

## Transportation Policy Brief #1

# Panama Canal Utilization

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Panama Canal Authority



Panama Canal Authority



Texas Ports Association

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## FOREWORD

The Lyndon B. Johnson School of Public Affairs at The University of Texas at Austin has established interdisciplinary research on policy issues as the core of its education program. A major part of this program is a nine-month policy research project (PRP), in the course of which two or more faculty members from different disciplines direct the research of 10 to 20 graduate students of diverse backgrounds on public policy issues of concern to a government or nonprofit agency.

During the 2016–2017 academic year, the Texas Department of Transportation (TxDOT) funded, through the Center for Transportation Research (CTR), a PRP addressing six key transport/logistics policy issues related to Texas international trade with foreign countries and domestic trade with other U.S. states. Overall direction and guidance was provided by Roger Schiller (TxDOT Maritime Division), who participated in classroom discussions at the beginning of the academic year.

As a consequence, the following policy issues were selected for study:

1. Panama Canal Utilization;
2. Texas Ports and the Panama Canal: Commodities and Infrastructure;
3. Global Logistics Hubs in Texas;
4. Texas-Latin American Trade;
5. Port Competition and Best Practices; and
6. Transportation and Trade Forecasts.

The findings of each policy issue are presented within the context of separate policy briefs. This particular policy brief, “Panama Canal Utilization,” was researched and written by Chi-Hsiang Chu and Nina Ledermann.

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## EXECUTIVE SUMMARY

The Panama Canal is an important node for world trade. About 5 percent of globally traded goods move through the Panama Canal, which serves 144 trade routes in over 80 countries. One important factor affecting the Panama Canal utilization is its competition with the Suez Canal. In recent years, several shipping companies have rerouted their vessels from Panama to the Suez Canal due to capacity constraints and long wait times. This decrease in traffic meant that the Panama Canal lost between 10 percent and 15 percent of annual revenue. In order to remain competitive, the Panamanian government authorized a \$5.4 billion Panama Canal expansion project, which included the construction of a third set of locks. The addition of the new locks doubled the canal's capacity and increased the maximum size of vessels that the canal can accommodate from about 5,000 twenty-foot equivalent units (TEUs) to almost 14,000 TEUs. Before the opening of the new lane, about 55 percent of total deadweight tonnage capacity in the global fleet was held by vessels too big to transit the 1914 locks. Since the completion of the expansion project, about 79 percent of total deadweight tonnage in the global fleet is able to use the Panama Canal.

In response, the Suez Canal completed its own expansion. The \$8.5 billion project was carried out by the Egyptian army and included the expansion of a 35-km-long central stretch of the canal, allowing two-way traffic for the first time in the Suez Canal's history. In addition to having increased their capacity, both canals are constantly providing new incentives and services in order to gain an advantage over their main competitor. Overall, it seems that the Panama Canal is increasing its competitiveness relative to its Egyptian counterpart, as the expanded Panama Canal allows for the passage of Neopanamax ships. This allows shipping companies to take advantage of economies of scale while decreasing transit time and transportation costs on trips between the U.S. and Asia.

The most significant effects of the Panama Canal expansion will likely be seen on the Asia–U.S. East Coast trade route, which accounts for about 36 percent of tonnage passing through the canal. Three Northeast Asian countries—China, Japan, and South Korea—are among the top 10 U.S. maritime trade partners and account for a collective share of more than 30 percent by value of total U.S. maritime trade. Thus, the U.S. is expected to see growing profits, especially from increased liquefied natural gas (LNG) shipments to the Asian market. Several global carriers, including Maersk, have already rerouted some of their Asia–U.S. East Coast services through the Panama Canal.

The recent Panama Canal expansion is expected to have positive effects on the Texas economy. The industries most likely to benefit from the new canal are LNG and liquefied petroleum gas (LPG). Texas is the leading U.S. state in natural gas production. More than 25 percent of America's proved natural gas reserves, as well as over 50 percent of the 100 largest natural gas-producing fields in the U.S., are located in Texas. Moreover, Texas produces slightly more than half of America's LPG. The demand for U.S. LPG is rising steadily, and LPG is already the most important domestic energy fuel in the Caribbean, Latin America, and most of Asia. The Texas LNG and LPG export industry are likely to benefit from the Panama Canal expansion due to reductions in transit time and costs. While only about 6 percent of the global LNG fleet and 35 percent of LPG vessels could fit through the original Panama Canal, the new locks can accommodate 90 percent of the world's LNG ships and most LPG carriers.



## PANAMA CANAL

Originally built in 1914, the Panama Canal connects the Atlantic Ocean to the Pacific Ocean and serves 144 trade routes in over 80 different countries.<sup>1</sup> About 5 percent of globally traded goods move through the Panama Canal.<sup>2</sup> The canal's main trade route links the U.S. East Coast to Asia, followed by the routes connecting the U.S. East Coast to South America's West Coast. Goods moving between these two routes account for about 36 percent and 16 percent of total tonnage passing through the canal respectively.<sup>3</sup> When shippers decide on the most suitable trade route, they take into account time, cost, capacity, and the type of commodity transported. In general, ship operators will choose the shortest and cheapest route through which the largest amount of goods can be shipped. Especially for its main trade route between Asia and the U.S. East Coast, the Panama Canal faces two competitors: the Suez Canal and the intermodal option, which involves shipping goods to the U.S. West Coast and from there via rail to the U.S. East Coast.

In recent years, several shipping companies have rerouted their vessels from the Panama Canal to the Suez Canal due to capacity constraints and long wait times. This decrease in traffic meant that the Panama Canal lost between 10 percent and 15 percent of annual revenue to the Suez Canal in the three years prior to expanding in 2007.<sup>4</sup> The original 1914 locks could only handle ships up to 5,100 TEUs, which put the Panama Canal at a disadvantage in an industry that prefers to use increasingly large vessels. Prior to the expansion, more than 30 percent of all tankers, bulk carriers, and container vessels were too big to pass through the Panama Canal.<sup>5</sup> Further challenges facing the Panama Canal were increasing transit times. Between 1999 and 2008, average transit times increased from 9 hours to over 13 hours.<sup>6</sup> Thus, in order to remain competitive, the Panama Canal Authority approved the expansion of the 1914 canal, adding a third set of locks. In response, the Suez Canal completed its own expansion project, which allows two-way traffic for the first time. However, the recent expansion projects were not the only changes the two canals implemented in order to maintain their share or gain additional shipping traffic. Both the Panama and the Suez Canals are constantly providing new incentives and services in order to gain an advantage over their main competitor.

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### PANAMA CANAL EXPANSION

In 2006, Panamanian voters decided in a national referendum to approve the Panama Canal expansion project, which turned out to be the largest investment and infrastructure project in the history of the country. With a total cost of over \$5.4 billion, the nine-year

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<sup>1</sup> Kimberly Amadeo, "How the Panama Canal Expansion Lowers Food Costs and Creates U.S. Jobs," *The Balance*, September 08, 2016, accessed January 02, 2017, <https://www.thebalance.com/panama-canal-expansion-impact-on-u-s-economy-3306274>.

<sup>2</sup> Alex Nussbaum and Naureen Malik, "Panama Canal Fever Sweeps Globe Again as New Era in Trade Nears," *Bloomberg.com*, May 24, 2016, accessed January 05, 2017, <https://www.bloomberg.com/news/articles/2016-05-25/panama-canal-fever-sweeps-globe-again-as-new-era-in-trade-nears>.

<sup>3</sup> Jean-Paul Rodrigue and Theo Notebook, "The Panama Canal Expansion: They Dug It, Will They Come?" *Port Economics*, June 22, 2016, accessed December 12, 2016, <http://www.porteconomics.eu/2016/06/22/the-panama-canal-expansion-they-dug-it-will-they-come/>.

<sup>4</sup> Costas Paris and Robbie Whelan, "The Panama Canal Expands," *The Wall Street Journal*, June 20, 2016, accessed January 03, 2017, <http://www.wsj.com/articles/the-panama-canal-expands-1466378348>.

<sup>5</sup> Merit R. Webster, "Redrawing Global Shipping Routes: The Panama Canal Gets an Upgrade," *Brown Brothers Harriman*, December 01, 2015, accessed December 20, 2016, <https://www.bbh.com/en-us/insights/redrawing-global-shipping-routes--the-panama-canal-gets-an-upgrade/10940>.

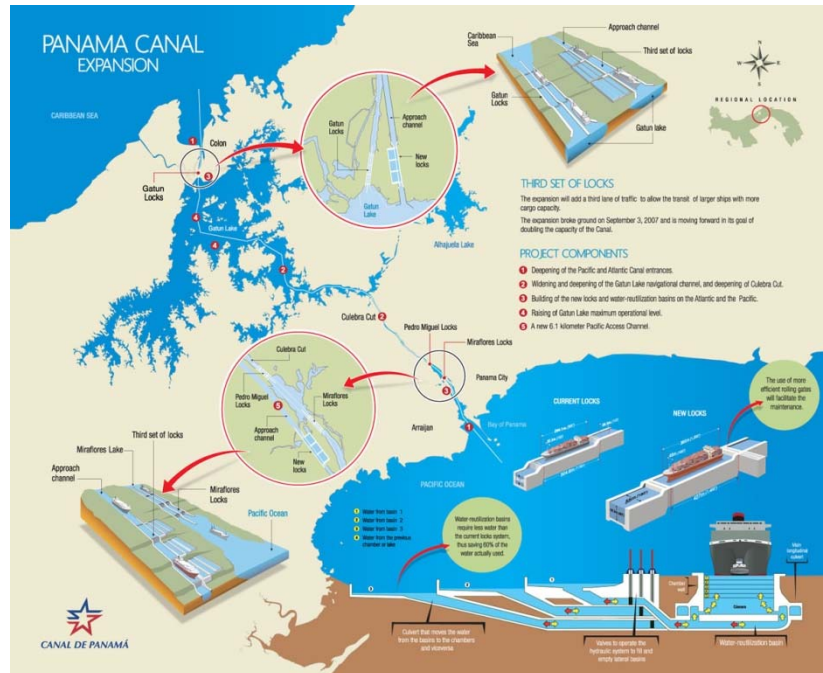
<sup>6</sup> Webster, "Redrawing Global Shipping Routes: The Panama Canal Gets an Upgrade."



expansion constituted about 30 percent of Panama’s annual GDP.<sup>7</sup> Of the 40,000 people who worked on the massive project, 95 percent were Panamanian nationals.<sup>8</sup> The construction, however, was plagued with several problems: eight workers lost their lives, and the project was completed two years late due to contractor disputes, cost overruns, and engineering failures.<sup>9</sup>

The expansion project included the building of a new set of locks on the Atlantic side, east of the Gatun locks, and on the Pacific side, southwest of the Miraflores locks. These new locks, which are 70 feet wider and 18 feet deeper than the original locks, added a third traffic lane that doubled the cargo capacity of the canal. Each of the new lock systems has nine water-saving basins that use 7 percent less water than the old locks and reuse about 60 percent of water used during each transit. A further component of the canal expansion was the raising of the Gatun Lake’s maximum operational level by 45 centimeters. Raising the Gatun Lake from 26.7 to 27.1 meters increased the lake’s water storage capacity by almost 200 million cubic meters, which enables the additional transit of about 1,100 ships per year. In addition to the new locks and raising the Gatun Lake, a new 6.1-km-long Pacific Access Channel was built, which connects the new Pacific locks with the Culebra Cut.<sup>10</sup> Figure 1 illustrates the expansion elements.

**Figure 1: Panama Canal Expansion**



Source: Panama Canal Authority<sup>11</sup>

<sup>7</sup> Chris Dupin, "Panama Canal’s Transit to the Future: Expanded locks expected to reshape U.S. East Coast port operations," *American Shipper*, August 2016, 37-42.

<sup>8</sup> Dupin, "Panama Canal’s Transit to the Future."

<sup>9</sup> Antonia Sohns, "The expansion of the Panama Canal transforms trade and the environment," *Medium*, June 24, 2016, accessed December 20, 2016, [https://medium.com/@foe\\_us/the-expansion-of-the-panama-canal-transforms-trade-and-the-environment-92fco7ac8ca#nnokjuivn](https://medium.com/@foe_us/the-expansion-of-the-panama-canal-transforms-trade-and-the-environment-92fco7ac8ca#nnokjuivn).

<sup>10</sup> Panama Canal Authority, "What is the Panama Canal Expansion Program?"

<sup>11</sup> Panama Canal Authority, "What is the Panama Canal Expansion Program?" *Canal de Panamá*, accessed January 03, 2017, <http://micanaldepanama.com/expansion/faq/>.

## CAPACITY

The addition of the third traffic lane, which allows for the passage of Neopanamax vessels, has doubled the Panama Canal’s total tonnage capacity to 600,000 PC/UMS (the Panama Canal Universal Measurement System). Panamax vessels, which are the largest ships that can be accommodated by the original locks, are 965 feet (294 m) long, 106 feet (32 m) wide, with a draft of 41.2 feet (12m). Neopanamax vessels, the largest ships that can pass through the new locks, measure 1,200 feet (366 m) in length, 160.7 feet (49 m) in width, and 49.9 feet (15 m) in draught. Thus, Neopanamax ships are about 25 percent longer, 52 percent wider, and 26 percent deeper than Panamax vessels. In terms of TEUs, Panamax vessels carry about 5,000 TEUs while Neopanamax vessels carry up to 14,000 TEUs. Larger ships allow for economies of scale, and thus lower the transportation cost per TEU. It is estimated that using the largest Neopanamax vessels, instead of the 5,000 TEU Panamax ships, generates operating cost savings of over 30 percent per TEU.<sup>12</sup> While the old locks allowed for the passage of about 43 vessels per day, the ACP believes that the new locks will eventually be able to accommodate between 15 and 17 ships, depending on whether or not the water-saving basins are used.<sup>13</sup> Over the course of a year, the expanded Panama Canal will be able to handle the transit of 16,000 vessels. Table 1 compares the Panamax and Neopanamax dimensions.

	Panamax	New Panamax
<b>Length</b>	294.13 m (965 ft.)	366 m (1,200 ft.)
<b>Width</b>	32.31 m (106 ft.)	49 m (160.7 ft.)
<b>Draught</b>	12.04 m (41.2 ft.)	15.2 m (49.9 ft.)
<b>TEU</b>	5,000	13,000 – 14,000

Source: Maritime Connector<sup>14</sup>

In order to accommodate the expected increase in traffic, the Panama Canal Authority is planning additional terminal facilities, including the Corozal Container Terminal and the Colon Container Port. The Corozal Container Terminal, which will be located on the Pacific side of the Panama Canal, is expected to add 3.2 million TEUs in capacity during Phase 1 (2018-2019) and an extra 2.1 million TEUs during the unspecified Phase 2. On the Atlantic side, a Chinese consortium has received a contract to build the Panama Colon Container Port, which should add a total capacity of 2.5 million TEUs. Moreover, the Panama International Terminal at the Pacific western-side entrance of the canal is currently expanding its capacity from about 500,000 TEUs to 2 million TEUs.<sup>15</sup>

<sup>12</sup> U.S. Department of Transportation Maritime Administration, "Panama Canal Expansion Study: Phase 1 Report: Developments in Trade and National and Global Economics," November 2013, accessed November 10, 2016, [https://www.marad.dot.gov/wp-content/uploads/pdf/Panama\\_Canal\\_Phase\\_I\\_Report\\_-\\_20Nov2013.pdf](https://www.marad.dot.gov/wp-content/uploads/pdf/Panama_Canal_Phase_I_Report_-_20Nov2013.pdf).

<sup>13</sup> Dupin, "Panama Canal's Transit to the Future."

<sup>14</sup> Maritime Connector, "Suezmax," *Maritime Connector*, accessed January 05, 2017, <http://maritime-connector.com/wiki/suezmax/>.

<sup>15</sup> Rodrigue and Notteboom, "The Panama canal expansion: they dug it, will they come?"

