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Phase II: The Future of LNG for the US and Gulf Coast Economies

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ABSTRACT

The continued growth of Liquefied Natural Gas (LNG) production and long-distance trade has traditionally been taken as a given by global energy analysts, who have premised their positive estimates on gas being both relatively scarce and demand for it virtually unquenchable. Unfortunately, current conditions in the global energy market suggest that what many have predicted as a near perpetual increase in the volume of traded LNG is in fact a bubble that is now in the process of bursting.

This report represents the efforts by the University of New Orleans Transportation Institute (UNOTI) beginning in 2014 to assist the Port of New Orleans (PONO) in evaluating the feasibility and best practices of equipping the PONO for potential storage and shore-side infrastructure for fueling vessels powered by LNG, as well as research into the feasibility of the widespread use of LNG as marine fuel, considering the new United Nation's International Maritime Organization's (IMO) MARPOL Annex VI maritime emissions regulations set to take effect in 2020. Additionally, this report examines both the short and long-term factors behind this new thinking about LNG, explore what it implies for the several multi-billion-dollar export projects being built in Louisiana, and the feasibility of LNG as a US export commodity and industrial feedstock to the petrochemical industry.

This report concludes by suggesting that development policy aiming to assist LNG export projects are likely misplaced, and that a primary focus on value-added petrochemical manufacturing, with a secondary value as potential for a marine fuel, is a more robust path for the region's policymakers to take.

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INTRODUCTION

The US Gulf of Mexico, long known for its offshore oil and gas production, has swiftly become an export nexus for America's onshore shale revolution. Ports and pipelines once geared to transport oil and gas sourced from abroad or pumped from the Gulf of Mexico into the interior of the country are now being harnessed to ship US-produced hydrocarbons to the rest of the world. While crude exports in the form of light-oil condensate have attracted most of the day-to-day headlines (Egan, M., 2016) huge, multi-billion-dollar investments in gas liquefaction facilities along the US Gulf coast are now being designed that could potentially remake global energy markets while simultaneously providing the basis for a long-term regional industrial revival, particularly in Louisiana.

According to the American Chemical Council (ACC), along the chemical corridor between New Orleans and Baton Rouge, LNG is fueling an industrial renaissance with over $47B being committed for industrial plant expansions or new builds, principally for the petrochemical and fertilizer sectors. Collectively, the state is seeing over $80B being committed for LNG related projects in all categories (Moore, M., et., al., 2016).

In addition to Louisiana’s currently operational and proposed LNG export facilities, the ACC has compiled a national list of 274 announced projects related to the shale oil and natural gas boom. The ACC notes that after years of volatile natural gas prices, the new shale gas economy creates a competitive advantage for U.S. manufacturers over global competitors that use more expensive, oil-based feedstock. The ACC estimates that once new projects come online after 2023, they could account for $93B in incremental output and generate approximately 62,000 direct chemical industry jobs in addition to an estimated 665,000 indirect jobs. Of the announced U.S. chemical industry investments, two-thirds are in bulk petrochemicals and plastic resins, comprising 500 companies in 40 states. Louisiana is sharing in this market growth from shale gas feedstock with the addition of twenty-six chemical industry related projects (See Table 5).

Although this is potentially good news for the US Gulf, there remain clouds on the horizon that are likely to cause economic hardship in the short-run and more significant obstacles longer term. Among these is the current depression in energy and commodity prices that has lingered since 2014, ushering in a new era of low prices for energy products. Underlying this is a global production glut in both oil and gas that has been caused by over investment on the supply side. On the demand side, significantly lower global economic growth, particularly in China, coupled with potentially disruptive changes in global trade agreements due to the new US government administration, are also conspiring to keep prices low, while renewables, long dismissed by fossil fuel analysts, wait in the wings to do to gas what they, in combination with gas, have done to coal. Together, they suggest a considerably dimmer view of LNG export development prospects than many will admit.

PROJECT DESCRIPTION

Phase I of this report was initiated to assist the Port of New Orleans (PONO) in evaluating the feasibility and best practices of equipping the PONO for potential storage and shore-side infrastructure for fueling vessels powered by LNG, as well as continuing to research the feasibility of the widespread use of LNG as a marine fuel in light of the new 2016 U.N. maritime emissions regulations set to take effect in 2020.

Phase II of this report examines global LNG trends and addresses the state of the LNG industry in Louisiana. This report examines and discusses both the short and long-term factors concerning the LNG export buildout in the context of global supply and demand, describes investment in such capacity to date, the crash in LNG prices, the crash's implications for the several multi-billion-dollar export projects being built in Louisiana, and the resulting feasibility of LNG as a US export commodity. In summary, some words of caution are offered about relying too much on a cyclical, boom-bust commodity business and give policy recommendations for more stable, long-term investment into LNG production and transport from the Gulf Coast.

METHODOLOGY

This report represents ongoing work conducted since 2014 studying the dynamic developments of Liquefied Natural Gas (LNG). The purpose is to gain a broad understanding of the potential effects of LNG commerce pertaining to three different components of Louisiana's oil and gas economy identified by UNOTI research staff: its use as a marine fuel; as an export commodity; and as an industrial feedstock, particularly for the chemical and fertilizer sectors. In addition to the literature review conducted, we used the following five qualitative methods based on our research needs:

Qualitative Methodology

- (1) Active Participant Observation
- (2) Individual open-ended qualitative interviews
- (3) Open-ended focus group interview with USCG personnel
- (4) Content analysis of secondary sources
- (5) Web-based review of the relevant federal and state regulations concerning LNG

Qualitative method one (1): employed active participant-observation which included the following organizations: The World Trade Center of New Orleans' Transportation Committee and the Regional Planning Commission's Freight Transportation Roundtable; USCG Sector New Orleans Local Area Committee.

UNOTI staff attended the Center for Planning Excellence Policy (CPEX) Forum "Boom Without Bust." Onsite visits to LNG bunkering facility at Port Fourchon, LA and key person interviews with Harvey Gulf International Marine personnel were conducted. Active participation occurred with the New Orleans Port Safety Committee. UNOTI staff attended the HHP (High Horse Power) Summit for the latest news of LNG facilities either being planned or under development at U.S. ports (Tacoma, Washington and Jacksonville, Florida) and participated in the Critical Commodities Conference in New Orleans to hear the latest news on the LNG industry and related perspectives such as the impact of the Panama Canal Expansion on LNG transport.

Qualitative method two (2): consisted of multiple individual open-ended qualitative interviews with the following industry leaders shown in Table 1.

QUALITATIVE METHOD TWO (2)		
INTERVIEWEE	JOB TITLE AND ORGANIZATION	TOPIC OF INTERVIEW
Chad Verret	Executive Vice President Alaska and LNG Operations / Project Director for Harvey Gulf International Marine's LNG-bunkered and OSV fleet facility at Port Fourchon, Louisiana	History of Harvey Gulf's involvement with LNG marine fueled OSV fleet, bunkering facility, permitting process and key public outreach reactions to LNG operation at Port Fourchon, Louisiana.
Davy Leblanc	Vice-President Fourchon Terminal Harvey Gulf International Marine: Galliano, Louisiana	Operator's perspective on LNG OSV fleet bunkering: safety, training, firefighting
Trevor Creel	Safety Manager of Port Facility	Safety issues of LNG bunkering, vessel fueling, operational procedures, firefighting
USCG officials	CDR Christopher T. Woodle Chief Prevention Department United States Coast Guard (USCG) Lieutenant Christopher G. Buckley Response Advisory Team USCG Eigth District Rsponse Department	LNG bunkering permitting processes and history of 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	Louisiana Economic Development (LED) [1]	Statewide impact of LNG on industrial expansions or new-builds within the Lower Mississippi River industrial corridoe and along the Calcasieu Ship Channel south of Lake Charles, LA. [1] The data which we obtained via discussions with LED through Spring of 2015.
Paul Aucoin	Executive Director of the Port of South Louisiana (PSL)	Impact of LNG as a feedstock on industrial expansions or new builds within the jurisdiction of the PSL

Table 1: Qualitative Method Two (2) Interviewees

For a national perspective, we interviewed industry professionals such as senior staff at USDOT's Maritime Administration (Washington, DC) and MARAD's New Orleans' Gateway office, USCG Sector New Orleans personnel regarding LNG as a marine fuel and the energy market, the Executive Vice President of LNG for Harvey Gulf International Marine, and a Board Member of the Natural Gas Supply Organization (NGSA), and members of the NGSA. The NGSA report entitled "Summer Outlook: Markets Matter" focuses on industrial demand. The low cost of natural gas is spurring 98 major industrial projects over the 2010-2020 decade, with the majority being new projects in petrochemical, fertilizer, steel, gas-to-liquids and paper/pulp. There are 29 expansions and 9 restarts. Total investment to build these proposed projects is estimated at $110-$120 Billion which will increase supply by 4.2 Bcf/d. (NGSA, 2015).

Qualitative method three (3): entailed an open-ended focus group interview with USCG personnel from Sector New Orleans to determine the potential for LNG as a bunkered marine fuel at the Port of New Orleans. These are the USCG 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 when the researchers are significantly lacking in information about the topic (Hesse-Biber & Leavy, 2011).

Qualitative method four (4): consisted of a content analysis of secondary sources derived from the following components: A review of industry standards for LNG bunkering authored by various consultancies; The review of all HHP whitepapers distributed post HHP; The 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. Our units of analysis were all references to the use of LNG as a marine fuel, as well as its wider industrial applications. Our unit of observation was all the media which are listed above.

