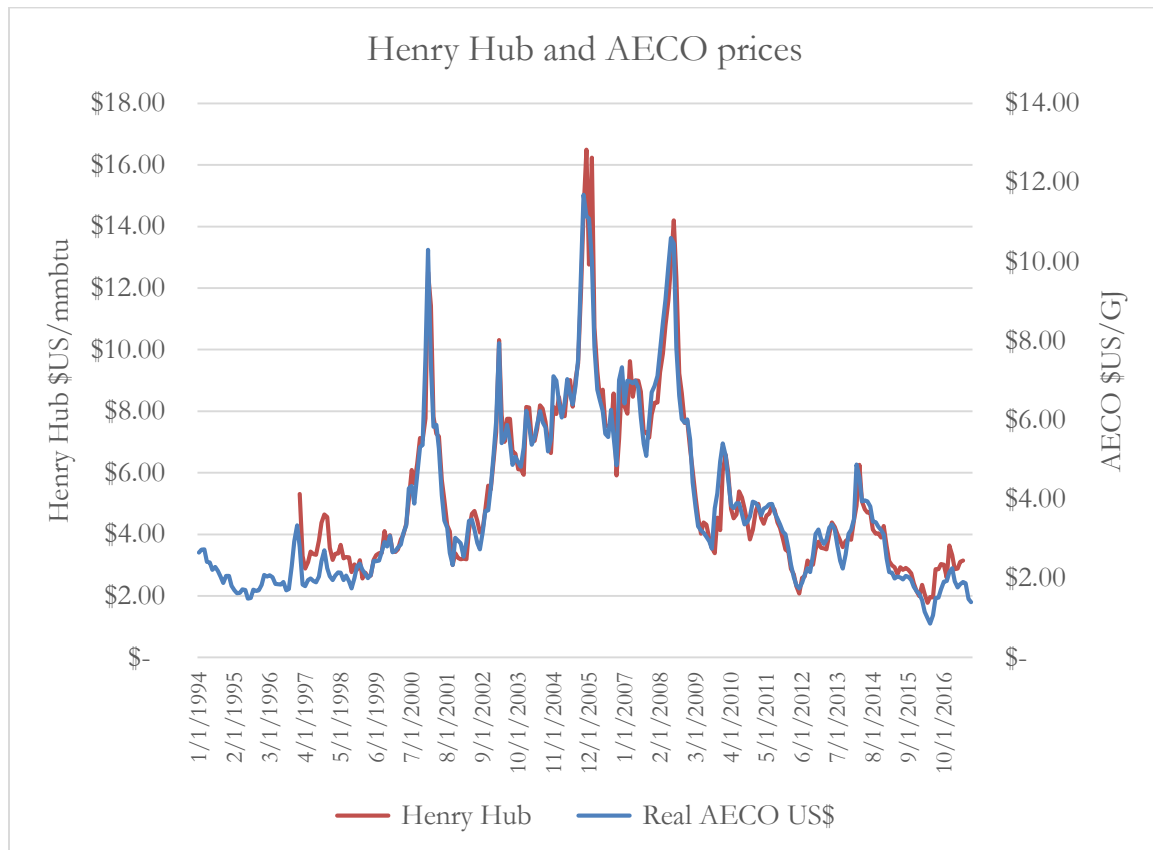


Figure 7: AECO and Henry Hub natural gas price comparison

Similarly, Japanese LNG historically shows a very strong correlation with Brent Crude oil prices.^{15,16}

¹³ U.S. Energy Information Administration (EIA). Henry Hub Natural Gas Spot Price. Accessed July 11, 2017.

¹⁴ Alberta Energy. Alberta Gas Reference Price History. Accessed July 11, 2017.

¹⁵ EIA. Europe Brent Spot Price FOB. Accessed July 11, 2017.

¹⁶ YCharts. Japan Liquefied Natural Gas Import Price. Based on World Bank data. Accessed July 11, 2017.

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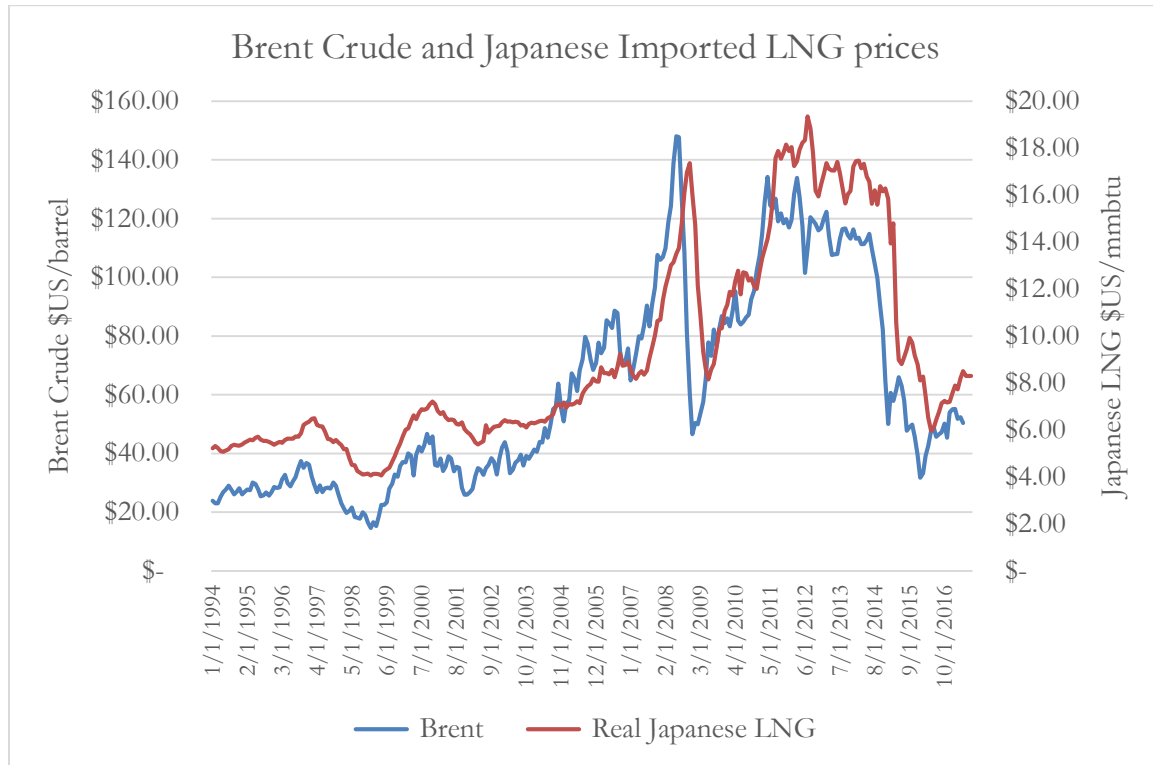


