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Liquefied Natural Gas Phase III: Export Competition in a Well Supplied, Flow-Shifting Global Economy

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ABSTRACT

With trillions of cubic feet of shale reserves, the United States' (U.S.) abundance of natural gas has prompted an increase in production of Liquefied Natural Gas (LNG) as an export commodity. While the Trump administration has taken strides to loosen policy set by the Federal Energy Regulatory Commission (FERC) in order to streamline U.S. LNG export facility permitting, UNOTI has reasoned that policies focused too heavily on LNG as an export is misguided. A more robust energy policy acknowledges the higher value of natural gas to the petrochemical manufacturing industries as well as the development and commercialization of new LNG technologies in the maritime industry, particularly as a marine fuel. Furthermore, U.S. energy independence fueled by shale mining will alter how the U.S. acts in the global market place, thereby destabilizing the system in place since the Bretton Woods Agreement in 1944. However, competing natural gas rich nations like Australia, Qatar, and Russia have similar goals to expand production indicating U.S. LNG export growth will not be without competition. In addition to potential increases in U.S. LNG exports and what this implies for global markets, this paper discusses current transportation developments in LNG powered marine vessel refueling technology allowing for waterside refueling as an alternative to shore side bunkering, as well as an overview of what increased U.S. shale frac'ing and LNG export implies for U.S. roadway infrastructure and how short sea shipping may provide an alternative to trucking and rail movements.

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PROJECT DESCRIPTION

The world's current abundance in natural gas reserves has prompted an expanding production of Liquefied Natural Gas (LNG) as an export commodity among the top producing nations of Australia, Qatar, Russia, and the United States (U.S.) with its estimated 862 trillion cubic feet (tcf) of natural gas reserves (KPMG Global Energy Institute, 2017). Beginning in 2018, the Trump administration took steps to streamline U.S. LNG export facility permitting by revising Federal Energy Regulatory Commission (FERC) policy. The combination of vast U.S. shale reserves and new policies have led to expedited permitting for the construction of new LNG export facilities. In addition, the expansion of the Panama Canal now accommodates larger vessels which uniquely positions the U.S. as a net exporter of energy for the first time in decades.

Energy analysts at the International Energy Agency (IEA) predict that by 2022 the U.S. will be challenging Australia and Qatar as the leader in global LNG exports (International Energy Agency, 2017). Most recently in June of 2018, Qatar Petroleum announced its plans to move forward with increasing its LNG output by 30% by 2023 (International Energy Agency, 2017) (Keefe, 2017). Thus, potential U.S. LNG exporters would be wise to continue to assess the feasibility of increasing the expansion of multi-billion-dollar processing and export infrastructure in a global LNG market that is forecasted to be well supplied.

Like the U.S., which is projected to have a total of six LNG liquefaction export facilities online by 2019 (Kiernan, 2017), Australia, Qatar, Russia, Iran, Azerbaijan and Turkmenistan all have plans underway to expand both piped natural gas infrastructure and LNG facility production to markets in Asia, India and Europe within the same timeframe (Ledesma, Palmer, & Henderson, 2014); (Sharifulin, 2016); (Farchy, 2016); (Afansasiev, 2016); (Khatinoglu, 2016); (Crooks, 2016); (Gurbanov, 2016). Due to the global oil and gas glut and resulting price collapse in 2014, these commodities have been holding steady at their deflated prices, so a key long-term challenge for U.S. LNG exporters will be their ability to secure traditional long-term LNG import contracts with existing and emerging economies at profitable rates.

Alternatives to LNG exporting include value-added manufacturing and U.S. LNG marine industrial developments. New LNG barge bunkering and waterside refueling technologies are emerging, spearheaded in the U.S. by marine vessel builder Conrad LNG. This is evidence of the growth to come in LNG as a marine fuel as we reach the 2020 deadline set by the International Maritime Organization (IMO) International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI convention for maritime vessel emissions reductions. Regardless, all these options will have significant effects on the U.S. transportation network. As we anticipate the increase of U.S. shale play production, we examine the implications of increased shale frac'ing on pipelines, short sea shipping (SSS) and the U.S. highway and road infrastructure.

METHODOLOGICAL APPROACH

This paper represents over two years of effort to understand what is happening in Louisiana, the United States, and the rest of the world as the result of Liquefied Natural Gas (LNG) in three categories: its use as a marine fuel; as an export commodity; and as an industrial feedstock, particularly for the chemical and fertilizer sectors. The following qualitative methods based on the specific research needs and time constraints were utilized for the study.

The first was participant-observation in the following:

- Active participation in the following: The World Trade Center of New Orleans' Transportation Committee; the Regional Planning Commission's Freight Transportation Roundtable; U.S.C.G. Sector New Orleans Local Area Committee
- Attendance at Center for Planning Excellence Policy (CPEX) Forum "Boom Without Bust"; May 2014.
- Onsite visits to LNG bunkering facility at Port Fourchon, LA; key person interviews with Harvey Gulf International Marine personnel
- Active participation in the New Orleans Port Safety Committee
- Attendance at the High Horse Power (HHP) Summit in October 2014 for the latest news of LNG facilities either being planned or under development at U.S. ports (Tacoma, Washington and Jacksonville, Florida)
- Participation in the Critical Commodities Conference in New Orleans April 7-9, 2015 to hear the latest LNG industry news and related perspectives such as the impact of the Panama Canal Expansion on LNG transport
- Numerous interviews with Chad Verret, point-person for Harvey Gulf Maritime International (HGMI) LNG bunkering station at Port Fourchon, LA and Executive VP for Alaska and LNG

- Interviews with senior staff at USDOT's Maritime Administration (Washington, DC) and MARAD's New Orleans' Gateway office
- Key person interviews with U.S.C.G. Sector New Orleans personnel regarding LNG as a marine fuel and the energy market

When using the method of participant observation, the observers used techniques modified from within the discipline of anthropology. For this project, the researchers utilized the urban ethnography– which includes ethnographic studies of businesses, corporations, and governments – as self-study of our own societal manifestations of cultural style.

Specifically, researchers utilized the practice known as "Participant-as-Observer" (Hesse-Biber, 2011), in which the senior researcher for this project, a well-known figure in the transportation planning community, had the option to modify his engagement with the participants throughout the study. In this method, the researcher is not a member of the group but is interested in participating in order to create a more complete understanding of the group's activities (Merriam, 1998). Using the Participant-as-Observer technique allows the researcher to observe events and situations informants describe in interviews to make the researcher aware of inaccuracies or bias in the information provided by the informant (Marshall & Rossman, 1995). This method was used to enhance the participation spectrum. In using this technique, the senior researcher's "observation role [was] secondary to [his] participant role" (Creswell, 2014).

Within the "participant as observer" technique, researchers also relied on open ended qualitative interviews. These interviews required researchers to ask questions "…based on a set of topics discussed in depth rather than…standardized questions" (Babbie, 2013). For this project, the researchers interviewed the following participants:

- Chad Verret, the director of Harvey Gulf Marine International's LNG-bunkered and fleet-operated facility at Harvey Gulf Maritime International in Port Fourchon, Louisiana

- Key staff at the Port of New Orleans regarding a potential LNG bunkering station
- U.S.C.G. officials regarding LNG bunkering permitting processes and recent history with the HGMI Port Fourchon LNG bunkering station as well as recently announced Mississippi River Export Terminals in Plaquemines, Parish (downriver of New Orleans)
- Senior staff members of Louisiana Economic Development (LED) regarding the statewide impact of LNG on industrial expansions or new-builds within the Lower Mississippi River and along the Calcasieu Ship Channel south of Lake Charles, LA
- Paul Aucoin, Executive Director of the Port of South Louisiana (PSL), on the impact of LNG as a feed stock on industrial expansions or new builds within the jurisdiction of the PSL

The strength of this approach is that it enables the researcher to become knowledgeable of those issues related to the topics under discussion which may provide an expanded context for analysis. As with participant observation, other researchers who sat down with these industry representatives to discuss the same topics would bring different knowledge bases to the interview. Therefore, topics which arose in the conversation experienced by these researchers as revelatory and indicative of directions for pursuing this research project might not surface at all for other researchers, who therefore might come to different conclusions.

The third method was an open-ended focus group interview with U.S.C.G. personnel from Sector New Orleans in order to determine the potential for LNG as a bunkered marine fuel at the Port of New Orleans. These are the U.S.C.G. personnel responsible for seeing that LNG bunkering at the Port of New Orleans proceeds in accordance with safety regulations. The primary advantage of the focus group method is that it puts the researcher in touch with the knowledge base of participants in the topic under study and allows participants to utilize one another to highlight important issues for the observer (Hesse-Biber, 2011). The open-ended nature of the interview facilitated the emergence of additional issues for consideration, thereby facilitating the direction of the research (Babbie, 2013).

The fourth and final aspect of the methodology consisted of a content analysis derived from the following components:

- Review of industry standards for LNG bunkering authored by various consultancies
- Review of all HHP whitepapers distributed post HHP 2014
- Review of all maritime industry web-based journal responses to the emergence of LNG as a marine fuel
- Daily review of key-word searches (LNG, marine fuels, maritime industry) and the compilation of related UNOTI library resources

In content analysis, the various materials fall within the domain of this research method (Babbie, 2013). The unit of analysis was all references to LNG as a marine fuel as well as its wider industrial applications. The unit of observation was all of the media listed above. This was not as thorough a content analysis as the potential application of the method allows for – coding of related groups of words as occurrences of repeated themes, combined with a statistical analysis of their frequency to determine their presumed significance to the group under study (or the phenomenon socially related to that group, i.e. LNG as the phenomenon and the maritime industry as the group (Colby, 1966)). Rather, in participation and conversation with the stakeholders outlined above, the researchers gained an overall sense that while the economic and environmental utility of LNG is well known in the industry, the current global energy climate precludes its use as a marine fuel pending regulatory intervention.

