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Evaluation Of Liquefied Natural Gas Receiving Terminals For Southern California

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Project Significance

At the time of this publication, applications for three different liquefied natural gas (LNG) receiving terminals proposed for Southern California are in the hands of federal, state and local regulators. LNG would be imported from overseas or brought to California from other US sources. The current proposals are:

- Long Beach Import Project (Figure 1), proposed by Sound Energy Solutions is an onshore facility proposed for Pier T in the Port of Long Beach.[1] There are currently four LNG receiving terminals in the United States (three on the East coast and one on the Gulf of Mexico). All four existing terminals are onshore facilities.

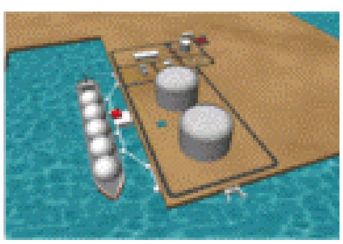

Figure 1: Proposed Long Beach Project.

- Crystal Clearwater Port Project (Figure 2), proposed by Crystal Energy, LLC, is an offshore oil platform converted to regasify imported LNG. This type of facility represents a new approach to LNG importation, and is the first terminal of this type to be proposed. The oil platform chosen for this project is Platform Grace, located 18 km (11 miles) off the coast of Oxnard. Platform Grace ceased oil production in 1995, and would need to be retrofitted for this purpose. [2]

Figure 2: Platform Grace.

- Cabrillo Port Project (Figure 3), proposed by BHP Billiton LNG International Inc, is a floating storage and regasification unit (FSRU). This is also a new type of LNG import facility. The proposed receiving terminal (similar in appearance to an LNG tanker) performs storage and regasification onboard, and would be moored to the sea floor 22.4 km (13.9 miles) off the coast of California.[3]

Figure 3: Proposed FSRU.

Background

The process of cooling natural gas to a liquid form is known as liquefaction. At -126°C (-260°F), natural gas undergoes a phase change, forming an odorless, colorless cryogenic liquid, called Liquefied Natural Gas. In liquid form, natural gas takes up 1/600th the volume of its gaseous form, allowing for much more efficient transport. [4]

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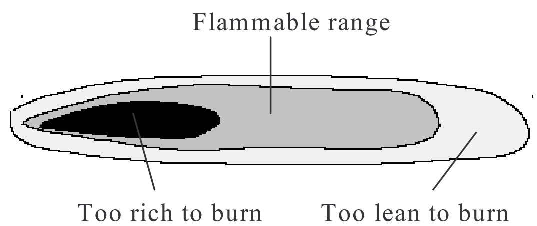
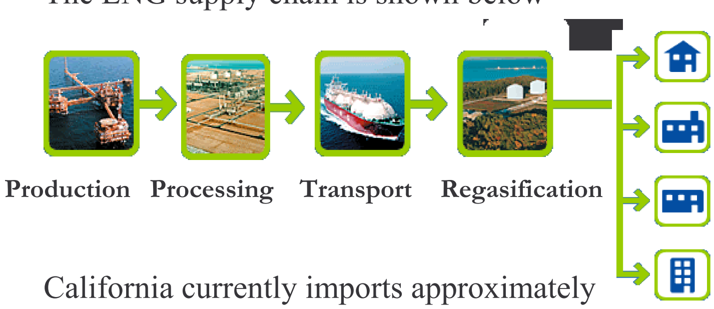


Figure 4: Cloud Diagram. [5]

LNG itself is not flammable, however the natural gas vapors are flammable in the range of 5 to 15 percent concentration in air. (Figure 4) Below 5 percent, there is not enough gas to sustain a burn. Above 15 percent, the gas concentration is too high to burn. The vapors do not have explosive properties in open spaces, however, if the cloud moves to a confined area, exposure to an ignition source will cause an explosion. A rapid phase transition with explosion-like properties can occur when a large volume of LNG is spilled onto water, quickly transitioning to gas[5].

The LNG supply chain is shown below[6]



California currently imports approximately 85% of its natural gas from domestic sources. The largest use of natural gas is for electricity generation[7] (Figure 5). According to the U.S. Department of Energy, U.S. natural gas demand is projected to rise 50 percent over the next 25 years. As demand increases in other states, California's domestic imports may be in jeopardy. Therefore, alternative natural gas supplies are being considered for the state. One alternative supply option would be the construction of a liquefied natural gas receiving terminal on the California coast.

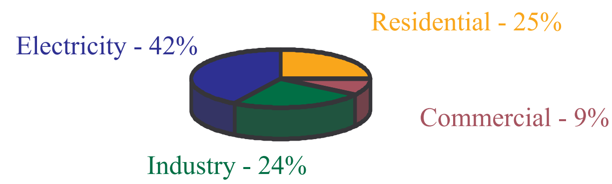


Figure 5: CA Natural Gas Consumption (2000). [7]

Project Objective

This report comparatively analyzed three LNG receiving terminal types – onshore, platform, and FSRU – using site-specific information from three currently proposed projects. The ultimate goal of this project was to compare information from the three specific proposals to outline general issues of concern for each of the three terminal types. This document was intended to be useful for community members and regulators who may seek an independent and factual account of the important issues regarding LNG receiving terminals.

Impacts were evaluated based on their expected magnitude and likelihood of occurrence. A ranking matrix was established for visual comparison of the terminals' strengths and weaknesses.

Community Safety Analysis

To compare community safety impacts, four accident scenarios and their potential effects were analyzed for each terminal type: operational failure, maritime accidents, natural phenomena, and terrorism/sabotage. Within each scenario, minor, moderate and major accidents were evaluated. This list is not inclusive comprehensive of all possible accident types, but instead represents the main safety issues faced by facilities.

