A PERSPECTIVE ON THE TRANSIT OF LNG THROUGH THE PANAMA CANAL

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Given growing Asian demand for LNG from the Atlantic Basin, the expanded Panama Canal is set to play an increasingly important role in global LNG trade. Through operational experience and frequent communication with the Panama Canal Authority, Cheniere is uniquely positioned to provide valuable insight into the dynamics of LNG transit through the Canal. In 2017, Cheniere shipped 35% of LNG cargoes passing through the Canal, while in 2018 it shipped 23%, making it the largest LNG user in both years. This paper will provide:

1) Analysis of transit history through the Neopanamax locks

In this section, Cheniere will discuss historical trends in Neopanamax transits for container, LPG and LNG carriers, including transit numbers, growth rates and seasonality for these three key sectors.

2) Assessment of future traffic potential for the Neopanamax locks

In this section, Cheniere will assess future transit needs by LNG carriers through 2030 using supply and demand based methodologies. Cheniere will compare this with the Panama Canal Authority’s expansion plans.
Introduction

The Panama Canal is an important link for trade between the Atlantic and Pacific basins. In 2006, the Panama Canal Authority (ACP) decided to build a third set of locks to accommodate increased trade volumes and larger vessel sizes\(^1\). Although the U.S. was still importing LNG when this expansion decision was made, in the following decade the shale gas revolution has made the U.S. one of the fastest growing LNG exporters in the world. The expanded canal opened in 2016, only one month after Cheniere’s Sabine Pass Liquefaction Project reached substantial completion. By November 2018, the Neopanamax locks had already accommodated 528 LNG vessel transits. It is remarkable to note how quickly the ACP’s planning and operation capabilities have adjusted to recent changes in expectations for LNG trade flows. With Panama Canal transits by LNG vessels expected to grow significantly in the coming decade, many customers are interested in learning the future traffic potential of the Neopanamax locks. Although it is challenging to forecast the many factors affecting global trade patterns, this paper argues that in a base case, business-as-usual scenario, the Panama Canal will be able to accommodate the expected increase in transits by containership, LPG and LNG vessels. In fact, there will likely be additional slots to accommodate seasonal demand in LNG and higher than expected growth in other sectors. This paper first analyzes the historical transit trends, and then provides a view of the transit requirements by containership, LPG and LNG vessels until 2030\(^2\).

Photo 1 The First LNG Cargo to Transit the Expanded Panama Canal on July 25\(^{th}\), 2016

Source: ACP

Part One: Analysis of Transit History through the Neopanamax Locks

Containerships dominate Neopanamax transits, accounting for 50% of total\(^3\). The average daily number of transits of containerships increased from 1.78 in 2016 to 3.37 in 2018\(^4\) (Figure 1). Prior to the Canal’s expansion, a post-Panamax vessel going from Asia to the U.S. East Coast had to either use the U.S. intermodal system or the Suez Canal. The U.S. intermodal system constitutes the transpacific maritime route in conjunction with the U.S. railway and road system connecting the West and East Coasts. Navigating this system is logistically complex and presents unpredictability for an industry that demands reliable delivery schedules\(^5\). The Suez Canal route requires longer

\(^1\) Ships designed to fit the original two sets of locks are referred as Panamax vessels; ships designed to fit the third set of locks are referred as Neopanamax vessels. For reference, the Panamax locks are 304.8 meters long, 33.5 meters wide; the Neopanamax locks are 427.0 meters long, 55.0 meters wide

\(^2\) Analysis in this paper is based on calendar year instead of the Panama Canal fiscal year

\(^3\) Based on data from July 2016 to November 2018, provided by the PCA

\(^4\) Based on data from January to November 2018, provided by the PCA

\(^5\) Containerships operate with regular itineraries, following a predefined series of port calls and with a regular rotation of vessels. For example, a weekly containership service between Northeast Asia and the U.S. East Coast via the Panama Canal requires an 8-vessel rotation generating 2 transits per week or 104 transits per year

\(^6\) Proposal for the Expansions of the Panama Canal, Panama Canal Authority, April 24, 2006
sailing time than the Panama Canal. Therefore, the opening of the Neopanamax locks led to a quick increase in the Panama Canal’s market share for the containership trade.