Qualitative method five (5): a web-based review of the relevant federal and state regulations concerning LNG. From this review, we compiled the following summation of the permitting and application process for a hypothetical LNG bunkering facility at the port of New Orleans:

A proposed LNG bunkering facility at the Port of New Orleans would fall under the auspices of the federal and state regulations governing projects onshore or in state waters. Under the Natural Gas Act, the Federal Energy Regulatory Commission (FERC) has jurisdiction over the siting, construction and operation of facilities used for export or import of natural gas. The involvement of the Environmental Protection Agency (EPA) happens at this point.

When filing with FERC, multiple agencies work together to produce one National Environmental Protection Agency (NEPA) document. The relevant ones for the Port of New Orleans could include the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service. Multiple agencies are involved at this stage in consultation during planning stages to identify environmental impacts. The EPA may serve as the coordinating agency for the production of the Environmental Assessment (EA) or Environmental Impact Statement (EIS).

A determination of the proposed facility's compliance with Emissions Standards must be prepared. It includes which emissions are part of the stationary source & the size of emissions. For an LNG bunkering facility, the evaporation emission which occurs during the process of marine vessel fueling and filling of the storage tanks would be primarily methane. This applies to construction activities, operation of stationary equipment, and any vessels associated with the operation of the project.

After FERC has conducted the NEPA Review and issued authorization, upon approval of the EPA, the LNG project applies for permits. Regarding air quality regulations, the state (or local agencies) issue air permits based on EPA delegation or approval. FERC completes general conformity analysis, if applicable. In Louisiana, these regulations are subsumed under the jurisdiction of the Louisiana Department of Environmental Quality (LDEQ) by the EPA under the Environmental Regulatory Code (Environmental Regulatory Code LAC Title 33).

For water permitting, the LDEQ administers the Clean Water Act (CWA, section 402) by a memorandum of agreement with the EPA.

The Environmental Reports prepared in conjunction with FERC must be included in the application. They must provide concise, clear statements of any environmental impacts and proposed mitigation procedures.

For the Port of New Orleans, all required LNG siting interaction with United States Coast Guard is outlined in the rubrics of CFR 49-193 parts A & B. The most salient points of these regulations concern the following: Protection from thermal radiation (e-CFR: Title 49: Transportation PART 193—LIQUEFIED NATURAL GAS FACILITIES: FEDERAL SAFETY STANDARDS Subpart B—Siting Requirements. § 2057); Flammable vapor-gas dispersion protection (e-CFR: Title 49: Transportation PART 193—LIQUEFIED NATURAL GAS FACILITIES: FEDERAL SAFETY STANDARDS Subpart B—Siting Requirements. § 2059); Wind forces (e-CFR: Title 49: Transportation PART 193—LIQUEFIED NATURAL GAS FACILITIES: FEDERAL SAFETY STANDARDS Subpart B—Siting Requirements. § 2067); and Onsite impoundment tanks of a capacity able to withstand severe weather events (e-CFR: Title 49: Transportation PART 193—LIQUEFIED NATURAL GAS FACILITIES: FEDERAL SAFETY STANDARDS Subpart B—Siting Requirements. § 2181).

LITERATURE REVIEW

LNG, Then and Now

To better understand the current difficulties in the global energy market, it is helpful to first recognize the sea change that has occurred in LNG production and distribution. Long overshadowed by coal and oil for most of its history, natural gas as a fuel has been considered a local or, via pipeline networks, a national or geo-regional energy resource due to the difficulty in transporting it long distances. This despite the fact that the primary component of natural gas, methane, was first liquefied as far back as 1820 (Global CCS Institute, 2016). Given technological realities it was not until the beginning of the 20th century when cheap, reliable cooling methods were adopted on a widespread industrial scale, that LNG became more than a scientific curiosity. The sheer expense of the technology made it uncompetitive in all but the most niche markets until well into the post-World War II era. It took until 1959 for the first LNG tanker, the Methane Pioneer, to successfully deliver a transatlantic cargo from Louisiana to the United Kingdom (Global CCS Institute, 2016).

From 1959 to the end of the century, the LNG trade began to expand in tandem with the adoption of natural gas as an alternative to the burning of coal or the use of nuclear power in electricity generation. In Britain, the voyage of the Methane Pioneer proved high-volume LNG trade was possible, and the British Gas Council proceeded with plans to import gas into the UK. Venezuela was deemed the likely source of supply for this debut of the LNG trade, but discovery of gas in Algeria and construction of the 260- million cubic feet per day (MMcf/d) Camel plant in 1964 led UK importers to choose North Africa over Latin America (Foss, M., 2016). This made the UK the world’s first importer of LNG and Algeria the world’s first exporter, but the trade would quickly expand.

Just a decade after the first international delivery of LNG across the Atlantic, the Pacific region saw its own LNG trade develop when ConocoPhillips started up the Kenai plant in Alaska (Conoco Phillips, 2016). Supplied from Conoco's North Cook Inlet gas field, the plant liquefied approximately 30 million cubic feet per day (MMcf/d) of gas that was then shipped by LNG tanker to Japanese utilities (Conoco Phillips, 2016). Alaska's proximity to Japan and Japan's growing need for gas during the heyday of its post-war manufacturing boom established a base for what was in 1969 still an expensive, technologically-difficult operation when compared to the coal and oil trade. The Kenai plant would remain open and shipping gas for 40 years.

During this initial wave of global LNG production and distribution, the US would go on to build four plants: Lake Charles, LA; Everett, MA; Elba Island, GA and Cove Point, MA. Additional receiving plants would be built in Europe and Japan (Dominion, 2016). US LNG imports would eventually peak in 1979 at 253 Bcf due to an increase in domestic natural gas supplies, while European demand slackened due to the development of newly discovered oil and gas resources in the North Sea and increased energy trade with the eastern bloc and the Soviet Union via cross-border pipelines (Yergin, D., 1991). Still, by the late 1980s the total volume of globally traded LNG had increased from virtually zero to 50 million tons per annum (mtpa) in just 20 years, largely driven by demand from Japan and the growing economies of an emerging East Asia (Foss, M., 2016).

The end of the 20th century marked the beginning of another era of LNG. The first LNG liquefaction plant in the Western Hemisphere, outside the United States, came on stream in 1999 in Trinidad & Tobago, while increased natural gas demand in the US sparked new interest in LNG imports. Two of the four original regasification terminals built in the US were put back into operation, while the US federal government authorized construction of more US LNG import facilities. Elsewhere, Qatar emerged as a major LNG exporter in the 1990s, eventually rising to become the world's largest, on the back of its massive North Field offshore gas reservoir (U.S. Energy Administration, 2016). Australia became an exporter in 1989 with the inauguration of shipments from its North-West Shelf project in Western Australia, which would be joined by the Darwin LNG export facility in 2006 (Appea, 2016).

Because of this renewed interest in gas from developed economies and growing demand from emerging economies, the global trade doubled again between the 1990s and the 2000s to100 mtpa, and then doubled again after the turn of the century. Although the global recession sparked by the bursting of the US housing bubble in 2008 pushed LNG flows back below the 200 mtpa threshold, the ensuing recovery in growth has meant that by 2016 the trade has recovered and will expand, according to Goldman Sachs, to 333 mtpa (Murtaugh, D., 2016). Although global trade in LNG has hit new heights, the market has now reached a structural tipping point that portends a sea change in how the sector has until now been organized.

Renaissance or Entrenchment?

Long discounted because of its costs, technical innovations in the form of hydraulic fracturing and horizontal drilling has made extraction of resources from shale economical and relatively easy. In just the space of a few years, US shale oil production reinvigorated moribund US onshore drilling and forced Saudi Arabia to increase production in order to defend its share of the market from US producers. Importantly for LNG, the combination of hydraulic fracturing and directional, horizontal drilling of shale have unlocked truly staggering amounts of natural gas (See Figure 1).