Figure 8: Brent and Japanese natural gas price comparison

The price forecast for AECO Alberta natural gas and Japanese LNG is prepared using forward prices for Brent crude oil and Henry Hub natural gas.^{17,18} Adjusting for exchange rates and indexing for inflation, the price differential between AECO Alberta natural gas and Japanese Imported LNG is projected to average only \$6.03/mmbtu. This is significantly below the average LNG export terminal's target to remain profitable.

In order to estimate the probability of a successful LNG export terminal in British Columbia, a useful tool is a Monte Carlo analysis where each "game" is a combination of LNG prices in Alberta (AECO) and Japan between January 1994 and July 2017.¹⁹ The following analysis is the result of calculating the potential profitability of a standard LNG export terminal through almost two million "games", representing different market prices in Alberta and Japan. The plant is assumed to produce 12 mtpa per annum with an expected in-service date of 2024. The discount rate for the net present value is 12%.

¹⁷ Chicago Mercantile Exchange. Henry Hub Natural Gas Futures Quotes. Accessed August 27, 2017.

¹⁸ Chicago Mercantile Exchange. Brent Last Day Financial Futures Quotes. Accessed August 27, 2017.

¹⁹ Monte Carlo statistical analyses are based on the law of large numbers. By varying assumptions across a large number of possible values, it is possible to develop a probability distribution of possible outcomes.

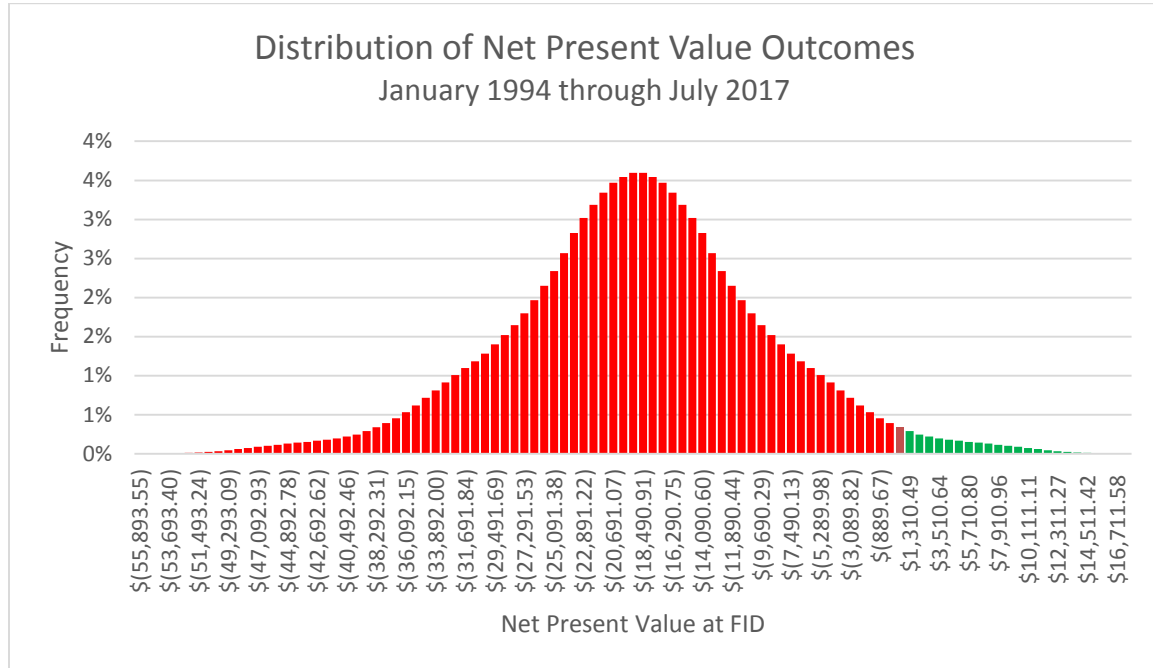


Figure 9: Results of monte carlo simulation

The results are daunting. The vast majority of outcomes are “in the red”. At a broad range of capital expenses per ton, British Columbia and Oregon LNG export terminals have only a 3% chance of being profitable at the final investment decision.

From this analysis, we can conclude that most of the LNG terminals currently under consideration in British Columbia won’t see the light of day. Thus, BC Hydro’s expected increase in consumption to electrify LNG facilities will not materialize.