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## RELIABILITY

In the years prior to the expansion, the Panama Canal's reliability suffered due to bottlenecks and unpredictable weather patterns that impacted channel depths. The old Panama Canal was increasingly unable to handle the large volume of traffic, which led to overcrowded ports and long wait times. With the addition of the third set of locks and the doubling of the canal's cargo capacity, the Panama Canal Authority expects that the average transit time will not exceed 8 to 10 hours. This excludes wait times, which are on average between 24 and 36 hours. However, it is possible that the Panama Canal will have to deal with new bottlenecks in the future because of increased traffic from vessel types that were unable to use the original locks. The number of transits allowed per day is limited; thus, bulk carriers and cargo ships will compete with LNG vessels for a speedy passage through the canal.<sup>16</sup> Since the old and the new lanes have shared entry and exit points, wait times for both parts of the canal could increase. For instance, in the first few months after the opening of the new canal, wait times sometimes exceeded 10 days due to high demand and extreme weather conditions.<sup>17</sup> Moreover, the Pacific terminals are operating near their maximum capacity, which means that they could not handle any potential increase in transshipment volume unless the Corozal terminal gets built in time.<sup>18</sup>

A further challenge for the Panama Canal's reliability is the El Niño climate phenomenon. El Niño is characterized by a temporal and periodic warming of the Pacific Ocean, which leads to reduced rainfall in Panama, and a subsequent drop in the water levels of the Gatun Lake. Reliable operation of the Panama Canal depends on an adequate water supply from the Gatun Lake. In previous years, severe El Niño droughts have forced the Panama Canal Authority to decrease the draft of passing vessels and to require ships to offload part of their cargo. The expansion project addressed this problem through adding water-savings basins and using locks that require 7 percent less water than the original system. Furthermore, the Panama Canal Authority has invested in forest protection and planting vegetation along the riverbanks in order to control water flows and avert erosion of the canal.<sup>19</sup> Considering all the precautions taken, Manuel Eduardo Benítez (Panama Canal Authority deputy administrator) predicts that the new canal can offer a draft of 46 feet throughout the year—50 feet of draft during most months—and has a design draft of 60 feet.<sup>20</sup>

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## TOLLS

In 2016, with the opening of the third set of locks, the Panama Canal Authority authorized a new toll structure that calculates transit fees based on different units of measurement for different market segments (Table 2). The toll rate further depends on whether a vessel is laden (carrying cargo, containers, or passengers) or in ballast (empty). The new toll structure did not change tariffs for container ships, which will still be charged based on TEUs.

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<sup>16</sup> Sohns, "The Expansion of the Panama Canal transforms trade and the environment."

<sup>17</sup> Mariana Parraga, "Wait Time For Vessels To Pass Panama Canal Shortens To Four Days," *Marine Insight*, December 29, 2016, accessed February 4, 2017, <http://www.marineinsight.com/shipping-news/wait-time-for-vessels-to-pass-panama-canal-shortens-to-four-days/>.

<sup>18</sup> Greg Miller, "Panama Canal narrows field of bidders for new container terminal," *Journal of Commerce*, May 05, 2016, accessed December 15, 2016, [http://www.joc.com/port-news/panama-canal-news/panama-canal-narrows-field-bidders-new-container-terminal\\_20160505.html](http://www.joc.com/port-news/panama-canal-news/panama-canal-narrows-field-bidders-new-container-terminal_20160505.html).

<sup>19</sup> Sohns, "The Expansion of the Panama Canal transforms trade and the environment."

<sup>20</sup> Dupin, "Panama Canal's Transit to the Future."

The tolls for container ships depend on the vessels' TEU range and consist of a tariff for total TEU allowance (\$50 or \$60), as well as a tariff per loaded container on board (\$30 to \$40).<sup>21</sup>

<b>Locks</b>	<b>TEU Range</b>	<b>Tariff for TTA Maximum Capacity</b>	<b>Tariff for Loaded Containers on Board (TEU)</b>
Panamax	< 1,000	\$60	\$30
	≥ 1,000 < 2,000	\$60	\$30
	≥ 2,000 < 3,500	\$60	\$30
	≥ 3,500	\$60	\$30
Neopanamax	< 6,000	\$60	\$40
	≥ 6,000 < 7,000	\$50	\$40
	≥ 7,000 < 8,000	\$50	\$40
	≥ 8,000 < 9,000	\$50	\$40
	≥ 9,000 < 10,000	\$50	\$35
	≥ 10,000 < 11,000	\$50	\$35
	≥ 11,000 < 12,000	\$50	\$35
	≥ 12,000	\$50	\$35

Source: Panama Canal Authority<sup>22</sup>

The new toll structure could significantly reduce toll costs for container ships on a roundtrip from Asia to the U.S. East Coast, since it cuts the cost per vessel capacity while raising it on loaded containers. The cost savings will be more significant with increasing vessel size. According to Andy Lane from Container Transport International Consultancy, an 11,000-TEU vessel loaded to 85 percent of capacity on the way to the U.S. East Coast, and 30 percent on the way back to Asia, would pay \$12 less per laden TEU (9.2 percent) than a 4,600-TEU vessel with corresponding measures. This might enable the Panama Canal to gain back some of the container services between Asia and the U.S. East Coast that had switched to the Suez Canal to take advantage of economies of scale from larger vessels. Furthermore, the Panama Canal Authority introduced a customer-loyalty program for container lines that grants toll reduction to customers that reach a certain TEU volume on canal transits.<sup>23</sup>

Similarly, as in previous years, the dry bulk segment will be charged a fee based on the amount of cargo carried and the ship's deadweight tonnage. Tolls for tankers, which make up 16 percent of Panama Canal traffic, are based on the PC/UMS and metric tons of cargo. A net Panama Canal ton is equal to 100 cubic feet of volumetric capacity. Fees for general cargo, refrigerated cargo and other segments will continue to be calculated based on PC/UMS. Tolls for LPG carriers are newly based on cubic meters instead of the previous PC/UMS. The new toll structure also includes two new market segments: LNG carriers and an intra maritime cluster, which refers to ships that provide services in Panama. Tolls for LNG vessels will be calculated

<sup>21</sup> Oxford Business Group, "New toll structure for Panama Canal set to come into effect in 2016," *Oxford Business Group*, August 30, 2015, accessed January 5, 2017, <https://www.oxfordbusinessgroup.com/analysis/locks-and-loads-preparation-opening-third-lane-panama-canal-new-toll-structure-set-come-effect-2016>.

<sup>22</sup> Panama Canal Authority, "Tolls Assessment," *Canal de Panamá*, May 11, 2015, accessed February 10, 2017, <https://www.pancanal.com/eng/op/tolls.html>.

<sup>23</sup> Peter L. Leach, "Panama's new toll structure could produce savings for carriers," *Journal of Commerce*, January 07, 2015, accessed March 10, 2017, [http://www.joc.com/maritime-news/container-lines/panama%E2%80%99s-new-toll-structure-could-produce-savings-carriers\\_20150107.html](http://www.joc.com/maritime-news/container-lines/panama%E2%80%99s-new-toll-structure-could-produce-savings-carriers_20150107.html).

based on cubic meters. As a further incentive, LNG vessels on a roundtrip through the Panama Canal are eligible to pay a cheaper roundtrip ballast fee, as long as the return transit in ballast is made within 60 days of the laden transit.<sup>24</sup> See Table 3.

LPG Vessels			LNG Vessels			
Bands in m3	Laden	Ballast	Bands in m3	Laden	Ballast	Ballast (Roundtrip)
First 5,000	\$5.50	\$4.40	First 60,000	\$2.50	\$2.23	\$2.00
Next 20,000	\$2.35	\$1.88	Next 30,000	\$2.15	\$1.88	\$1.75
Next 30,000	\$2.30	\$1.84	Next 30,000	\$2.07	\$1.80	\$1.60
Rest	\$1.80	\$1.44	Rest	\$1.96	\$1.71	\$1.50

Source: Panama Canal Authority<sup>25</sup>

## SERVICES

While the expansion project has increased the Panama Canal’s relevance for the global shipping industry, its management is also offering a variety of other services that increase the canal’s competitiveness. The Panamanian government is trying to establish the canal as a major transshipment hub, where big vessels using the expanded canal can offload their cargo onto smaller, regional ships. An important element in increasing the Panama Canal’s transshipment capacity is the construction of the Corozal Container Terminal. The Corozal terminal will be located on the canal’s Pacific side and include a container yard, a 2,081-linear-meter dock, as well as warehouse facilities and offices.<sup>26</sup> Operated by Hutchison Port Holdings, the Corozal terminal will have access to the Panama Canal Railway, which links the Pacific Balboa terminal to the three terminals on the Atlantic side.<sup>27</sup> The Panama Canal Railway is a further crucial element for promoting the canal as a transshipment hub, since it connects the Pacific side with the Atlantic side, allowing shipping companies to unload containers at either side of the canal. Panama’s investment in creating a transshipment hub is based on the expectation that transshipment at the canal’s Pacific terminals will increase due to changes in carrier networks and growing trade in Latin America.<sup>28</sup> However, it is also possible that a potential increase in transshipment activity will benefit other Pacific hubs such as Cartagena, Columbia, Manzanillo, and Lazaro Cardenas in Mexico, or Callao in Peru.<sup>29</sup> Moreover, Asaf Ashar, professor emeritus at the University of New Orleans’ National Port and Waterways Institute, predicts that transshipment will not increase as dramatically as expected by the Panamanian authorities.<sup>30</sup>

<sup>24</sup> Oxford Business Group, “New toll structure for Panama Canal set to come into effect in 2016.”

<sup>25</sup> Panama Canal Authority, “Tolls Assessment.”

<sup>26</sup> Port Technology, “Panama Search for Development Operators,” *Port Technology*, October 11, 2016, accessed January 19, 2017,

<https://www.porttechnology.org/news/panama-canal-searches-for-new-development-operators>.

<sup>27</sup> Miller, “Panama Canal narrows field of bidders for new container terminal.”

<sup>28</sup> Joseph Bonney, “Panama Canal expansion will affect shipping - but how?” *Journal of Commerce*, June 25, 2016, accessed January 04, 2017, <http://www.joc.com/port-news/panama-canal-news/panama-canal-expansion-will-affect-shipping-how-20160625.html>.

<sup>29</sup> Bonney, “Panama Canal expansion will affect shipping – but how?”

<sup>30</sup> Ibid.



According to Ashar, it is more likely that shipping companies will combine smaller services and continue direct calls, skipping transshipment altogether. A further service intended to increase Panama’s competitiveness is the development of the new Panama Pacífico Special Economic Area (SEA). Located on the western shore of the Panama Canal, the SEA is a public-private partnership that intends to attract foreign direct investment through offering special tax, legal and labor incentives to interested firms.<sup>31</sup> The SEA’s 3,450 acres of land already house more than 230 companies, including Dell, Caterpillar, and 3M.

## INCENTIVES

As a further way to remain competitive with the Suez Canal, the Panama Canal Authority offers incentives to shippers such as the Green Connection Environmental Recognition Program and the Panama Canal Loyalty Program. The Green Connection Environmental Recognition Program, which includes both the Green Connection Award and the Environmental Premium Ranking, is a new incentive intended to reward shipping companies that use technologies and standards designed to reduce the amount of greenhouse gases emitted. The Environmental Premium Ranking incentive, which was launched on January 1, 2017, awards qualified customers with points that enable them to upgrade their status within the Panama Canal’s Customer Ranking System. A good score improves a customer’s chance to book for transit through the canal.<sup>32</sup>

In order to qualify, ships must fulfill at least one of the prerequisites listed in Table 4:

	INDICATOR	LEVEL 1	LEVEL 2	DOCUMENTATION
1	Energy Efficiency Design Index threshold	at least 20 percent below the reference line	at least 30 percent below the reference line	International Energy Efficiency Certificate
2	Environmental Ship Index (ESI) threshold	at least 35 points	at least 80 points	ESI database
3	Low nitrogen oxide (NOx) threshold	at least 10 percent below Tier II limit	at least 20 percent below Tier II limit	Engine International Air Pollution Prevention (EIAPP) Certificate
4	LNG-fueled engine		LNG-fueled engine	LNG engine description

Source: Panama Canal Authority<sup>33</sup>

Ships that qualify as “Level 1” will accumulate an additional 10 percentage points per transit towards their overall rank, while those qualifying as “Level 2” will improve their ranking by 20 percentage points for each passage through the canal.

<sup>31</sup> Henry Kardonski, “Panama’s SEA Change Boosts Access to Global Markets,” *Inbound Logistics*, January 2016, accessed December 07, 2016, <http://www.inboundlogistics.com/cms/article/panamas-sea-change-boosts-access-to-global-markets/>.

<sup>32</sup> Eric Kulisch, “Panama Canal offers incentive for clean-burning vessels,” *American Shipper*, November 01, 2016, accessed January 03, 2017, <http://www.americanshipper.com/main/news/panama-canal-offers-incentive-for-cleanburning-ves-65897.aspx>.

<sup>33</sup> Panama Canal Authority, “Panama Canal Launches Environmental Premium Ranking to Recognize Ships with High Environmental Efficiency,” News release, October 31, 2016, *Canal de Panamá*, accessed February 3, 2017, <http://www.pancanal.com/eng/pr/press-releases/2016/10/31/pr612.html>.

The Green Connection Award, which was launched in July 2016, recognizes customers that meet the highest environmental performance standards as defined by the International Maritime Organization. Potential candidates are evaluated based on environmental issues such as<sup>34</sup>:

- The Energy Efficiency Design Index,
- Environmental Ship Index,
- Engine performance and the amount of nitrous oxides emitted
- Vessels powered by LNG
- The reduction in CO<sub>2</sub> emissions due to using the Panama Canal instead of other routes

The first vessel to receive the Green Connection Award was the Maran Gas Apollonia, Shel International Trading & Shipping Company, for reducing the amount of carbon dioxide emission by using the shortest route through the Panama Canal.<sup>35</sup>

A further incentive started by the Panama Canal Authority, the Panama Canal Loyalty Program, offers volume-based, tiered discounts to container lines that regularly send large vessels through the Panama Canal. Container ships make up more than 30 percent of canal transits, as well as about half of the total annual toll revenue. The toll reductions are based on cumulative TEU volumes, and increase from lines that fall into Category 4 to those that fall into Category 1. Category 4, the baseline, includes total annual vessel capacity volumes of up to 450,000 TEUs, while Category 3 covers volumes between 450,000 and 1 million TEUs. Category 2 encompasses annual capacity volumes between 1 and 1.5 million TEUs, while Category 1 covers capacity volumes over 1.5 million annual TEUs. Carriers in Category 1 will receive a 14-percent toll reduction from the base rate, which is about \$6.5 million per year.<sup>36</sup>

## SUEZ CANAL

### SUEZ CANAL EXPANSION

While the Panama Canal worked on adding a third set of locks, its main competitor, the Suez Canal, completed its own expansion project. Originally opened in 1869, the Suez Canal connects the Red Sea with the Mediterranean Sea, offering ships a shorter route than travelling around Africa's southern tip. About 7.5 percent of global maritime trade passes through the Suez Canal.<sup>37</sup>

Similar to the Panama Canal, the Suez Canal experienced increasing capacity constraints and excessive wait times in recent years, which made the expansion project necessary. On August 5, 2014, the Suez Canal Authority and Egypt's President Abdel Fattah el-Sisi announced their plans for the Suez Canal expansion project, which would add a second lane, allowing two-

<sup>34</sup> Panama Canal Authority, "Panama Canal Launches Environmental Recognition Award."

<sup>35</sup> Panama Canal Authority, "First-Ever LNG Vessel Transits the Expanded Panama Canal, Ushering in New Era for the Segment and Global LNG Trade," News release, July 26, 2016, *Canal de Panamá*, accessed December 29, 2016, <http://www.pancanal.com/eng/pr/press-releases/2016/07/26/pr602.html>.