RESULTS/FINDINGS

Overview of Anticipated Effect of FERC Regulatory Changes

The Department of Energy Organization Act of 1977 (DOE Organization Act), headed by the Secretary of Energy, established the Office of Fossil Energy for authorizing exports of natural gas, including LNG. Section 3 of the Natural Gas Act (NGA) gives DOE authority over exports of U.S.-produced natural gas, including LNG. Section 3(c) of the NGA states that any U.S. natural gas exports to free trade associated countries that require "national treatment" are automatically considered in the public interest and applications to export gas meeting this criterion must be approved without modification or delay.

The Federal Energy Regulatory Commission (FERC) is an independent agency under DOE that regulates the interstate transmission of natural gas, oil and electricity. It also has authority over the permitting, construction and operation of LNG terminals and interstate natural gas pipelines. It is composed of five, five-year term commissioners including a Chairman, consisting of two Republicans and two Democrats, and the chairman shares the same party as the President. All five commissioners are appointed by the President and confirmed by the Senate. The Chairman presides over all commission actions regarding applications and rulemakings (Siciliano, 2017).

Because of expired terms and the February 2017 resignation of FERC Chairman Norman Bay (appointed under the Obama Administration), there was only one member on the commission (Democrat Cheryl LaFleur who was appointed on January 26 by Trump) available to replace Bay as interim Chairman. This left the commission without a quorum. Quorum is necessary to make final FERC decisions on regulations and permitting of LNG and natural gas pipeline projects (Traywick, 2017).

Over the course of several months in early 2017, President Trump nominated four new FERC commissioners including the new chairman. From there, President Trump nominated Neil Chatterjee, a long-time adviser to Senate Majority Leader Mitch McConnell (R-KY), Rob Powelson, a Pennsylvania utility commissioner and

strong supporter of natural-gas development, senate aide Richard Glick, general counsel to the Senate Energy and Natural Resources Committee, and co-head of Jones Day's global energy practice Kevin McIntyre, as FERC Chairman (St. John, 2016). Chatterjee has worked on major energy and environmental policy in the Senate. He led Senate Majority Leader McConnell's campaign to convince states to oppose the Clean Power Plan and worked to lift the ban on crude oil exports. Powelson has served on the Pennsylvania Public Utility Commission since 2008 and is known for his criticism of states that have proposed frac'ing bans (Traywick, 2017).

This major overhaul of FERC came at a critical tipping point in the global LNG market. Federal lawmakers and industry groups alike had urged Trump to fill the four vacancies because lacking commission quorum delayed a potentially massive expansion of the U.S. gas pipeline network brought on by the shale boom, which in turn affects decision making by perspective LNG export companies.

During the 2017 spring Congressional session, legislation was proposed to expedite FERC authorization of pipeline and LNG facilities, but was rejected. This gave rise to continued frustrations by gas, pipeline and LNG company initiatives in terms of the existing FERC permitting regulations. The new FERC nominations and senate confirmations, in context with Trump's executive order with respect to "high priority" infrastructure projects, has now made possible new streamlined FERC authorizations for natural gas pipelines and LNG terminals to be permitted with much more haste. Two of these high priority projects, the Atlantic Coast Pipeline and the Alaska LNG Project, are currently under review by FERC, as reported by media conglomerate McClatchy. This comes after Trump criticized the Obama era FERC's denial to authorize the Jordan Cove LNG project (Magill, 2017).

At one point, at least $50 billion worth of project applications sat in limbo before the commission (DiSavino, After six decades, U.S. set to turn natgas exporter amid LNG boom, 2017). In Louisiana alone, there is an

estimated $90 billion worth of LNG projects currently operating, under construction, or proposed/in FERC pre-filing. (Figures 1 & 2).

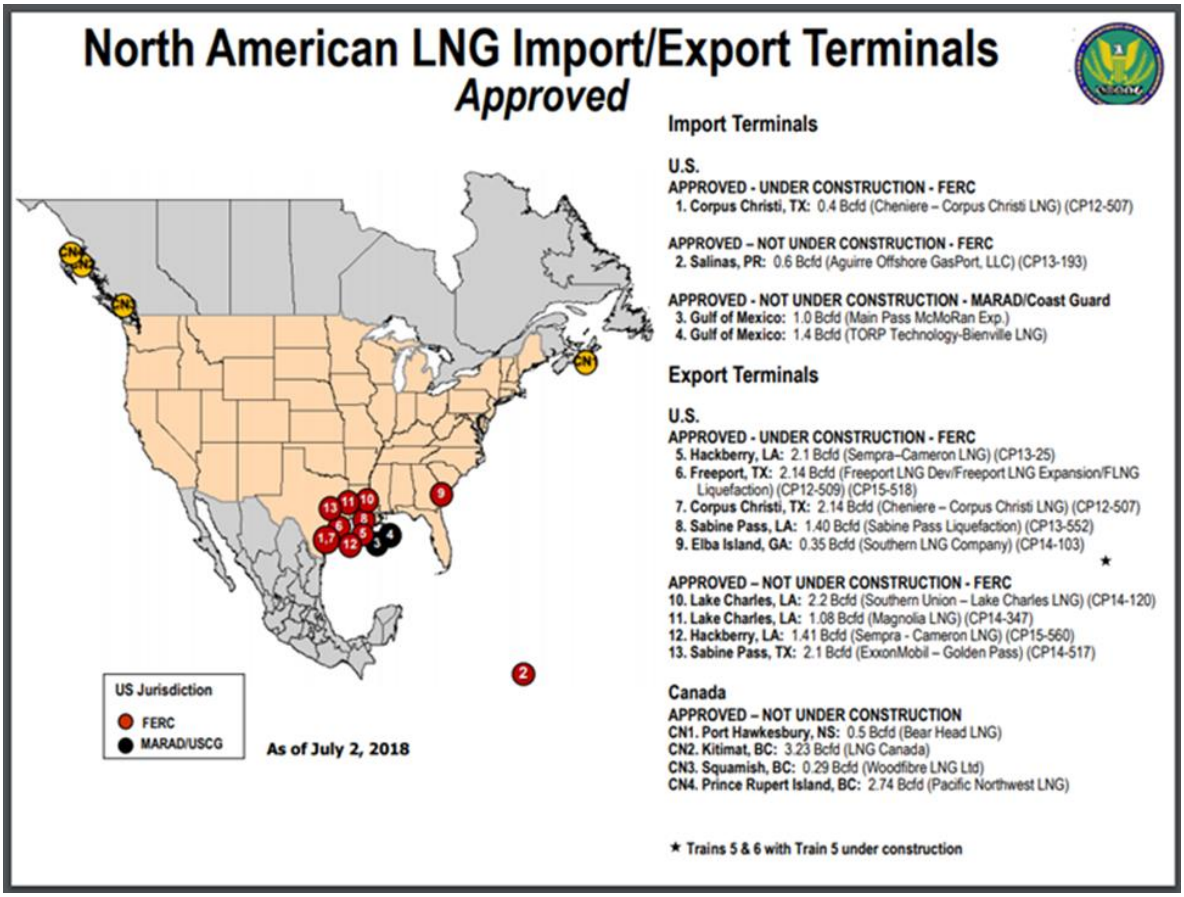

Figure 1. North American LNG Import/Export Terminal; Approved. Source: FERC. Retrieved from https://www.ferc.gov/industries/gas/indus-act/lng/lng-approved.pdf

