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LNG Bunkering for Marine Vessels at the Port of New Orleans: Siting and Facility Components
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PROJECT DESCRIPTION

ABSTRACT

This paper represents the efforts by the Merritt C. Becker, Jr. UNO Transportation Institute (UNOTI) to assist the Port of New Orleans (PONO) in evaluating the feasibility of equipping the PONO for the storage and shore-side infrastructure needed for fueling vessels powered by Liquefied Natural Gas (LNG). The report gives the current status of various projects that have been built according to site-specific applications of best practices in the industry and related regulatory agencies. 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. Since that time, crude oil prices have been falling significantly. At their peak they were in excess of \$115 per barrel. Today, the price per barrel is roughly \$37. This is a decrease of \$80 over a very short period of time. Consequently, as indicated by an 18 month literature review, key person interviews and discussions with a knowledgeable group of regional stakeholders, the extended duration of depressed oil prices (which continues downward) has the marine fuel component of the maritime industry in a holding pattern regarding the widespread adoption of LNG for marine vessels.

However, this is not the case for either LNG as an export commodity or as an industrial feedstock within Louisiana. There are significant LNG export terminals under various stages of development with the first project being Cheniere's Sabine Pass LNG Export Terminal, which plans to ship its first LNG cargo in January 2016. Along the chemical corridor between New Orleans and Baton Rouge, LNG is fueling an industrial renaissance with over \$22B 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, with another concentration of projects south of Lake Charles, LA. Most recently two projects were announced in Plaquemines Parish, downriver of New Orleans, on both the East and West Banks of the Mississippi River. These additions show the geographic distribution of LNG Export Terminals statewide.



Figure 1. Harvey Gulf International Marine Offshore Vessel ,Port Fourchon, LA 2015 (Piellisch, 2015)



Figure 2. Cheniere's LNG Export Terminal, Cameron Parish, LA (Dlouhy, 2014)

EXECUTIVE SUMMARY

The University of New Orleans Merritt C. Becker Transportation Institute (UNOTI) was approached by the Port of New Orleans in 2014 to develop an assessment of best practices regarding the construction of shore-side LNG bunkering facilities and the overall feasibility of the LNG fueling facility. When this request was made, the maritime industry was expected to convert their fleets from diesel to LNG, due to fuel cost savings and in compliance with planned environmental regulations. However, when OPEC began dramatically decreasing the price of crude oil in the mid-2010s, these cost incentives ceased to exist, especially the economic factor. LNG is less expensive than diesel, but the cost of retrofitting vessels for LNG or new-building LNG fueled vessels currently negates its use. We reached this conclusion after many open-ended interviews with regional and Port stakeholders as well as a focus group with United States Coast

Guard (USCG) Sector New Orleans personnel who are responsible for the regulatory compliance of LNG situated bunkering facilities within the PONO. This focus group was our source for the probable price of crude oil and its relation to LNG as a marine fuel. In their opinion (USCG) the price of oil will remain depressed for probably 5 more years which will impede the widespread use of LNG as a marine fuel, barring the imposition of global environmental regulations which would make fleet conversion a regulatory necessity. The prolonged time factor, and the continuing uncertainty about oil prices, according to both USCG, USDOT MARAD representatives and national / international experts, is impeding the maritime industry from adopting LNG as a viable fuel.

Consequently, there exists today no interest among users of the Port of New Orleans for LNG bunkering. Further, there are no market demands in the region for LNG marine fuel. What does exist are the general requirements outlined in the Code of Federal Regulations (CFR); specifically CFR 33-127-B, as the current state of best practices for LNG bunkering. Of greatest concern to the USCG are severe weather events, proximity to neighborhoods, and proximity to roadways.

UNOTI has also compiled various statistics on the use of LNG as an industrial feedstock for the resurgent redevelopment and expansion in the Louisiana industrial corridor along the Lower Mississippi River between Baton Rouge and New Orleans. As well, LA has multiple LNG export terminals either under construction, awaiting permitting by FERC or in the planning stage. For these later two categories, LNG is a hot commodity in Louisiana.

Louisiana is home to the nation's first LNG powered fleet of Offshore Supply Vessels operated by Harvey Gulf Maritime International (HGMI) who built the first LNG bunkering station in the U.S. at their OSV facility at Port Fourchon, LA. The state will also be home to the

first LNG Export Terminal, scheduled for its first shipment in January of 2016: Cheniere's Sabine Pass LNG Onshore Export Terminal in Cameron Parish. There are numerous other LNG export terminals currently under development, but the nation's energy markets make their future somewhat cloudy.