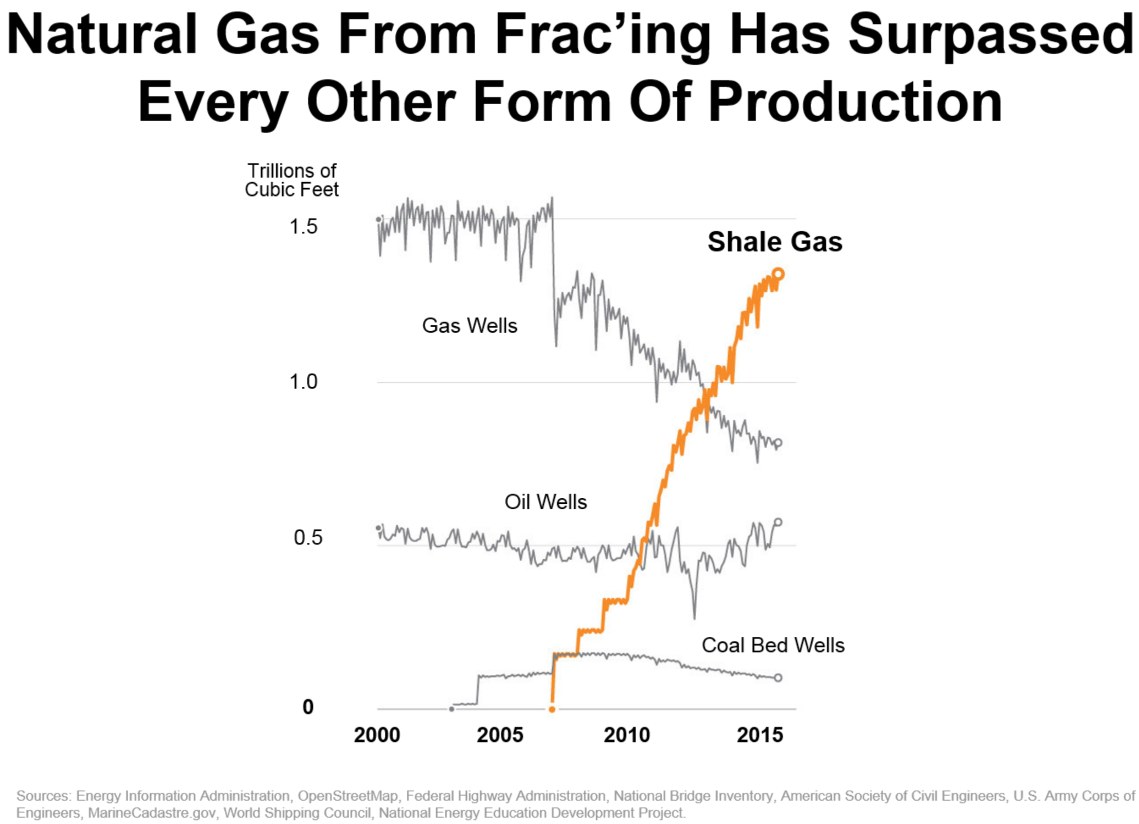

Figure 1. Natural Gas from Frac'ing. *Sources: Energy Information Administration, OpenStreetMap, Federal Highway Administration, National Bridge Inventory, American Society of Civil Engineers, U.S. Army Corps of Engineers, MarineCadastre.gov, World Shipping Council, National Energy Education Development Project.*

The US, for instance, is estimated to contain a recoverable 862 trillion cubic feet (Tcf) of natural gas (KPMG Global Energy Institute., 2016). As a result, US companies have responded by reversing course on construction of LNG import facilities. Instead, the focus now in the US market is the building of export terminals, and the first US cargo from this new wave of liquefaction plants was delivered in February 2016 followed by 19 more shipments through July 2016 (LNG World News Staff, 2016). US gas is now even reaching the Middle East, seemingly akin to carrying coal to Newcastle, with two US cargoes of LNG dispatched from Cheniere Energy's Sabine Pass plant in Louisiana being delivered to Kuwait and Dubai in the United Arab Emirates (UAE)—the first time US energy exports have been received in this region since the

1890s (Crooks, E., 2016). Other US LNG cargoes have been received in Latin America and India, and with the opening of the expanded Panama Canal, Asian markets may soon be receiving US LNG (Schuler, M., 2016).

Although the US shale revolution has yet to be replicated elsewhere, other countries are also estimated to possess large amounts of shale resources and can be expected to eventually unlock similar quantities of natural gas. More immediately pressing for the health of the LNG trade however, is the sheer amount of conventionally-derived gas that is also projected to enter the LNG market (See Figure 2).

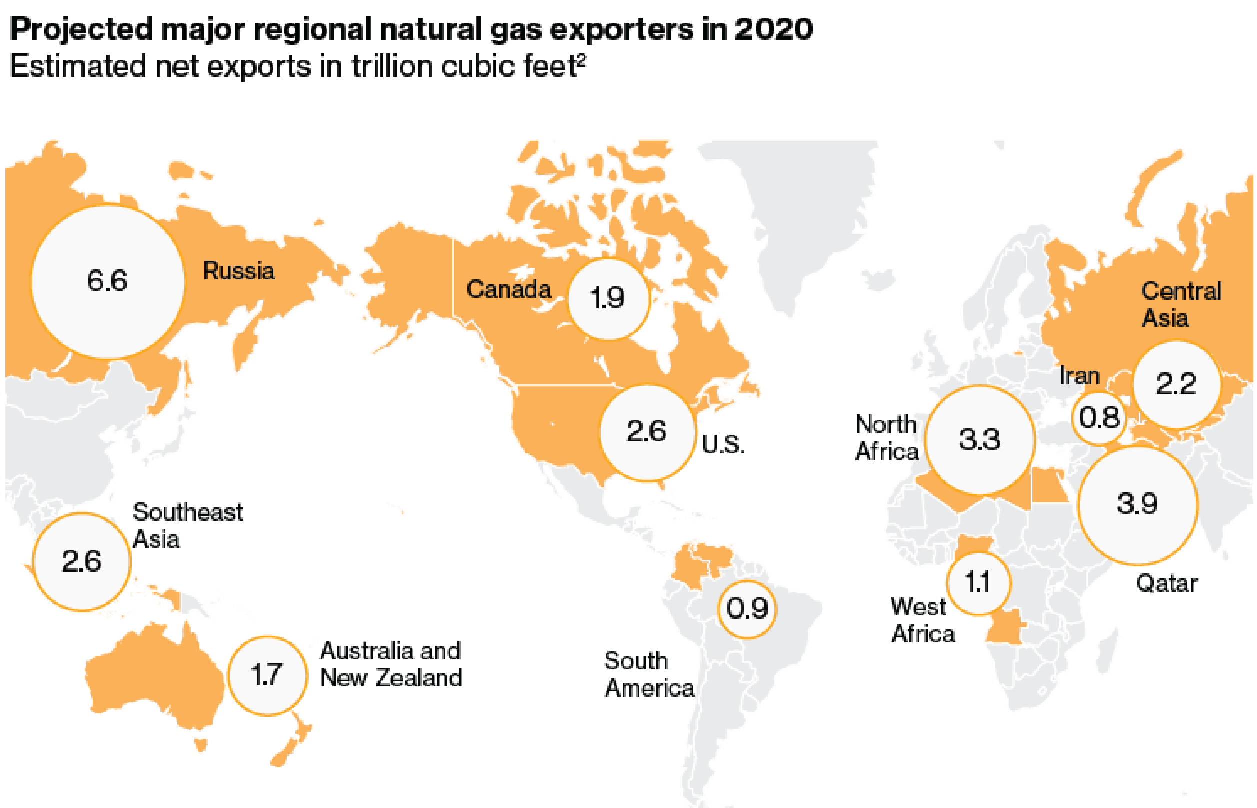

Figure 2. Projected Major Regional Natural Gas Exporters in 2020. Source: Bloomberg. https://www.bloomberg.com/graphics/2016-energy-pipelines/

Australia, for instance, will soon have ten LNG export projects up and running, and it is estimated that Australian LNG exports will surpass even those of Qatar by exporting 86 mtpa. None of this gas, it should be noted, is produced from shale as in the US. Of Australia's booming LNG business, 67% is sourced from conventional on and offshore gas reserves and the rest from onshore coal seam deposits. Although some of this gas will feed the Australian domestic market, the clear majority will be exported (The Oxford Institute for Energy Studies, 2014).

Australia isn't the only place where large amounts of LNG are about to be exported, nor the only place where purely conventional gas is being found or is about to be produced. To the north, in Canada, investors intend to build as many as 14 LNG export facilities (Marlow, I. and B. Jang, 2014). Meanwhile, East African offshore fields have been proven by separate consortia led by Italy's Eni, Norway's Statoil and US independent Anadarko to contain huge amounts of gas.

Mozambique's Rovuma Basin, for instance, contains over 80 Tcf (PLSX, 2016) while neighboring Tanzania's waters contains 57 Tcf (Reuters, 2016). In the Mediterranean, explorers have recently found a combined 50 Tcf spread across Egypt and Israel's offshore, while in West Africa a huge new gas province is being opened up in the waters off Senegal and Mauritania that could equal those already found off the continent's eastern coast (*Race on to Dominate East Mediterranean Super Hub*, PLS, February 15, 2016).

Finally, there is Russia, which contains massive gas reserves, all of which can be shipped to market via existing pipelines or planned pipelines and LNG projects now being built. Russia, for instance, intends to pipe 1.3 Tcf from Gazprom's Chayanda and Kovykta gas fields in Eastern Siberia to China every year via its 'Power of Siberia' pipeline starting in 2019 (Russia beyond the Headlines, 2016). On the opposite side of the country, Russia intends to expand its penetration of the European gas market with its Nord Stream II pipeline, which will bypass Gazprom's delivery route across Ukraine via a route across the Baltic. If completed, it will be able to deliver nearly 2 Tcf of gas per year to European markets (Farchy, J., 2016). Russian companies are also swiftly developing the Arctic Yamal-Nenets region, where Yamal LNG will put the first production train of a 16.5 mtpa project on stream in 2017 (Afansasiev, V., 2016).

The story is similar for other up and coming Eurasian producers. Iran's agreement to curtail its nuclear program, for example, has effectively freed it from most economic sanctions, and in addition to returning to the oil market Tehran will soon be putting large amounts of gas out to tender, too. Over the next five years, Iran plans to ship 2.4 Tcf per year to neighboring countries, with an additional 425 Bcf possibly going to export markets in the EU, India and East Asia (Khatinolgu, D., 2016). Azerbaijan and the rest of the Caspian Basin, meanwhile, is set to enter the European gas market when the Southern Gas Corridor, now under construction, is completed in 2019. It will ship over 500 billion cubic feet (Bcf) per year westward to customers in Turkey, Greece, the southern Balkans and Italy without the need to go through Russia (Crooks, E., 2016). Finally, Turkmenistan aims to produce and ship up to 3.4 Tcf per year by 2020 once several pipeline links to the West and China are completed (*Turkmenistan Find May Extend Giant Galkynysh Field*. PLS. 2016).