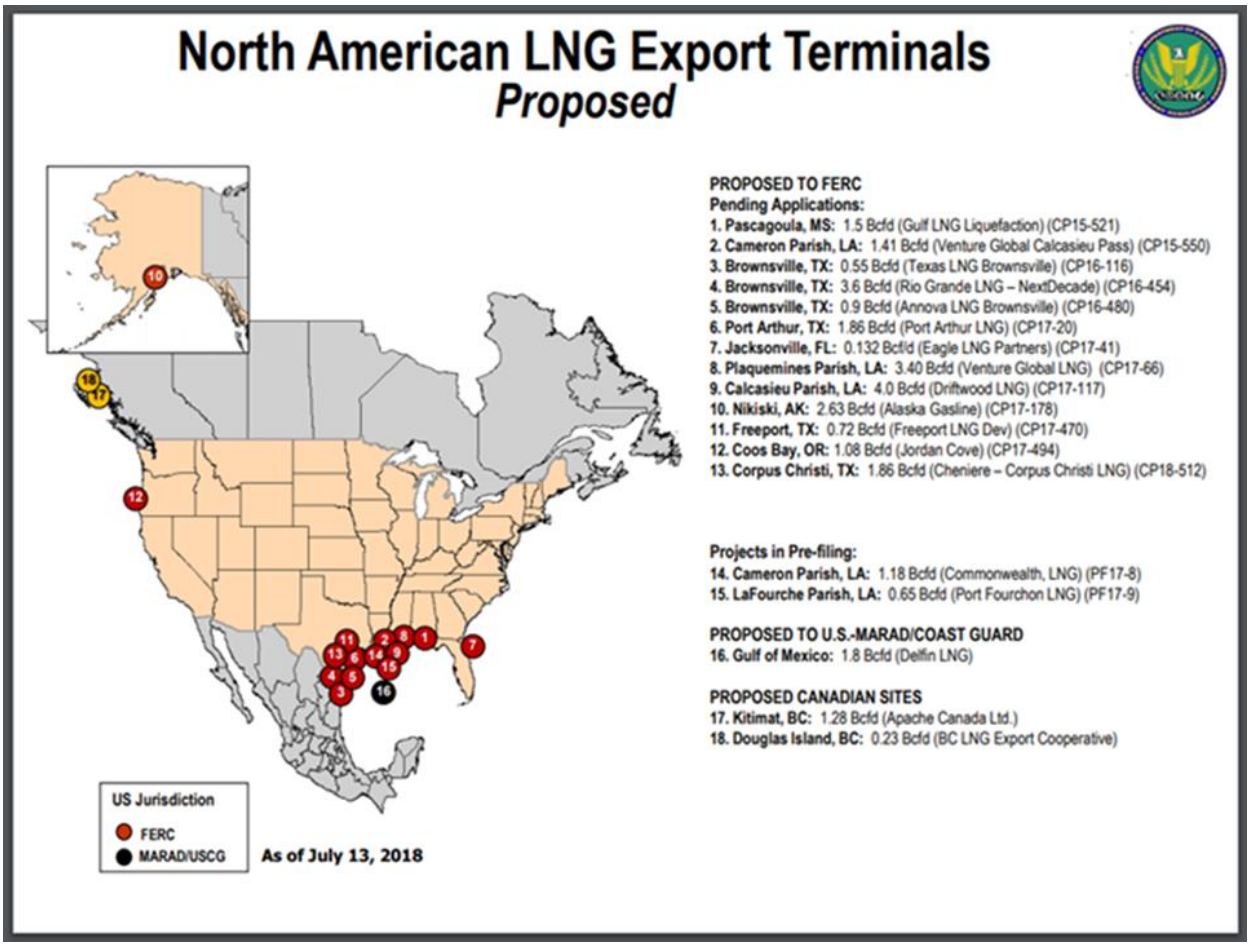

Figure 2. North American LNG Import/Export Terminal; Proposed. Source: FERC. Retrieved from https://www.ferc.gov/industries/gas/indus-act/lng/lng-approved.pdf

There are now three LNG terminals operating/exporting LNG in the U.S. including Dominion's Cove Point facility in Maryland and four more LNG export facilities in the construction phase (Table 1).

Project	Developer	Start Date (or projected date)	Capacity (bcfd - billion cubic feet/day)	Status
***KENAI LNG**	Conoco Phillips, Kenai, AK	1969	0.2	**ONE TRAIN (intermittent operation)**
CHENIERE / SABINE PASS LNG	Cheniere Energy, Sabine Pass, LA	Feb. 2016	3.5	**4 TRAINS IN OPERATION,** 1 under construction**,** 1 planned
DOMINION - COVE POINT LNG	Dominion, Cove Point, MD	Apr. 2018	0.82	**1 TRAIN IN OPERATION**
Elba Island, GA	Southern LNG Company, Elba Island, GA	2019	0.35	10 (small scale) trains under construction
Sempra- Cameron LNG	Sempra Energy, Hackberry, LA	2019	2.1	3 trains under construction
Cheniere - Corpus Christi LNG	Cheniere Energy, Corpus Christi, TX	2019	2.14	2 trains under construction
Freeport LNG Dev/Freeport LNG Expansion/FLNG Liquefaction	Freeport LNG, Freeport, TX	2019	2.14	3 trains under construction

Status KEY: **IN OPERATION = red+bold+uppercase** | Under Construction or planned = lowercase

Source: US energy Information Administration, FERC, 23 July 2018. Retreived from https://www.ferc.gov/industries/gas/indus-act/lng/lng-approved.pdf

*Kenai LNG in Alaska did not export LNG in 2016

Table 1. U.S. LNG Terminals in Operation and Under Construction.

In addition to the 2018 FERC appointments, we could very well see Secretary of Energy Rick Perry promote U.S. natural gas industries by increasing DOE budgets to fund fossil fuel programs. "Perry also could direct DOE's Assistant Secretary for Fossil Energy, to act more quickly on applications for long-term, large-scale exports of U.S.-produced LNG while at the same time complying with the requirements of the Natural Gas Act (NGA) and [the National Environmental Protection Act] NEPA" (Collins, Liquefied Natural Gas Is All the Rage in the Trump Administration, 2017). However, LNG companies that are in the planning stages are finding difficulty in attracting long term commitments from buyers to allow them to justify the billions of dollars in liquefaction export facility construction costs. This is largely due to the current global supply glut. U.S. companies have signed single-digit long-term LNG customer agreements since mid-2016 (DiSavino, New U.S. pipelines to drive natural gas boom as exports surge, 2017).

If the new FERC confirmations weren't indicative of the trend towards increased U.S. LNG exportation, U.S. Senator Cassidy of Louisiana also introduced the License Natural Gas Now Act, which is intended to boost the state's exports of LNG by revising the current system put in place by the DOE several decades ago. Senator Cassidy has stated that "The previous administration created hurdles that stalled LNG projects that benefit the

economy, environment and Louisiana workers," and that the "legislation adds certainty to the approval process and brings investment and better-paying jobs, to Louisiana." The LNG Act would essentially eliminate the federal approval needed to export LNG under longstanding laws that were made to ensure the U.S. maintains a stable energy supply (Magill, 2017).

Thus, it is likely that the new FERC commissioners will continue to expedite applications for permitting and construction of LNG terminals, as well as interstate natural gas pipelines. Based on the current FERC commissioner's background and praise from various proponents of shale, natural gas, pipeline, and LNG industries, the flood gates have opened for shale gas pipeline infrastructure and LNG export facility permitting. However, the key end-use factor in the growth of U.S. LNG export facilities will be individual companies making FIDs and whether the billions of dollars required for facility and infrastructure startup costs will prove to outweigh the risks of entering a highly competitive and oversupplied global LNG market. Under these conditions, alternative uses for LNG are being sought.

Challenges to LNG as a Guaranteed U.S. Export

The U.S. Gulf Coast, known for its offshore oil and gas production, is quickly becoming an export hub for the abundant shale reserves of U.S. natural gas. Port and pipeline infrastructure that used to serve the importation of oil and gas from abroad or drilled from the Gulf of Mexico is being reverse engineered to export oil and gas commodities to markets in South America, Europe and Asia. Louisiana's Cheniere Energy is leading the way in the natural gas production surge as the first U.S. exporter of LNG in six decades. Cheniere Energy, along with several other multi-billion-dollar investments in gas liquefaction facilities along the U.S. Gulf Coast being built and/or permitted, pose a potential to transform global energy markets.

Relative to LNG demand, significantly lower global economic growth - particularly in China - combined with an oversupplied LNG market, conspire to not only keep prices low, but also alter traditional relationships between LNG producers and consumers. This in turn is likely to create a highly competitive global market. In the past, LNG trade consisted almost entirely of long-term contracts linked to oil prices that provided the

builder of LNG liquefaction plants the security necessary to invest. In the absence of that security, investment is riskier and, therefore, less likely to occur in the first place. As a result, the LNG trade is moving increasingly in the direction of short-term contracts de-linked from oil prices that are made in the spot market, and it is no longer only the seller and end user who are negotiating contracts, but middlemen traders such as Japan who may resell unneeded cargoes, turning what had once been long-term, steady customers of LNG producers into periodic competitors (Daiss, 2016); (McFarlane & Vukmanovic, 2016). Additionally, since 2013, worldwide renewable energy investments added 142 gigawatts of renewable capacity compared to 141 gigawatts in new fossil fuel generating capacity (Randall, 2015). All these factors combine to create a hard-to-predict future for the global LNG export industry, especially in terms of the amount of new LNG export facilities that the U.S. export market can sustain. Regardless, in 2016 Cheniere Energy reported record revenue of $1.28 billion, and is expected to control over half of the U.S. LNG export capacity by 2020, making it one of the nation's biggest buyers of natural gas (DiSavino, After six decades, U.S. set to turn natgas exporter amid LNG boom, 2017). This implies that up the supply chain, big U.S. shale producers such as Chesapeake Energy Corp, Cabot Oil and Gas Corp, Range Resources Corp and EQT Corp could see benefits from increases in LNG exports.

China

A July 13, 2017 report by the IEA predicts growing gas demand to come from Asia, and that China is anticipated to lead this demand accounting for 40% of global demand growth driven by government policies that will be addressing air pollution in cities currently relying on coal power stations (Vaughan, 2017). According to Bloomberg News, U.S. LNG exports accounted for almost 7% of China's LNG imports this past March. However, barriers to future LNG trade exist. Through 2023, Chinese companies have existing long-term contracts with non-U.S. suppliers for more LNG than its domestic demand currently requires (Griggs, 2017). China already has a geographically diversified LNG supply chain from Qatar, Australia, Malaysia, Indonesia, and agreements with Russia's Gazprom to bring 3.8 bcf/d of gas from Central Siberia to the cities of North East China as well as the Turkmen Galkynysh field which currently exports two bcf/d to West China and is capable

of significant expansion. China will inevitably use these vast Asian supplies along with domestic production to negotiate prices with other global LNG suppliers (Michael, 2017).

India

The IEA also cites examples of the growing use of gas in India because of industry taking over from the power sector, especially for use in the chemical and fertilizer sectors (Verma, DiSavino, & Vukmanovic, 2017), similar to trends in the U.S. Gulf's LNG feedstock chemical corridor. However, here too lies a problem as GAIL, India's largest gas importer, has existing contracts to purchase 5.8 million tons of U.S. LNG annually for twenty years but is now asking Cheniere to re-negotiate the price. R.K. Garg, head of finance at Petronet LNG, another of India's biggest gas importers told Reuters that at current oil prices, long-term gas contracts can be acquired at rates as low as $6-7 per million British thermal units (mBtu), while the Cheniere contract price currently costs India $8.50 per mBtu. Therefore, any new LNG agreements with India depend on how GAIL and Cheniere deal with a $22 billion long-term supply contract signed in 2011 (Vaughan, 2017).

South Korea

Additionally, IEA reported that while Japan is already a large importer of gas, South Korea's recent decision to rely less on coal and nuclear power could see the country increase its appetite for LNG as well (Chung, 2017). The recent commencement of Cheniere's 20-year contract with South Korea provides some evidence for this trend.