LNG as a feedstock for numerous industries is evident, particularly in the chemical and fertilizer sectors, and is causing an industrial revolution along the Mississippi River between New Orleans and Baton Rouge, south of Lake Charles along the Sabine Pass at the Texas / Louisiana border, and downriver of New Orleans where new export terminals are being planned. Finally, UNOTI has put these projects within a national perspective regarding the supply and demand of LNG using the latest projections from the Natural Gas Supply Association's (NGSA) 2015 Summer Outlook.

BACKGROUND

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. Our first marine powered LNG maritime project is now operational based at Port Fourchon and the first LNG Export Terminal will ship its maiden cargo of LNG in January 2016.

Historically, Louisiana has a long association with the LNG industry, beginning in January 1959 when the first LNG-transporting vessel, The Methane Pioneer, sailed from Lake Charles, Louisiana to Canby Island, United Kingdom. This event 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 Vessels (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 is located along the Calcasieu Ship Channel on the LA-TX border in Cameron Parish. The terminal is located at the widest point on the Sabine River with a maintained depth of 40 feet. It will have 2 docks that will not protrude into the open waterway while docked. Four dedicated docks will be 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 will have 5 storage tanks with a combined capacity of 17 Bcfe (billions of cubic foot equivalent). Phase 1 consists of 4 trains which will be complete in late 2015 and operational in the first quarter of 2016. Phase 2 consists of 2 additional trains which will be completed in 2019. The total project is expected to cost more than \$18B. (An LNG train is a plant's liquefaction and purification facility.)

Design production capacity is expected to be ~4.5 mtpa per train



Significant infrastructure in place including storage, marine and pipeline interconnection facilities; pipeline quality natural gas to be sourced from U.S. pipeline network

Figure 3. Sabine Pass Liquefaction Projects: Trains 1-4 (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 recent 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 I. Table II 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 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 current support infrastructure for LNG, and a trained workforce familiar with the technical issues associated with this cryogenic fuel.

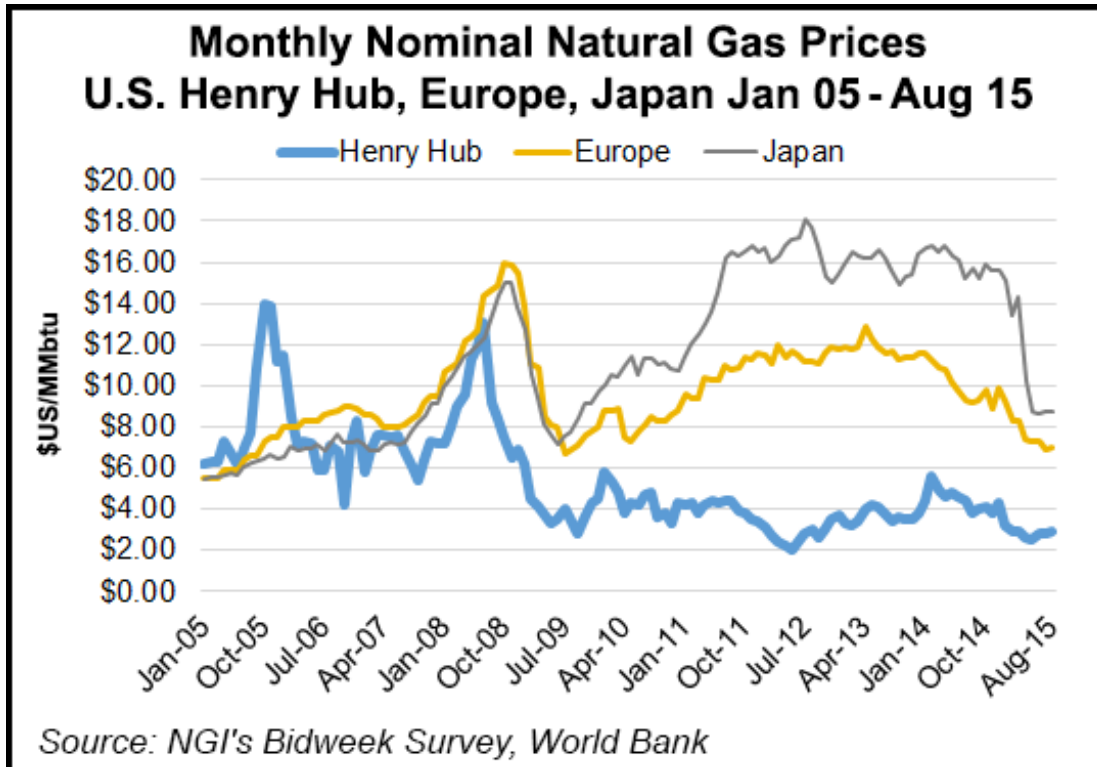


Figure 4.