In summary, natural gas and LNG are not in short supply. As of 2016, the latest count of LNG facilities worldwide stood at 38 existing liquefaction plants, with another 11 currently under construction, 16 planned and 28 either proposed or under study (see Table 2).

These in turn supply the world's existing 115 regasification terminals. Another 16 such terminals are being built, while 26 are either planned or currently under study (Global LNG Info.com, 2016). This infrastructure buildout translates into an expected global LNG production capacity of 420 mtpa by 2020, but demand is actually forecast to shrink in that time even with more regasification terminals likely to come on stream in the near term. Goldman Sachs estimates that global demand for LNG is likely to drop 3% by 2020 to 323 mtpa—a drop of 10 mtpa from 2016's estimate of global production and consumption of the commodity—largely due to an increase in piped gas exports and slowing demand in China (Murtaugh, D., 2016).

Country	Liquefacation Plants On Stream
Australia	7
Qatar	6
Malaysia	3
Indonesia	3
USA	2
Norway	2
Egypt	2
UAE	1
Yemen	1
Trinidad & Tobago	1
Russia	1
Peru	1
Papua New Guinea	1
Oman	1
Nigeria	1
Libya	1
Equatorial Guinea	1
Brunei	1
Angola	1
Algeria	1
TOTAL	**38**

Country	Liquefacation Plants Under Construction
USA	5
Australia	3
Malaysia	2
Russia	1
Total	**11**

Country	Liquefacation Plants Planned & Proposed
USA	14
Canada	10
Russia	6
Australia	5
Nigeria	3
Mozambique	3
Papua New Guinea	1
Cameroon	1
Tanzania	1
Total	**44**

Country	Liquefacation Plants Suspended & Cancelled
Iran	3
USA	3
Indonesia	2
Australia	2
Colombia	1
Venezuela	1
Canada	1
Papua New Guinea	1
Total	**14**

Source: World's LNG Liquefaction Plants and Regasification Terminals. Global LNG Info.com. July 2016. http://www.globallnginfo.com/world%20lng%20plants%20&%20terminals.pdf. Accessed on July 12, 2016.

Table 2: Global Distribution of LNG production Plants on Stream, Under Construction, Planned & Proposed.

Therefore, prices are expected to remain low for years, with global energy consultancy Facts Global Energy (FGE) predicting that LNG, already down 68% from 2014, will fall to $3/mbtu by mid-2017 or 2018 (See Figures 3 and 4).

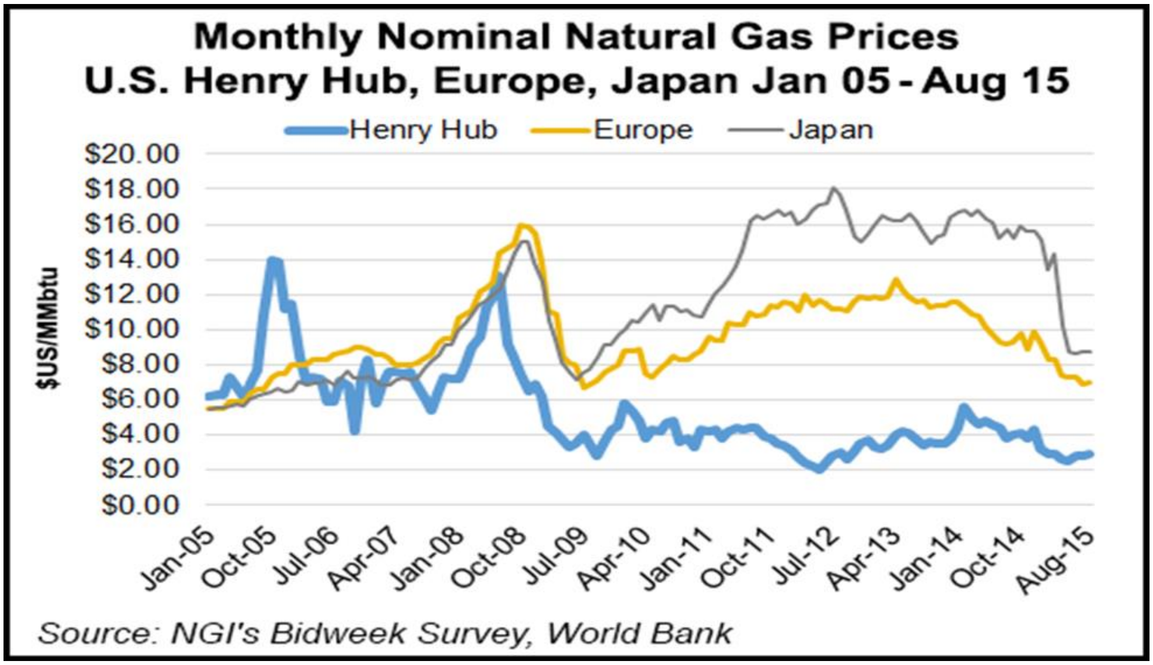

Figure 3. Monthly Nominal Natural Gas Prices 2005-2015 (Natural Gas Intelligence)

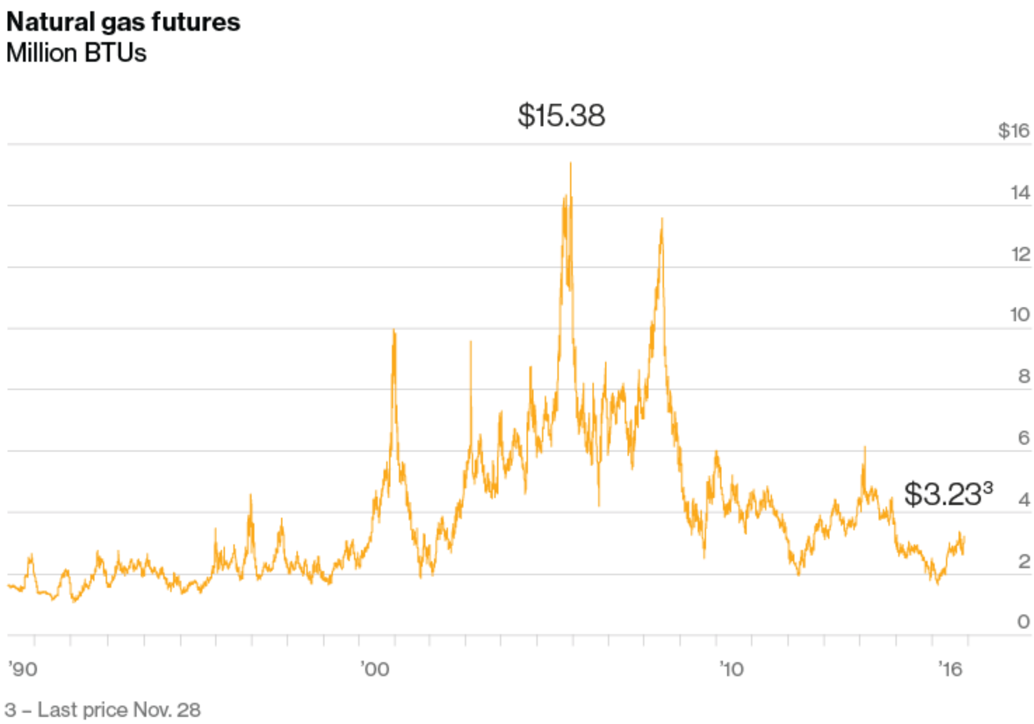

Figure 4. Natural Gas Futures. Source: Bloomberg. https://www.bloomberg.com/graphics/2016-energy-pipelines

The implication, said FGE Chairman Fereidun Fesharaki, is that some LNG producers, either in the US or Australia, will be forced to limit production in order to bring global supply into balance with demand. Although these low prices are good for consumers in the long run, in the medium-term producers are going to suffer greatly. Put simply, argues Fesharaki, "Some people are going to have to lose billions" (Murtaugh, D., 2016).

The prospect of an oversupplied LNG market for some years to come has in turn revolutionized the relationship between LNG producers and consumers. In the past, the 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 them. Without such security, investment becomes much riskier and therefore, less likely to occur in the first place. Now, 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 the end user who is only negotiating contracts, but middlemen traders as well (Russell, C., 2016 and Daiss, T., 2016). End users such as Japan are even getting into the game by reselling unneeded cargoes, turning what had once been long-term, steady customers of LNG producers into periodic competitors (McFarlane, S. and O. Vukmanovic, 2016).

Louisiana and LNG

Regarding the status of LNG as a marine shipping fuel, in many cases press releases and related journal or news reports exceed the actual realities of many projects, particularly in light of today's energy markets. For Louisiana, however, this is not the case. Louisiana's first LNG powered maritime project is now operational. Based at Port Fourchon, Royal Dutch Shell and Harvey Gulf International Marine, LLC completed the first LNG bunkering terminal and fuel transfer to an LNG powered offshore supply vessel in North America, in January 2016 (Ship and Bunker.com, Feb 16, 2016).

Historically, Louisiana has a long association with the LNG industry, beginning in 1959 with The Methane Pioneer. This proved that large quantities of natural gas could be transported safely across the ocean. Thus, began an ever-expanding relationship between LNG and Louisiana which continues to this day. LA has the first operating Offshore Supply Vessel (OSV) fleet and the first LNG bunkering station at Harvey Gulf's vessel facility, located at Port Fourchon on the Gulf Coast. However, in the current market, no other marine applications for LNG have been found within the state.

