Corpus Christi Liquefaction, LLC

Corpus Christi Liquefaction Project

Draft Resource Report 10 — Alternatives
Docket No. PF12-3-000

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ACRONYMS AND ABBREVIATIONS

AAV  Ambient Air Vaporizers
Bcf/d  billion cubic feet per day
CNG  compressed natural gas
Commission  Federal Energy Regulatory Commission
CCL  Corpus Christi Liquefaction, LLC
CCL Project  Corpus Christi Liquefaction Project
CCLNG  Corpus Christi LNG, L.P.
ERDC  U.S. Army Corps of Engineers Engineering Research and Development Center
F  Fahrenheit
FERC  Federal Energy Regulatory Commission
GTL  gas to liquids
LNG  liquefied natural gas
MIT  Massachusetts Institute of Technology
mmtpa  million metric tonnes of LNG per annum
NFPA  National Fire Protection Association
NGH  natural gas hydrates
NSI  Naval Station Ingleside
PCCA  Port of Corpus Christi Authority
Project  CCL Project
Sabine Pass  Sabine Pass Liquefaction, LLC, and Sabine Pass LNG, L.P.
SCV  Submerged Combustion Vaporizers
SPLNG  Sabine Pass LNG Terminal
U.S.  United States
## RESOURCE REPORT 10 --ALTERNATIVES

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<td>- Discuss the costs and benefits associated with the alternative.</td>
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<td>2. For large projects, address the effect of energy conservation or energy alternatives to the project. (§ 380.12(l)(1))</td>
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<td>3. Identify system alternatives considered during the identification of the project and provide the rationale for rejecting each alternative. (§ 380.12(l)(1))</td>
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10.0 ALTERNATIVES

10.1 INTRODUCTION

This resource report describes the alternatives considered by Corpus Christi Liquefaction, LLC (“CCL”) for the proposed Corpus Christi Liquefaction Project (“CCL Project” or “Project”) in identifying the best method of accomplishing the CCL Project objective, starting with examination of the broadest feasible range of alternatives and narrowing those alternatives to the CCL Project as currently proposed. Selection of the preferred CCL Project site and overall design was the result of a comprehensive evaluation process that involved weighing the potential environmental, logistical, economic, safety, and engineering costs and benefits of each aspect of the CCL Project. As a result, the previously selected site for the Corpus Christi liquefied natural gas (“LNG”) Import Terminal (“Corpus Christi LNG Import Terminal”) in San Patricio and Nueces Counties, Texas, is considered the most environmentally acceptable, technologically feasible, and economically viable option for meeting the stated Project objective.

Alternatives for the CCLNG Import Terminal site were evaluated and assessed in conjunction with the Federal Energy Regulatory Commission’s (“FERC” or “Commission”) review and approval of the CCLNG Terminal in Docket Nos.:

- CP04-37-000 - April 18, 2005, Corpus Christi LNG, L.P.\(^1\) received NGA Section 3 authorization to site, construct and operate the Corpus Christi LNG Import Terminal on the Corpus Christi site.
- CP04-44-000, CP04-45-000, and CP04-46-000 - April 18, 2005 Order also authorized Cheniere Corpus Christi Pipeline Company\(^2\) to construct and operate a 23-mile long sendout pipeline commencing at the Corpus Christi LNG Import Terminal and extending in a northwesterly direction along a corridor that would allow for interconnection points with approximately eight interstate and intrastate natural gas transmission pipelines in South Texas (“Corpus Christi Pipeline”).

The Corpus Christi LNG Import Terminal and Corpus Christi Pipeline were not constructed due to changes in global market conditions. The site of the proposed CCL Project is the same site previously authorized by the Commission for the Corpus Christi LNG Import Terminal. In addition, the marine facilities required for the export of LNG have already been evaluated and approved as part of the Corpus Christi LNG Import Terminal review. Because the site has already been reviewed and approved by the Commission for construction and operation of the Corpus Christi LNG Terminal, in order for an alternative to be considered preferable to the proposed CCL Project the alternative must:

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\(^1\) Now Corpus Christi LLC (“Corpus Christi LNG”)
\(^2\) Now Cheniere Corpus Christi Pipeline, L.P.
• Provide a significant environmental advantage over the CCL Project as proposed;
• Meet the CCL Project objectives and schedule;
• Allow for compliance with federal safety regulations for liquefaction facilities, and
• Be technically and economically feasible and practicable.