Under the Cheniere-South Korean original 2012 contract, about 35 million tons of LNG will be shipped annually to South Korea, which was the world's second-largest buyer in 2016, representing at least $548 million annually, and the second most after Japan. As the world's number two LNG importer, Korean Gas (KOGAS) has been importing about 30 million tons of LNG per year, mainly from Qatar (Collins & Malik, 2017). Since the recent election of South Korean President Moon Jae-in, his promise to transition away from coal and nuclear

power favoring natural gas and renewables looks to be the case. With a Korean Gas supply agreement in effect, Cheniere being one of only two current U.S. LNG exporters is positioned to capitalize.

Europe

Some LNG analysts claim that Europe could emerge as a global player in the natural gas market due to its ability to act as a clearinghouse for surplus or spot LNG cargoes. This is a good possibility given that various European countries have existing re-gasification capacity and the versatility to use LNG for uses ranging from power generation to manufacturing to household heating. Europe could also be the most effective in negotiating LNG and pipeline prices due to its connectivity to Russian and Eastern natural gas pipelines. It won't be the center of the LNG universe, but its re-gasification infrastructure could play a significant role in consuming US surplus (Keefe, 2017) (Rampton & Gardner, 2017).

Poland

On June 8, 2017 the first ever LNG shipment was delivered from Cheniere Energy to Poland (Scislowska, 2017). To lessen reliance on Russian gas, Poland expects to sign a long-term LNG deal with the U.S.; however, of the 16 billion cubic meters of gas they import annually, the majority is delivered by Russia's Gazprom whose contract does not expire until 2022. Once expired, Poland plans to replace Russian gas with supplies via pipeline from Norway and LNG from the U.S. (Rampton & Gardner, 2017).

The Eastern European region around Poland is also home to the Three Seas Initiative whose members include Poland, Austria, Hungary, Latvia and Estonia. The project has goals to expand regional energy infrastructure, including LNG import terminals and gas pipelines (Rampton & Gardner, 2017) (National Cooperative Highway Research Program, 2015).

Lithuania

Lithuania's state LNG company, Lietuvos Duju Tiekimas, signed a deal with Cheniere Energy and received its first and second LNG deliveries in August and September of 2017 (Staff, Lithuania's LDT buys second US LNG cargo, 2017); (Sytas, 2017) (Babbie, 2013).

South America (50% of 2016 U.S. LNG exports)

Contrary to expectations and perhaps even the latter analysis and forecasts by the EIA and others, so far, the main receivers of U.S. LNG to date have been markets in Latin America (Table 2). Per EIA data, exports from Cheniere Energy to Argentina (16.7 billion cubic feet - bcf), Brazil (9.2 bcf), Chile (29.4 bcf) and Mexico (27.5 bcf) combined accounted for nearly 50% of total U.S. LNG exports in 2016. Smaller quantities of LNG were also delivered to Asia, India, and Europe, but the large amount delivered to South American markets was unexpected (Kiernan, 2017).

Table 2. US LNG exports to Latin America and the Caribbean in 2016 (million cubic feet)

Country	million cubic feet
Chile	29,405
Mexico	27,470
Argentina	16,661
Brazil	9,196
Dominican Republic	2,945
Barbados	100
Total	**85,777**

Source: US Energy Information Administration

Table 2. U.S. LNG exports to Latin America and the Caribbean in 2016.

Value-Added Manufacturing

Although the Gulf Coast's petrochemical build-out is prone to the same boom-bust dynamic and macroeconomic forces that negatively affect LNG (Blum, Houston's petrochemical boom could soon face a big

swoon: Oil's low cost means Gulf Coast is losing its price advantage, 2016), this sector provides a good example of the type of value-added manufacturing-based development that is really what the region and the U.S. needs. LNG provides the basis for a long-term regional industrial revival, particularly in Louisiana where LNG is a key feedstock to the growing petrochemical industry.

According to the American Chemical Council (ACC), LNG is fueling an industrial renaissance in south Louisiana with over $47B being committed for industrial plant expansions or new builds, principally in the petrochemical and fertilizer sectors. Collectively, the state is seeing over $80B being committed for LNG related projects in all categories (Blum, Houston's petrochemical boom could soon face a big swoon: Oil's low cost means Gulf Coast is losing its price advantage, 2016); (Blum, Gulf Coast petrochemical boom contributing to global plastics glut, 2016). In addition to Louisiana's Cheniere Energy and other proposed or under construction LNG export facilities, the ACC lists 274 announced projects related to the shale oil and natural gas boom (Moore, Rose-Glowacki, Sanchez, & Swift, 2017). It is estimated that once new projects come online by 2023, they could account for "$93B in incremental output" and generate approximately "62,000 direct chemical industry jobs" and an estimated 665,000 indirect industry related jobs. Of these investments, two-thirds are in bulk petrochemicals and plastic resins, and Louisiana is sharing in this market growth with the addition of 26 chemical industry related projects (Moore, Rose-Glowacki, Sanchez, & Swift, 2017). This is good news for Louisiana and the U.S. Gulf. However, energy and commodity prices remain depressed since 2014's drop in prices, a result of the global production glut in both oil and gas commodities.

Energy-intensive petrochemical production and distribution can likely provide a broader industrial revival in the region versus LNG's capital-intensive resource extraction operation that simply ships energy overseas to be burned for electricity production, processed into more valuable products, or even resold. Like energy policy of other major hydrocarbon-producing regions in the world (Al Omran & Stancati, 2016), the top priority for U.S. policy makers should be to capture the long-term industrial feedstock value-chain that inexpensive and lower-

carbon-emitting U.S. shale gas represents versus policy that focuses on shipping vast quantities of LNG abroad at what appears to be increasingly competitive pricing indexes.

Trump Executive Order 232: Steel Tariffs

While NAFTA is amid an ongoing renegotiation process, the U.S. currently maintains free trade agreements with Canada and Mexico as well as Australia, Bahrain, Chile, Colombia, Dominican Republic, El Salvador, Guatemala, Honduras, Jordan, Morocco, Nicaragua, Oman, Panama, Peru, Republic of Korea and Singapore. However, while expedited FERC permitting processes favor the oil and gas and LNG industries, on March 8, 2018 President Trump issued Executive Order 232 in an effort to bolster U.S. manufacturing. The order placed a 25% tariff on imported steel and 10% on aluminum. By some estimates, this could raise the cost of U.S. steel by as much as 6% and inevitably drive up the construction cost for any new U.S. LNG or pipeline projects (Chriss, 2018).

"In 2012, revenues from leases, royalty payments and bonus bids for the U.S. outer continental shelf (OCS) totaled $6.86 billion. Since 2006 the four Gulf Coast states of Texas, Louisiana, Mississippi and Alabama share 37.5% of the Gulf of Mexico portion of that revenue — that is the vast majority because there is only modest offshore activity anywhere else along a U.S. coastline" (Ausick, 2014). So, with a disproportionately high percentage of all U.S. crude oil production and refining taking place in the Gulf Coast and steel accounting for 83% of all break bulk cargo and 30% of general cargo by tonnage for the Port of New Orleans (Hayes, 2018), these factors combine to create a volatile situation for LNG export growth. When factoring in that the State of Louisiana's financial/tax benefit breakeven threshold must be a minimum market price of $81 per barrel of oil (Ausick, 2014), and the current Brent Crude price as of July 27, 2018 was $75.06 (oilprice.com, 2018), the contradictions in Trump's trade policy/strategy are apparent and effectively work to cancel out any pro-LNG-export industry-momentum created by a streamlined FERC policy. As the American Institute of International Steel (AIIS) notes, "Adding 25 percent to the cost of nearly every ton of steel that is brought into the country is a shortsighted tactic that will do long-term harm to the U.S. economy" (Chriss, 2018).

Chinese Tariffs Hinder U.S. Port Growth

As a result of U.S. tariffs of over $200 billion against China, Chinese retaliatory tariffs are arresting the growth of U.S. ports in the Gulf of Mexico. While boasting an export growth of 4.4% in 2018, these ports saw an average decline of 13.8% in total exports to China (Mongelluzo, 2019). According to the Port Import/Export Reporting service (PIERS), "China is the region's largest single market for exports, with the Gulf ports shipping 143,420 TEU in 2018" (Mongelluzo, 2019). Exports in resins, containerized grain, and cotton saw the biggest declines amongst Gulf ports' exports from 2018 to 2017. Resin exports to China from Houston increased 8%, declined 26% from New Orleans, and dropped 5% from Mobile. Cotton exports saw a decline of 70% with shipments from Houston, New Orleans, and Mobile decreasing 66 to 100%.

IMPACTS/BENEFITS OF IMPLEMENTATION

LNG as a Marine Fuel: Shoreside and Barge

In Europe, the development of LNG as a marine fuel has developed at a faster pace than in the U.S. While LNG fueled shipping has recently gained attention in the U.S. and is high on the agenda throughout various global maritime industry companies, notably Harvey Gulf, Tote and Conrad in the U.S., the market drivers have changed from being originally motivated by the low price of LNG compensating for the costs related to installation and/or retrofitting of LNG fuel equipment and new LNG vessel construction and design, and a shift towards compliance with emissions regulations imposed by the IMO MARPOL Annex VI convention that takes effect in 2020.

A European study by DNV GL has revealed the potential for LNG as a marine fuel would put to use the current spare capacity of the existing LNG import terminals. “The consolidated quantitative results show that by 2030 up to 2 million m^3/y [cubic meters a year (or) 70.6 billion cubic feet/year] of LNG is to be bunkered by ships (with Algeciras, Las Palmas and Barcelona as most important ports) and by 2050 approximately 8 million m^3/y of LNG” (Lakshmi, 2017). The study concludes that existing LNG terminals will need to develop break bulk capacity to allow for loading LNG to small carriers and LNG bunker vessels. This indicates the increasing need to develop local intermediate storage capacity to accommodate increasing LNG demand by larger LNG powered vessels. Much like in-flight military refueling jets, smaller LNG barge bunkering and refueling vessels could be used for delivering batches of LNG to ports onshore bunkering facilities, while larger LNG powered vessels will likely play an important role at U.S. ports and LNG export facilities (Lakshmi, 2017).