In other instances, however, LA is experiencing over $80B in industrial expansions or new-builds principally being driven by the abundance of LNG and its support infrastructure in the state and its emergence as a primary location for LNG export terminals. The first U.S. on-shore LNG Export Terminal, Cheniere LNG, is located on the Sabine River Pass on the LA-TX border in Cameron Parish (See Figure 5).

Figure 5. Cheniere's LNG Export Terminal, Sabine Pass, Cameron Parish, LA. Source: Cheniere Energy 2016.

The terminal is located at the widest point on the Sabine River with a maintained depth of 40 feet. The facility has two docks that do not protrude into the open waterway while docked. Four dedicated docks are stationed at the export terminal to ensure safe and timely escorts by crews specifically trained to berth LNG vessels. The terminal can simultaneously unload LNG vessels from each berth to maximize its efficiency and thru-put. It has five storage tanks with a combined capacity of 17 bcfe (billions of cubic feet equivalent). Phase 1 consists of four trains of which train 1 began operation in the first quarter of 2016 (An LNG train is a plant's liquefaction and purification facility). As of October 2016, train 2 has reached substantial completion. Phase 2 consists of two additional trains (3 and 4) which will be completed in late 2019. The total project is expected to cost more than $18B (Figure 6).

Figure 6. Cheniere LNG's Sabine Pass Liquefaction Projects: Trains 1-6. Source: Supply Update: Gulf of Mexico & Surrounding Area.

For Louisiana, there is an industrial revolution occurring due to the use of LNG as both an energy source and as an industrial feedstock. The low cost of LNG has fueled a renaissance in the chemical and related industries throughout the state but most are located within the Lower

Mississippi River, between Baton Rouge and New Orleans and below Lake Charles in Southwest LA. At a 2014 forum sponsored by the Center for Planning Excellence in Baton Rouge, the Louisiana Chemical Association's Executive Director Dan Borne described the net impact on his industry. "To date, we've seen over $80B announced for industrial new builds and expansions due to low-cost LNG. It's a renaissance for our industry and for the state." (Kemp, 2014).

Currently in Louisiana, there are 18 LNG-fueled industrial operations under construction in St. Charles, St. James and St. John parishes along the I-10 corridor between Baton Rouge and New Orleans (see Table 3).

CORPORATION	PARISH	CAPITAL $ billions	DIRECT JOBS CREATED
Nucor Steel - U.S.	St. James	$3.4	1250
Yuhuang Chemical - China (methanol)	St. James	$1.85	400
EuroChem - Russia (fertilizer)	St. John	$1.5	200
South Louisiana Methanol (U.S./New Zealand)	St. James	$1.3	63
AM Agrigen Fertilizers - India	St. Charles	$1.25	150
Monsanto Expansion - U.S.	St. Charles	$1.0	95
Entergy / Little Gypsy Expansion U.S.	St. Charles	$1.0	15 - 20
		CAPITAL $ millions	
Pin Oak Terminals - U.S. (crude oil)	St. John	$750	80 - 100
NuStar - U.S. (crude oil tank storage)	St. James	$365	32
Syngas Energy - Malaysia (methanol)	St. James	$360	86
Petroplex International - U.S. (crude oil)	St. James	$300	60
Marubeni Corporation-Gavilon Trading - Japan (grain)	St. James	$250	100
First Bauxite Corporation - Canada (proppants *sp?*)	St. John	$200	100
Bunge North America expansion - U.S. (grain)	St. Charles	$140	*
Momentive Specialty Chemicals	St. Charles	$38	8
Kongsberg Maritime - Norway (office & training)	St. Charles	$15	200
Denka Performance Elastomers - Japan (Corporate Headquarters)	St. John	*	16 (corporate)
Formosa Petrochemical Corporation - Taiwan (industrial complex feasibility study)	St. James	$9.4 (billion)	*
Total Capital Investment = $ 20.7 billion	**Direct Jobs Created= 2,855 - 2,880**		
Source: Paul Aucoin, Port of South Louisiana			

Table 3 - Developing LNG Based Projects in the Industrial Corridor within the Port of South Louisiana

Table 4 shows the status of six LNG export terminals currently under various stages of development in LA. Most recently, two more companies announced they are seeking approval from the Federal Energy Regulatory Commission (FERC) to build significant facilities south of New Orleans in Plaquemines Parish on both sides of the Mississippi River for exporting LNG to Europe and Asia beginning in 2020 (Associated Press, 2015). This is all due to the cost of LNG, the existing support infrastructure for LNG, and a trained workforce familiar with the technical issues associated with this cryogenic fuel.

LNG Export Terminals in Louisiana	Location	Project Cost	Capacity	Site	Direct Jobs	Indirect Jobs	Construction Jobs	Production Start	FERC Permit	Developer
Live Oak LNG	Calcasieu Ship Channel	$2 Billion	5 MTPA		100	385	1,000	late 2019	late 2016	Parallax Energy
Sabine Pass LNG		$18 Billion for 1st 4 trains	31.5 MTPA	1,000 acres				late 2015		Cheniere Energy Inc.
		Trains 5 & 6 pending								
		1st LNG Export Terminal to open								
Louisiana LNG	Plaquemines Parish									
Cameron LNG	Hackberry, LA	$10 Billion	12 MTPA					2018	9/10/2014	Sempra LNG, GDF SUEZ S.A., Mitsui & Co.
										Japan Investment, LLC
Magnolia LNG	Port of Lake Charles	$3.5 Billion	8 MTPA	115 acres	65-70	175	1,000	2018		Liquified Natural Gas Limited (Australia)
Sasol Ethane Cracker	Westlake, LA (near Lake Charles)	$8.9 Billion			500		3,300			
Venture Global LNG	Plaquemines, Parish West Bank		20MTPA	632 acres				2020	Pending	Venture Global
	Pointe-a-la-Hache									
Louisiana LNG	Plaquemines Parish, Davant East Bank		6MTPA	190 acres				2020	Pending	Louisiana LNG
	Lease from Plaquemines Port Harbor &									
	Terminal District									

Table 4 - LNG Export Terminals in Louisiana

Renewables on the Horizon

If a multi-year production glut and restructuring of the global LNG market from one that advantaged producers to one that advantages consumers were not enough, a final factor to consider is the long-term rise of renewable energy as a significant contributor to the global energy mix. Renewable energy technologies have long been discounted by analysts, particularly those immersed in the fossil fuel industry, as a non-factor in their supply-demand considerations, insofar as these technologies are mostly viewed as a threat to fossil fuel's share of the market in the distant future. Even then, gas producers see themselves as a bridge to that renewable energy future, and a vital component of this future given the presumed intermittency issues that will come with it.

Unfortunately, the future is either already here or coming very quickly. In the first quarter of 2016, the solar energy industry added more generating capacity than coal, natural gas and nuclear power combined (Solar Energies Industries Association, 2016). A total of 1,665 megawatts of solar was added in that time, accounting for 64% of all new US generating capacity and bringing the total number of solar photovoltaic installations across the country to over a million. In comparison, new gas-fired electricity generation that was installed in the US during the first quarter of 2016 was just 18 megawatts. When wind is added to the mix the gap becomes even starker, as new wind installations amounted to 707 megawatts.

Nor is this a one-time fluke, but, rather, the emergence of a long-term trend in electricity markets both in the US and around the world. The shift in investment into renewable energy and away from fossil fuel-based electricity generation began in 2013, when the world as a whole added 142 gigawatts of renewable capacity and 141 gigawatts in new fossil fuel generating capacity (Randall, T., 2015). This is largely being driven by dramatic and sustained drops in the price of renewable energy production, which is now on par or even cheaper than grid electricity in much of the world (Meyers, G., 2016). Solar and wind producers are now winning electricity generation tenders without subsidies, and in May Dubai's Electricity and Water Authority received a bid for 800 megawatts of electricity sourced from the Sheikh Maktoum Solar Park Phase III at a price of just $0.03 per kilowatt-hour. This price is not only a record low, but beats all available fossil fuel-based electricity options right in the heart of the oil and gas-producing Middle East (Apricum Group, 2016).

Capacity is not the same as actual power generated, of course, since the wind does not always blow and the sun does not always shine, but in US all forms of renewable electricity production, including hydroelectric, nonetheless stands at 14% of total produced—a not insignificant factor. In Germany, at the forefront of the renewable energy revolution due to significant government support, renewables have competed effectively not only against nuclear power which the Germans are phasing out, but also much cheaper coal and natural gas. In the period 2013-2015, German renewable generation increased 42 billion kilowatt-hours while natural gas dropped 11 bkwh, hard coal dropped 9 bkwh, lignite dropped 6 bkwh, and nuclear dropped 5 billion kilowatt hours (bkwh) (Romm. J., 2016). Meanwhile, Goldman Sachs predicts that between 2015-2020, "solar and onshore wind will add more to the global energy supply than US shale oil production did from 2010-2015 (42). In the US, wind alone could supply 20% of domestic electricity generation by 2030 (Walton, R., 2016).

FINDINGS

Significant factors such as the presence of Harvey Marine Gulf's LNG powered fleet and the new 2016 U.N. / IMO emissions regulations slated to take effect in 2020, indicate the feasibility of LNG as a marine fuel and the potential of equipping PONO for shore side infrastructure and storage of LNG and its use as a marine fueling facility.

Despite Louisiana experiencing a new cargo export potential with LNG and the subsequent construction and pending permitting of LNG Export Terminals in diverse locations along Louisiana's shorelines, the primary finding of this report, based on the state of the current energy market, precludes the utility of a focus on LNG as an export commodity.