This resource report is organized into five major sections: Section 10.2 discusses the “no action” alternative; Section 10.3 discusses alternative energy sources; Section 10.4 provides a description of other potential system alternatives that could be implemented to meet the CCL Project objectives; Section 10.5 discusses alternative sites; and Section 10.6 discusses alternative configurations for the CCL Project facilities, including other layouts and liquefaction processes.

10.2 NO-ACTION ALTERNATIVE

This section addresses the consequences of not constructing the proposed CCL Project. Potential adverse impacts associated with the CCL Project (i.e., impacts to surface and groundwater quality, fisheries, wildlife, vegetation, geologic resources, soils, air and noise quality, etc.) would be avoided under the no-action alternative. However, selection of the no-action alternative also would mean that the objectives of the CCL Project would not be accomplished.

Corpus Christi Liquefaction is proposing to provide liquefaction services on the site of the previously permitted CCLNG Import Terminal, transforming it into a facility capable of liquefying domestic natural gas for export while retaining some limited capability to regasify imported foreign-sourced LNG if necessary. Corpus Christi Liquefaction expects to offer customers these services at attractive pricing. This service would provide customers with an attractive option to source natural gas supply from the U.S. pipeline grid at prices indexed to Henry Hub.

The CCL Project will facilitate the development of unconventional, and particularly shale, gas-bearing formations in the U.S. The rapidly developing Eagle Ford Shale in South Texas and emerging Permian shale plays in West Texas (e.g., Wolfcamp, Bone Springs) are in close proximity to the CCL Project and would particularly benefit from its development. Exporting natural gas, in addition to facilitating market flexibility potential for transport to other U.S. domestic market uses, as LNG will provide the U.S. with significant benefits, including:

• Stimulate the Texas state, regional and national economies through job creation, increased economic activity and tax revenues;
• Promote domestic production of petroleum and reduced reliance on foreign sources of oil;
• Promote midstream infrastructure development in the Eagle Ford shale and reduce the frequency of natural gas flaring;
• Further the President’s National Export Initiative, by improving U.S. balance of payments through the exportation of approximately 2.1 billion cubic feet per day (“Bcf/d”) of natural gas;
• Raise domestic natural gas productive capacity and promote stability in domestic natural gas and associated liquids pricing;
• Promote liberalization of global natural gas trade through fostering of a global LNG market;
• Advance national security and the security of U.S. allies through diversification of global natural gas supplies; and
• Increase economic trade and ties with foreign nations including neighboring countries in the Americas and displacing environmentally damaging fuels in those countries.

The no-action alternative would deny the U.S. these many benefits associated with the development of the CCL Project. Furthermore, no-action would lead to greater long-term environmental damage from the frequency of flaring as hydrocarbon resources are developed in South and West Texas without the benefit of infrastructure that would capture natural gas produced in association with oil. The U.S. has experienced a sharp increase in flaring activity in recent years as drilling in unconventional oil-rich formations has increased. In Texas, wellhead flaring of natural gas is also on the rise as drilling activity for petroleum liquids has intensified in the Eagle Ford shale and in the Permian region of West Texas. Ultimately, failure to develop additional markets for this associated natural gas may preclude or significantly delay further development of the oil and natural gas liquids resource in South and West Texas. The CCL Project would provide both infrastructure and access to new markets that would incentivize producers active in these plays to capture associated natural gas and reduce flaring activity.