Conrad LNG

In midyear 2008, Conrad Shipyard, LLC completed construction of the first dedicated LNG bunker barge for the U.S./North American LNG marine vessel market. The new barge is a critical supply chain component in reducing the environmental impact of maritime activity during the ongoing conversion process of ships from

diesel fuel to LNG. This first 2,200 cubic meter (77,692 sq. ft.) barge was commissioned in early 2016 and was delivered in the Fall of 2018 to the port of Jacksonville, Florida, where it services TOTE's "Marlin class" container vessels and other LNG-powered vessels in the Port of Jacksonville. The barge was built at Conrad's Orange, TX yard and was tested at Harvey Gulf's Port Fourchon facility before being transported to JAXport. As more U.S. Jones Act ship-owners and operators seek to meet stringent 0.1% sulfur limits within ECAs by converting to LNG as a cleaner bunker fuel, WesPac/CME plans to exercise its options with Conrad LNG to construct additional LNG fueling barges to serve other North American ports (Edgar, 2017). According to LNG World Shipping, there are six LNG bunkering vessels in service and another 12 on order.

Carriage Ban

In March 2018 SEA\LNG, the multi-sector industry coalition of 31 members including shipping companies, classification societies, ports, major LNG suppliers, downstream companies, infrastructure providers, shipyards, OEMs, and financial institutions, vied to propel widespread adoption of LNG marine fuel and vocalized their support for a carriage ban on non-compliant fuels proposed by the IMO's sulfur reduction mandate (Green, 2018). The IMO's sub-committee on pollution prevention and response (PPR) has agreed on draft amendments to the MARPOL Annex VI Convention prohibiting the carriage of non-compliant fuel oil that exceeds the 0.50% sulfur limit. However, this "carriage ban" doesn't apply to marine vessels that have gained approval to meet the sulfur limit through alternative methods such as exhaust gas cleaning systems (EGCS), better known as exhaust "scrubbers."

"We urge formal approval of this proposal at MEPC 72 in April to ensure early adoption at MEPC 73 (in October)" said Peter Keller, SEA\LNG chairman and executive vice president of Tote. "This will allow the shipping industry to work with the IMO, Flag, and Port State authorities to develop robust and consistent enforcement processes in a timely manner" said Mr. Keller (Green, 2018). The fuel carriage ban will prove less risky to shipping lines who are considering new build and exhaust retrofitting options to achieve marine fueling compliance solutions such as LNG.

Strict enforcement will lessen the chances of LNG powered vessel investments being undermined by maritime shipping companies who might otherwise continue to burn non-compliant fuels at the risk of paying fines or simply sliding by. The initiative will also send a strong message to ports such as the Port of New Orleans and other maritime fuel suppliers by encouraging them to make critical investments in LNG bunkering infrastructure to deliver compliant marine fuels to U.S. and foreign flagged vessels alike.

INFRASTRUCTURE IMPLICATIONS

Pipelines

Regarding shale oil and gas pipeline projects, several are under construction including Energy Transfer Partners LP's Rover, TransCanada Corp's Leach Xpress, Williams Cos Inc.'s Atlantic Sunrise and Louisiana's TransCanada Corporation Cameron Access pipeline project and proposed Bayou Bridge Pipeline. These pipelines will transport shale gas to markets in Canada, the U.S. Midwest and Southeast, and to Gulf Coast export terminals. A minimum of five pipelines from the Marcellus and Utica shale regions recently opened with a total of seven billion cubic feet per day (bcf/d) capacity. Potentially, five more pipelines are due for completion in the near future with five bcf/d capacities. Pipeline capacity from Pennsylvania, Ohio and West Virginia was around 23 bcf/d in 2016, according to the EIA and Thomson Reuters data. A total of 35 bcf/d capacity is possible if all pipelines, planned and under construction, are completed (St. John, Trump FERC Nominees Bring Certainty for Pipeline Development, Less Certainty for Distributed Energy, 2016) (St. John, Where Will a President Trump Take FERC and Federal Grid Policy, 2016).

While definite projections for permitted, planned and constructed pipelines and LNG export facilities remain hard to determine, what is clear is that the natural gas and LNG industries have praised Trump's FERC nominations. "Kevin McIntyre has years of experience in energy expertise and we hope that the Senate will move quickly to consider his nomination, along with Neil Chatterjee, Richard Glick, and Rob Powelson," said Dena Wiggins, president and CEO of the Natural Gas Supply Association. "FERC has lacked a quorum since February [2018] and the billions of dollars of investment and thousands of job opportunities in the U.S. continue to be sidelined by a lack of a quorum at FERC. It is essential that the nominees be given the opportunity to be approved as quickly as possible" (Collins, Liquefied Natural Gas Is All the Rage in the Trump Administration, 2017).

In summary, while the rosy EIA annual report on gas markets has forecasted that global LNG export capacity could reach approximately 20 tcf [650 bcm] annually by 2022, compared to less than 15.96 [452 bcm] a year in 2016, it simultaneously projects demand to reach only 16.24 tcf [460 bcm] by 2022 giving the market a 6.71 tcf [190 bcm] annual surplus capacity (Chestney, 2017). This would likely put further pressure on gas prices, heighten global export competition, discourage new LNG investment, and stifle LNG company's FIDs, regardless of streamlined U.S. FERC permitting policies for the natural gas and LNG industries.

Expansion of the Panama Canal

With the drive to turn the U.S. into a global powerhouse for natural gas exports by both the Trump administration and industry stalwarts, the canal's expansion has coincided with pro-LNG-export initiatives by creating a money saving route to Asia. The deeper and wider Panama Canal can now accommodate oversized LNG tankers that previously could not pass through the canal. Jason Feer notes that this development decreases the easterly Atlantic Ocean-Asia route via the Suez Canal by 11 days and could decrease shipping costs by as much as 35%. In 2016, the U.S. EIA was predicting that by 2021, as many as 550 LNG tankers could be crossing the canal annually (Zaretskaya, 2016). However, in more recent developments, container ships, which have an established track record of strict adherence to canal passage schedules, are being given scheduling preference over LNG vessels. The apparent favoritism for container ships by the Panama Canal Authority (ACP) is causing delays and daily booking limits for LNG tankers, being set by the ACP who cites the unreliable schedules of LNG shippers (Rogers, 2018). Even the LNG carriers themselves admit that "their vessel itineraries are subject to greater variability due to the increasingly flexible [unreliable] nature of the trade" as well as additional issues such as shortages in the provision of tug boat escorts and crews (Corkhill, 2018).

Roads and Motor Carriers

Due to the looming changes with FERC and the documented increase in LNG exports by Cheniere Energy, if a rapid increase in gas and LNG production is to occur, it places substantial demands on the nation's transportation infrastructure. In many cases due to the isolated locations of frac'ing sites, freight traffic damage to road infrastructure is occurring on roadways that were not originally designed for industrial volumes and weight loads. Likewise, there is similar concern for the increased freight and subsequent wear and tear damage to highway infrastructure resulting from increased natural gas shipments via truck to end-use export terminals at our nation's major LNG export facilities. An exhaustive 2016 study, "*The Impact of Fracking on Freight Distribution Patterns*" by Mark Abkowitz at Vanderbilt University (Abkowitz, 2016), notes that this problem is especially troublesome for rural roadways where they were not typically built to tolerate heavy haul standards, or adequate road infrastructure is absent altogether. North Dakota, Wyoming, and Montana are all examples of states that had rural sources of oil and gas production but inadequate transportation infrastructure at the times when their respective oil and gas booms occurred. Additionally, Abkowitz (2016) states that rural regions often lack the jurisdictional staffing to oversee the management of private companies during active frac'ing projects. Supplies involved in drilling, constructing, and hydraulically fracturing a well are typically trucked to the site.

As Abkowitz (2016) notes, few tools currently exist to assist in mitigating the impact to roads and other modes of transportation. With the development of evaluation tools, it is also more likely that safety factors of transporting oil and gas can be improved for all transportation modes. Abkowitz (2016) notes that "to reduce the number of oil and gas related trucks on roads, it has been suggested that greater reliance could be placed on pipelines and/or barges to transport wastewater that results from the hydraulic fracturing process" (Abkowitz, 2016). This method could perhaps take some of the pressure off local and regional roads not designed to handle this type of industrial activity.

Curiously, and potentially relating to regulation decisions dictated by FERC, Abkowitz (2016) has also found that various analysts have argued that delayed approval of new pipeline construction has the effect of increasing the transport of oil and gas by truck as opposed to pipeline, increasing potential safety concerns for road and highway travel. A further finding is that the shortage of truck drivers in the U.S. could worsen existing problems. As of 2014, the American Trucking Association estimated a shortage of 30,000 drivers, which could rise to 239,000 by 2022. There are multiple reasons for this shortage but Abkowitz (2016) notes that oil and gas development is considered a prime factor. In less established production regions, the absence of transmission pipelines significantly increases truck traffic as well as truck traffic transferring to rail traffic. For example, Abkowitz (2016) cited research that found that pipelines transport 27% of crude oil produced in North Dakota and approximately 65% is being sent to refineries by rail. Furthermore, the absence of pipelines requires flaring of natural gas, which attributes to millions of dollars in lost revenues each year.