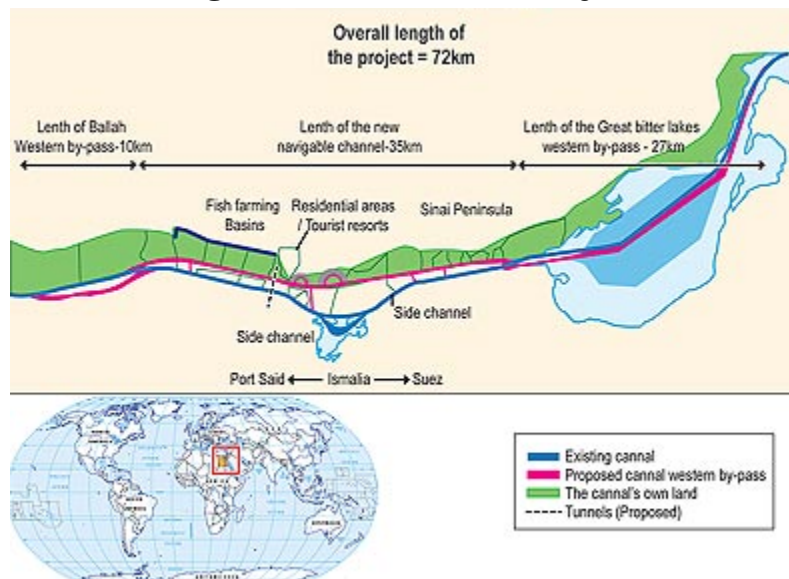
<sup>36</sup> Bill Mongelluzzo, "Panama Canal bets loyalty incentives will boost competitiveness with Suez," *Journal of Commerce*, September 16, 2015, accessed December 03, 2016, [http://www.joc.com/port-news/panama-canal-news/panama-canal-bets-its-loyalty-incentives-will-make-it-competitive-suez\\_20150916.html](http://www.joc.com/port-news/panama-canal-news/panama-canal-bets-its-loyalty-incentives-will-make-it-competitive-suez_20150916.html).

<sup>37</sup> Joe Lo, "Suez Canal expansion inaugurated with promises of further development," *Container Management*, August 10, 2015, accessed February 09, 2017, <http://container-mag.com/2015/08/07/suez-canal-expansion-inaugurated-promises-development/>.



way traffic for the first time in the canal's history. The expansion cost \$8.5 billion and was completed by the Egyptian army, who worked 24/7 on the massive construction project.<sup>38</sup> Unlike the Panama Canal Expansion, the Suez project did not experience any delays, and was completed within only 12 months. The project included the expansion of a 35-km-long central stretch of the canal, in order to allow for two-way traffic. The new channel is 24 meters deep and 320 meters wide.<sup>39</sup> Moreover, the existing 37-m western bypasses of Ballah and the Great Bitter Lakes were expanded to a width of 320 meters and a depth of 20 meters (66 ft).<sup>40</sup> In addition to digging a new channel and expanding the existing bypasses, the Suez project also included the construction of six underground tunnels that allow the passage of vehicles, as well as a rail connection to the Sinai Peninsula.<sup>41</sup> In February 2016, a new 8.5-km-long and 18.5-m-deep access channel was opened, linking the East Port Said directly to the Mediterranean Sea. This new channel provides 24-hour access to East Port Said, eliminating the need for vessels heading for the Suez Canal Container Terminal to wait for up to 8 hours between convoys of ships transiting the Suez Canal.<sup>42</sup> Figure 2 illustrates the Suez expansion.

**Figure 2: New Suez Canal Project**



Source: La Voce di Trieste <sup>43</sup>

<sup>38</sup> Bonney, "Panama Canal expansion will affect shipping – but how?"

<sup>39</sup> Emmanuel Mair, "Suez Canal: Egypt's gift to the world or Egypt's gift to itself?" *Container Management*, (September/October 2015): 5.

<sup>40</sup> Joe Lo, "Suez Canal expansion inaugurated with promises of further development."

<sup>41</sup> Oliviero Baccelli, Anna Arianna Buonfanti, Olimpia Ferrara, and Roberto Zucchetti, "The new Suez Canal: economic impact on Mediterranean maritime trade," *Maritime Economy*, 2015, accessed December 09, 2016, [http://www.srm-maritimeconomy.com/wp-content/uploads/woocommerce\\_uploads/2015/12/abstract-suez-eng.pdf](http://www.srm-maritimeconomy.com/wp-content/uploads/woocommerce_uploads/2015/12/abstract-suez-eng.pdf).

<sup>42</sup> Tom Boyd, "Suez Canal Access Channel is Officially Opened." *APM Terminals*, February 26, 2016, accessed March 05, 2017, <http://www.apmterminals.com/en/news/press-releases/2014/12/suez-canal-access-channel-officially-opens>.

<sup>43</sup> Paolo G. Parovel, "Il nuovo Canale di Suez ed i porti adriatici di Trieste, Koper e Rijeka," *La Voce di Trieste*, August 07, 2015, accessed December 06, 2016, <http://www.lavoceditrieste.net/2015/08/07/il-nuovo-canale-di-suez-ed-i-porti-adriatici-di-trieste-koper-e-rijeka/>.

The expansion of the Suez Canal, which for the first time allowed two-way traffic, increased the canal's capacity by 50 percent. Prior to the 2015 expansion, the Suez Canal had a maximum capacity of about 78 ships per day, which translates into 28,470 annual transits. However, the canal consistently operated below its maximum capacity, reporting an average of 47 vessel transits per day.<sup>44</sup> Since the completion of the expansion, the canal's maximum capacity has increased to 97 ships per day.<sup>45</sup> Even prior to the expansion, the Suez Canal could handle all vessels but the very largest oil tankers. Suezmax ships are those vessels that meet the limitations of the Suez Canal and can transit in a laden condition. The term Suezmax is almost entirely used for tankers. Unlike the Panama Canal, the Suez Canal has no locks, which means that the major limiting factors for vessels are beam (width), length, draught, and height. Currently, the Suez Canal allows for transit of Suezmax ships with a maximum draught of 20.1 m (66 ft), and a beam of 50 m (164 ft). In order to pass under the 70 m (230 ft) Suez Canal Bridge, the maximum head room (air draft) allowed for transiting ships is 68 m (223.1 ft). A typical Suezmax has a deadweight of 240,000 tons.<sup>46</sup> Because of these limitations, some of the largest fully laden tankers still cannot transit the Suez Canal unless they unload some of their cargo to other tankers or a pipeline terminal. These very large crude carriers and ultra large crude carriers, which can carry up to 320,000 gross registered tons, still have to travel around the Cape of Good Hope. See Table 5 for a comparison of Suezmax and Neopanamax vessels.

	Suezmax	Neopanamax
Length	275 m (902.2 ft)	366 m (1,200 ft)
Width	50 m (164 ft)	49 m (160.7 ft)
Draught	20.1 m (66 ft)	15.2 m (49.9 ft)
TEU	18,000 <sup>47</sup>	13,000 – 14,000

Source: Ship Trade House <sup>48</sup>

To further increase the Suez Canal's capacity, the Egyptian government is planning to expand the existing Port Said container terminal, as well to build additional terminals. These projects are part of a master plan, announced in March 2015, which intends to turn the Suez Canal into a major logistics region. In late 2015, Phase 2 of the Port Said project was completed, expanding the container terminal's full capacity from 3.3 million TEUs to over 5 million TEUs. The ultimate goal is to increase Port Said's capacity to 20 million TEUs by 2050, which will be achieved through adding a solid bulk terminal, a terminal for the logistics of new and used cars, a general cargo terminal, as well as a terminal for the storage of liquid bulk. In addition, a container terminal with an annual handling capacity of 5.2 million TEUs will be built on the Canal's southern port of Ain Sokhna.<sup>49</sup>

<sup>44</sup> Baccelli et al., "The new Suez Canal: economic impact on Mediterranean maritime trade."

<sup>45</sup> Ibid.

<sup>46</sup> Ship Trade House, "Suezmax," *Ship Trade House*, accessed January 05, 2017,

<http://shiptradehouse.com/en/suezmax>.

<sup>47</sup> Webster, "Redrawing Global Shipping Routes: The Panama Canal Gets an Upgrade."

<sup>48</sup> Ship Trade House, "Suezmax."

<sup>49</sup> Baccelli et al., "The new Suez Canal: economic impact on Mediterranean maritime trade."

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## RELIABILITY

Similar to the Panama Canal, the Suez Canal experienced increasing capacity constraints and excessive wait times in recent years, which made the expansion project necessary. Between 2004 and 2014, the annual amount of cargo passing through the Suez Canal increased from 520 million tons to 822 million tons.<sup>50</sup> Average wait times for vessels transiting the canal were as high as 8 to 11 hours, and were often unpredictable. Unpredictable wait times were especially troublesome for container ships, which account for more than 50 percent of Suez Canal traffic.<sup>51</sup>

According to the Suez Canal Authority, the addition of a second lane reduced average transit times from 18 to 11 hours.<sup>52</sup> The wait time to transit the canal dropped from 11 hours to 3 hours since ships no longer need to anchor in the Great Bitter Lake while waiting for ship convoys travelling in the opposite direction to pass.<sup>53</sup> Furthermore, the new 8.5-km-long access channel links the East Port Said directly to the Mediterranean Sea. This new access channel eliminates the need for vessels heading for the Suez Canal Container Terminal to wait for up to 8 hours between convoys of ships transiting the Suez Canal.<sup>54</sup> Reduced wait times allow shipping companies to cut capital immobilization costs, as well as vessel operating costs. On average, a half-day reduction in transit times creates savings of about \$11,120 due to lower operating costs and \$9,531 due to shorter cargo immobilization.<sup>55</sup> However, savings can be substantially higher for ships with high operation costs or high average value of the cargo transported.

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## TOLLS

The Suez Canal is a major source of income for Egypt, and the main contributor of foreign currency. In 2014, the Egyptian government earned over \$5.4 billion through Suez Canal transit fees, which accounted for almost 2 percent of the country's GDP. SeaIntel estimates that ships passing through the Suez Canal on their way from Asia to the U.S. East Coast are charged an average toll of \$465,000 per transit. However, the Suez Canal Authority reported falling year-on-year toll revenues every month since the completion of the expansion project. Between August 2015 and January 2016, monthly tolls decreased by 11 percent from \$462 million to \$412 million.<sup>56</sup>

Suez Canal tolls are calculated based on the Suez Canal net tonnage (Table 6), which is close to a ship's international gross tonnage, and measures about half a vessel's deadweight.<sup>57</sup>

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<sup>50</sup> Ibid.

<sup>51</sup> Oliviero Baccelli "The new Suez Canal: economic impact on Mediterranean maritime trade."

<sup>52</sup> Chelsea Mitchell, "The Panama Canal vs. The Suez Canal," *Marisol International*, July 31, 2015, accessed January 20, 2017, <http://blog.marisolintl.com/the-panama-canal-vs.-the-suez-canal>.

<sup>53</sup> Turloch Mooney, "Egypt's Next Big Thing," *The Journal of Commerce*, August 24 (2015): 42-43.

<sup>54</sup> Boyd, "Suez Canal Access Channel is Officially Opened."

<sup>55</sup> Baccelli et al., "The new Suez Canal: economic impact on Mediterranean maritime trade."

<sup>56</sup> Ibid.

<sup>57</sup> Suez Canal Authority, "Tolls Table."

Vessel Type		Table 6: Suez Canal Net Tonnage													
		First 5000		Next 5000		Next 10000		Next 20000		Next 30000		Next 50000		Rest	
		Laden	Ballast	Laden	Ballast	Laden	Ballast	Laden	Ballast	Laden	Ballast	Laden	Ballast	Laden	Ballast
1	Tankers of Crude Oil	7.88	6.70	5.58	4.74	4.22	3.59	2.09	1.78	1.80	1.53	1.55	1.32	1.52	1.29
2	Tankers of Petroleum Products	7.88	6.70	5.58	4.74	4.22	3.59	2.80	1.78	2.74	1.53	2.47	1.32	2.38	1.29
3	Dry Bulk Carriers	7.88	6.70	6.02	5.12	4.76	4.05	1.74	1.48	1.53	1.30	1.44	1.22	1.38	1.17
4	LPG Carriers	7.88	6.70	5.70	4.85	4.22	3.59	3.43	2.92	3.00	2.55	2.80	2.38	2.80	2.38
5	LNG Carriers	7.88	6.70	6.13	5.21	5.30	4.51	4.10	3.49	3.80	3.23	3.63	3.09	3.53	3.00
6	Chemical Carriers & Other Liquid bulk Carrier	8.24	7.00	6.37	5.41	5.08	4.32	3.70	3.15	3.30	2.81	3.10	2.64	3.05	2.59
7	Container ships	7.88	6.70	5.41	4.60	4.20	3.57	2.94	2.50	2.73	2.32	2.15	1.83	2.05	1.74
8	General Cargo Ships	7.88	6.70	6.08	5.17	4.24	3.60	3.18	2.70	3.08	2.62	3.03	2.58	2.97	2.52
9	Ro/Ro Ships	7.88	6.70	5.86	4.98	4.56	3.88	3.29	2.80	3.08	2.62	2.97	2.52	2.86	2.43
10	Vehicle Carriers	7.88	6.70	5.41	4.60	4.05	3.44	2.89	2.46	2.73	2.32	2.15	1.83	2.05	1.74
11	Passenger Ships	7.88	6.70	5.54	4.71	4.56	3.88	3.23	2.75	3.18	2.70	3.08	2.62	2.97	2.52
12	Special Floating Units	8.55	-	5.66	-	5.09	-	3.61	-	3.40	-	3.08	-	2.97	-
13	Other Vessels	8.24	7.00	5.55	4.72	4.67	3.97	3.40	2.89	3.29	2.80	3.08	2.62	2.97	2.52

Source: Suez Canal Authority <sup>58</sup>

## SERVICES

The Suez Canal has two shipyards: the Port Said Shipyard at the northern entrance of the Canal, and the Port Tawfik Shipyard at the southern entrance. Services offered by the shipyards include ship building, as well as the repair of transiting vessels. The Suez Canal also owns a fleet of 12 multi-type dredgers that work on the canal and its wait areas, as well as a fleet of 31 different tugs used for salvage, firefighting, towing and berthing. Moreover, the Suez Canal Authority Research Center in Ismailia conducts technical studies and consultancy work in areas related to the canal.<sup>59</sup>

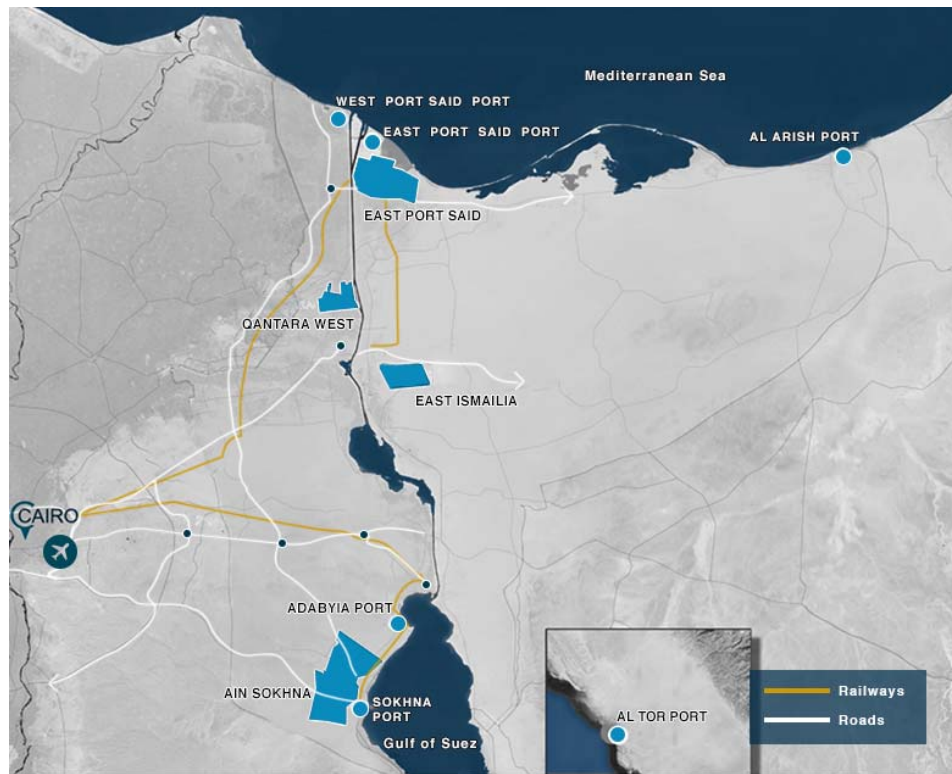
As part of the 2015 Master Plan, the Egyptian government developed the Suez Canal Corridor Area Project (SCZone), a special economic zone with intermediate and final deadlines set for 2030 and 2050. The SCZone intends to make the Suez Canal a center of economic development through industrial hubs, research centers, and logistics areas, as well as connecting routes between the regions east and west of the Canal (Figure 3). The project includes the development of three major areas: Port Said in the north, Qantara (Ismailia) in the middle, and Ain Sokhna on the southern end of the Suez Canal.<sup>60</sup>

<sup>58</sup> Suez Canal Authority, "Tolls Table," *Suez Canal Authority*, 2015, accessed February 05, 2017, <http://www.suezcanal.gov.eg/English/Tolls/Pages/TollsTable.aspx>.