Regarding the acceleration of LNG as an industrial feedstock, as supported by the American Chemistry Council's growth projection data for the use of LNG in the petrochemical industry, our fieldwork revealed a petrochemical manufacturing boom in the parishes between New Orleans and Baton Rouge. This secondary finding from our research is indicative that a primary focus on value-added petrochemical manufacturing is a more robust path for the region's policymakers to take, given the existing global glut and low price of oil and gas futures.

LNG as Marine Fuel

In addition to research of LNG as an export commodity and petrochemical industry feedstock, The University of New Orleans Transportation Institute (UNOTI) has spent 2.5 years researching LNG as a marine fuel. The first phase of this project was initiated in the summer of 2014 when the Port of New Orleans tasked UNOTI with investigating the feasibility of an LNG bunkering facility within their jurisdiction. UNOTI was approached when oil prices were peaking to develop an assessment of best practices regarding the construction of shore-side LNG bunkering facilities and the overall feasibility of an LNG fueling facility. At that time, the maritime industry was expected to convert their fleets from diesel to LNG, due to fuel cost savings and to follow compliance with anticipated environmental regulations. However, also in 2014, OPEC began dramatically decreasing the price of crude oil and, thus, the cost incentives for fuel conversion ceased to exist. LNG is less expensive than diesel, but the cost of retrofitting vessels for LNG or building new LNG fueled vessels negated its use as a marine fuel.

Since that time, crude oil prices continue to fluctuate. At their peak in June of 2014, oil prices were more than $110 per barrel (See Figure 7). As of Dec 2015, prices decreased by

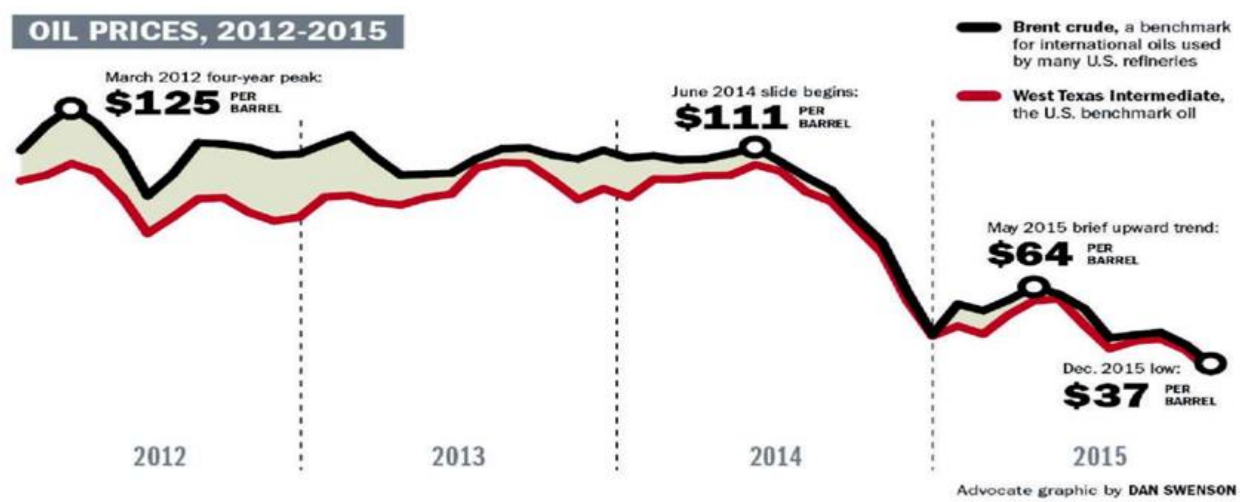

Figure 7: Oil Prices, 2012-2015. Source: Thomson, 2015.

$74 with the month’s average price per barrel being roughly $37. Through the end of 2017, oil prices are forecast to hover near the current price range of approximately $50-55 per barrel (See Figure 8). Consequently, the extended duration of depressed oil prices has the marine fuel component of the maritime industry in a holding pattern regarding the widespread adoption of LNG as fuel for marine vessels.

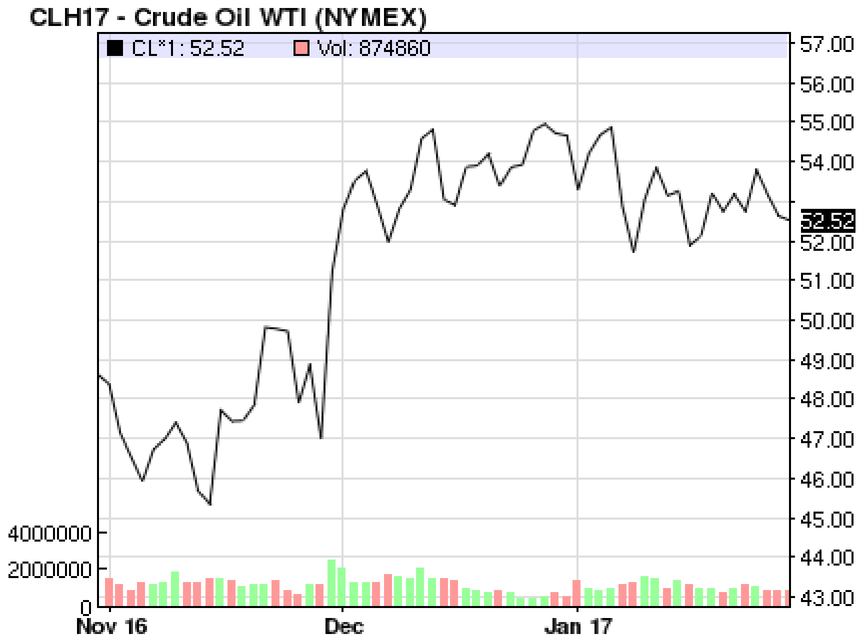

Figure 8. Price of crude oil per barrel as of January 30, 2017. Source: Nasdaq, 2017

Interviews with officials at the United States Coast Guard (USCG) Sector New Orleans and the US Maritime Administration (MARAD) have confirmed the opinion that for the near term, the relative cost of a barrel of crude oil will remain depressed from peak 2014 levels. Thus, up until October 27, 2016 when the International Maritime Organization (IMO) released its new MARPOL ANNEX VI emissions regulations (Saul, J., 2016), there has been little interest in using LNG as a marine fuel within the Lower Mississippi River region, primarily caused by the decrease and continued fluctuation of the cost of oil. In this environment, large scale investment decisions by shipping companies, marine terminal operators, port authorities or other financial interests particularly in the United States, had been put on hold. Because of the new U.N. emissions regulations, the outlook on LNG as a marine fuel may change significantly as IMO MARPOL ANNEX VI regulations are required to take effect by 2020. But overall, based on the combination of the ongoing price depression of available “clean” crude oil, the feasibility to retrofit emissions systems of existing diesel-powered ships with “scrubbers” to reduce emission rates, and the rate at which there is demand for new ships that are built with LNG powered technology, the future of an LNG-as-marine-fuel energy sector remains blurry.

Our findings regarding the economic potential of LNG bunkering by ports as a marine fuel – in addition to its access by fleets – show that ports and shipping lines that completed these projects by 2013 are probably seeing a significant return on their investments. However, given the current volatility of global energy markets, which is projected by many to extend for the foreseeable future, existing conditions in the energy sector makes capital investment in LNG as a marine fuel a risky endeavor. How long will it remain risky is the big question? Our sources uniformly predicted that this would be the case pending global imposition of environmental regulations – i.e. penalties or carbon taxes – which would make compliance by means of LNG bunkering and fleet conversion regulation driven.

Given the new IMO regulations that call for maritime emissions reductions by 2020, the best recommendation that can be made from this research at present is for the Port of New Orleans to join with the International Chamber of Shipping (ICS) in encouraging the IMO division of the United Nations to continue taking the lead in globally-applied emissions standards. These standards, recently updated at the 21st Conference of the Parties (or "COP") to the United Nations Framework Convention on Climate Change (UNFCCC) – generally referred to as COP21 – are summarized as "Mandatory regulations already adopted by IMO [which] will ensure that all ships built after 2025 will be at least 30% more efficient than ships operating today. Combined with further technical and operational measures plus new technology, international shipping should be able to reduce its CO2 per tonne-kilometre by 50% before 2050" (Hinchcliffe, 2015).

The ISC adds that it will be paramount to “ensure that sufficient quantities of compliant marine fuel of the right quality will indeed be available, and that this radical switchover to cleaner fuels will be implemented smoothly, in a harmonized manner, without distorting shipping markets or having negative impacts on the movement of world trade, about 90% of which is carried by sea” (gCaptain, 2016). As the shipping industry is committed to the most rapid reduction possible of its share of greenhouse gas emissions, and the transfer of the global shipping fleet to LNG is the most efficacious way to attain this end, the Port of New Orleans would be best advised to aggressively support an IMO-derived driven global implementation of policies which would make this fleet conversion ultimately more cost effective than continued reliance upon cheap diesel as a marine fuel.

During the Spring of 2014, there was a harbinger of this activity which the Port of New Orleans was well-advised to participate in: “Companies with some extensive marine and liquefied natural gas (LNG) expertise have joined in an effort to provide LNG as a maritime fuel globally…the goal is to make LNG the ‘marine fuel of choice’. Siemens Drilling and Marine, a second Siemens' business, Dresser-Rand (D-R), and Lloyd's Register (LR) are joining forces to provide marine vessels powered by natural gas, seeking to meet the increasingly tougher emissions standards for shipping regionally and globally” (Nemec, 2015).