In 2015 the National Cooperative Highway Research Program (NCHP) published a first of its kind report titled, *Impacts of Energy Developments on U.S. Roads and Bridges* (National Cooperative Highway Research Program, 2015). The report reviewed types of damage due to energy development, state's tools being used to determine costs associated with energy development, methods to assess damage, state's data gathering methods used in assessing pavement life cycles, and best practices of assessing damage (National Cooperative Highway Research Program, 2015) (United States Department of Transportation, 2011).

As new studies on this topic continue to emerge, it should be noted that most of the previous studies have focused on the impacts to roads, while there has been a lack of studies of the effects of energy transportation on multi-modal uses or how to incorporate a multi-modal plan for the transportation of energy commodities. Additionally, Abkowitz (2016) noted a Transportation Research Board subcommittee found a gap in the analyses of oil and gas impacts conducted for long-range transportation plans. A determination of how to incorporate other modes of transportation in the frac'ing industry would help alleviate these stresses on the

trucking industry. A cursory overview indicates that inland waterways and short sea shipping (SSS) could provide some relief.

Inland Waterways and Short Sea Shipping

The Mississippi River is the world's longest navigable river at 2,100 miles from its mouth at the Gulf of Mexico to its head of navigation in the Twin Cities in Minnesota. Collectively, the U.S. is home to 12 navigable rivers and 3,000 miles of shielded navigable bays for a total of 14,650 miles (See Figures 3 & 4). The preponderance of refineries on the U.S. Gulf Coast and the ability of the inland river system to *safely* move LNG into the Gulf may provide new incentives for U.S. policymakers to change cabotage laws, which govern the movement of domestic- and foreign-flagged marine vessels between ports of call on domestic waterways. Currently, the Merchant Marine Act of 1920, often referred to as the Jones Act, governs shipping activity in the U.S. and was designed to protect domestic maritime shipping by restricting the penetration of foreign flagged vessels in U.S. markets.

Figure 3. U.S. Navigable Waterways. Source: Zeihan, 2014.

The notable outlier in this system is of course Cuba (Zeihan, 2014). Expanding U.S.-Cuba trade has operational and regulatory implications for the entire U.S. energy industry through the reduction of Jones Act restrictions and the lifting of economic sanctions allowing direct U.S.-Cuba vessel movements. This would encourage the expansion of SSS operations in the Gulf of Mexico as petrochemical flows to South America increase (already 50% of all U.S. exports), creating the necessary demand for services like container on barge shipping (United States Department of Transportation, 2011). With the expansion of the Panama Canal and the improvements to the Cuban port infrastructure, Cuba becoming a maritime trans load hub is likely.

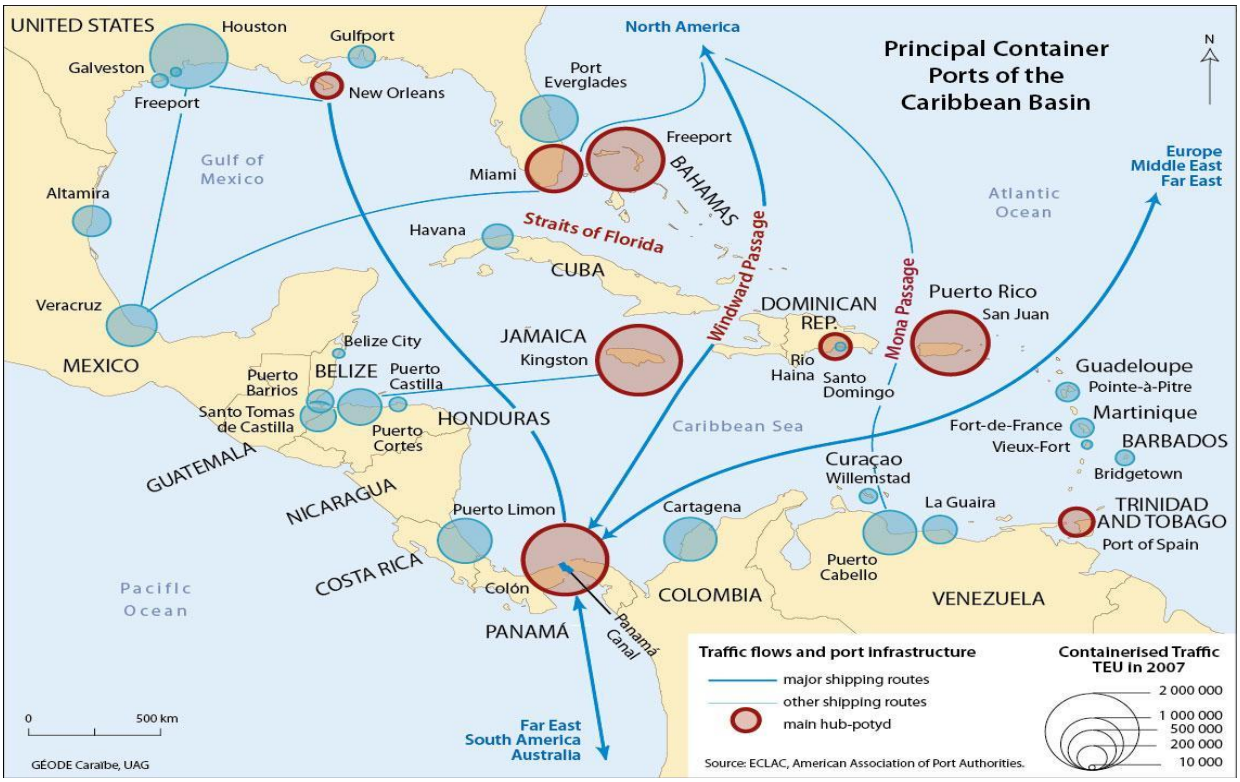

Figure 4. Map of Gulf of Mexico Port Infrastructure and Freight Flows. Source: ECLAC, American Association of Port Authorities.

Export is Costly: Diversify and Utilize LNG Domestically

While the new expedited permitting process for LNG terminals and pipelines under a Trump-approved FERC could likely result in a considerable domestic increase of natural gas and LNG production, LNG as a reliable and steady export is not a sure bet. Furthermore, while the changes to FERC favorably impact oil and gas developer's success, the Trump Administration's imposed steel and aluminum tariffs inevitably drive up the construction cost of any new U.S. LNG export/import facility or pipeline projects effectively canceling out significant industry-forward movement created by recently relaxed FERC permitting policies. As well, the ability of existing and planned LNG exports companies to secure traditional long-term contracts with LNG buyers continues to pose concern for these companies when deliberating FIDs. The difficulty of knowing for certain the fluctuation of global prices for oil and gas and an ample global supply for the foreseeable future all but ensures that prices will remain highly competitive.

Though there exists uncertainty in terms of future U.S. export volumes of LNG, there are two positive outcomes: (1) there will be no shortage of natural gas available for use as feedstock to the U.S. petrochemical

industry. This is positive in-and-of the fact that the wide array of petrochemical derived products will provide for robust value-added exports in an already emerging industrial renaissance in America, particularly in the Gulf Coast Region, and (2) there is industry growth in both onshore and barge vessel LNG bunkering for fueling maritime vessels. Due to the IMO MARPOL Annex VI convention, there will undoubtedly be an increasing demand for LNG as a marine fuel in the U.S., as already evident in Europe.

Despite recent "positives" in the resurgence of global oil and gas prices in the first two quarters of 2018, coupled with new U.S. export partners such as the recent 20-year joint venture between Japan's Sumitomo Corporation and Tokyo Gas with Cove Point LNG (Staff, Cove Point LNG ships first commercial cargo, Japan set for May delivery, 2018), the near-term future for LNG as an export commodity is not a sure bet. Even with the marketplace addition of Floating Liquefied Natural Gas (FLNG) and other downsized liquefaction/export facilities that are capable of filling the gap for spot-market clients unwilling to sign traditional long term LNG contracts (Gordon, 2018), the lingering specter of a global supply glut (e.g. unpredictable future LNG output by Qatar, Russia, and Australia) coupled with the known world reserves of natural gas, LNG as a reliable and steady U.S. export commodity, remains highly questionable.

Without doubt, as the U.S. shale revolution continues to unfold, a key concern for many communities located in major U.S. shale plays will be the impacts to these community's local roads and U.S. highway infrastructure. Also, heightened demands on a dwindling truck driver labor pool, as well as all safety related concerns that come with increases in the demand to transport U.S. shale oil and gas must be considered. Regarding existing driver shortages, autonomous trucking might provide some near-term solutions for shale transport, but the widespread and reliable implementation of this technology is still some time into the future.

Another possible alternative for transporting U.S. shale products might lie within the maritime industry, utilizing the 14,650-mile Mississippi (MS) River tributary system in concert with Short-Sea-Shipping for river-based transport to Gulf Coast refining and petrochemical facilities, but major policy alterations regarding the

Jones Act, as well as addressing the antiquated inland MS River tributary lock and dam system, would first be required. Environmental policies governing the transport of oil and gas via inland waterways (as well as by pipeline) also need to be addressed to make river-based shale oil and gas transport feasible.

With a very high percentage of U.S. oil and gas refinement (Hayes, 2018) and upwards of $90 billion in petrochemical industry investments simultaneously occurring in Louisiana and the Gulf Coast region, it is counterintuitive to focus U.S. shale-based energy policy strictly on exportation. That agenda requires billions of dollars in facility investments with no guarantee of long-term sales on top of weathering transportation obstacles to reach global customers. If we factor in the Port of New Orleans current growth strategy (The Port of New Orleans, 2018), coupled with gas industry related commerce generated by the multiple ports of the South Louisiana port complex, transporting LNG half-way-round the world with no long-term contracts in place is simply displacing a valuable commodity from where it has domestic application; this is counterproductive.

