A techno-economic study of shipping LNG to Indonesia from US, Australia, and Qatar by LNG carrier

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Keywords: LNG, Natural Gas, LNG Carriers LNG, LNG Shipping, Indonesian LNG.

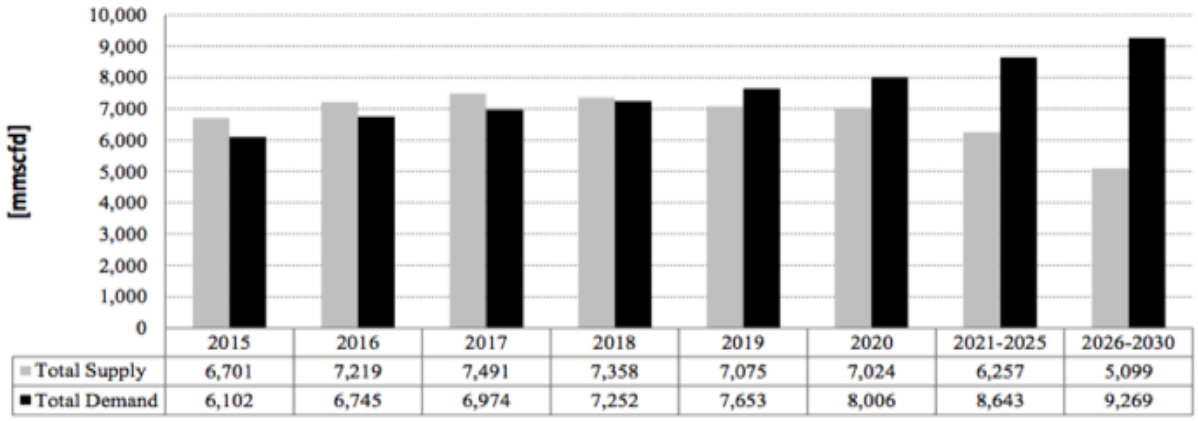
Abstract: With respect to the Indonesian natural gas supply and demand, the margin between combined supply and the next 15 years demand results to a negative supply after the year 2019. It is mandatory for the government to increase the supply either by importing natural gas from the other countries. From Indonesian location, there are a few countries which have abundant resources of natural gas in different locations as potential exporters. For this paper, we developed a model that estimates the cost of shipping one MMBTU of LNG on a per-voyage basis from three natural gas producer countries which are the US, Qatar, and Australia. The shipping cost of the project is calculated by summing up the port and passage fees, LNG carrier hire cost and fuel oil cost. This analysis demonstrates that shipping from Australia has the lowest cost with 0.43 USD / MMBtu. The shipping costs from Qatar and the US are 1.03 USD/MMBtu and 3.16 USD/MMBtu, respectively. Based on the analysis, the shipping cost is mostly influenced by the fuel cost compared to other costs. The pure-gas burning propulsion system is also feasible to be used. The cost-benefit of using boil-off gas generated rather than oil fuel as a primary fuel should be studied further to give more comprehensive analysis.

1. Introduction

According to the report published by Ministry of Energy and Mineral Resources, there will be a decline in natural gas supply and the total demand will exceed the total supply by 2019 [1]. In this case, it is mandatory for the government to meet the natural gas demand either by boosting the oil and gas exploration activity to discover new oil reserves or importing LNG product directly from other countries [2].

Since the oil discovery has a high uncertainty [3-6], the second solution seems more reasonable to do. The government is planning to import natural gas for the first time by 2019 from other countries [2]. Importing in the form of LNG is one the best choice because of the complicated geographical condition of Indonesia, which is separated with other countries by deep sea [7]. As shown in Figure 1, the Indonesian archipelago is located between two oceans, the Pacific and Indian, and consists of small islands which are stretched evenly in the eastern region [8]. Eastern

region seabed ranges from 1,000 to 7,000 meters deep. Due to the fact that pipelines cannot be used to deliver the gas through the deep sea area for long distances, importing pipeline gas it is not relevant for this case [9-11].



	2015	2016	2017	2018	2019	2020	2021-2025	2026-2030
Total Supply	6,701	7,219	7,491	7,358	7,075	7,024	6,257	5,099
Total Demand	6,102	6,745	6,974	7,252	7,653	8,006	8,643	9,269

Figure 1: Indonesian Natural Gas Supply-Demand 2015-2030 [1].

This research aims to asses the scenarios of importing LNG from the potential exporter countries. The plan is also supported by the new regulation regarding the opening of the import faucet of LNG which was announced by the Indonesian government in 2017 [12].

Figure 2: Map of Indonesia [8].

Although Indonesia is predicted to import LNG by 2019, journals published on this specific topic are not found. Comprehensive literatures of LNG shipping cost are available but discussing the general concept or using the other countries as the cases, not Indonesia [13-16]. There is a paper by [17] about Indonesia LNG shipping but Indonesia is set as an LNG exporter, not an importer.