The new U.N. / IMO standards will enforce a decrease of sulfur emissions from its current maximum rate of 3.5% of fuel content, down to 0.50% (Saul, J., 2016). Heavy fuel oil refiners will undoubtedly be affected by the new mandates. “Around 3 million barrels per day of high-sulfur fuel oil go into bunker fuel for ships, and most of that will be replaced with lower-sulfur distillates” according to Reuters. "Refiners will not invest to de-sulfurize fuel oil and there is not enough low-sulfur fuel oil to meet demand from the shipping sector," said Robert

Campbell, head of oil products research with consultancy Energy Aspects. As a result, refineries that don't have the ability to convert fuel oil into higher quality gas products may find it difficult to remain profitable as the demand for lower-quality fuel disappears due to this new U.N. regulation. As a result, this could prove beneficial to Louisiana, to boost demand for investments and further research into using LNG as a marine fuel. On October 31, 2016, the ICS said that "the clear decision about implementation in 2020 should make it easier for ship owners to consider alternative compliance options such as fitting exhaust gas cleaning systems ('scrubbers') or using low sulphur fuels such as LNG. However, overall uncertainty about future oil and gas prices – aside from uncertainty about likely differentials between low sulphur and residual fuel in 2020 – mean that such decisions will not be easy" (gCaptain, 2016).

Despite the uncertainties surrounding LNG as a marine fuel, Louisiana is home to the nation's first LNG powered fleet of offshore supply vessels operated by Harvey Gulf Maritime International (HGMI – Figure 9) who built the first LNG bunkering station in the U.S. at their offshore supply vessel (OSV) facility at Port Fourchon, LA. Where there previously existed little interest among users of the Port of New Orleans for LNG bunkering as well as there being no market demands in the region for LNG marine fuel, there is potential for interest in both to be rekindled in response to the new U.N. fuel emissions regulations.

Figure 9. Harvey Gulf International Marine Offshore Vessel, Port Fourchon, LA 2015. Photo: Piellisch, 2015.

Implications for Louisiana and the US Gulf Coast

To summarize, current trends in the global LNG market are not very conducive to more investment in additional production facilities, and it is likely that many of the planned export terminals and liquefaction plants now being planned will end up never being built (See Figure 10). Moody's has already come to this conclusion, and issued a market warning in 2014 that argued that "the vast majority of the nearly 30 liquefaction projects currently proposed in the US, 18 in western Canada, and four in eastern Canada," will be cancelled (Walton, R. 2016). The logic, says the ratings agency, is that the drop in oil prices, to which many LNG contracts are tied, relative to US gas prices has "wiped out" the price advantage that US-based LNG projects enjoyed vis-à-vis their competitors. As of the end of October 2016, crude oil prices remain low due to deadlock at a technical OPEC meeting in Vienna where the goal to come to an agreement on an output reduction deal, set in motion in September 2016, could not yet be agreed upon

(Spivak, I., 2016). This is indicative that disagreement among OPEC member states may continue as they try to work out a coherent supply management plan. When this OPEC plan materializes is left to be determined.

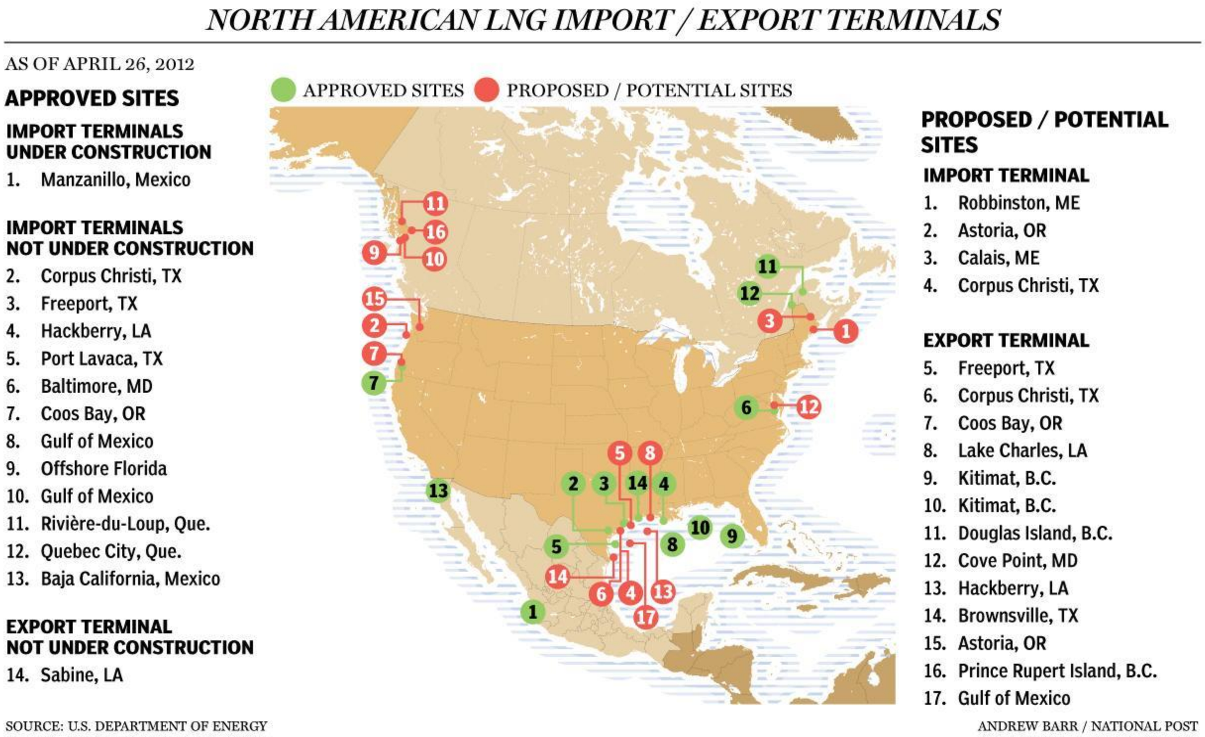

Figure 10. North American LNG Import/Export Terminals. Source: McAllister & Jones, 2012 & US Department of Energy.

Although some projects now under construction will get built, those plants which eventually get to produce will enjoy a classic first-mover advantage that will not apply to companies following in their path. The addition of even more LNG onto the market will merely push prices lower for longer, eliminating any incentive investors may have in risking additional capital in second wave projects once the current export infrastructure buildout comes to a halt (de Vriend, W., April 12, 2016). In other words, the golden age of gas and LNG that many have predicted and invested billions into creating is looking more and more like a bubble caused by cheap credit and expectations of demand growth that are simply not coming true.

The best example of this latter phenomenon is China, which the International Energy Agency (IEA) in 2011 predicted would go from consuming as much gas as Germany consumed in 2010 - 2.62 million Tera joules (TJ) - to that of the entire EU in 2035. The IEA made similarly positive predictions for demand in both the Middle East and India. It predicted Indian demand for gas would quadruple from 2011 consumption levels of 1.33 million TJ by 2035 (de Vriend, W., April 13, 2016). Trade in gas between the major regions of the globe was in turn expected to be over 35 trillion cubic feet by 2035, with LNG taking up a good portion of that total. Now, IEA believes demand for LNG will be much less than anticipated, arguing in 2015 that “the belief that Asia will take whatever quantity of gas at whatever price is no longer a given. The experience of the past two years has opened the gas industry's eyes to a harsh reality: in a world of very cheap coal and falling costs for renewables, it was difficult for gas to compete” (de Vriend, W., April 12, 2016).

This leaves the US Gulf in a complex situation. In Louisiana, for example, a total of nine major LNG export terminals are currently in various states of operation and planning (See Figure 11). Cheniere Energy’s 31.5-mtpa Sabine Pass plant is currently the lone operational facility, which put its first production train on stream in January 2016. The other projects being developed in the state include the other Cameron Parish facilities: The 8-mtpa Magnolia LNG plant at the Port of Lake Charles; Live Oak LNG’s 5 mtpa facility on the Calcasieu Ship Channel; Sempra Energy’s Cameron LNG 12-mtpa project in Hackberry LA; G2 LNG’s 14 million tons per annum (mtpa) project also on the Calcasieu River Ship Channel; and SCT&E LNG’s 12-mtpa project on Monkey Island. Two more facilities underway in Plaquemines Parish are Shell’s 6 mtpa Louisiana LNG project in Port Fourchon, LA (which includes bunkering for

Harvey Gulf's LNG powered offshore supply vessel fleet) and Venture Global LNG's proposed 20-mtpa facility at Port Sulphur (Federal Energy Regulatory Commission, 2016).