RECOMMENDATIONS AND CONCLUSIONS

A factor that is increasingly critical to the economic vitality of any U.S. port (and certainly for the sustainment of the Port of New Orleans who must compete with an active containership hub like the Port of Houston) is the timeliness of investment in LNG bunkering infrastructure. Based on the impending IMO MARPOL Annex VI Convention set for 2020, there will undoubtedly be an increasing demand for LNG as a marine fuel in the U.S., as already evident in Europe. UNOTI postulates that U.S. ports that fail to invest in LNG bunkering infrastructure in the near-term, be that shore or by barge, will find themselves scrambling to attract shipping business, as ports that are capable of LNG bunkering and refueling will attract the new era of LNG powered ships.

Foreign flagged vessels and marine shipping companies that frequent U.S. ports will inevitably need fuel, and as old and new ships alike continue the process of switching from diesel to LNG, U.S. ports that do not invest in LNG marine fuel bunkering will quickly lose competitiveness. Using the Port of New Orleans as a prime example, the port is losing business three-fold under the current administration's policies: [1] the impacts of steel trade tariffs will cause a substantial hit to the Port's annual income stream, [2] focusing on LNG solely as an export commodity ignores the bourgeoning Gulf Coast petrochemical industry, and [3] failing to invest in LNG marine fueling infrastructure could cause one of the world's largest port complexes to forfeit business with ocean liners who make the switch to LNG. Those ships would likely seek business at competing ports such as Houston, JaxPort (currently providing container service to Puerto Rico with two Marlin Class LNG powered ships), Tampa, or any other U.S. port that invests in LNG refueling infrastructure. With the 2020 countdown to the mandatory IMO MARPOL Annex VI Convention for maritime vessel emissions reductions, any U.S. port that fails to invest in LNG maritime fuel bunkering infrastructure, will likely, pun intended, miss the boat.

While loose predictions by energy analysts claim the U.S. as a *dominant* global exporter of LNG sometime between 2019 and 2022, a large degree of uncertainty remains. There is no decisive evidence that guarantees

that U.S. energy policy focused strictly on LNG exportation won't turn into a failing endeavor, leaving the expensive steel and aluminum bones of perhaps as many as a dozen multi-billion-dollar U.S. LNG export facilities to rust away.

What *is* highly certain is that there exist trillions of cubic feet in global natural gas reserves that companies are hungry to extract, are concurrently making investments with private dollars to create the infrastructure required to facilitate that process, and *with* government support. Notwithstanding, there *is also* global industry consensus that LNG is and will be increasingly in demand for use in electricity production, petrochemical feedstock manufacturing, *and as a maritime fuel*; but the demand will exist on a highly competitive world stage where a country's future export volumes are uncertain at best, fluctuating due to a multitude of ever changing geo-political and economic factors.

UNOTI continues to urge that U.S. natural gas energy policy best practice is not to focus on export and export alone, but rather adopt a diversified and climate responsible energy policy that focuses on the Ports of South Louisiana, the Gulf Coast, and the U.S. remaining globally competitive by investing in necessary LNG fueling infrastructure, as well as continued investment in the existing petrochemical sector of Coastal Louisiana and the Gulf Coast. Certainly though, for both academia and industry alike, the consensus on the anticipated demand and growth of global LNG *production* warrants the importance of a well thought out, long term, and sustainable U.S. LNG policy that emphasizes taking into consideration both existing *and currently underutilized* transportation modes the U.S. has available for defining and implementing future energy and energy transport policy.

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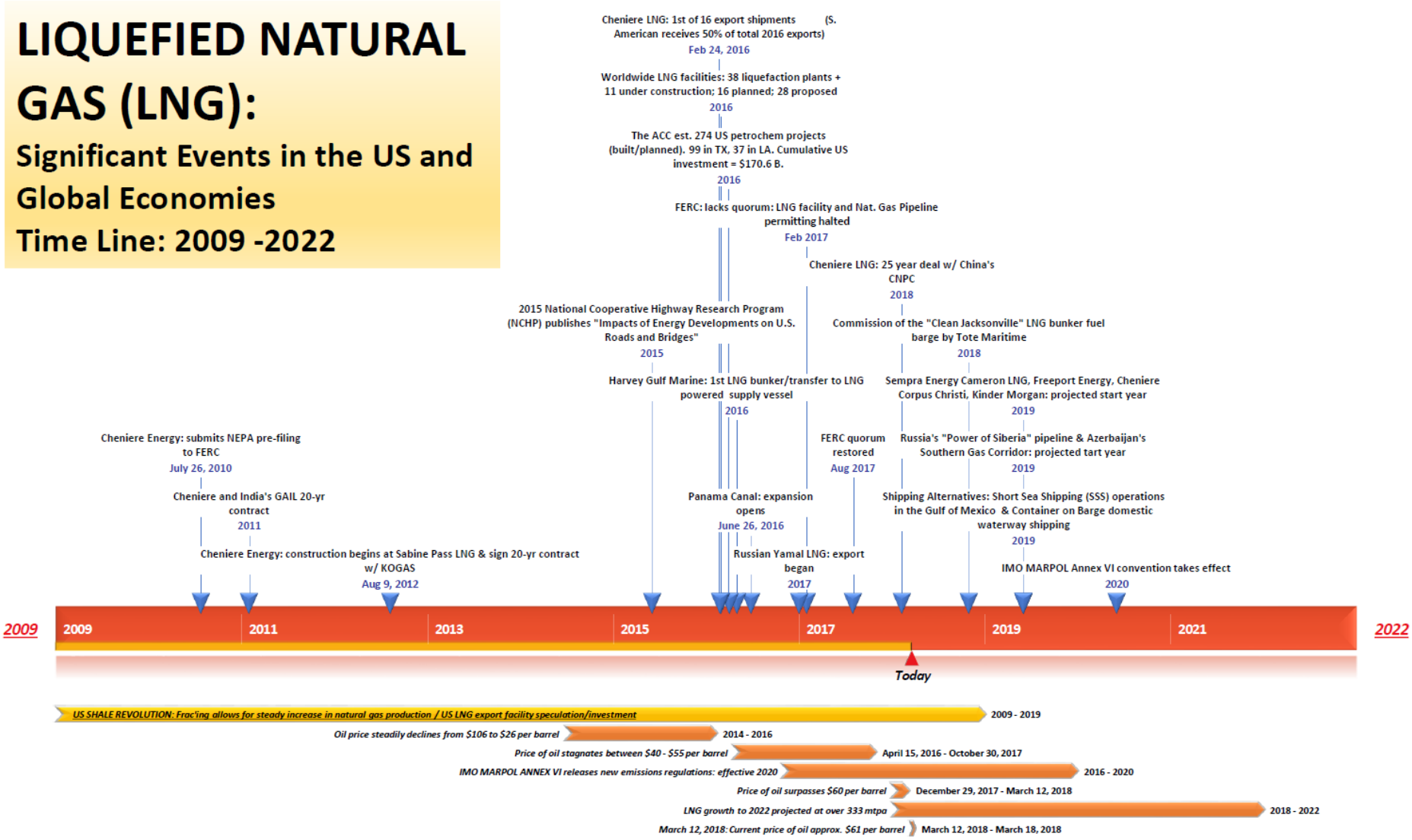
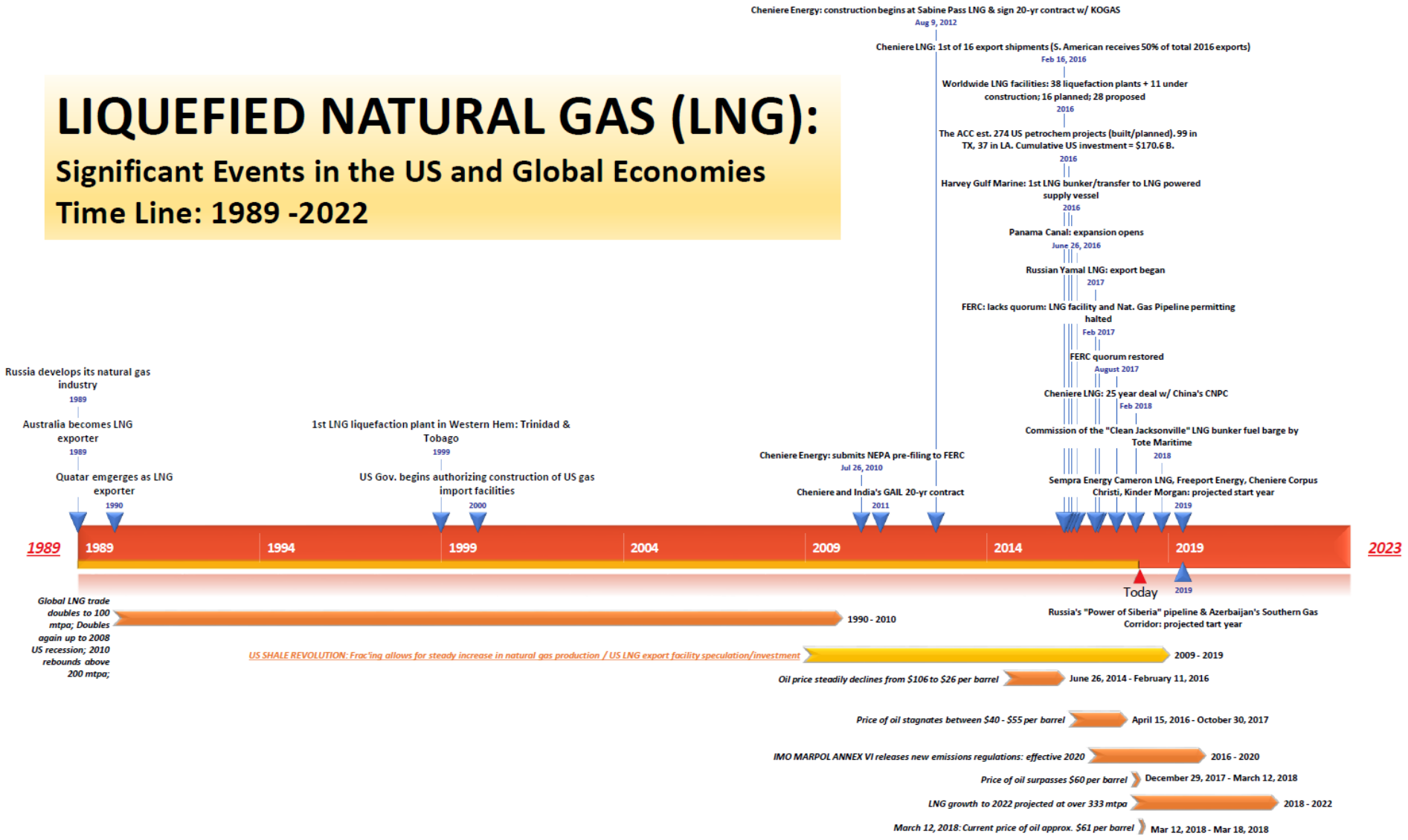
APPENDIX