Monthly Nominal Natural Gas Prices 2005-2015 (Natural Gas Intelligence)

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

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 II - LNG Export Terminals in Louisiana

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 MIPA		100	385	1,000	late 2019	late 2016	Parallax Energy
Sabine Pass LNG		\$18 Billion for 1st 4 trains	31.5 MIPA	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 MIPA					2018	9/10/2014	Sempra LNG, GDF SUEZ SA, Mitsui & Co., Japan Investment, LLC
Migrolia LNG	Port of Lake Charles	\$3.5 Billion	8 MIPA	115 acres	65-70	175	1,000	2018		Liquid 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		20 MIPA	632 acres				2020 Pending		Venture Global
	Pointe-a-la-Hache									
Louisiana LNG	Plaquemines Parish, Divant East Bank		6 MIPA	190 acres				2020 Pending		Louisiana LNG
	Lease from Plaquemines Port Harbor & Terminal District									

For a national perspective, based on multiple conversations with Chad Verret, Executive Vice President of LNG and Alaska for Harvey Gulf International Marine and Board Member of the Natural Gas Supply Organization (NGSA), we have reviewed the most recent market assessment by the NGSA entitled “2015 Summer Outlook: Markets Matter”. As stated in this report, the focus of this report is 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).

NORTH AMERICAN LNG IMPORT / EXPORT TERMINALS

AS OF APRIL 26, 2012

APPROVED SITES

IMPORT TERMINALS UNDER CONSTRUCTION

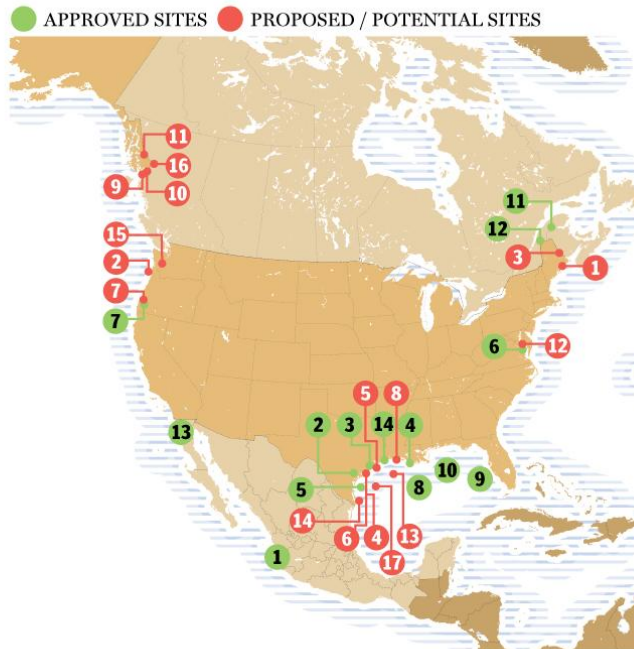
- 1. Manzanillo, Mexico

IMPORT TERMINALS NOT UNDER CONSTRUCTION

- 2. Corpus Christi, TX
- 3. Freeport, TX
- 4. Hackberry, LA
- 5. Port Lavaca, TX
- 6. Baltimore, MD
- 7. Coos Bay, OR
- 8. Gulf of Mexico
- 9. Offshore Florida
- 10. Gulf of Mexico
- 11. Rivière-du-Loup, Que.
- 12. Quebec City, Que.
- 13. Baja California, Mexico

EXPORT TERMINAL NOT UNDER CONSTRUCTION

- 14. Sabine, LA



PROPOSED / POTENTIAL SITES

IMPORT TERMINAL

- 1. Robbinston, ME
- 2. Astoria, OR
- 3. Calais, ME
- 4. Corpus Christi, TX

EXPORT TERMINAL

- 5. Freeport, TX
- 6. Corpus Christi, TX
- 7. Coos Bay, OR
- 8. Lake Charles, LA
- 9. Kitimat, B.C.
- 10. Kitimat, B.C.
- 11. Douglas Island, B.C.
- 12. Cove Point, MD
- 13. Hackberry, LA
- 14. Brownsville, TX
- 15. Astoria, OR
- 16. Prince Rupert Island, B.C.
- 17. Gulf of Mexico

SOURCE: U.S. DEPARTMENT OF ENERGY

ANDREW BARR / NATIONAL POST

Figure 5. North American LNG Import/Export Terminals (McAllister & Jones, 2012)