The main difference between the terminal types evaluated is the impact magnitudes under moderate and major accident scenarios. The proposed onshore facility would be the closest to a dense population, and it is assumed this will be the case for all onshore facilities in Southern

California. Therefore, in terms of community safety, the highest impact magnitude would be for the onshore terminal, followed by the Platform and then the FSRU, although the impacts are similar for the two offshore terminals. However, if an onshore location can be found that is suitable for vessel traffic and is in a remote location, the potential impact of the facility may decrease substantially.

The platform facility is expected to be more vulnerable to operational disturbances due to the longer unloading time and the lack of redundancy in the LNG unloading system. The relatively smaller footprint of the facility limits its capacity. The absence of storage tanks may decrease the likelihood of large releases of LNG into the water. However, the possible presence of active oil pipelines in the vicinity of the platform may complicate emergency response and cleanup efforts. Expanding the unloading system or adding storage capabilities to the platform could improve the reliability of the facility. The addition of storage to a platform facility would require an additional review of the platform's structural integrity as well as a new evaluation of LNG spill impacts.

Emergency response capabilities differ between onshore and offshore facilities. While offshore facilities are farther from emergency response teams, studies predict short burn times for LNG fires. Once an LNG fire begins, there is limited action that can be taken by the emergency response team. Onshore facilities are closer to emergency services, but this may not translate into a quicker response time due to differences in transportation and traffic. It is recommended that each facility have its own emergency response protocol, and not rely solely on outside response.

Environmental Analysis

Possible impacts to marine communities (benthic and pelagic), air quality, and terrestrial and freshwater biology were evaluated for each terminal type. These environmental areas were chosen for analysis based on general NEPA guidelines.

When considering environmental impacts of the three terminal types, the most important factor is not the terminal type; it is the location. Environmental impacts of any project are dependent on the biological resources in the area as well as the potential to impact those resources.

The most noticeable difference between terminal types was seen when analyzing air quality impacts. We used a simple Gaussian-plume model to model air quality, which corroborates the information presented in the three project proposals. Based on this model, it appears that there are significant air quality concerns with the onshore project. Additional technology may be required to significantly reduce emissions of NO_2, PM_{10}, and SO_2, due to the terminal's close proximity to the population. The offshore projects allow for dissipation of emissions before reaching the shore, thus the air quality impact to potential human receptors is minimal under all circumstances.

The construction phase of all projects may cause several impacts to the surrounding environment, such as destruction of habitat or disruptions in feeding, breeding, or migration areas. If important biological resources are present at a proposed site, construction and operation of a terminal will have more significant impacts to the environment.

For offshore terminal types, noise due to construction, operation and decommissioning can have a significant impact to marine mammals. Timing of construction should be considered, so as not to disturb migration.

All proposed projects would increase marine traffic. Vessels may strike marine mammals or reptiles, significantly impacting pelagic communities. In addition, increased vessel traffic is likely to increase petroleum hydrocarbons discharged into the water. Petroleum products can cause skin and eye irritation in marine mammals, and are toxic if ingested.

Socioeconomic Analysis
Socioeconomic analysis categories included: population affected, economy and employment, property value, housing, public services, and traffic effects. The magnitudes of impact vary throughout the project life cycle. The greatest impacts on society appear to occur during the construction and decommissioning phase of all projects.

When comparing the three terminal types, the onshore project appears to have the widest range of socioeconomic effects. It received the best ranking in terms of economic and employment indicators. However, negative impacts on population and traffic appear to be much more significant when compared to the offshore projects.

Not one of the socioeconomic impacts associated with the FSRU project stood out as either significantly beneficial or detrimental in our analysis. Local economy and employment benefits are likely as a result of the proposed project; however, relative to general population size, these benefits are expected to be minimal.

The FSRU and platform projects show only minor differences with respect to socioeconomic effects. It is expected that the platform terminal will have a greater traffic impact during construction and decommissioning due to the location of project activities. The platform will be built and decommissioned locally. In comparison, most of the FSRU project will be built and decommissioned outside of the local area.

Recommendations
This document does not intend to determine the "best" LNG receiving terminal type. This analysis is strictly informational and educational in its scope. Its focus is on understanding and analyzing important aspects of each terminal so that communities and agencies may make more informed decisions regarding LNG receiving facilities. Our analysis of key issues and impacts for each proposed terminal type leads to general recommendations that may be applied to other LNG terminals.

KEY RECOMMENDATIONS

- Remote siting lowers safety risks, therefore siting a facility away from densely populated areas is recommended.
- Care should be taken to avoid sensitive ecological areas when siting a facility.
- Additional technology may be required to reduce emissions of criteria pollutants, especially for facilities close to the general population.
- Prior to siting a facility, local communities should consider housing availability and potential increases to traffic flow due to construction, operation, or decommissioning of a facility.

The three proposed Southern California terminals are currently undergoing extensive reviews at the federal, state and local level. Additional information will become available as the applications progress, and should be integrated into any analysis regarding the receiving terminals.

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[1] Sound Energy Solutions. http://www.soundenergysolutions.com/
[2] Crystal Energy (2004). Clearwater Port, California State Lands Commission Deepwater Port Application Supplement.
[3] Entrix, Inc. (2003). Environmental Analysis, Cabrillo Port, Prepared for BHP Billiton LNG International, Inc.
[4] Marks, M. (2003). Liquefied Natural Gas in California: History, Risks, and Siting, California Energy Commission.
[5] LNG in Vallejo, The LNG Health and Safety Committee of the Disaster Council (2003). Liquefied Natural Gas in Vallejo: Health and Safety Issues, City of Vallejo.
[6] South Hook LNG. http://www.southhooklng.co.uk/
[7] California Energy Commission. http://www.energy.ca.gov.