LPG vessels constitute the second largest source of Neopanamax transits, accounting for 26% of all transits\(^7\). The average daily transits of LPG vessels increased from 0.88 in 2016 to 1.72 in 2018\(^8\) (Figure 1). As the U.S. continues to produce more natural gas liquids (NGLs) than it can consume domestically, LPG export to Asia continues to increase. Before the expansion of the Panama Canal, the majority of the very large gas carriers (VLGCs) had to transit via the Cape of Good Hope. By the end of 2016, nearly all Pacific bound LPG VLGCs were transiting through the Neopanamax locks\(^9\).

For LNG vessels, the Neopanamax locks opened one month after the substantial completion of the first U.S. LNG export project. Since February 2016, Cheniere’s Sabine Pass LNG Terminal has brought five trains online with 22.5 MTPA of nameplate capacity, and Cove Point LNG Terminal started operation in March 2018 with 5.25 MTPA of nameplate capacity. Both long-term SPAs by Asian buyers as well as spot market demand from Asia and Mexico drove a steady increase in average daily transits for LNG vessels from 0.31 in 2016 to 0.88 in 2018\(^10\) (Figure 1).

In addition to containerships, LPG and LNG vessel traffic, there were small volumes of dry bulk carriers and other vessels that in aggregate represented 1.18 average daily transits in 2018\(^11\) (Figure 1).

![Figure 1](image)

**Neopanamax Average Daily Transits by Segment**

Source: ACP

It is worth noting that the transit pattern of each type of vessel follows the demand and seasonality of the underlying commodity it carries. Northbound\(^12\) trade from Asia to the U.S. East Coast dominates containership transits. Because containerships usually carry lower value cargoes on their back haul than on their head haul, a portion of them return via the Suez Canal to take advantage of the less expensive transit toll charged by the Suez Canal than by the Panama Canal on their return journey. Containership trade volume usually starts to increase in the second quarter and peaks in the third quarter each year as merchandisers build up inventories for North America’s holiday season (Figure 2).

LPG transits are driven by trade from the U.S. to Asia but transits in both directions are roughly balanced in historical data given ballast and laden trips take the same route. Even though the majority of Asia’s LPG demand is in the residential heating and cooking sector, which peaks in the winter, demand for LPG in the petrochemical sector as a substitute for naphtha usually peaks in the summer when LPG use in residential heating is low. The U.S. is also competing with the Arabian Gulf Countries for Asia’s LPG demand and the transit requirement is highly sensitive to price arbitrage opportunities.

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\(^7\) Based on data from July 2016 to November 2018, provided by the PCA
\(^8\) Based on data from January to November 2018, provided by the PCA
\(^9\) http://tanktransport.com/2018/05/panama-canal-expansion-affecting-lpg-market/
\(^10\) Based on data from January to November 2018, provided by the PCA
\(^11\) Based on data from January to November 2018, provided by the PCA
\(^12\) Northbound refers to transit going into the Atlantic basin and Southbound refers to transit going into the Pacific basin
For LNG vessels, given there is demand in Asia, Southbound transits dominate and demand peaks during the winter heating season which generally lasts from November to February in Asia. Peak demand of LNG theoretically increases both the Southbound and Northbound transits, but the Southbound or the laden direction might be more pronounced due to urgent cargo delivery deadlines for the winter heating season. This also reflects the larger trend in LNG trade where vessels continue to trade on spot market rather than liner trade, and subsequently pick up cargoes on their back haul that see them move globally before coming back towards the U.S. East Coast.