10.3 ALTERNATIVE ENERGY SOURCES

The primary purpose of the CCL Project is to provide a market solution to allow the further deliberate development of emerging sources of domestic natural gas, natural gas liquids and oil, in particular the Eagle Ford Shale. In addition, the ability to export domestic gas as LNG will serve the purpose of greatly expanding the market scope and access for domestic natural gas producers and, thus, serve to encourage domestic production at times when U.S. market prices might not otherwise do so. Continued production, along with the added flexibility provided by the import capabilities of the CCL Project, will improve the availability of natural gas to supply domestic markets when conditions support it. Natural gas has been termed a “bridge fuel” between the dominant fossil fuels used today and renewable fuels because it is clean burning and can reliably serve as a backup fuel to intermittent renewable energy sources. In this regard, natural gas has become a major international commodity.

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3 The volume of domestic natural gas vented or flared has grown by 71% in the previous six years, to 166 Bcf (0.45 Bcf/d) in 2010 from 96 Bcf (0.26 Bcf/d) in 2004. See EIA at http://www.eia.gov/dnav/ng/hist/n9040us2a.htm.
4 The number of permits issued by the Texas Railroad Commission to allow natural gas flaring in Texas has quintupled in three years, to 537 permits over the 10-month period from September 2010 through July 2011, from 107 flaring permits issued in 2008. See “Shale oil boom sends waste gas burn-off soaring,” Reuters, July 25, 2011.
A two-year study by the Massachusetts Institute of Technology (“MIT”) encourages U.S. policymakers to consider the nation’s growing supply of natural gas as a substitute for aging power plants utilizing other fossil fuels. Under a scenario that envisions a federal policy aimed at cutting greenhouse gas emissions to 50 percent below 2005 levels by 2050, the MIT study (2011) found a substantial role for natural gas because when used to fire a power plant, gas emits about half of the carbon dioxide emissions as conventional plants utilizing other fossil fuels.

Similarly, there is a current growing demand in many developing countries for low-cost, environmentally friendly fuels. The standard of living for the general population and the advancement of commercial development in these developing countries is being significantly impacted due to their reliance on expensive and “dirty” foreign-sourced fuel oil and oil products.

Like the U.S., many countries are emphasizing renewable energy resources such as wind or solar power as a means to reduce greenhouse gas emissions and other pollutants. Although this is an effective solution, most renewable sources are intermittent and not sufficiently reliable. Also, many locations simply do not have sufficient real estate, sunlight, wind, or water to adequately serve the population’s needs, even if the necessary infrastructure were built. As a result, these countries must have an alternate energy source to supplement or back up the renewable energy.

Overall, natural gas provides the most dependable, economically attractive, and environmentally acceptable fuel for use in residential, commercial, and industrial markets. Compared to using other fuels, such as oil or coal, the use of natural gas clearly benefits the environment, complements the use of renewables and provides a cost-effective solution to energy demands. Specifically, compared to other fossil fuels, the use of natural gas:

- Results in significantly lower emissions of sulfur oxides (which are a primary cause of acid rain deposition);
- Generates lower emissions of total suspended particulate, hydrocarbon, carbon monoxide, and nitrogen oxide;
- Eliminates residual wastes and the subsequent land requirements for the disposal of such wastes; and
- Provides a lower cost, reliable energy source which in turn contributes to social and commercial development.

In summary, natural gas was determined to be the most environmentally sound and cost-effective solution of the practical and available supplemental energy options. As a clean burning fuel, natural gas minimizes the emission of air pollutants that contribute to acid rain and cause concern over the greenhouse effect. Of the fossil fuels, natural gas combustion results in the lowest levels of carbon dioxide and sulfur dioxide emissions.
10.4 SYSTEM ALTERNATIVES

System alternatives are those alternatives that could replace all or part of the CCL Project by making use of other existing or proposed natural gas export facilities, pipelines, or other methods of transporting natural gas. Corpus Christi Liquefaction examined potential system alternatives for the CCL Project that included other existing and proposed LNG export facilities in North America (Sections 10.4.1 and 10.4.2), export via pipeline (Section 10.4.3), and other methods of transporting natural gas (Section 10.4.4).