LIQUEFIED NATURAL GAS (LNG):
Significant Events in the US and Global Economies
Time Line: 2009 -2022
Cheniere LNG: 1st of 16 export shipments (S. American receives 50% of total 2016 exports)
Feb 24, 2016
Worldwide LNG facilities: 38 liquefaction plants + 11 under construction; 16 planned; 28 proposed
2016
The ACC est. 274 US petrochem projects (built/planned). 99 in TX, 37 in LA. Cumulative US investment = $170.6 B.
2016
FERC: lacks quorum: LNG facility and Nat. Gas Pipeline permitting halted
Feb 2017
Cheniere LNG: 25 year deal w/ China's CNPC
2018
2015 National Cooperative Highway Research Program (NCHP) publishes "Impacts of Energy Developments on U.S. Roads and Bridges"
2015
Commission of the "Clean Jacksonville" LNG bunker fuel barge by Tote Maritime
2018
Harvey Gulf Marine: 1st LNG bunker/transfer to LNG powered supply vessel
2016
Sempra Energy Cameron LNG, Freeport Energy, Cheniere Corpus Christi, Kinder Morgan: projected start year
2019
Cheniere Energy: submits NEPA pre-filing to FERC
July 26, 2010
FERC quorum restored
Aug 2017
Russia's "Power of Siberia" pipeline & Azerbaijan's Southern Gas Corridor: projected tart year
2019
Cheniere and India's GAIL 20-yr contract
2011
Panama Canal: expansion opens
June 26, 2016
Shipping Alternatives: Short Sea Shipping (SSS) operations in the Gulf of Mexico & Container on Barge domestic waterway shipping
2019
Cheniere Energy: construction begins at Sabine Pass LNG & sign 20-yr contract w/ KOGAS
Aug 9, 2012
Russian Yamal LNG: export began
2017
IMO MARPOL Annex VI convention takes effect
2020
2009
2009
2011
2013
2015
2017
2019
2021
2022
Today
US SHALE REVOLUTION: Frac'ing allows for steady increase in natural gas production / US LNG export facility speculation/investment
2009 - 2019
Oil price steadily declines from $106 to $26 per barrel
2014 - 2016
Price of oil stagnates between $40 - $55 per barrel
April 15, 2016 - October 30, 2017
IMO MARPOL ANNEX VI releases new emissions regulations: effective 2020
2016 - 2020
Price of oil surpasses $60 per barrel
December 29, 2017 - March 12, 2018
LNG growth to 2022 projected at over 333 mtpa
2018 - 2022
March 12, 2018: Current price of oil approx. $61 per barrel
March 12, 2018 - March 18, 2018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August 2017
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2018
Sempra Energy Cameron LNG, Freeport Energy, Cheniere Corpus Christi, Kinder Morgan: projected start year
2019
Russia develops its natural gas industry
1989
Australia becomes LNG exporter
1989
Quatar emgerges as LNG exporter
1990
1st LNG liquefaction plant in Western Hem: Trinidad & Tobago
1999
US Gov. begins authorizing construction of US gas import facilities
2000
Cheniere Energy: submits NEPA pre-filing to FERC
Jul 26, 2010
Cheniere and India's GAIL 20-yr contract
2011
1989
1989
1994
1999
2004
2009
2014
2019
2023
Today
2019
Global LNG trade doubles to 100 mtpa; Doubles again up to 2008 US recession; 2010 rebounds above 200 mtpa;
1990 - 2010
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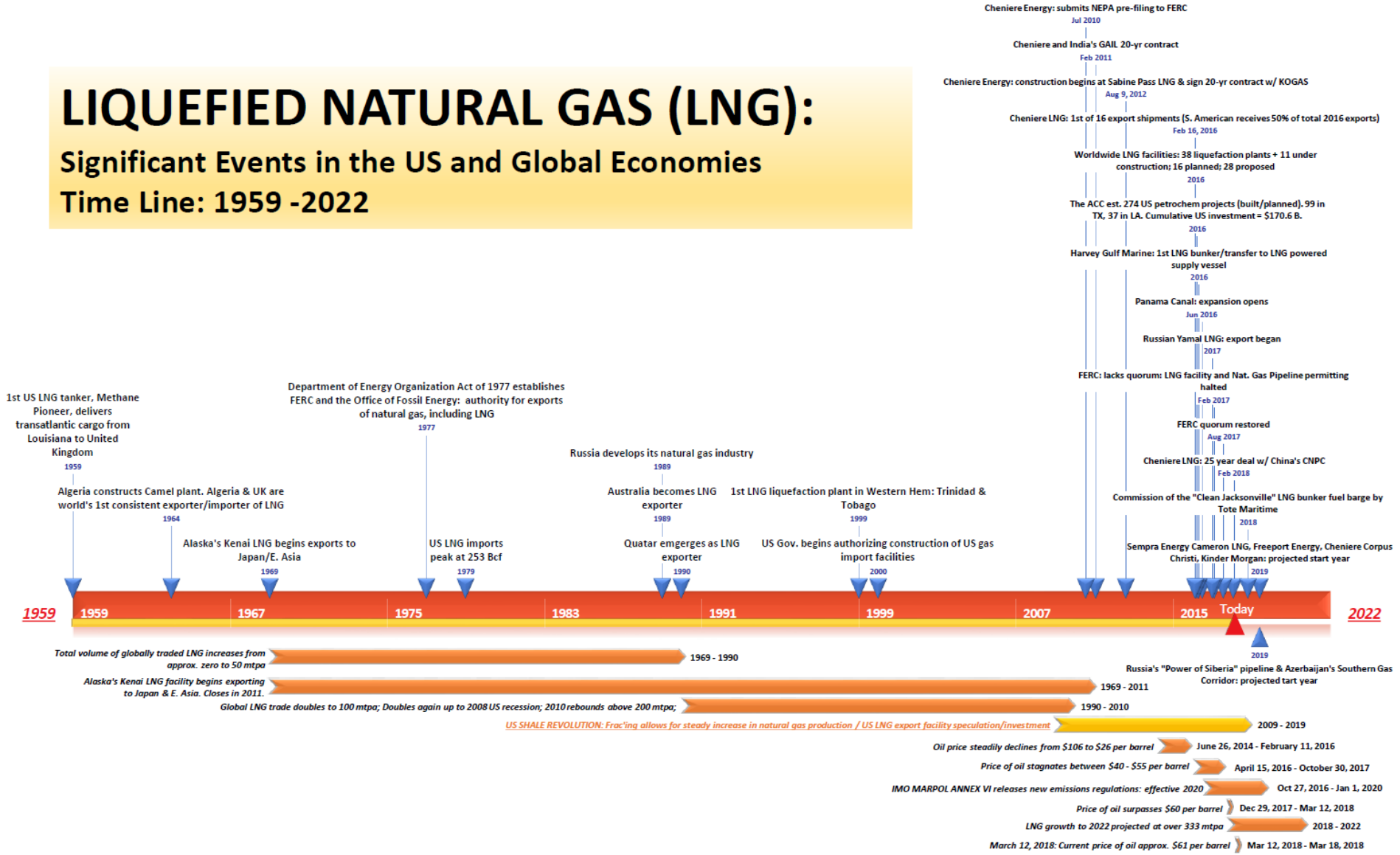
LIQUEFIED NATURAL GAS (LNG):
Significant Events in the US and Global Economies
Time Line: 1959 -2022
1st US LNG tanker, Methane Pioneer, delivers transatlantic cargo from Louisiana to United Kingdom
1959
Algeria constructs Camel plant. Algeria & UK are world's 1st consistent exporter/importer of LNG
1964
Alaska's Kenai LNG begins exports to Japan/E. Asia
1969
Department of Energy Organization Act of 1977 establishes FERC and the Office of Fossil Energy: authority for exports of natural gas, including LNG
1977
US LNG imports peak at 253 Bcf
1979
Russia develops its natural gas industry
1989
Australia becomes LNG exporter
1989
Quatar emgerges as LNG exporter
1990
1st LNG liquefaction plant in Western Hem: Trinidad & Tobago
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2018
Sempra Energy Cameron LNG, Freeport Energy, Cheniere Corpus Christi, Kinder Morgan: projected start year
2019
1959
1959
1967
1975
1983
1991
1999
2007
2015
Today
2022
2019
Russia's "Power of Siberia" pipeline & Azerbaijan's Southern Gas Corridor: projected tart year
Total volume of globally traded LNG increases from approx. zero to 50 mtpa
1969 - 1990
Alaska's Kenai LNG facility begins exporting to Japan & E. Asia. Closes in 2011.
1969 - 2011
Global LNG trade doubles to 100 mtpa; Doubles again up to 2008 US recession; 2010 rebounds above 200 mtpa;
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