**Figure 2**

Neopanamax Traffic by Segment

Since the opening of the Neopanamax locks, the ACP has gradually increased the official number of Neopanamax transit allowances from 6 to 8 per day. Moreover, the ACP is actively testing higher numbers of daily transits. For example, they have already achieved 9 transits on more than 40 days, 10 transits on 15 days and 11 transits on 3 days. The ACP expects the Neopanamax locks to consistently offer 12 slots on a daily basis by 2023 or 2024. Particularly for LNG vessels, the ACP has been proactive in tracking and communicating with customers to improve service and throughput. So far, they have proven able to transit 3 vessels on 5 occasions (Photo 2) and 4 vessels on 2 occasions (Photo 3). Furthermore, the ACP changed regulations in October 2018, in order to accommodate more traffic flow by lifting certain night time transit and passing area restrictions. As it builds experience with LNG transits, the ACP is working on further relaxing certain operational restrictions to achieve even more frequent transits for LNG vessels.

**Photo 2**

Three LNG Carriers Transitting the Neopanamax Locks on April 17, 2018

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13 Beginning October 1st, 2018, the PCA started to allow meetings between opposing LNG vessels in Gatun Lake as well as transiting during hours of darkness in certain areas of the Canal. https://www.pancanal.com/common/maritime/advisories/2018/a-29-2018.pdf
Part Two: Assessment of Future Traffic Potential for the Neopanamax Locks

Containership transit forecast

Once the Neopanamax locks were able to accommodate large containership transits through the Panama Canal, the ACP quickly attracted additional services in 2017 and 2018, many of which previously had to ship through the Suez Canal. Our discussions with various commentators indicate average transits may reach around 5 to 6 per day by 2030. We note that in a business-as-usual scenario, the Panama Canal may find it challenging to attract transits on containerships' backhaul journey due to relatively low merchandise value onboard. Additionally, the ongoing U.S.-China trade war adds short-term and long-term uncertainties to containership trade volumes.

In our analysis, we assume an annual addition of one headhaul service to the Panama Canal route through 2030. This assumption implies that containership transits would grow at a compound annual growth rate (CAGR) of 3.6% from 2018 to 2030. To sense check, according to a report by consultants McKinsey & Company, the global container trade growth rate was 1.7 times that of the real GDP growth rate from 2011 to 2016. Assuming that container trade growth between Asia and the U.S. is also 1.7 times that of the U.S. GDP growth, and that U.S. GDP grows at 2.0% in the long-term, then the growth of container trade between Asia and the U.S. could be expected to be around 3.4%, which is in line with our assumption. Based on this assumption, transits via the Neopanamax locks would be expected to reach 4.9 per day for containerships by 2030.

LPG vessel transit forecast

In 2017, the U.S. produced 3.7 million barrels per day (MMbbl/d) of LPG and exported 1.2 MMbbl/d. From 2017 to 2030, the U.S. Energy Information Administration (EIA) expects U.S. LPG production to grow at a CAGR of 2.8%, and LPG demand to grow at a CAGR of 2.4%. Assuming no change in U.S. LPG imports and storage from the 2017 level, U.S. LPG exports would grow by 54% from its 2017 level, reaching 1.9 MMbbl/d in 2030.

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14 One head-haul service includes 1 transit per week or 52 transits per year
17 LPG includes ethane, propane, normal butane and isobutene. https://www.eia.gov/dnav/pet/pet_sum_snd_d_nus_mbblpd_a_cur.htm
18 Based on 2018 Annual Energy Outlook reference case and we use the growth rate of natural gas plant liquid production as a proxy for the growth rate of LPG production. https://www.eia.gov/outlooks/aeo/data/browser/#/?id=11-AEO2018&cases=ref2018&sourcekey=0
For U.S. LPG exports, Northeast Asia and Central / South America are the two main destination markets that are expected to drive use of the Panama Canal. The share of U.S. LPG exported to these two markets has increased from 10% in 2008 to 40% in 2016, but has plateaued since then19. Furthermore, between these two markets, the shift towards the Northeast Asia market had already plateaued by 2016, the year when the Neopanamax locks first opened (Figure 3). This suggests that the Neopanamax locks have not had a big impact on pre-existing trade patterns. Therefore, we assume that LPG transits via the Panama Canal will grow at the same rate as total U.S. LPG exports, by 54% from 2017 to 2030, reaching 2.4 per day (assuming no further significant shifts in global LPG trade patterns).