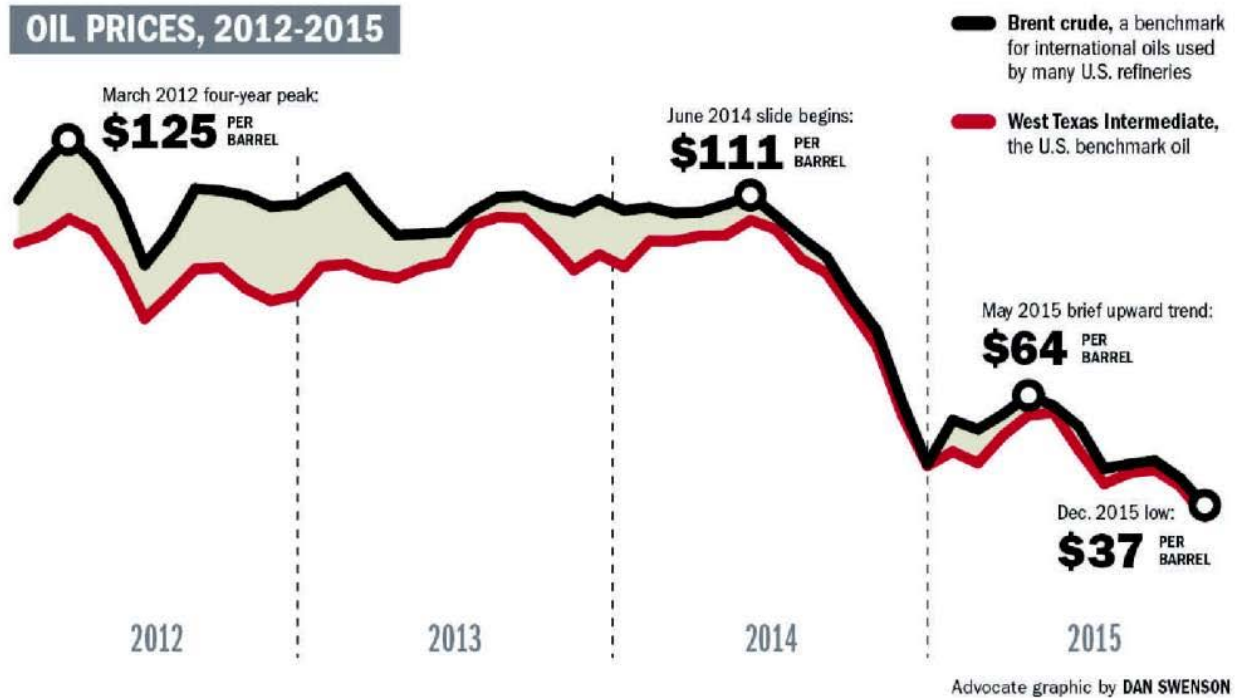


Figure 6. Oil Prices, 2012-2015 (Thompson, 2015)

METHODOLOGICAL APPROACH

This paper represents over 15 months of effort to understand what is happening in Louisiana as the result of Liquefied Natural Gas (LNG) in three separate categories: its use as a marine fuel; as an export commodity; as an industrial feedstock, particularly for the chemical and fertilizer sectors. We used four qualitative methods based on our research needs and time constraints.

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; USCG 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 and key person interviews with Harvey Gulf International Marine personnel
- Active participation in the New Orleans Port Safety Committee.
- Attendance at the HHP (High Horse Power) 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 news LNG industry 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 USCG Sector New Orleans personnel regarding LNG as a marine fuel and the energy market.

When we refer to the method of participant observation, we used techniques which have been modified from their practice in exotic locations within the discipline of anthropology. For this project, we used urban ethnography – which includes ethnographic studies of businesses, corporations, and governments – as self-study of our own societal manifestations of cultural style rather than those of an exotic other.

Specifically, we used a variety of this practice known as “Participant-as-Observer” (Hesse-Biber & Leavy, 2011, p. 206), in which the senior researcher for this project, Amdal, was a well-known figure in the transportation planning community. This method was used for the fuller end of the participation spectrum. Amdal’s “observation role [was] secondary to [his] participant role” (Creswell, 2014, p. 191).

The second method was multiple individual open-ended qualitative interviews, “...based on a set of topics discussed in depth rather than...standardized questions” (Babbie, 2013, p. 317) when we spoke to the following industry leaders:

- 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;
- Ongoing discussions with key staff of the Port of New Orleans regarding a potential LNG bunkering station;
- Discussions with USCG 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);
- Discussions with senior staff members of Louisiana Economic Development LED (Louisiana Economic Development LED)¹ 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.