<sup>59</sup> Suez Canal Authority, "Services," *Suez Canal Authority*, accessed December 02, 2016, <http://www.suezcanal.gov.eg/English/Services/Pages/default.aspx>.

<sup>60</sup> Baccelli et al., "The new Suez Canal: economic impact on Mediterranean maritime trade."

**Figure 3: Suez Canal Corridor Area Project**



The Port Said project includes an expansion of the existing Suez Canal Container Terminal, which works around the clock and serves as a transshipment port in the Mediterranean. In addition, a solid bulk terminal, a terminal for the logistics of new and used cars, a general cargo terminal, as well as a terminal for the storage of liquid bulk will be built. A 4,000-hectare area for manufacturers, commercial activities, retail sales, and residential use will be built around Port Said, which will also be connected to Ain Sokhna. In Qantara, a 670-hectare residential area will be built for light and small manufacturing industries. Furthermore, a new container terminal with infrastructures for the storage of dry and liquid bulks will be built in the port hub of Ain Sokhna, at the southern end of the Suez Canal. Moreover, an area of over 8,000 hectares behind the Ain Sokhna port will be developed for light productions, heavy industry, and commercial and residential purposes.<sup>62</sup>

## INCENTIVES

In March 2016, the Suez Canal Authority announced a temporary 30-percent cut in transit tolls for container ships that move from the U.S. East Coast to Southeast Asia.<sup>63</sup> Originally, the discount was to last between March 7 and June 5, and only applied to vessels that did not call at any ports between these two destinations. Later, the Suez Canal Authority extended the transit discount incentive until September 3, and increased its range to between 45

<sup>61</sup> Suez Canal Economic Zone, "Overview," *Suez Canal Economic Zone*, accessed November 29, 2016, <https://sczone.eg/English/aboutsczone/Pages/overview.aspx>.

<sup>62</sup> Baccelli et al., "The new Suez Canal: economic impact on Mediterranean maritime trade."

<sup>63</sup> Dusting Braden, "Suez Canal offers steep discount, kind of," *Journal of Commerce*, March 31, 2016, accessed November 19, 2016, [http://www.joc.com/maritime-news/container-lines/suez-canal-offers-steep-discount-kind\\_20160331.html](http://www.joc.com/maritime-news/container-lines/suez-canal-offers-steep-discount-kind_20160331.html).



percent and 65 percent. The transit discount was introduced after falling oil prices made it cheaper for container vessels to drive around the longer Cape of Good Hope route than paying the Suez Canal toll fees. According to a SeaIntel report, the historically low fuel costs allowed ships to save an average of \$235,000 by avoiding the Suez Canal and traveling around Southern Africa.<sup>64</sup> Most of the vessels bypassing the Suez Canal did so on their way back from the U.S. East Coast to Asia, when they had less cargo.

A further incentive offered by the Suez Canal Authority is a 3-percent discount in canal fees for regular users who pay three to five years in advance. In order to qualify, regular users have to deposit funds into an account with the Central Bank of Egypt, from which the transit fees will be deducted every time a ship uses the Canal.<sup>65</sup> The deal has been offered to Maersk Line, CMA CGM SA, Mediterranean Shipping Company SA, Hapag-Lloyd AG, China Ocean Shipping Company, and Evergreen, who are the largest shipping companies using the Suez Canal.

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PANAMA CANAL – SUEZ CANAL MATRIX

One important factor affecting the Panama Canal utilization is its competition with the Suez Canal. When shippers decide whether to use the Panama or Suez Canal, they take into account time, cost, capacity, and the type of commodity transported. In recent years, several shipping companies have rerouted their vessels from the Panama Canal to the Suez Canal due to capacity constraints and long wait times, which caused the Panama Canal to lose between 10 percent and 15 percent of annual revenue to the Suez Canal.<sup>66</sup> In order to remain competitive, the Panama Canal completed an expensive expansion project in 2016, adding a third set of locks. In response, the Suez Canal concluded its own expansion project, which allows two-way traffic for the first time. In addition to having increased their capacity, both canals are constantly providing new incentives and services in order to gain an advantage over their main competitor (Table 7).

**Table 7: Panama Canal – Suez Canal Matrix**

	Panama Canal	Suez Canal
<i>Capacity</i>		✓
<i>Reliability</i>		✓
<i>Tolls</i>	✓	✓
<i>Services</i>	✓	✓
<i>Incentives</i>	✓	✓

In terms of capacity, the Suez Canal still has the upper hand over the Panama Canal. The expanded Panama Canal allows for the transit of Neopanamax ships, which are about 366 meters long, 49 meters wide, 15 meters deep, and can carry up to 14,000 TEUs. The Suez Canal,

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<sup>64</sup> Braden, "Suez Canal offers steep discount, kind of."

<sup>65</sup> Ben Meyer, "WSJ: Suez Canal looking to secure advance payments for tolls," *American Shipper*, October 26, 2016, accessed December 29, 2016, <http://www.americanshipper.com/main/news/wsj-suez-canal-looking-to-secure-advance-payment-f-65836.aspx>.

<sup>66</sup> Paris and Whelan, "The Panama Canal Expands."

which has no locks, can accommodate ships carrying 18,000 TEUs. Moreover, the expanded Panama Canal can handle about 60 ships per day<sup>67</sup>, while the Suez Canal has a maximum capacity of 97 vessels per day.<sup>68</sup> However, the Suez Canal's ability to handle larger ships may not be a decisive competitive advantage. Only about 200 container ships within the global fleet are too big to use the new Panama Canal locks, and most of them operate between Europe and Asia.<sup>69</sup> Moreover, the Panama Canal expansion greatly increased the capacity of ships that can pass through the new locks from about 5,000 TEUs to 14,000 TEUs. Thus, shipping companies that rerouted services from the Panama Canal to the Suez Canal due to size restrictions might reconsider their decision, especially since using the Panama Canal on trips from Asia to the U.S. East Coast is much shorter. As an example, the trip from Hong Kong to New York (without any intermediate port calls) takes about 25 days and 22 hours via the Panama Canal, compared to approximately 26 days and 20 hours via the Suez Canal.<sup>70</sup> In addition, a ship travelling through the Suez Canal is likely to call at one or more transshipment hubs in Asia or the Mediterranean, which can add even more time and cost to the trip. Therefore, Neopanamax vessels can save over 20 percent on total transportation costs by using the Panama Canal instead of the Suez Canal.<sup>71</sup> Asia to U.S. East Coast and Gulf ports for time sensitive cargo is likely to use the Panama Canal rather than the Suez Canal even though currently Suez tolls are slightly lower.<sup>72</sup> Moreover, both canals are offering a variety of significant and competitive toll incentives for frequent customers.

Both canals have struggled continuously with reliability issues, a problem they tried to address through their expansion projects. The Suez Canal was able to reduce unreliable wait times from about 11 to 3 hours, which decreased the average time it takes for a vessel to transit from 18 to 11 hours. Similarly, the addition of a third set of locks doubled the Panama Canal's capacity, reducing average transit times to 8 or 10 hours. However, wait times to use the canal are still between 24 and 36 hours.<sup>73</sup> It is also possible that the Panama Canal will have to deal with new bottlenecks in the future because of increased traffic from vessel types that were unable to use the original locks. A further challenge for the Panama Canal's reliability is the El Niño climate phenomenon, which could make water supply and draft restrictions unpredictable. Thus, in terms of reliability, it seems that the Suez Canal has a potential advantage.

With regard to services and incentives offered, there is no clear winner. Both governments are trying to promote their canal as a major transshipment hub and increase its relevance through adding new terminals, improving multi-modal connections and establishing special economic areas. Moreover, both canals offer some form of customer loyalty programs: the Panama Canal Loyalty Program offers volume-based, tiered toll discounts to container lines that regularly send large vessels through the Panama Canal, while the Suez Canal offers a 3-percent discount in canal fees for regular users who pay three to five years in advance. As a further incentive, the Panama Canal's Green Connection Environmental Recognition Program rewards shipping companies that use environmentally friendly standards and technologies. The Suez Canal Authority offers temporary cuts in transit fees for container ships travelling between the U.S. East Coast and Southeast Asia.

Overall, it seems that the Panama Canal is increasing its competitiveness relative to its Egyptian counterpart. This is mainly due to that fact that the expanded Panama Canal allows for the passage of Neopanamax ships, which means that shipping companies can take advantage of economies of scale while decreasing transit time and transportation costs on trips between the

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<sup>67</sup> Dupin, "Panama Canal's Transit to the Future."

<sup>68</sup> Baccelli et al. "The new Suez Canal: economic impact on Mediterranean maritime trade."

<sup>69</sup> Dupin, "Panama Canal's Transit to the Future."

<sup>70</sup> Leach, "Panama's new toll structure could produce savings for carriers."

<sup>71</sup> Webster, "Redrawing Global Shipping Routes: The Panama Canal Gets an Upgrade."

<sup>72</sup> Leach, "Panama's new toll structure could produce savings for carriers."

<sup>73</sup> Parraga, "Wait Time for Vessels to Pass Panama Canal Shortens to Four Days."



U.S. East Coast and Asia. Within a few weeks after opening the new lane, the Panama Canal displaced its competitor as the leading route for all-water container services between Asia and the U.S. East Coast.<sup>74</sup> Later that year, the CKYHE rerouted one service from the Suez to the Panama Canal, while the 2M Alliance transformed one of their trans-Suez services into a round-the-world-service using the Panama Canal on their eastbound trip.<sup>75</sup>

Other factors that could influence the Panama Canal's competitiveness are changing global sourcing patterns, improvements in intermodal services, and a future interocean canal across Nicaragua. If wages in China continue to rise, manufacturing will increasingly move into cheaper Southeast Asian nations, which are located closer to the Suez Canal.<sup>76</sup> This might again increase the relevance of the Suez Canal over its Central American competitor. A second competitor to the Panama Canal is the intermodal system. Ships travelling from East Asia to the U.S. East Coast can circumvent both canals by shipping goods to the U.S. West Coast, and from there via rail to the other side. This option is faster but more expensive compared to using the Panama Canal. In recent years, the U.S. intermodal system has experienced several challenges, including severe bottlenecks, labor strikes, chassis shortages, and congestion at main West Coast ports.<sup>77</sup> However, should these issues be addressed effectively, the intermodal system might increase its attractiveness relative to the Panama Canal. Finally, Chinese investors are planning to build a 272-mile-long sea-level canal across Nicaragua, connecting the Caribbean Sea with the Pacific Ocean.<sup>78</sup> The Nicaragua Canal could accommodate larger ships than the expanded Panama Canal, but it is not clear whether or not the project will ever be completed. The project would face severe environmental and engineering challenges, as well as costs as high as \$70 billion.<sup>79</sup>

## PANAMA CANAL UTILIZATION

### FLEET CAPACITY

The addition of the third set of locks doubled the Panama Canal's capacity, and greatly increased the number of vessels that can transit the canal. Before the opening of the new lane, about 55 percent of total deadweight tonnage capacity in the global fleet was held by vessels too big to transit the 1914 locks. Since the completion of the expansion project, about 79 percent of total deadweight tonnage in the global fleet is able to use the Panama Canal. The expansion will have the biggest impact on the container ship sector, which constitutes more than 30 percent of Panama Canal transits and about 50 percent of its total toll revenue. While about 63 percent of container ships were unable to use the 1914 canal, the addition of the new set of locks has decreased this number to 2 percent, or about 200 vessels. However, this percentage is expected to decrease to 95 percent by 2019, as shipping companies will use increasingly large vessels.<sup>80</sup>

Moreover, most LNG carriers, as well as all of the current LPG fleet is able to transit the expanded Panama Canal. While only about 6 percent of LNG vessels were able to pass through the old canal, the new locks can accommodate about 90 percent of the global LNG fleet. The

<sup>74</sup> Barnard, Bruce, "Panama Canal ousts Suez as top Asia-US East Coast route," *Journal of Commerce*, July 13, 2016, accessed January 21, 2017, [http://www.joc.com/port-news/panama-canal-news/panama-canal-ousts-suez-top-asia-us-east-coast-route\\_20160713.html](http://www.joc.com/port-news/panama-canal-news/panama-canal-ousts-suez-top-asia-us-east-coast-route_20160713.html).

<sup>75</sup> Dupin, "Panama Canal's Transit to the Future."

<sup>76</sup> Webster, "Redrawing Global Shipping Routes: The Panama Canal Gets an Upgrade."

<sup>77</sup> Ibid.

<sup>78</sup> Bonney, "Panama Canal expansion will affect shipping – but how?"

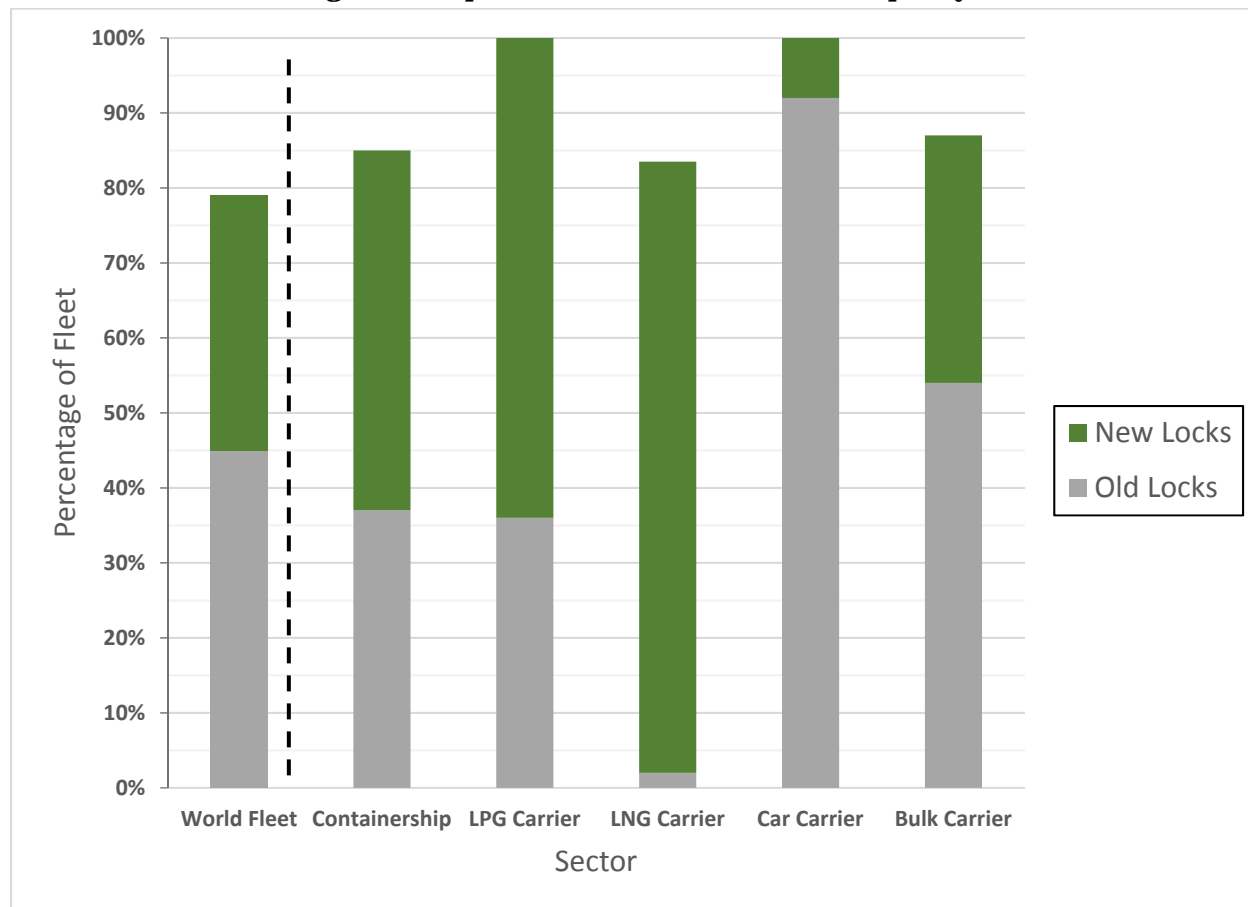
<sup>79</sup> Ibid.