10.4.1 Existing LNG Export Facility

The only LNG export facility currently operating in North America is the Kenai LNG Plant, located in the Cook Inlet Basin area, Alaska, which began operation in 1967. The original export authorization has been amended and extended numerous times by the Department of Energy. The current amendment authorizes the export of approximately 98.1 Bcf of natural gas over two years (ConocoPhillips Alaska Natural Gas Corporation and Marathon Oil Company, 2008). The Kenai LNG Plant sends all available LNG to Pacific Rim countries (mostly, Japan), and cannot be economically or practically expanded to service other markets because of its remote location. Therefore, the objective of the CCL Project, which is to provide an outlet for domestically produced natural gas primarily from the Eagle Ford Shale in Texas, could not be accomplished by securing export capacity at the Kenai LNG Plant.

10.4.2 Proposed LNG Export Facilities

This section provides an evaluation of other formally proposed LNG export facilities in North America and the ability of those projects to meet the objectives of the CCL Project (FERC, 2011).

Sabine Pass Liquefaction Project

Sabine Pass Liquefaction, LLC, and Sabine Pass LNG, L.P. (collectively referred to as “Sabine Pass”), subsidiaries of Cheniere Energy, Inc., have proposed the Sabine Pass Liquefaction Project to add liquefaction capabilities to the existing Sabine Pass LNG (“SPLNG”) Terminal in Cameron Parish, Louisiana. The Sabine Pass Liquefaction Project is being designed to process approximately 2.6 Bcf/d of natural gas to be delivered through interconnected interstate pipelines. LNG would be stored in the SPLNG Terminal’s five existing storage tanks and would be exported via LNG carriers that would arrive to the SPLNG Terminal via marine transport through the Sabine Pass Channel. The liquefaction facilities would consist of four ConocoPhillips Optimized Cascade™ LNG trains, each capable of processing up to 0.7 Bcf/d of natural gas, with average liquefaction capacity of approximately 4.5 million metric tons of LNG per annum (“mmtpa”). Sabine Pass filed an application in Docket No. CP11-72-000 with the FERC on January 31, 2011, and the FERC published an Environmental Assessment for the Sabine Pass Liquefaction Project on December 28, 2011. Sabine Pass expects to commence construction activities in early 2012 and to have the first LNG train ready to export LNG in 2015. In the fourth quarter of 2011,
Cheniere Energy announced contracts with three international firms to sell LNG for trains one, two, and four, and announced that a contract for the remaining train three was imminent.

LNG from only one of the four proposed trains at the Sabine Pass Liquefaction Project is available for contract and it is anticipated to be sold soon. Its limited capacity (up to 0.7 Bcf/d of natural gas) would be insufficient to meet the objective of the CCL Project to process an average of 2.1 Bcf/d of natural gas for export. In addition, the Sabine Pass Liquefaction Project is located more than 250 miles to the northeast of the Eagle Ford Shale, making it a less economically feasible alternative for the CCL Project. Figure 10.4-1 shows the location of the Sabine Pass facility in relation to the CCL Project.

Freeport Liquefaction Project

Freeport LNG Development, L.P., Freeport LNG Expansion, L.P., and FLNG Liquefaction LLC (collectively referred to as “Freeport”) have proposed the Freeport Liquefaction Project in Brazoria County, Texas. Freeport plans to add liquefaction and exportation capabilities to the existing Freeport LNG import terminal on Quintana Island. The facilities proposed for the Freeport Liquefaction Project include three natural gas liquefaction refrigerant units, expansion of existing terminal facility components, a second ship berthing area, a third LNG storage tank, additional LNG vaporization and natural gas sendout facilities, and a nonjurisdictional pretreatment facility. The Freeport Liquefaction Project is being designed to process approximately 1.8 Bcf/d of natural gas. Freeport entered the FERC pre-filing process on January 5, 2011 (FERC Docket No. PF11-2-000) and plans to file an application with the FERC in March 2012. Freeport plans to commence construction in January 2013 and expects to be ready to begin exporting LNG in January 2016.