Figure 3 Panama Canal Addressable Market Share of Total U.S. LPG Exports (Rolling 12 Month Average)

Source: EIA

LNG vessel transit forecast

We have estimated the base case future LNG transits using supply-based and demand-based methodologies. In the supply-based methodology, we estimate transits based on total export production from U.S. and Trinidad and Tobago LNG facilities. In the demand-based methodology, we estimate transits based on expected demand from Asia for Atlantic basin LNG. In addition, we estimate the high case future LNG transits based on the profile of long-term SPA customers for U.S. LNG projects.

Supply-based methodology base case: In this case we assume that LNG transits via the Panama Canal will be predominantly influenced by the growth in U.S. LNG exports, while Asia, for the foreseeable future, continues to dominate demand growth. We have used the Wood Mackenzie H2 2018 Supply Scenario, which forecasts total U.S. LNG production will reach around 120 MTPA by 2030, based on projects that have taken FID as well as those that have made or are expected to make significant commercial progress. We assume that the same proportion of U.S. LNG production will flow through the Panama Canal as did in 201720, when 44%21 of the U.S. laden cargoes transitted through the Panama Canal. Then by 2030, 53 MTPA can be expected to transit the Canal. This suggests laden LNG vessel transits through the Canal could reach 1.9 per day on average by 2030. We use a similar methodology to estimate laden transits from the Atlantic LNG project in Trinidad and Tobago, but assume a much lower facility utilization rate given expected decline in gas supply to the project. Finally, based on annual data for 2017, we observed that 59%22 of total LNG transits were laden cargoes. By applying the same ratio, we forecast 3.3 average total daily transits (including both laden and ballast) in 2030 by LNG vessels.

Demand-based methodology base case: Wood Mackenzie forecasts total Pacific basin demand for Atlantic basin LNG to reach 75 MTPA by 2030, of which 58% or 43 MTPA will require transit through the Panama Canal, based on its supply-demand and trade flow forecast. Again, we assume that, as in 2017, 59% of total LNG transits would

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19 Northeast Asia markets include Japan, China and South Korea; Central and South America markets include Argentina, Chile, Colombia and Ecuador. Data source: https://www.eia.gov/dnav/pet/pet_move_expc_a_epil_eex_mbbipd_m.htm
20 The last full year for which data is available at time of writing
21 Based on data provided by the PCA
22 Based on data provided by the PCA and Kpler
be laden. These assumptions imply average total daily transits of 2.8 (including laden and ballast) by 2030 (Figure 4). The fact that the demand-based methodology results in a lower number than the supply-based methodology suggests that Wood Mackenzie views the proportion of U.S. production transiting the Panama Canal is lower in 2030 than the 44% observed in 2017.

**Figure 4** Equivalent Daily Transits Based on Wood Mackenzie Forecast of Atlantic to Pacific Flows

![Graph showing equivalent daily transits](image)

Source: Cheniere Interpretation of Wood Mackenzie data (2018 H2)

**High case:** We recognize LNG demand is seasonal and the base case does not always represent peak demand during winter months. For example, an average of 51% of U.S. laden LNG cargoes transited through the Panama Canal from October 2017 to January 2018,

23 given an unprecedented demand surge in China due to its aggressive coal-to-gas switching policies. While we expect this ratio to fluctuate throughout the year, we do believe it to be range-bound because a large majority of U.S. capacity is tied to long-term SPA commitments. In fact, 27% of SPA capacity is observed to be committed to European utilities and another 10% to buyers in South and Southeast Asia for whom shipping via the Cape of Good Hope is cheaper than through the Panama Canal (Figure 5). This means even in the extreme case where all of the portfolio buyers send cargoes to Northeast Asia, a maximum of 63% of U.S. capacity will use the Panama Canal, translating to a high case of 4.8 daily transits (Figure 6). This is unlikely to happen given Pacific Basin suppliers will be called first to supply within the region and portfolio players will likely optimize cargoes regionally.