<sup>80</sup> Ibid.

roll-on/roll-off trade will also benefit since vessels carrying 30 percent more vehicles, or 8000 car-equivalent units will be able to transit the expanded canal. The new canal can also accommodate dry-bulk carriers and tankers with twice the capacity of the 1914 locks. While the original canal could move cruise ships with 2,000 passengers, the new lane allows for the transit of cruise ships carrying up to 4,000 passengers.<sup>81</sup> Figure 4 illustrates the canal’s capacity.

Despite its benefits for a large percentage of the global fleet, the Panama Canal expansion is less likely to significantly affect oil markets. Very large crude carriers, which have a cargo capacity of over two million barrels and carry most of the petroleum traded in the global market, can still not fit through the expanded Panama Canal.<sup>82</sup>

**Figure 4: Expanded Panama Canal Fleet Capacity**



Source: Hellenic Shipping News<sup>83</sup>

Note: This figure depicts the proportion of fleet capacity in each sector that is capable of transiting the old locks, and the additional proportion of fleet capacity that will be able to transit through the new locks. Units used: deadweight tonnage for the world fleet and bulk carriers; TEU for container ships; cubic meters for LPG and LNG carriers; and vehicle capacity for car carriers.

The graph is based on statistics provided June 20, 2016.<sup>84</sup>

<sup>81</sup> Dupin, “Panama Canal’s Transit to the Future.”

<sup>82</sup> Nussbaum and Malik, “Panama Canal Fever Sweeps Globe Again as New Era in Trade Nears.”

<sup>83</sup> Hellenic Shipping News, “The Panama Canal Goes Forth into a New Dimension,” *Hellenic Shipping News*, June 28, 2016, accessed January 19, 2017, <http://www.hellenicshippingnews.com/the-panama-canal-goes-forth-into-a-new-dimension/>.

<sup>84</sup> Hellenic Shipping News, “The Panama Canal Goes Forth into a New Dimension.”

## NEOPANAMAX VESSELS

The fact that bigger ships can fit through the expanded Panama Canal provides shippers with more options. In particular, larger vessels allow shippers to take advantage of economies of scale. Unit costs decrease as the size of the ship increases, since fixed costs such as crew salaries and administrative fees increase in smaller proportion compared to the size of the vessel. Moreover, the new lane permits the passage of wider and more stable ships that carry more cargo and less ballast. Prior to the expansion project, the largest ships that could pass through the Panama Canal were the 5,000 TEU Panamax vessels. With the addition of the third set of locks, Neopanamax vessels, which are 70 feet wider and 18 feet deeper than the Panamax ships and carry up to 14,000 TEUs, can pass through the canal for the first time in its history.<sup>85</sup> Table 8 shows the increase in canal operations.

**Table 8: Monthly Canal Operations**

	July 2016	August 2016	September 2016	October 2016	November 2016	December 2016	January 2017
<i>Total</i>	946	908	945	973	969	1043	1111
<i>Neopanamax</i>	59	76	81	108	103	154	160
<i>Neopanamax %</i>	6.24	8.37	8.57	11.10	10.63	14.77	14.40
<i>Neopanamax Daily Average</i>	1.9	2.45	2.7	3.48	3.43	4.97	5.16

Source: Panama Canal Authority<sup>86</sup>

The day the new lane opened, 170 Neopanamax vessels had already reserved bookings in advance for passing through the canal. Just within the first two weeks of operation, 24 Neopanamax ships passed through the new locks: 11 container ships, 11 LPG carriers, and 2 car carriers. The first Neopanamax vessel to transit the new canal was the 9,400-TEU vessel COSCO Shipping Panama. On January 26, 2016, the ship transited the new set of locks on its way from Piraeus, Greece to Asia. The number of Neopanamax vessels using the Panama Canal increased steadily from 59 in July to 154 in December 2016. By the end of the year, 581 Neopanamax vessels had passed through the expanded Panama Canal. In the first few months after opening the third lane, the Panama Canal Authority restricted the number of Neopanamax ships that could transit to four vessels per day, two in each direction. Later in the year, this number was increased to six Neopanamax ships per day.<sup>87</sup>

According to the Panama Canal Authority, several major liners have rerouted their service to the Panama Canal since the opening of the new lane. As of December 2016, ten Neopanamax liner services are using the Panama Canal, most of which on the U.S. East Coast to Asia trade lane. The Canal estimates that by the end of 2017, 11 Neopanamax services and 21 Panamax services will be deployed through the Panama Canal.<sup>88</sup>

<sup>85</sup> Kulisch, Eric, "Feeder vessel size to influence Panama Canal patterns," *American Shipper*, October 03, 2016, accessed February 10, 2017, <http://www.americanshipper.com/main/news/feeder-vessel-size-to-influence-panama-canal-patte-65566.aspx>.

<sup>86</sup> Panama Canal Authority, "Advisories to Shipping," *Canal de Panamá*, accessed January 07, 2017, <http://www.pancanal.com/common/maritime/advisories/index.html>.

<sup>87</sup> Dupin, "Panama Canal's Transit to the Future."

<sup>88</sup> Ibid.

## MARKET SEGMENT

Table 9 shows recent Panama Canal traffic by market segment in terms of number of transits, PC/UMS, and long tons of cargo. The Panama Canal Universal Measurement System does not measure the actual weight of a ship's cargo but applies a mathematical formula for the measurement of total vessel volume.<sup>89</sup> In both 2016 and 2015, the largest market segment by number of transits and PC/UMS tonnage was containers, followed by dry bulk.

Market Segment	Number of Transits		PC/UMS Net Tonnage (Thousands)		Long Tons of Cargo (thousands)		Percent of Increase or Decrease		
	2016	2015	2016	2015	2016	2015	Transits	CP/SUAB	Cargo
<b>Container</b>	2,977	3,069	119,800	115,125	39,651	38,953	-3.0%	4.1%	1.8%
<b>Dry Bulk</b>	2,634	3,264	65,800	82,944	89,525	114,955	-19.3%	-20.7%	-22.1%
<b>Vehicle Carriers / RoRo</b>	809	844	46,759	48,207	4,824	4,979	-4.1%	-3.0%	-3.1%
<b>Chemical Tankers</b>	1,899	1,679	39,619	34,766	38,319	33,805	13.1%	14.0%	13.4%
<b>Crude Product Tankers</b>	581	654	15,575	18,283	15,066	18,897	-11.2%	-14.8%	-20.3%
<b>Liquefied Petroleum Gas</b>	449	420	11,542	10,165	6,234	5,164	6.9%	13.5%	20.7%
<b>Refrigerated</b>	948	963	9,040	8,989	3,340	3,319	-1.6%	0.6%	0.60%
<b>General Cargo</b>	710	804	8,419	9,054	4,846	5,666	-11.7%	-7.0%	-14.5%
<b>Passengers</b>	213	208	8,185	8,374	-	-	2.4%	-2.3%	-100%
<b>Liquefied Natural Gas</b>	17	2	1,507	38	-	-	750.0%	3846.2%	
<b>Other</b>	447	476	3,199	4,070	2,349	3,405	-6.1%	-21.4%	-31.0%
<b>Total</b>	11,684	12,383	329,445	340,016	204,154	229,144	-5.6%	-3.1%	-10.9%

Source: Panama Canal Authority<sup>90</sup>

The table shows that between fiscal years 2015 and 2016, there was a general decrease in Panama Canal traffic. In 2016, the Canal counted 5.6 percent fewer transits compared to the previous year, which translates into a 3.1-percent decrease in total PC/UMS tonnage. All market segments saw a decrease in Panama Canal traffic statistics between 2015 and 2016, with the exception of LNG carriers, LPG carriers, and chemical tankers. The general decrease in Panama Canal traffic can be explained by the fact that in 2016, the global shipping industry experienced its worst downturn in 30 years. Overcapacity, lower consumer demand, and a slowing global economy caused freight rates to plunge, which negatively affected profits for shipping companies. The severe shipping industry downturn even led to the bankruptcy of South Korea's Hanjin Shipping Company, one of the world's largest container carriers.

While the fiscal year 2016 saw a general decrease in Panama Canal traffic, some market segments were hit especially hard. Both dry bulk and crude product tankers experienced a more than a 20-percent decrease if measured by the amount of cargo that passed through the canal. The dry bulk sector experienced its all-time low in February 2016 due to an oversupply of ships

<sup>89</sup> Eric Kulisch, "Neopanamax vessels account for small share of Panama Canal traffic," *American Shipper*, October 20, 2016, accessed February 02, 2017, <http://www.americanshipper.com/main/news/neopanamax-vessels-account-for-small-share-of-pana-65774.aspx>.

<sup>90</sup> Panama Canal Authority, "Transit Statistics," *Canal de Panamá*, accessed December 19, 2016, <http://www.pancanal.com/eng/op/transit-stats/index.html>.

and weak global demand. One main problem faced by the dry bulk industry is the weakening of the Chinese economy, which is the largest importer of dry bulk. In particular, China's demand for coal and iron ore has decreased rapidly since the end of 2015, in an effort to reduce its dependency on polluting fuel.<sup>91</sup>

Similarly, crude product tankers experienced a significant decrease in Panama Canal utilization between 2015 and 2016. Very-large crude carriers and ultra-large crude carriers that transport the majority of global crude oil can still not fit through the expanded Panama Canal. However, Suezmax tankers, which carry about one million barrels of crude oil, are able to pass through the new set of locks. Thus, some oil traders were hoping to increase their use of the Panama Canal. However, Panama Canal transits by crude product tankers have not increased in 2016, probably due to the global shipping downturn and the need for expensive retrofits. For oil tankers, the global shipping industry downturn was especially severe. While daily earnings in early 2016 were around \$50,000 to \$60,000, they plummeted to \$1,000 in late August. Moreover, even though bigger tankers can fit through the new locks, between 50 percent and 75 percent of oil tankers must first undergo expensive retrofits in order to be able to transit the canal. Modifications are necessary since the new locks use tug boats to pull ships rather than locomotives like the original locks. While the new parts are relatively inexpensive—between \$1,000 and \$3,000 per ship—vessels must be dry docked for the retrofits, which could cost between \$100,000 and \$150,000. Many shippers are not willing to invest in these expensive retrofits while the industry is facing severe financial strains. However, it is possible that crude product tanker traffic through the Panama Canal will increase in the next few years once the shipping industry has recovered and the necessary retrofits were made. It is estimated that an oil tanker travelling from the Caribbean to the U.S. West Coast could save more than \$300,000 by passing through the Panama Canal instead of taking the longer route around Cape Horn. In particular, oil tankers could use the Panama Canal in ballast position when picking up cargo from the Middle East during an around-the-world rotation.<sup>92</sup>

While most market segments experienced a decrease in Panama Canal traffic in 2016, chemical tankers, LPG carriers, and especially LNG carriers saw a significant increase. One main reason for this increase in traffic is probably the fact that the expanded Panama Canal can accommodate most of the chemical tanker, LNG carrier and LPG carrier fleet. Unlike crude oil, petroleum products are usually loaded onto several smaller ships that can use the expanded Panama Canal. Thus, about 90 percent of LNG carriers and most very large gas carriers that carry LPG, such as propane or butane, can fit through the new set of locks.<sup>93</sup> Moreover, the Panama Canal expansion coincided with the U.S. shale revolution that significantly increased American natural gas production and with it the LNG and LPG byproducts.

The increase in LNG carriers that passed through the Panama Canal was especially dramatic. LNG carrier transits increased by 750 percent between 2015 and 2016, while PC/UMS tonnage increased by 3846 percent. Prior to the expansion project, LNG carrier transits were rare, considering that only 23 of the 421 LNG vessel fleet was able to fit through the Panama Canal.<sup>94</sup> A further incentive for LNG carriers to use the Panama Canal is the new toll structure,

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<sup>91</sup> Reuters, "Weak demand, vessel surplus to create horror 2016 for commodities shipping," *CNBC*, December 28, 2015, accessed December 29, 2016, <http://www.cnbc.com/2015/12/28/weak-demand-vessel-surplus-to-create-horror-2016-for-commodities-shipping.html>.

<sup>92</sup> Liz Hampton, "Big oil tankers' need for retrofit delays use of new Panama Canal," *CNBC*, 23 August, 2016, accessed February 05, 2017, <http://www.cnbc.com/2016/08/23/reuters-america-big-oil-tankers-need-for-retrofit-delays-use-of-new-panama-canal.html>.

<sup>93</sup> U.S. Energy Information Administration, "Panama Canal expansion unlikely to significantly change crude oil, petroleum product flows," *U.S. Energy Information Administration*, June 23, 2016, accessed January 06, 2017, <https://www.eia.gov/todayinenergy/detail.php?id=26792>.

<sup>94</sup> Brandon Johnson and Uday Turaga, "The Panama Canal's Expansion Impacts Crude Oil, LPG, and LNG," *ADI Analytics*, July 25, 2016, accessed January 18, 2017, <http://adi-analytics.com/2016/07/25/the-panama-canals-expansion-impacts-crude-oil-lpg-and-lng/>.

which offers significant cost savings for ships that pass through the canal during their roundtrips. Customers in the LNG market segment can receive a special ballast fee if they use the same vessel for a roundtrip through the Panama Canal, and the transit in ballast is completed within 60 days of the laden transit.<sup>95</sup>

## U.S. - ASIAN MARITIME ROUTES

### OVERVIEW

The Panama Canal is an important and strategic gateway connecting the Pacific and Atlantic Oceans. It handles about 5 percent of global trade.<sup>96</sup> According to data from the Panama Canal Authority, the United States and China are the top two countries using the Panama Canal by origin and destination of cargo (see Table 10). The most significant trade routes serviced by the Panama Canal are the U.S. East Coast-Asia route, followed by the West Coast South America-U.S. East Coast route. Besides, among the top 10 U.S. maritime trade partners, three Northeast Asian countries—China, Japan, and South Korea—account for a collective share of more than 30 percent by value of total U.S. maritime trade.<sup>97</sup> Therefore, the upgraded Panama Canal, which can handle twice as much cargo, will likely attract more ships and affect the global trade routes, especially between the U.S. East Coast and Northeast Asia.