This paper aims to fill the gap of the lack of study about the LNG import to Indonesia. This research is prepared to encourage the other scholars to do similar investigations to provide various scenarios of LNG import to Indonesia. Also, the explanation on this paper delivers a new perspective to the LNG producer countries to target Indonesia as the market.

2. Indonesian Natural Gas Market

To open the access of importing gas and making the natural gas affordable for power generation, the Indonesian Government determined the price of domestic natural gas which is 14,5% of Indonesian Crude Prices (ICP) in the plant gate [12]. If the domestic natural gas price is higher than that rate, the government is allowed to import the LNG from the other countries. Previously, LNG import was not allowed to maximise the absorption of domestic gas, although the domestic gas price is more expensive than LNG import. The Indonesian Crude Price changes every month. For example, in November 2017, the ICP is USD 56.76/bbl. Therefore, the LNG price from overseas must be less than 14.5% of 56.76 USD/bbl, which is 8.23 USD/MMBTU, in the plant gate to compete with the domestic natural gas.

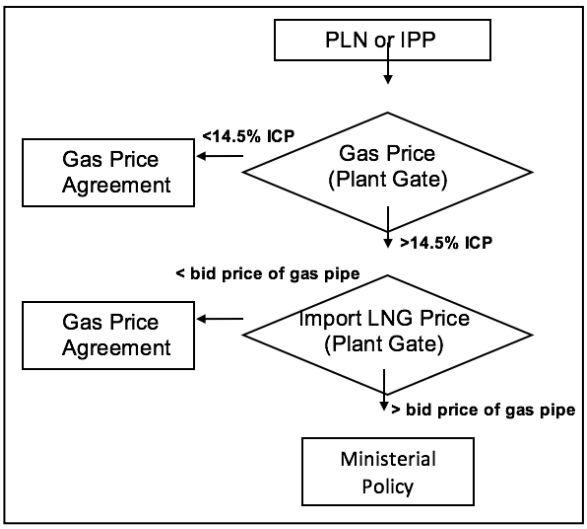


Figure 3: Scheme of Indonesian Gas Allocation.

3. LNG Supply Chain

LNG is the process of changing natural gas to liquid for the more efficient transportation [18]. LNG is a fast-growing method of monetising natural gas and is the cleanest- burning hydrocarbon [19-23]. The LNG value chain begins upstream with exploration and production and then moves on to the midstream with processing and transportation and then finally into the downstream where it is liquefied and then eventually regasified and distributed to consumers [10, 24].

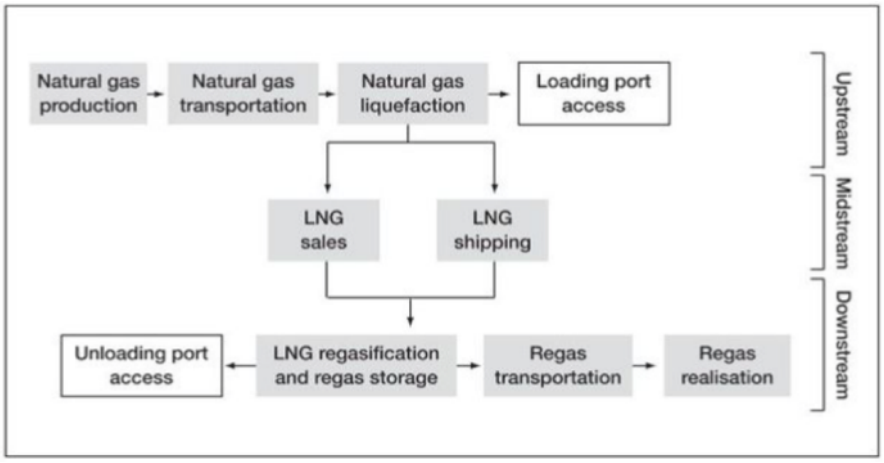


Figure 4: LNG Supply Chain
Source: The Law and Bussiness of LNG, Second Edition (2012).

LNG projects are capital intensive at every stage, and they are often front-end loaded meaning that revenues from the project do not accumulate until the project is complete [25]. The traditional LNG structure allows for long-term contracts usually 20-25 years which guarantees a sales volume and is sufficient for investment pay-back [24].

The process of making LNG is mainly cooling the natural gas to a temperature of -162ºC (-260ºF) which makes it a liquid and then regasifying it before distribution [10, 26]. he prospects for LNG are very high in the future, and global demand is said to grow at around 5% annually. Global demand for LNG could increase to about 430 MPTA (million tonnes per annum) in 2025. For comparison, just 80,000 tonnes of LNG were shipped by two carriers in 1964, the first year of the LNG trade.

The company can acquire the LNG carrier in two ways: by purchasing and owning the vessel or chartering it under the time or voyage [9,10]. For simplicity, we assume that the company prefers chartering the vessel to owning it. Under a time charter, the vessel is hired for a specific period (e.g. 12 months), with the charterer paying a daily rate of hire for the vessel. The shipowner provides the vessel with the crew, stores and provisions, ready to load cargo and proceed on a voyage. The charterer pays for the expenditure directly resulting from compliance with its instructions, such as bunkers (fuel costs and a significant item), port charges and the costs of loading and discharging the cargo.