¹ The data which we obtained via discussions with LED approximately through spring of 2015.

- Discussion with Paul Aucoin, Executive Director of the Port of South Louisiana (PSL), on the impact of LNG as a feedstock on industrial expansions or new builds within the jurisdiction of the PSL.

The strength of this approach is it enables the researcher to become knowledgeable of those issues related to the topics under discussion of which he or she may previously have been unaware. The main drawback of this research method involves critiques of its reliability (ibid, 325). 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 us 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 USCG 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 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 it (Hesse-Biber & Leavy, 2011). The open-ended nature of the interview facilitated the emergence of significant issues we were completely unaware of, thereby facilitating the direction of the research (Babbie, 2013). The primary weakness of this methodology in terms of replicating our results would be the difficulties involved in assembling this same group (Babbie, 2013) for other researchers.

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

- Review of industry standards for LNG bunkering authored by various consultancies.
- The review of all HHP whitepapers distributed post HHP 2014.
- 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.

In content analysis, the various materials fall within the domain of this research method (see Babbie, 2013, p. 331). Our unit of analysis was all references to the use of LNG as a marine fuel, as well as its wider industrial applications. Our unit of observation was all of the media which are 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; see Colby, 1966, p. 68). Rather, in participation and conversation with the stakeholders we outlined above, we began to gain an overall sense of repetition within our materials of the conclusion of this paper: that while the economic and environmental utility of LNG is well known in overall industry, the current global energy climate precludes its use as a marine fuel pending regulatory intervention.

FINDINGS

Concerning any extant best practices which could be adapted to LNG bunkering at the Port of New Orleans, our USCG focus group directed us to the federal regulations concerning port-sited LNG bunkering facilities, which are detailed in CFR 33-127. This is the only extant record of best practices by federal officials. Our focus group discussion led us to the three primary factors taken into account by the USCG when considering the Port of New Orleans as a site for the bunkering of LNG as a marine fuel: severe weather probabilities, proximity to neighborhoods, and proximity to roadways. We also reviewed updated reports on LNG bunkering and best practices authored by DNV and ABS.

Regarding the acceleration of LNG as an industrial feedstock for new industry however, our fieldwork revealed a petrochemical manufacturing boom in the parishes between New Orleans and Baton Rouge. This is the secondary finding from our research.

Thirdly, Louisiana is experiencing a new cargo export potential with LNG and the construction of the required LNG Export Terminals in diverse locations. Initially, these terminals were all located along the Calcasieu Ship Channel south of Lake Charles. More recently LNG Export Terminals have been proposed for two sites south of New Orleans in Plaquemines Parish, Louisiana. Local industry and political leaders see this as a positive indicator for the continued strength of the LNG industry within Louisiana.

IMPACTS/BENEFITS OF IMPLEMENTATION

After spending over 15 months researching LNG as a marine fuel, UNOTI personnel have determined that, to quote Gertrude Stein “There is no there, there.” Recent interviews with officials at the USCG Sector New Orleans and MARAD have confirmed this opinion: the relative cost of a barrel of crude oil will remain depressed for the near term. Furthermore, at the current time there is no interest in using LNG as a marine fuel within the Lower Mississippi River region. Primarily this lack of interest is due to the overall energy sector being in turmoil, caused by the decreasing cost of oil. Projections for the future range widely with some experts predicting costs to decrease to \$20.00 per barrel within this decade while others speculate that the price of oil will reach \$90.00 by 2020 (see Murray, 2015; Conti, 2014). As a result, the future for the energy sector currently is quite blurry. In this environment, large scale investment decisions are being put on hold for at least 5 years by shipping companies, marine terminal operators, port authorities or other financial interests, particularly in the United States, when it comes to LNG as a marine fuel.

But UNOTI has summarized other LNG facilities under development or soon to be operational in Louisiana. This project provides a detailed assessment of the impact of LNG as an inexpensive feedstock for industries involved in the production of chemicals, fertilizers or related products. But for all these categories, the economics of LNG and the energy sector in particular, is key. Crude oil costs continue downward while LNG remains very inexpensive for industrial users.

RECOMMENDATIONS AND CONCLUSIONS

Our overall conclusion regarding the economic potential of LNG bunkering by ports for its use as a marine fuel – in addition to its access by fleets – is that ports and shipping lines which 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 at least the next five years, makes capital investment in LNG as a marine fuel is inadvisable at this time. 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 regulatory regulation driven.

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 International Maritime Organization (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). 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.,

therefore the Port 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. There is in fact as of this writing a harbinger of this activity which the Port of New Orleans would be 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 three companies announced Thursday. They said 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).

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