**Table 10: Top 15 Countries by Origin and Destination of Cargo Fiscal Year 2016 (Long Tons)**

Rank	Country	Origin	Destination	Intercoastal	Total	Total Excluding Intercoastal	Percent of Total
1	United States	90,601,908	48,425,590	1,872,249	139,027,498	137,155,249	67.0%
2	China	14,309,907	24,346,444	-	38,656,351	38,656,351	18.9%
3	Chile	11,690,237	13,625,533	-	25,315,770	25,315,770	12.4%
4	Peru	7,083,524	12,363,533	-	19,447,057	19,447,057	9.5%
5	Japan	5,672,413	13,361,308	-	19,033,721	19,033,721	9.3%
6	Korea, Republic of	9,365,172	6,864,052	-	16,229,224	16,229,224	7.9%
7	Mexico	6,601,069	9,457,746	651,353	16,058,815	15,407,462	7.5%
8	Colombia	8,639,924	7,260,834	402,702	15,900,758	15,498,056	7.6%
9	Ecuador	5,054,404	7,315,911	-	12,370,315	12,370,315	6.0%
10	Canada	8,453,316	2,678,470	61,585	11,131,786	11,070,201	5.4%
11	Guatemala	2,021,304	5,669,781	24,699	7,691,085	7,666,386	3.7%
12	Panama	851,136	4,835,022	78,266	5,686,158	5,607,892	2.7%
13	Trinidad and Tobago	3,521,850	270,024	-	3,791,874	3,791,874	1.9%
14	Spain	1,231,179	2,396,811	-	3,627,990	3,627,990	1.8%
15	Belgium	1,448,507	2,091,516	-	3,540,023	3,540,023	1.7%

Source: Panama Canal Authority<sup>98</sup>

<sup>95</sup> Panama Canal Authority, "Toll Assessment."

<sup>96</sup> U.S. Department of Transportation Maritime Administration, "Panama Canal Expansion Study."

<sup>97</sup> Ibid

<sup>98</sup> Panama Canal Authority, "Transit Statistics."



## U.S.-ASIA IMPORTS AND EXPORTS

In 2016, the major commodity exports from the U.S. to Asia through the Panama Canal were grains and energy products (see Table 11). Since the expanded Panama Canal allows for the transit of most LNG carriers, the U.S. can expect increased profits from LNG shipments to the Asian market. The most important commodity travelling from Asia to the U.S. is container cargo (see Table 12).

<b>Commodities</b>	<b>Atlantic to Pacific</b>
Grains	35,794
Petroleum and Petroleum Products	34,174
Container Cargo	18,099
Chemicals and Petroleum Chemicals	12,466
Coal and Coke (excluding petroleum coke)	6,671
Nitrates, Phosphates and Potash	4,007
Unclassified	3,477
Miscellaneous	2,568
Ores and Metals	1,842
Machinery and Equipment	1,693
Other Agricultural Commodities	1,119
Miscellaneous Hazardous Cargo	951
Manufactures of Iron and Steel	620
Lumber and Products	571
Animal / Vegetable Oils and Fats	340
Minerals, miscellaneous	127
Canned and Refrigerated Foods	91
<b>Grand Total</b>	<b>124,611</b>

Source: Panama Canal Authority<sup>99</sup>

<sup>99</sup> Panama Canal Authority, "Transit Statistics."



<b>Commodities</b>	<b>Pacific to Atlantic</b>
Container Cargo	22,601
Ores and Metals	9,192
Minerals, miscellaneous	6,912
Petroleum and Petroleum Products	6,904
Grains	5,018
Manufactures of Iron and Steel	4,603
Chemicals and Petroleum Chemicals	3,940
Machinery and Equipment	3,521
Miscellaneous	3,374
Nitrates, Phosphates and Potash	3,295
Canned and Refrigerated Foods	2,478
Animal / Vegetable Oils and Fats	2,230
Lumber and Products	1,889
Other Agricultural Commodities	1,746
Coal and Coke (excluding petroleum coke)	1,456
Unclassified	674
Miscellaneous Hazardous Cargo	264
<b>Grand Total</b>	<b>80,094</b>

Source: Panama Canal Authority<sup>100</sup>

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## TRADE ROUTES BETWEEN THE U.S. AND ASIA

There are three main trade routes for Northeast Asian goods to U.S. markets<sup>101</sup>.

(1) Transpacific to the U.S. West Coast

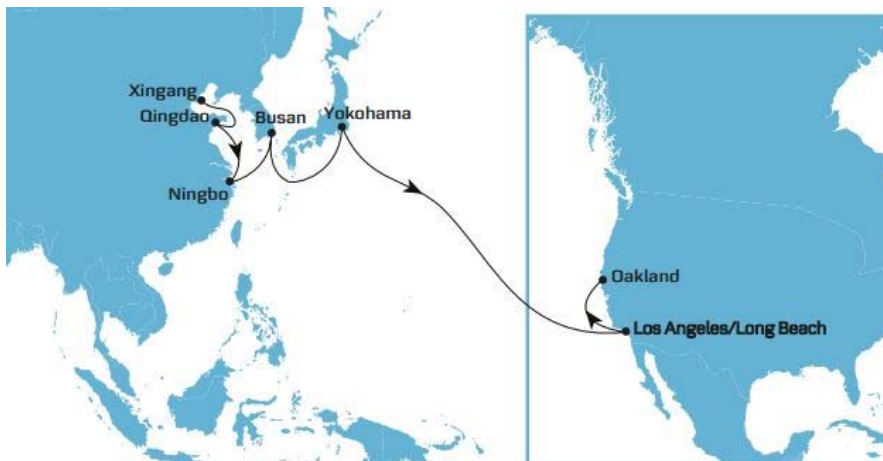
Example of Trade Route: Maersk's TP8 Eastbound

The Maersk Line TP8 route goes from Korean and Northern Chinese ports to Oakland, as seen in Figure 5. On its route, it calls upon Xingang, Qingdao, Ningbo, Busan, Yokohama, Los Angeles/Long Beach, and Oakland. The estimated transit time from Xingang to Los Angeles is 20 days.

<sup>100</sup> Panama Canal Authority, "Transit Statistics."

<sup>101</sup> U.S. Department of Transportation Maritime Administration, "Panama Canal Expansion Study."

**Figure 5: Maersk / TP8 Eastbound**



Source: Maersk Line<sup>102</sup>

(2) Transpacific to the U.S. East Coast via the Panama Canal

Example of Trade Route: CMA CGM’s Manhattan Bridge

The Manhattan Bridge operates on the Asia to North America East Coast route, as Figure 6 shows. The eastbound route starts from the Port of Qingdao and calls at Ningbo and Shanghai, before travelling through the Panama Canal to the port of New York. The transit time from central China to New York is about 29 days.

**Figure 6: CMA CGM / Manhattan Bridge**



Source: Oceanwide Logistics Global Network <sup>103</sup>

<sup>102</sup> Maersk Line, “TP8 Eastbound,” *Maersk Line*, accessed January 10, 2017, [http://www.maerskline.com/~media/maersk-line/routnet/east-west-network/20170213/TP8%20EASTBOUND\\_02022017.pdf](http://www.maerskline.com/~media/maersk-line/routnet/east-west-network/20170213/TP8%20EASTBOUND_02022017.pdf)

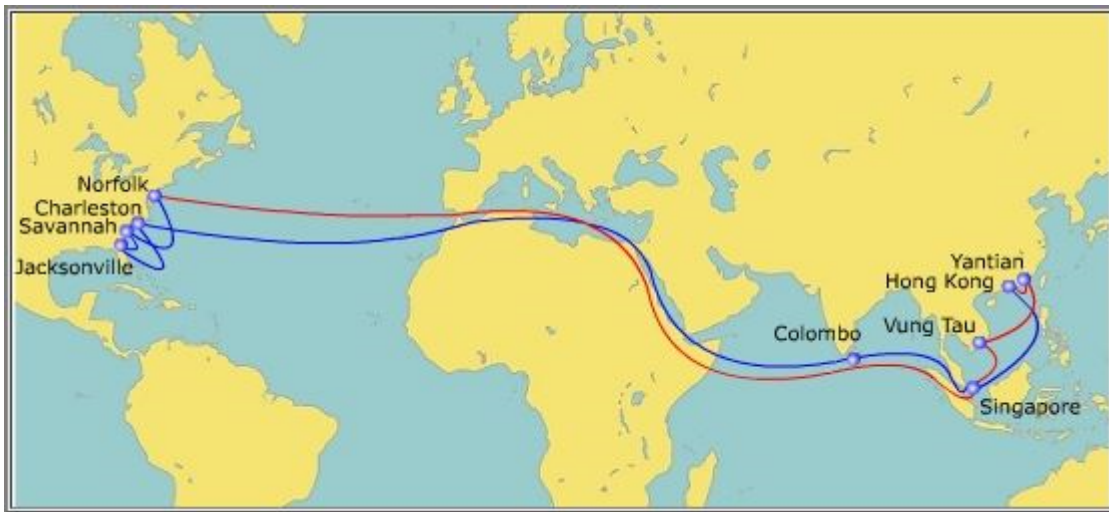
<sup>103</sup> Oceanwide Logistics Global Network, “CMA Relaunch of Manhattan Bridge Service,” *Oceanwide Logistics Global Network*, accessed January 10, 2017, <http://www.olgn.org/index.php/cma-relaunch-of-manhattan-bridge-service/>.

(3) Asia to U.S. East Coast via the Suez Canal

Example of Trade Route: Evergreen's AUE3

Evergreen Line's AUE3 connects major Asian ports to the U.S. East Coast via the Suez Canal. This service rotates through this series of ports: Hong Kong, Yantian, Singapore, Suez Canal, Algeciras, Norfolk, Savannah, Jacksonville, Charleston, Algeciras, Suez Canal, Singapore, Cai Mep, Hong Kong (as Figure 7 depicts). It takes roughly 31 days from Hong Kong to Norfolk.

**Figure 7: Evergreen / AUE3**



Source: Shipment Link<sup>104</sup>

EFFECT ON ASIA – US TRADE ROUTES AFTER PANAMA CANAL EXPANSION

The cheapest route to send goods from Northeast Asia to the U.S. East Coast is via the Panama Canal. However, the Panama Canal lost its main market in recent years because of capacity constraints and long wait times.<sup>105</sup> Global shipping companies therefore rerouted their services through the Suez Canal or began using the intermodal option. Thus, to win back their credibility, the Panama Canal Authority started the Panama Canal Expansion project in 2006. After almost 10 years of construction, the Panama Canal doubled its capacity to allow for the passage of larger ships. While the old locks could accommodate Panamax ships of up to 5,000 TEUs, the new locks can hold Neopanamax vessels of about 14,000 TEUs.<sup>106</sup> Thus, the majority of the current global fleet can now fit through the Panama Canal.

Due to the extensive expansion project, East and Gulf Coast ports are anticipating a great increase in Asia–U.S. shipments via the Panama Canal. Hence, they are now frantically upgrading their port facilities to face the upcoming demand. Many consultants also predict the Panama Canal expansion will have a positive impact on the U.S. East Coast. A report from the

<sup>104</sup> Shipment Link, "Routing Network: Asia-U.S. East Coast Service-3(AUE3)," *Shipment Link*, accessed January 11, 2017, [http://www.shipmentlink.com/tvs2/jsp/TVS2\\_ServiceProfile.jsp?line=AUE3&segment=W](http://www.shipmentlink.com/tvs2/jsp/TVS2_ServiceProfile.jsp?line=AUE3&segment=W).

<sup>105</sup> Webster, "Redrawing Global Shipping Routes: The Panama Canal Gets an Upgrade."

<sup>106</sup> Port Technology, "Maersk Line in New Panama Canal Strategy," June 27, 2016, accessed January 03, 2017, <https://www.porttechnology.org/news/maersk-line-in-new-panama-canal-strategy>.

Boston Consulting Group and C.H. Robinson estimates that around 10 percent of all cargo volume will shift from the West Coast to the East Coast by 2020.<sup>107</sup>

In addition to U.S. East Coast ports, global carriers also responded immediately to this lucrative opportunity. According to the Journal of Commerce, “four from the CKYHE Alliance and two from the G6 Alliance have announced enhanced Asia-U.S. East Coast services using more than 50 ships with capacities of 6,000 TEUs to 10,000 TEUs.”<sup>108</sup>

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#### EXAMPLE OF NEW TRADE ROUTE: MAERSK

In the three years prior to the Panama Canal expansion, Maersk Line, one of the world’s largest container carriers, gave up on the Panama Canal and began using the Suez Canal to transport goods from Asia to the U.S. East Coast<sup>109</sup>. However, they changed their policy right after the opening of the expanded Panama Canal. In July 2016, Maersk announced they would reroute their TP12 service through the new locks of the Panama Canal<sup>110</sup> with ships having a capacity of 8,500 TEUs.<sup>111</sup> TP12 starts in Hong Kong and stops in Chiwan, Yantian, Ningbo, Shanghai and Busan, before travelling to Newark, Baltimore, and Norfolk via the Panama Canal (as Figure 8 shows).

On February 13, 2017, Maersk announced another new service in the Asia-U.S. trade route via the Panama Canal: TP16. According to the company, travelling through the Panama Canals reduces the transit time from China to the U.S. East Coast by eight days. The new service starts in Hong Kong and ends in Miami, calling Yantian, Shanghai, Busan, Savannah, Norfolk and Charleston<sup>112</sup> (see Figure 9).

Although there haven’t been any prominent shifts in global shipping in the first few months after the opening of the third set of locks, it is expected that the Panama Canal expansion will have a significant effect on U.S. trade lanes in the long term.

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<sup>107</sup> Nerijus Poskus, “The Panama Canal is Getting Wider: Here’s What It Means for American Commerce,” *Flexport*, accessed January 02, 2017, <https://www.flexport.com/blog/panama-canal-expansion/>.

<sup>108</sup> Bonney, Panama Canal expansion will affect shipping – but how?”

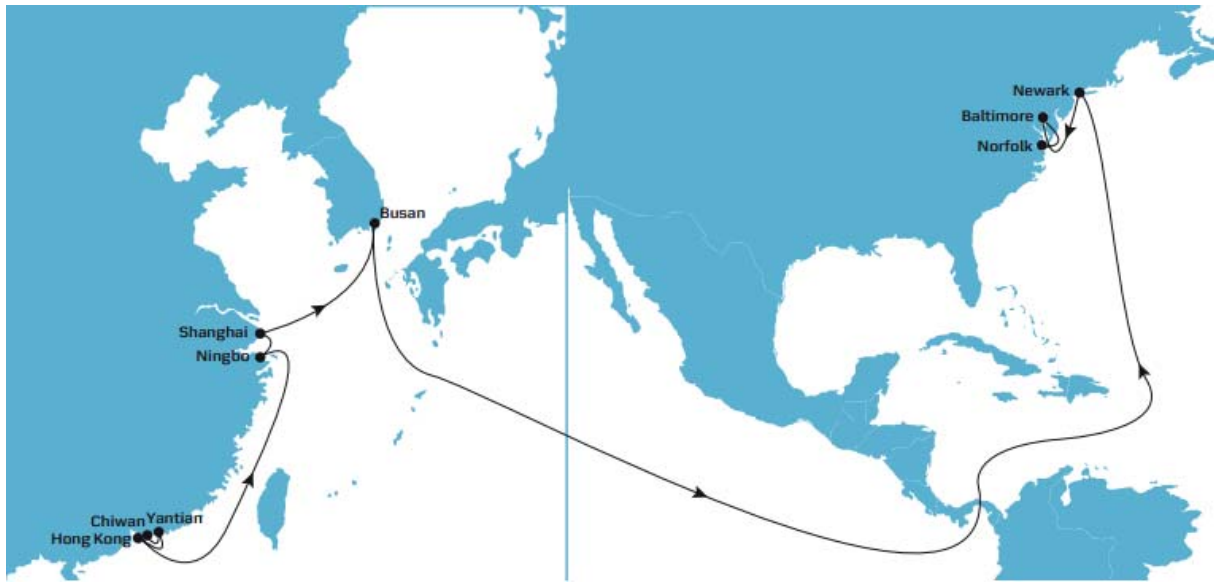
<sup>109</sup> Kyunghee Park, “Maersk Line to Dump Panama Canal for Suez as Ships Get Bigger,” *Bloomberg*, March 11, 2013, accessed January 12, 2017, <https://www.bloomberg.com/news/articles/2013-03-11/maersk-line-to-dump-panama-canal-for-suez-as-ships-get-bigger>.