4. Result & Discusions

4.1. Fuel Consumption

Fuel consumption is estimated using the logical structure described in section 3.1 and presented in Table I below. As the pure fuel-oil based system used in the first case, no boil-off gas is consumed for power. The boil-off gas generated is re-liquefied to make the total energy of LNG remains stable until reaching the port of destination. Figure 8 shows the total voyage fuel consumption for all three exporting countries considered. From all three scenarios, it is evident that the fuel consumption from the US is the highest one due to the greater number of sailing days compared to Australia and Qatar.

Table 1: Fuel Oil Consumption Calculation

Components	Australia	Qatar	US	unit
Fuel consumption (laden)	141.11	141.11	141.11	MT /day
	533.90	1,295.04	3,984.26	MT
Fuel consumption (ballast)	138.99	138.99	138.99	MT / day
	525.88	1,275.59	3,924.40	MT
In Port (cargo operation)	50.00	50.00	50.00	MT
Total fuel consumption	1,109.78	2,620.63	7,958.66	MT / voyage
Fuel price	581.42	581.42	581.42	USD / tonne
Fuel oil cost	**645,248.61**	**1,494,615.81**	**4,598,250.44**	**USD / voyage**
	0.24	**0.55**	**1.69**	**USD / MMBtu**

For the second scenario, the total energy required by the LNG carrier is met by the boil-off gas generated in ladden and ballast condition. The total energy needed from three different countries is shown in Table II. Based on the calculation of boil-off gas generated in Table III, the total energy required from Australia, Qatar, and the US can be covered by the BOG only. In other words, the pure-gas burning system is feasible because the vessel does not need fuel oil to support the BOG in the burning system. Although there is no component of fuel oil cost, the total energy of LNG transferred to storage in the port destination will decrease.

Table 2: The Total Energy Required for LNG Carrier

Components	Australia	Qatar	US	unit
Total fuel consumption	1,109.78	2,620.63	7,958.66	MT / voyage
	43,281,442	102,204,578	310,387,562	MJ / voyage
	41,023	**96,871**	**294,191**	**MMBTu / voyage**

Table 3: Boil-Off Gas Generated

Components	Australia	Qatar	US	unit
Boil off rate (ladden)	0.15%	0.15%	0.15%	m3 / day
	1,419	3,442	10,588	m3 / voyage
	30,931	75,026	230,822	MMBTu / voyage
Boil off rate (ballast)	0.06%	0.06%	0.06%	m3 / day
	568	1,377	4,235	m3 / voyage
	12,372	30,011	92,329	MMBtu / voyage
Total	**1,986**	**4,818**	**14,823**	**m3 / voyage**
	43,303	**105,037**	**323,151**	**MMBtu / voyage**

4.2. Shipping Cost

The cost to ship one MMBtu of liquefied natural gas from three different countries is given in Table IV. Shipping costs range from 0.43 to 3.16 USD / MMBtu depending on the LNG sources. The shipping cost from the US is the highest one with 31.16 USD / MMBtu because of the longer distance than Australia and Qatar. On the other hand, shipping cost from Australia and Qatar are 0.43 and 1.03 USD / MMBtu respectively. The total shipping cost incurred is still likely to increase because the regasification cost component has not been included in the calculation model.

Table 4: Shipping Cost Calculation

Cost Components	Australia	Qatar	US	unit
Port and passage fees	0.04	0.11	0.33	USD / MMBtu
LNG carrier hire cost	0.15	0.37	1.14	USD / MMBtu
Fuel oil cost	0.24	0.55	1.69	USD / MMBtu
Total shipping cost	**0.43**	**1.03**	**3.16**	**USD / MMBtu**

Fuel oil and LNG carrier hire cost have a higher impact on the total shipping cost compared to port and passage fees. The fuel oil and LNG carrier hire cost themselves are related to the total sailing days. If the sailing duration from a country is higher than another country, the cost of vessel hire will be higher because in the case given, the vessel is chartered based on time charter.

5. Conclusions

Using the pure HFO burning system, the shipping costs from Australia, which costs 0.43 USD / MMBtu, has the lowest rate among three countries analysed for an average transport distance of 3,200 nm. For Qatar and the US, the shipping costs are 1.03 and 3.16 USD / MMBtu for an average transport distance of 7,762 nm and 23,880 nm, respectively. From the analysis, it was found that the shipping costs are most sensitive to the sailing distances. The pure-gas burning propulsion system is also feasible to be used because the vessel does not need fuel oil to support the BOG in the burning system. The boil-off gas generated is more than enough to meet the energy required of the vessel to sail from the exporter countries to Indonesia. The cost-benefit of using boil-off gas produced rather than oil fuel as a primary fuel should be studied further to give more comprehensive analysis.

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