**Figure 5** U.S. Long-term SPA Customers

![Diagram showing U.S. Long-term SPA Customers](image)

**Figure 6** LNG Transit Forecast

![Graph showing LNG Transit Forecast](image)

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23 Based on data provided by the PCA; For delivery into Asia in November 2017 to February 2018
24 As of December 31, 2018; total SPA volumes of 81 MTPA had been announced
To summarize, LNG transits is expected to be 3.0 per day in the base case averaging across our two methodologies and 4.8 per day in the high case. The base case could be considered to represent a business-as-usual annual average and the high case is expected to represent high demand for Atlantic basin LNG due to seasonality and market inefficiencies in global trade flows.

Besides containerships, LPG, and LNG vessels, the Neopanamax locks serve a variety of other vessel segments, the biggest among which are the dry bulk carriers. In 2018, the average daily transit of dry bulk carriers through the Neopanamax locks was 0.64, while all other remaining vessel types were 0.53. Given the dry bulk industry’s insensitivity to voyage time and high sensitivity to transit tariffs, we are skeptical that dry bulk carriers will rise to be a significant segment for the expanded canal. Even with an aggressive 3.0% CAGR, the average daily transit volume by the dry bulk carriers in 2030 would only be 0.9, which is still within the number of remaining slots available.

**Conclusion**

Based on our assumptions, containerships are expected to continue to dominate Neopanamax transits but will likely experience slower growth in the future. LPG transits, while continuing to grow, are expected to be caught up and even surpassed by LNG transits by 2030. In the base case, total transits from these three sectors will reach 10.3 per day, leaving 1.7 daily slots or 51 slots per month available. These remaining slots leave room to manage short periods of peak LNG demand or higher than expected growth in other sectors. Even in the high LNG transit case, which is considered unlikely, we still expect flexibility to be available, considering complementary seasonality profiles and different dominant trade directions of containerships and LNG vessels.

It is worth noting that there are various factors that could impact the assumptions used in this analysis, including but not limited to: the growth rate of the global economy, the potential for the current U.S.-China trade dispute to impact U.S.-China trade flows and in particular containership and LPG transits, the growing market efficiency of the LNG trade flows as volumes become more flexible and greater volumes are traded on a short-term/spot basis, growth in LPG volumes produced and exported by the U.S., and the number of containerships used for long distance trade. Some of these factors will be positive and some will be negative with respect to their influence on the final conclusion of this paper, so it can be expected that overall there will likely be some netting out of the various factors to bring us back in line with the overall conclusion, namely that for the foreseeable future the Panama Canal should be able to accommodate LNG trade flows from the Atlantic to the Pacific basin.

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**Figure 9 Expected Neopanamax Slots vs. Transit Requirement Forecasts**

Source: Cheniere Analysis (2018)

25 Based on data from January to November 2018, provided by the PCA
This paper contains certain statements that are, or may be deemed to be, “forward-looking statements” within the meaning of Section 27A of the Securities Act of 1933, as amended, and Section 21E of the Securities Exchange Act of 1934, as amended. All statements, other than statements of historical or present facts or conditions, included herein are “forward-looking statements.” Included among “forward-looking statements” are, among other things, forecasts regarding ship transits and likely destinations and demand for assorted cargoes, including LNG. Although we believe that the expectations reflected in these forward-looking statements are reasonable, they do involve assumptions, risks and uncertainties, and these expectations may prove to be incorrect. You should not place undue reliance on these forward-looking statements, which speak only as of the date of this paper, and which are expressly qualified in their entirety by reference to the Risk Factors discussed in our periodic reports that are filed with and available from the Securities and Exchange Commission. These forward-looking statements were made as of the date of this paper, and other than as required by law, we undertake no obligation to update or revise any forward-looking statement.