<sup>110</sup> Gordon Smith, “Maersk Line change its TP12 service through Panama Canal,” *Maritime Herald*, August 03, 2016, accessed January 19, 2017, <http://www.maritimeherald.com/2016/maersk-line-change-its-tp12-service-through-panama-canal/>.

<sup>111</sup> Chris Dupin, “Maersk, MSC to reroute Asia-U.S. East Coast service through Panama Canal,” *American Shipper*, 21 July, 2016, accessed January 10, 2017, <http://www.americanshipper.com/main/news/maersk-msc-to-reroute-asiaus-east-coast-service-th-64749.aspx>.

<sup>112</sup> Maersk Line, “Maersk Line enhances Asia-Europe and Transpacific services,” *Maersk Line*, February 13, 2017, accessed February 25, 2017, <http://www.maerskline.com/da-dk/countries/int/news/news-articles/2017/02/maersk-line-enhances-ae-and-tp-services>.

**Figure 8: Maersk / TP12 Eastbound**



Source: Maersk Line <sup>113</sup>

**Figure 9: Maersk / TP16 Eastbound**



Source: Maersk Line <sup>114</sup>

<sup>113</sup> Maersk Line, "Routenet." *Maersk Line*. Accessed February 24, 2017. <http://www.maerskline.com/da-dk/shipping-services/routenet/maersk-line-network/east-west-network>.

<sup>114</sup> Maersk Line, "Routenet."

## IMPORTANCE FOR TEXAS

The recent Panama Canal expansion will have positive effects on the Texas economy. The main benefits will be in the export markets, since none of the Texas ports except for Houston are currently able to receive the largest Neopanamax vessels. Texas is the leading goods export state in the United States, and its ports handle about 19 percent of U.S. port tonnage, which translates into 564 million tons of cargo per year.<sup>115</sup> Thus, Texas may benefit from the expanded Panama Canal through increased exports in liquid bulk, dry bulk, general cargo, break bulk cargo, and containers. Specific commodities that might be increasingly exported from Texas through the Panama Canal are petrochemical and chemical products, military cargo, agricultural produce, coal, value added manufacturing products, paper products, and consumer goods.<sup>116</sup>

However, the industries most likely to benefit from the new canal are LNG and LPG. One reason for this is that the expanded Panama Canal allows for the passage of larger ships, which allows producers to save transportation costs through economies of scale. Another reason is that the Panama Canal expansion coincided with the U.S. shale boom that significantly increased Texas natural gas production. Cheap natural gas is an important component in the production of LNG and LPG. Several major oil- and gas-refining facilities are located along the Texas Gulf Coast, and petrochemical and petroleum products constitute the main export commodities for Texas ports.<sup>117</sup>

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## LIQUEFIED NATURAL GAS

In recent years, oil and gas exploration, extraction, and refining activities in Texas have increased significantly due to improved drilling technology. Horizontal drilling and hydraulic fracturing (fracking) explore tight shale fields in quantities large enough to make the effort profitable. As of today, Texas is the leading U.S. state in natural gas production. More than 25 percent of America's proved natural gas reserves, as well as over 50 percent of the 100 largest natural gas-producing fields in the U.S. are located in Texas.<sup>118</sup> In 2014, Texas had about 98,279 producing natural gas wells and 37 active natural gas storage facilities, which is among the highest in the country.<sup>119</sup>

Since 2004, natural gas marketed production levels in Texas have been steadily rising due to higher natural gas prices and advanced horizontal drilling and fracking technologies (Figure 10). In 2014, production levels reached 7.95 trillion cubic feet, before slightly dropping in the following two years due to lower natural gas prices.<sup>120</sup>

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<sup>115</sup> Panama Canal Stakeholder Working Group, "Preparing Texas Land and Sea for the Panama Canal expansion," *Panama Canal Stakeholder Working Group*, November 2012, accessed January 13, 2017, [https://ftp.dot.state.tx.us/pub/txdot-info/panama/final\\_report.pdf](https://ftp.dot.state.tx.us/pub/txdot-info/panama/final_report.pdf).

<sup>116</sup> Panama Canal Stakeholder Working Group, "Preparing Texas Land and Sea for the Panama Canal expansion."

<sup>117</sup> Panama Canal Stakeholder Working Group, "Preparing Texas Land and Sea for the Panama Canal expansion."

<sup>118</sup> U.S. Energy Information Administration, "Natural Gas," *U.S. Energy Information Administration*, accessed February 04, 2017, <https://www.eia.gov/dnav/ng/hist/n9050tx2a.htm>.

<sup>119</sup> Jolanda Prozzi and Megan Kenney, "Moving Texas Exports: Examining the role of transportation in export commodity supply chains: Executive Summary," *Texas A&M Transportation Institute*, March 2016, accessed February 10, 2017, <http://d2dtl5nnlpfror.cloudfront.net/tti.tamu.edu/documents/TTI-2016-1.pdf>.

<sup>120</sup> U.S. Energy Information Administration, "Texas State Profile and Energy Estimates," *U.S. Energy Information Administration*, accessed February 04, 2017, <https://www.eia.gov/state/analysis.php?sid=TX>.



**Figure 10: Texas Natural Gas Marketed Production**



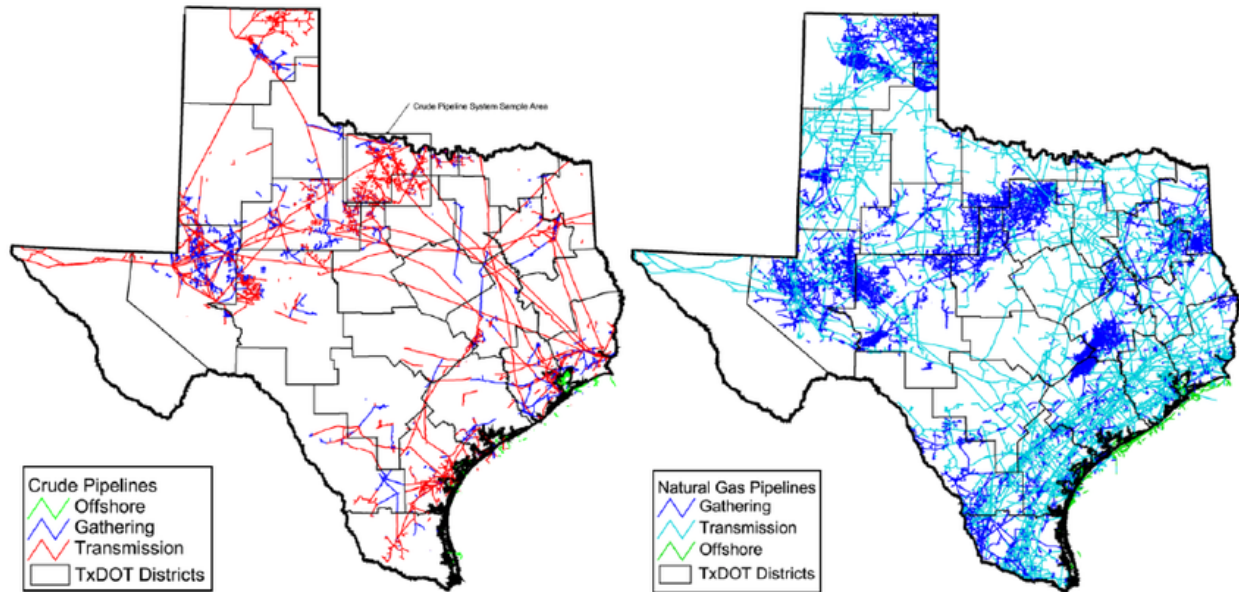
Source: U.S. Energy Information Administration <sup>121</sup>

Texas has a very extensive system of natural gas pipelines (Figure 11) and is home to the most natural gas market hubs, which are areas of exchange and commerce along the state’s pipeline network. The three largest natural gas market hubs in the state are located in Carthage, Henry, and Egan.<sup>122</sup>

<sup>121</sup> U.S. Energy Information Administration, “Natural Gas.”

<sup>122</sup> Prozzi and Kenney, “Moving Texas Exports.”

**Figure 11: Texas Pipelines: Crude and Natural Gas**



Source: Texas A&M Transportation Institute<sup>123</sup>

Part of the natural gas produced in Texas is converted into LNG. LNG is created when natural gas (primarily methane) is reduced to a temperature of -260 Fahrenheit at atmospheric pressure. Texas is well positioned to increase LNG exports due to its extensive natural gas network. Currently, Texas has two LNG import terminals along its Gulf Coast: one in Freeport and one in Sabine Pass. Both import terminals are developing LNG export capability, and further export terminals are planned or under construction. Currently, there are two LNG export terminals under construction in Texas: Freeport LNG’s terminal in Freeport, and a Cheniere project in Corpus Christi (Figure 12). The Freeport liquefaction and export terminal has three trains under construction that permit the export of 1.8 billion cubic feet (Bcf) of LNG per day. The first two trains are scheduled to start operating in 2019, while the third train will begin service in 2020. The Corpus Christi terminal will have a total permitted capacity of 2.14 Bcf per day and is expected to be operational in 2018.<sup>124</sup>

<sup>123</sup> Ibid.

<sup>124</sup> U.S. Energy Information Administration, “Texas State Profile and Energy Estimates.”

**Figure 12: LNG export terminals along the U.S. Gulf of Mexico**



Source: U.S. Energy Information Administration <sup>125</sup>

Currently, the only U.S. terminal that ships shale gas overseas is Cheniere Energy Inc.'s Sabine Pass terminal in Louisiana. Asia is the biggest buyer of U.S. LNG, followed by Latin America. For instance, in December 2016, 10 out of the 12 LNG tankers that left Sabine Pass terminal were headed for Asian countries. It is expected that LNG vessels carrying U.S. LNG to Asia will account for approximately 20 percent of cargo by volume passing through the Panama Canal by 2020.<sup>126</sup>

The booming Texas LNG market is likely to benefit from the expanded Panama Canal due to shorter transit times and toll incentives. While only about 6 percent of the global LNG fleet could fit through the original Panama Canal, the new locks can accommodate 90 percent of the world's LNG vessels.<sup>127</sup> In terms of capacity, the new locks allow for the passage of vessels with an LNG-carrying capacity of up to 3.9 Bcf, compared to a maximum of 0.7 Bcf for the old locks.<sup>128</sup> Therefore, the expanded Panama Canal significantly reduces travel time (Figure 13) and transportation costs for LNG carriers from the U.S. Gulf Coast to its main Asian import markets.

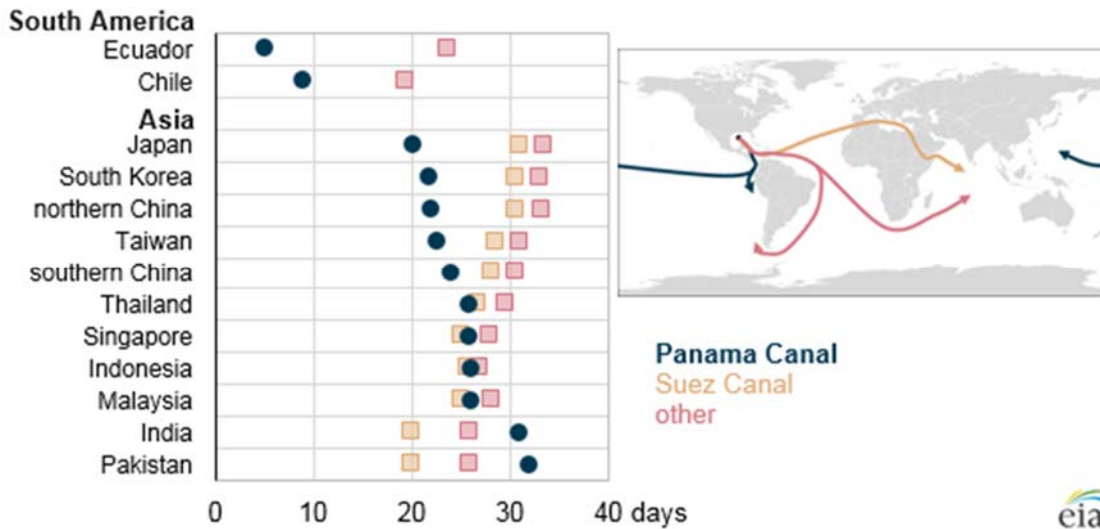
<sup>125</sup> U.S. Energy Information Administration, "Growth in domestic natural gas production leads to development of LNG export terminals," *U.S. Energy Information Administration*, March 4, 2016, accessed February 07, 2017, <https://www.eia.gov/todayinenergy/detail.php?id=25232>.

<sup>126</sup> Ryan Collins, "Forget Latin America, Asia is the Biggest U.S. LNG Buyer Now," *Bloomberg*, January 3, 2017, accessed February 19, 2017, <https://www.bloomberg.com/news/articles/2017-01-03/asia-becoming-destination-of-choice-for-u-s-lng-exports>.

<sup>127</sup> Dupin, "Panama Canal's Transit to the Future."

<sup>128</sup> U.S. Energy Information Administration, "Expanded Panama Canal reduces travel time for shipments of U.S. LNG to Asian markets," *U.S. Energy Information Administration*, June 30, 2016, accessed February 12, 2017, <https://www.eia.gov/todayinenergy/detail.php?id=26892>.

**Figure 13: Approximate voyage time from U.S. Gulf Coast through Panama Canal or other routes**



Source: U.S. Energy Information Administration <sup>129</sup>

Note: Calculations assume export from the Sabine Pass liquefaction terminal at an average LNG Carrier speed of 19.5 knots and one-day transit time through the Panama and Suez Canals.

The four northern Asian countries of Japan, South Korea, China, and Taiwan collectively make up almost two-thirds of global LNG imports. For instance, a typical trip from Sabine Pass to Japan will take 20 days through the Panama Canal, compared to 31 days through the Suez Canal and 34 days for the route around the southern tip of Africa. The route through the expanded Panama Canal will also significantly reduce transit times for LNG vessels travelling from the U.S. Gulf Coast to South America. For example, the trip to Chile’s regasification terminals will be reduced from 20 days to 8 or 9 days, while the voyage to prospective terminals in Colombia and Ecuador will take 5 days instead of 25 days.

A further advantage for the Texas LNG sector are the new Panama Canal toll structures, which greatly reduce transportation costs for LNG carriers travelling from the U.S. Gulf Coast to northern Asia. It is estimated that the round-trip costs for LNG vessels between the U.S. Gulf Coast and northern Asia using the Panama Canal are between \$0.30/MMBtu (per million British thermal units) and \$0.80/MMBtu lower than traveling through the Suez Canal, and about \$0.20/MMBtu to \$0.70/MMBtu lower compared to the trip around the southern tip of Africa.<sup>130</sup>

Factors that could potentially limit Texas from taking full advantage of the expanded Panama Canal are inadequate pipeline infrastructure and LNG tanker shortages. The state’s vast natural gas pipeline network may still be inadequate for serving the increased demand, particularly to Texas ports. Resulting bottlenecks could add costs to the LNG supply chain and raise the price of exports. Moreover, industry experts warn that shortages in the LNG fleet, such as inadequate ship capacity, could make it difficult for Texas to successfully handle expected increases in LNG exports from its Gulf Ports.<sup>131</sup>

<sup>129</sup> U.S. Energy Information Administration, “Expanded Panama Canal reduces travel time for shipments of U.S. LNG to Asian markets.”

<sup>130</sup> Ibid.