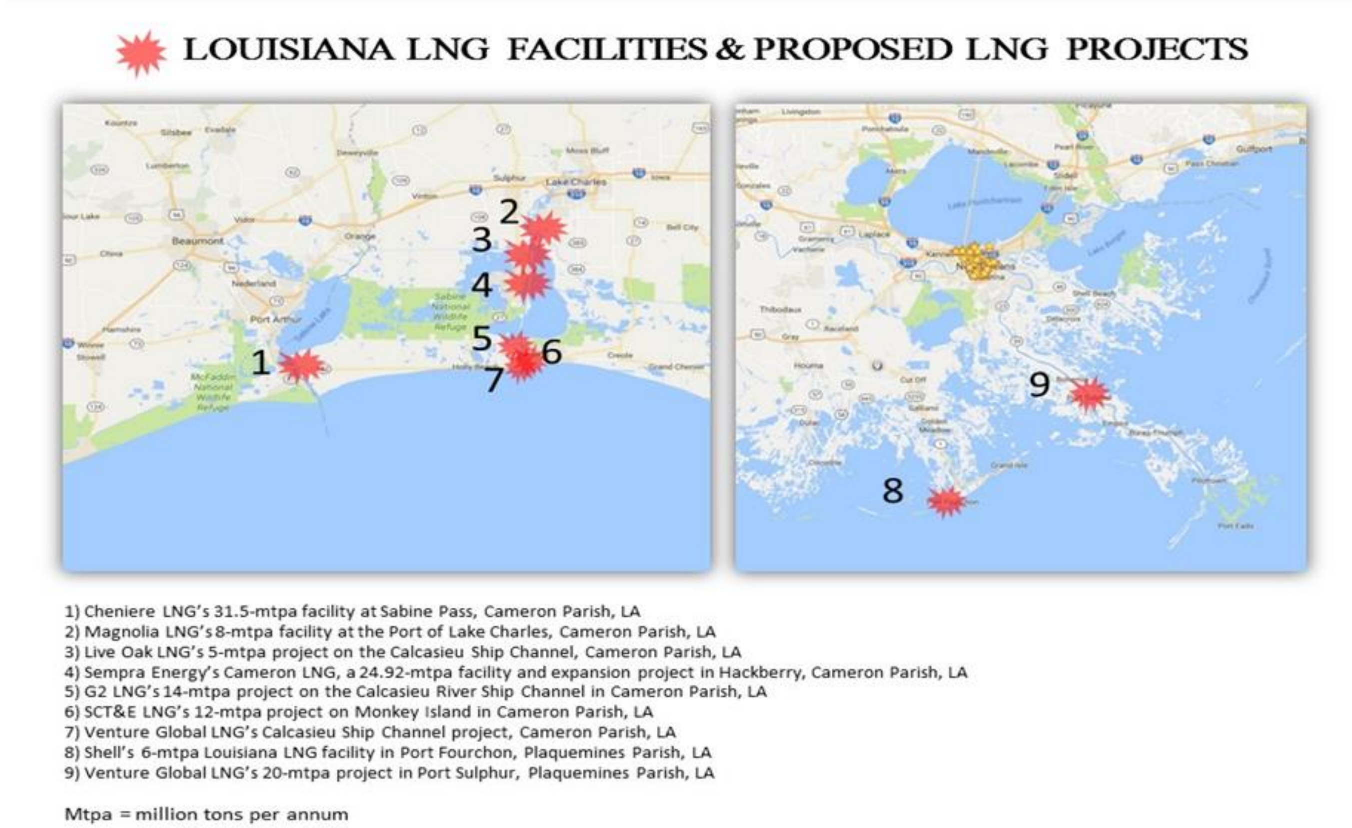

Figure 11. Louisiana Existing and Proposed LNG Facility Map. Source: UNOTI 2016.

It remains to be seen whether these projects will eventually come to fruition and, if built, will be constructed to their nameplate capacity. Already, Shell has decided to defer a Final Investment Decision for Louisiana LNG for at least a year, a follow up to a similar decision the UK supermajor made in regard to its Kitimat LNG project in British Colombia, Canada (Williams, S., 2016). Other projects have been similarly delayed, with the Brookings Institution releasing a report just that echoes Moody's 2015 market assessment. Brookings believes that only five US LNG plants, including two already on stream, will eventually be completed (Meyers, R., 2015). Increased competition from other LNG producers and natural gas suppliers, an overall slump in demand growth, especially in China, and the prospect of an eventual rise in US natural gas prices due to increasing use of America's cheap gas as an industrial feedstock in the petrochemical sector are viewed as the primary culprits.

Petrochemicals, Not LNG

Looking ahead, it would appear that the US Gulf Coast's major industrial growth engine will be LNG as a feedstock for petrochemicals, and to a lesser or to-be-determined extent, as a marine fuel. Already, investment in petrochemicals along the Gulf Coast is expected to outpace that of LNG as an export (Olson, B. And A. AL Orman, 2016). As of April 2016, The ACC estimated a total of 274 announced petrochemical projects being built or planned, representing a combined investment of $170.6billion for the US as a whole (Moore, M., et., al., 2016). Of these, 99 are based in Texas with 26 in neighboring Louisiana (Blum, J., 2015). All are taking advantage of plentiful cheap natural gas that is now available in the US to make high-value industrial feedstocks and consumer products, likely earmarked for export, as overall US demand for petrochemicals is projected to remain flat (Blum, J., 2015).

Among the plants in Louisiana being built or expanded as a result of the influx of cheap natural gas from shale is a $3 billion joint venture between South Korea's Lotte Chemical Corp. and LACC LLC, Atlanta, a subsidiary of Axiall Corp to construct an ethane cracker (a facility that breaks up ethane gas molecules resulting in ethylene, which is used to manufacture plastics, used in 90 percent of manufactured products) and monoethylene glycol plant, which broke ground in June 2016 (Brelsford, R., 2016). Another is Sasol's integrated ethane cracker and downstream derivatives complex now under construction in Westlake, LA, that is scheduled to become operational in 2018 (Oil & Gas Journal, 2016). Meanwhile, Yuhuang Chemical aims to start construction of one of the biggest methanol production plants in the US at a 1,300-acre site in Louisiana's St. James Parish late in 2016 (Petrochemical Update, 2016).

Louisiana is clearly sharing in the market growth from shale gas feedstock with the addition of 26 chemical industry related companies with a total of 37 existing or planned projects (Moore, M., et., al., 2016). (See Table 5)

TABLE V	LOUISIANA VALUE ADDED PETROCHEMICAL FACILITIES					
	PRODUCT TYPE					
	ETHANE CRACKER	ETHYLENE	FERTILIZER	AMMONIA	EPDM, GMA (adhesives)	METHANOL / OTHER
FACILITY NAME / LOCATION						
AM Agrigen Industries (St. Charles Parish, LA)						X
Axiall/Lotte Chemical (Lake Charles, LA)	X					
CF Industries (Donaldsonville, LA)			X			
Dow Chemical (St. Charles, LA; Plaquemine, LA)	XX				X	X
Dyno Nobel/Incitec Pivot (Waggaman, LA)				X		
EuroChem (St. John the Baptist Parish, LA)			X			
Formosa (Point Comfort, LA; James, LA)	XX					X
Hexion (expansion in LA)						X
Huntsman Corporation (Geismar, LA		X				X
Indorama Ventures (Lake Charles, LA)		X				X
Investimus Foris (Grant Parish, LA)				X		
Lion Copolymer (Geismar, LA)					X	
Lotte Chemical (Plant in LA) and Lotte Chemical/Mitsubishi Chemical (at Lake Charles, LA)						XX
Matheson (Lake Charles, LA)	X					
Methanex (Geismar, LA)						X
Mosaic Company (Faustina, LA)				X		
Nachurs Alpine Solutions (St. Gabriel, LA)			X			
PotashCorp (Geismar, LA)			X			
South Louisiana Methanol (James Parish, LA)						X
Stepan Co. (Ascension Parish, LA)						X
Syngas Energy Holdings (St James Parish, LA)						X
Valero Energy (methanol plant at St. Charles, LA)						X
Westlake Chemical (Lake Charles, LA; Sulphur, LA; Geismar, LA)	X	X				X
Williams Olefins (expanding ethylene, propylene capacities and possible second cracker at Geismar, LA)	X	X				X
Yuhuang Chemical (methanol plant and derivatives at St James Parrish, LA)						X
SOURCE: Note On Shale Gas, Manufacturing & The Chemical Industry. American Chemical Council. September 7, 2016.						

Table 5: Louisiana Value Added Petrochemical Facilities. Source: American Chemistry Council 2016.

Altogether, the Louisiana Chemical Association estimates that over $47 billion in new industrial investment related to cheap natural gas has already been committed in the state (Petrochemical Update, 2016). To this may soon be added a planned ExxonMobil-Saudi Basic Industries Corp. petrochemical plant aiming to produce and ship chemicals and plastics to customers outside the US from a to5be-chosen site in either Texas or Louisiana (Olson, B. And A. AL Orman, 2016).

CONCLUSION

Looking to the Future

Although the Gulf Coast's petrochemical buildout is prone to the same boom-bust dynamic and macroeconomic forces that are now negatively affecting LNG (Blum, J., 2016), it nonetheless provides a good example of the type of value-added manufacturing-based development that is really what the region, and the US as a whole, need. Whereas LNG is at heart a simple, capital-intensive resource extraction operation that ships energy from one global region to another, energy-intensive petrochemical production and distribution can likely provide a broader, deeper industrial revival in the region than simply pumping gas, freezing it and then sending it overseas for others to either burn for electricity production or process into more valuable products.

If, as has often been said, burning oil in internal combustion engines is akin to lighting a Picasso on fire to produce heat – due to the inherent value of petroleum in the petrochemical business – then doing the same for natural gas, the so-called queen of the fossil fuels, is doubly foolish. Capturing more of the long-term value chain that cheap natural gas represents should therefore be a top priority for policy makers along the US gulf coast, much as it has become the priority in other major hydrocarbon-producing regions in the world. Saudi Arabia, for instance, has recently announced a multi-year, multi-billion-dollar initiative to diversify its economy away from oil and natural gas towards exactly the kind of advanced manufacturing which the discovery and development of vast quantities of shale gas once again makes possible in the US (Al Omran, A. and Stancati, M., 2016). Plentiful amounts of inexpensive industrial feedstock and relatively low-carbon energy should not be something the US should be so eager to ship abroad.

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