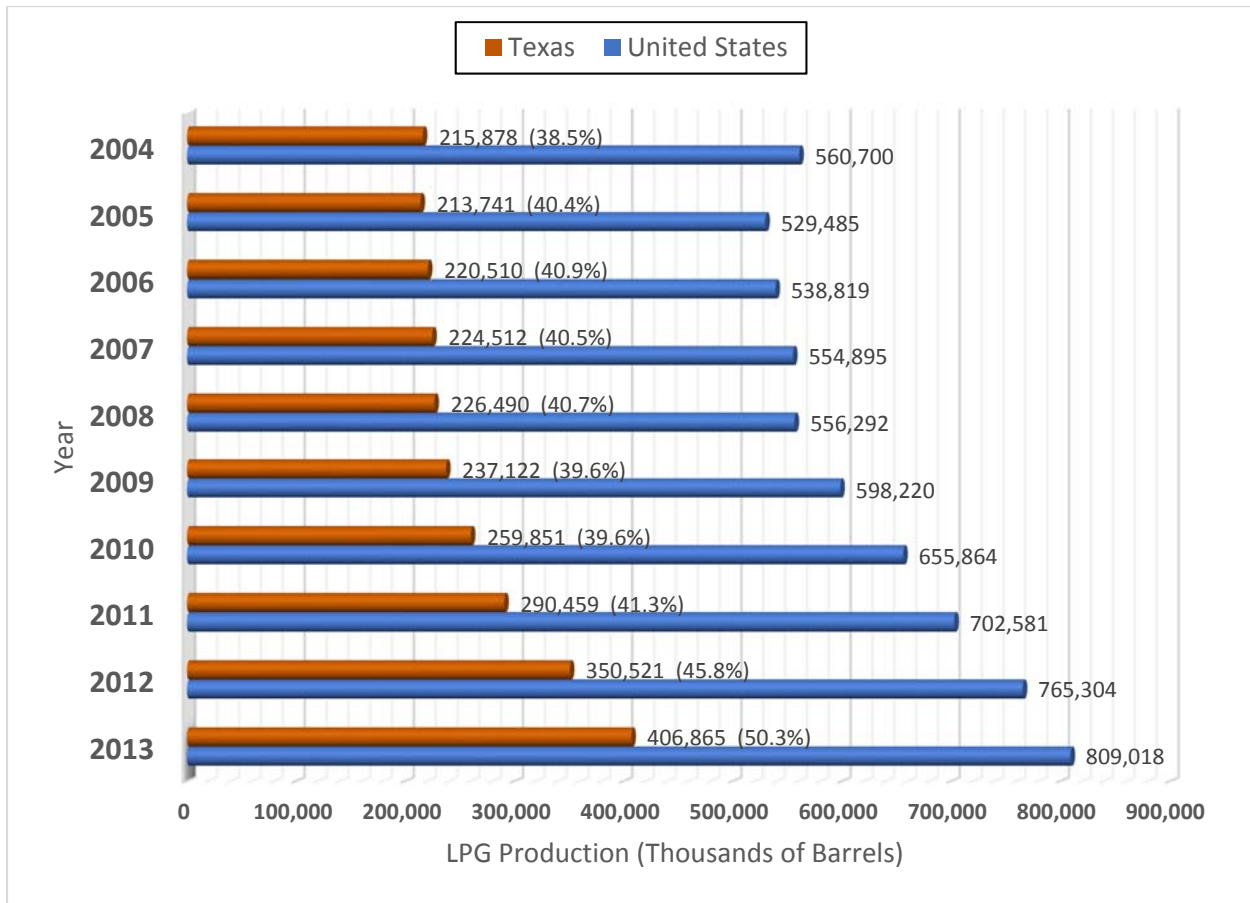
<sup>131</sup> Prozzi and Kenney, “Moving Texas Exports.”

LIQUEFIED PETROLEUM GAS

A further industry that is likely to benefit from the Panama Canal expansion are Texas LPG exports. LPGs are hydrocarbon gases, mainly propane and butane, which are derived from natural gas processing or crude oil refining. LPG is used for heating, cooking, and fuel for automobiles and buses. In addition, the hydrocarbon gases are an important feedstock for the petrochemical industry. Unlike LNG, which has to be cooled down to minus 162 degrees Celsius, LPG is easily converted to its liquid form.<sup>132</sup> Thus, LPG can be transported in lightly pressurized tankers and does not require any expensive liquefaction and regasification facilities. The global LPG market is about 30 percent larger than the market for LNG.<sup>133</sup>

The shale revolution led to an increase in U.S. natural gas production, including the process that extracts LPG from natural gas. Between 2004 and 2013, U.S. LPG production has risen 31 percent, while Texas LPG production saw a 47-percent increase in the same time period (Figure 14). Since 2013, Texas produces slightly more than half of the nation’s LPG.<sup>134</sup>

**Figure 14: LPG Production from Natural Gas Processing**



Source: Texas Comptroller<sup>135</sup>

<sup>132</sup> Jack O’Connell, “The Other Gas,” *The Maritime Executive*, November 25, 2014, accessed February 05, 2017, <http://www.maritime-executive.com/magazine/The-Other-Gas-2014-11-25>.

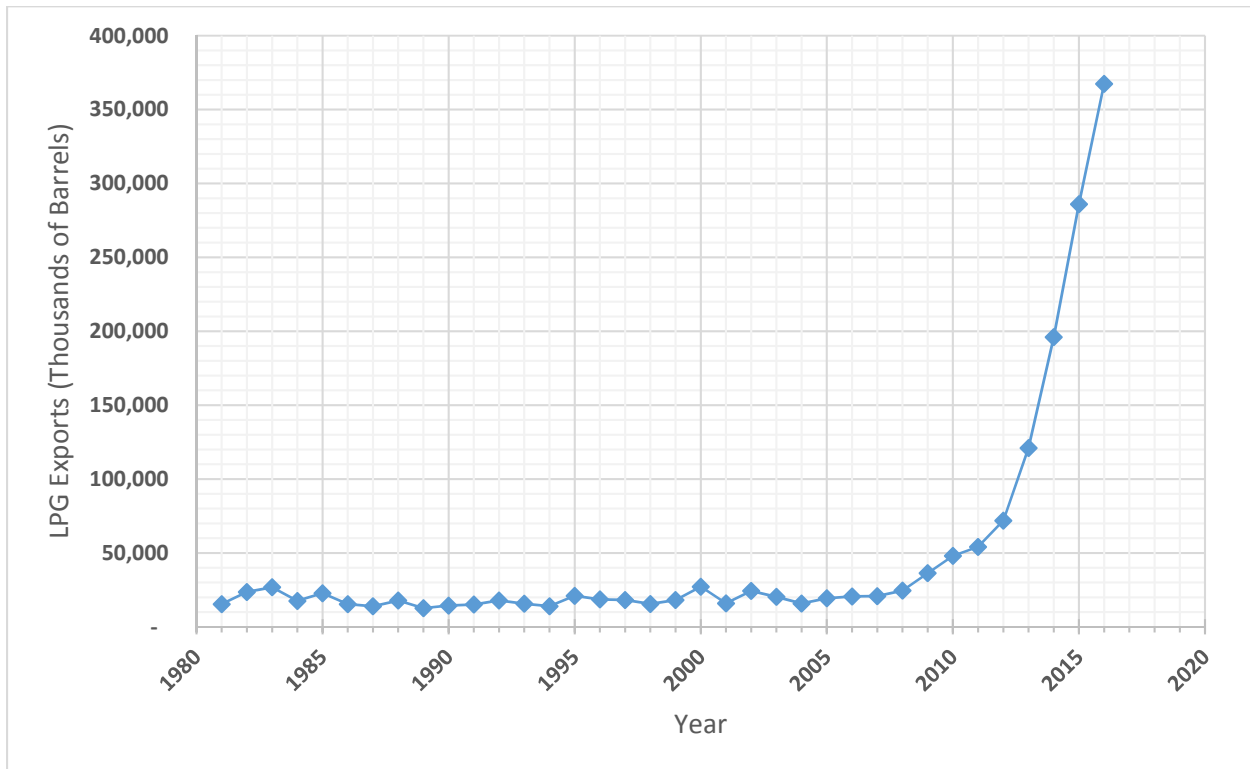
<sup>133</sup> O’Connell, “The Other Gas.”

<sup>134</sup> Mulverhill, “Fueling the World: Shale Production Lifts LPG Exports.”

<sup>135</sup> Lauren Mulverhill, “Fueling the World: Shale Production Lifts LPG Exports,” *Texas Comptroller*.

In 2012, the United States became a net exporter of LPG for the first time in history. Between 2008 and 2013, U.S. LPG exports increased by 395 percent, while exports from the Gulf Coast region rose by 642 percent during the same time (Figure 15). LPG exports from Texas are increasing dramatically as well. For example, in 2013, Texas LPG exports increased by 86 percent.<sup>136</sup>

**Figure 15: United States Annual LPG Exports**



Source: U.S. Energy Information Administration<sup>137</sup>

The demand for U.S. LPG is rising steadily. LPG is already the most important domestic energy fuel in the Caribbean, Latin America and most of Asia.<sup>138</sup> The main usage for LPG in Asia and South America is as a cooking and heating fuel.<sup>139</sup> However, LPG demand from Europe is also strong. The top five export destinations for U.S. LPG are Mexico, the Netherlands, Japan, Canada, and the Dominican Republic (Figure 16).

<sup>136</sup> Ibid.

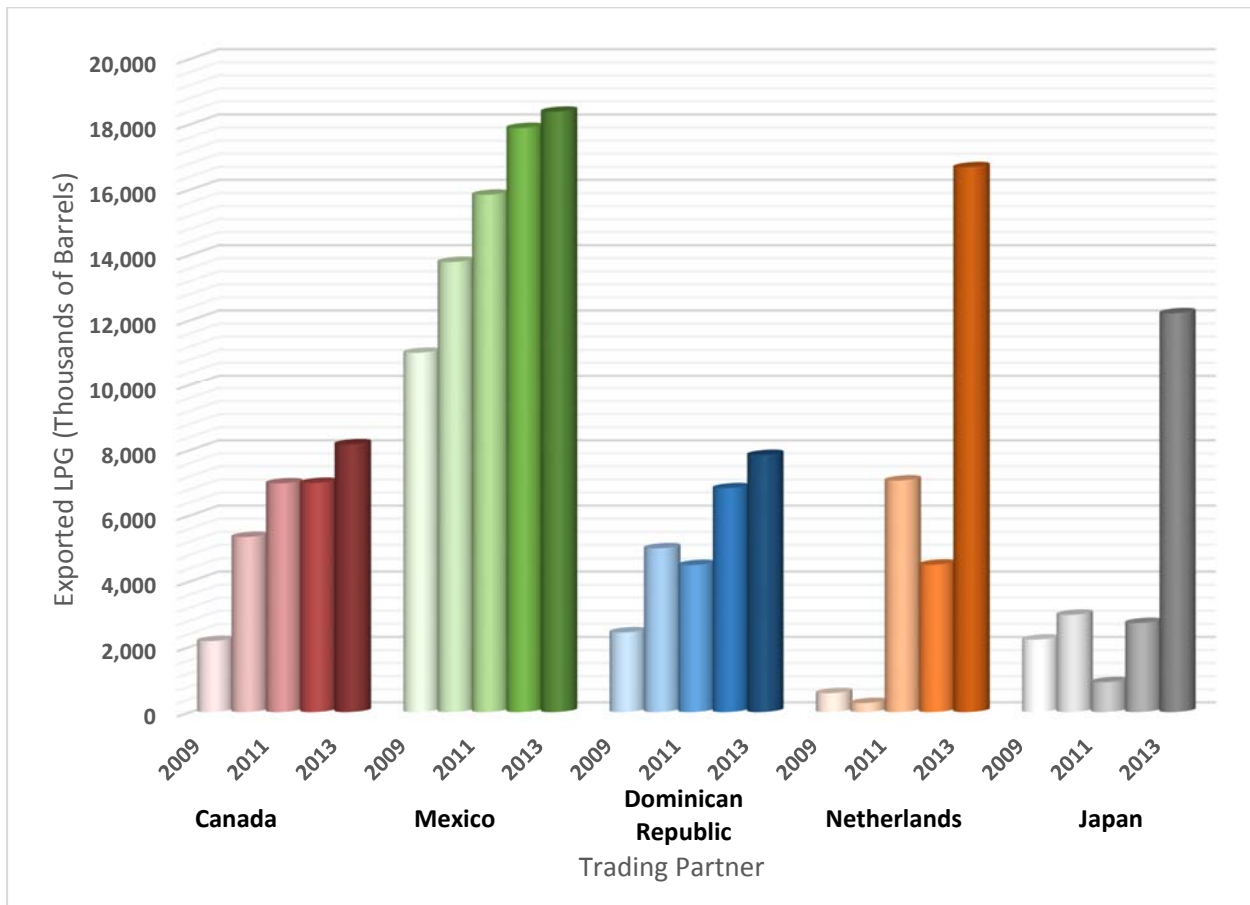
<sup>137</sup> U.S. Energy Information Administration, “Petroleum and other Liquids,” *U.S. Energy Information Administration*, accessed February 09, 2017, [https://www.eia.gov/dnav/pet/pet\\_move\\_expc\\_dc\\_NUS-Zoo\\_mbb1\\_a.htm](https://www.eia.gov/dnav/pet/pet_move_expc_dc_NUS-Zoo_mbb1_a.htm).

<sup>138</sup> Mulverhill, “Fueling the World: Shale Production Lifts LPG Exports.”

<sup>139</sup> O’Connell, “The Other Gas.”



**Figure 16: Largest Export Destinations for U.S. LPG, 2009-2013**



Source: Texas Comptroller <sup>140</sup>

The increase in LPG exports led to the expansion of existing export terminals, as well as the construction of new export facilities along the Texas Gulf Coast.<sup>141</sup>

The Texas LPG export industry is likely to benefit from the Panama Canal expansion due to reductions in transit time and costs. While only about 35 percent of the global LPG fleet was able to pass through the old Panama Canal, the new locks can accommodate most of the very large gas carriers, which can transport over 500,000 barrels of LPG.<sup>142</sup> Prior to the opening of the third set of locks, these large LPG carriers had to travel around Cape Horn or offload their cargo onto smaller ships. The fact that only small LPG vessels could pass through the original Panama Canal created logistical bottlenecks for U.S. propane exports to Asia, which often required shippers to do ship-to-ship transfers.<sup>143</sup> The practice of ship-to-ship transfers should be greatly reduced, if not eliminated, thanks to the expanded locks. Moreover, allowing large LPG carriers to pass through the Panama Canal, instead of traveling around Cape Horn, decreases the transit time for LPG vessels from the U.S. Gulf Coast to Asia by over two weeks.<sup>144</sup> This

<sup>140</sup> Mulverhill, “Fueling the World: Shale Production Lifts LPG Exports.”

<sup>141</sup> Ibid.

<sup>142</sup> O’Connell, “The Other Gas.”

<sup>143</sup> U.S. Energy Information Administration, “Panama Canal expansion unlikely to significantly change crude oil, petroleum product flows.”

<sup>144</sup> O’Connell, “The other Gas.”

shortened transit time will reduce shipping costs for the U.S. Gulf Coast to Asia route by 50 percent, which will make transit costs similar to those between the Middle East and Asia.<sup>145</sup>

## CONCLUSION

In 2007, the Panama Canal Authority approved a \$5.4 billion expansion project in order to address capacity constraints and long wait times that affected the canal's competitiveness. The new set of locks doubled the Panama Canal's capacity and allowed for the transit of Neopanamax ships that carry up to 14,000 TEUs. Meanwhile, Panama's main competitor, the Suez Canal, completed its own expansion project, which included adding a third lane to allow for two-way traffic for the first time. While both canals improved their services and added new incentives for shipping companies, the tide seems to be turning in favor of the Panama Canal. Since the new locks can accommodate larger Neopanamax vessels, shippers can take advantage of economies of scale while saving cost and time by using the shorter Panama Canal route on their way from Asia to the U.S. East Coast. Several big shipping companies, including Maersk, have already started rerouting some of their Asia-U.S. East Coast services through the Panama Canal. In Texas, the Panama Canal expansion is expected to have positive effects on the LNG and LPG export industries, since about 90 percent of the global LNG fleet and most LPG carriers are able to use the new set of locks.

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<sup>145</sup> Ibid.

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