The Freeport Liquefaction Project is located more than 150 miles to the east of the Eagle Ford Shale, making it a less economically feasible alternative for the CCL Project due to the increased distance of pipeline and the associated increase in environmental impacts required to transport natural gas from the Eagle Ford Shale to the Freeport facility. Figure 10.4-1 shows the location of the Freeport facility in relation to the CCL Project.
Kitimat LNG

Kitimat LNG, Inc. is proposing to construct and operate an LNG export, liquefaction and LNG send-out terminal at Bish Cove near the Port of Kitimat, British Columbia, Canada. The Kitimat LNG Project, if constructed, would include new gas pipelines, marine berths, LNG storage, liquefaction, and LNG loading facilities. The terminal would take delivery of gas from the Western Canadian Sedimentary basin via the nearby Pacific Trail pipelines, which will be connected to Spectra Energy’s existing Westcoast Pipeline system. The main market for the Kitimat LNG Project would be Japan and other countries in the Pacific Rim. The sendout capacity would be 5 to 10 mmta of LNG. The Kitimat LNG Project was granted a license to export LNG in October 2011 by Canada’s National Energy Board.

It would not be economically feasible to transport natural gas sourced from the Eagle Ford Shale in Texas to the proposed Kitimat LNG facility. Furthermore, regular deliveries of LNG from Kitimat LNG to markets in Europe and other locations in the Atlantic basin would not be feasible due to the shipping
distances involved. Therefore, the Kitimat LNG Project would not be an economically or practically feasible alternative for the CCL Project.

**Douglas Channel LNG**

The BC LNG Export Co-Operative LLC is proposing to construct and operate an LNG export, liquefaction, and LNG send-out terminal on Douglas Channel near Douglas Island, British Columbia, Canada. The Douglas Channel LNG Project, if constructed, would include two trains and have a sendout capacity of 1.8 mmtpa of LNG. A Natural Gas Export License Application was submitted for the Douglas Channel LNG Project in March 2011. If approved, the Douglas Channel LNG Project is scheduled to be in-service to export LNG by the fourth quarter of 2013.

As with the Kitimat LNG Project, it would not be economically feasible to transport natural gas sourced from the Eagle Ford Shale in Texas to the proposed Douglas Channel LNG facility. Furthermore, regular deliveries of LNG from the Douglas Channel LNG Project to markets in Europe and other locations in the Atlantic basin would not be feasible due to the shipping distances involved. Therefore, the Douglas Channel LNG Project would not be an economically or practically feasible alternative for the CCL Project.

**10.4.3 Export via Pipeline**

Several pipelines exist that export natural gas from the U.S. to Canada or Mexico. However, export to other countries in Europe, Central America, the Caribbean, or South America via pipeline would involve very long distances on land or across oceans. The technology for installing pipelines across oceans does not currently exist, and land routes, where feasible, would be prohibitively expensive. Therefore, export of natural gas via pipeline to countries other than Canada and Mexico cannot be considered an alternative to the CCL Project.

**10.4.4 Other Methods of Transporting Natural Gas**

There are three technologies and processes that can convert natural gas into other products that, like LNG, can be sent overseas to be used as fuel. Corpus Christi Liquefaction reviewed these alternate technologies and determined they did not fully fit the purpose and need of the CCL Project.

Gas to Liquids (“GTL”) is a process that converts natural gas into heavier liquid hydrocarbons such as naptha or diesel. The process has been applied on a large scale where large stranded gas reserves exist, such as those in Qatar, Nigeria, and Malaysia. After evaluation, Corpus Christi Liquefaction does not consider a GTL facility to be a viable option for the following reasons:

- These facilities have high capital costs, high operation and maintenance costs, and are energy intensive; and
- The low sulfur diesel created carries a premium price, and does not have the same environmental benefits of natural gas.
Compressed Natural Gas (“CNG”) is made by compressing natural gas to high pressures (2,900 to 3,600 pounds per square inch) so that it occupies less than 1 percent of the volume it occupies at atmospheric pressure. The CNG can then be stored and transported in spheres or bullets. CNG is used mostly as a substitute for gasoline in buses, taxis, and other vehicles. Corpus Christi Liquefaction concluded that CNG is not a suitable option to meet the purpose of the CCL Project for the following reasons:

- Because of the high pressures involved and the fact that the same amount of energy requires over 6 times the volume as LNG, larger scale transportation becomes very expensive. Therefore CNG would not be suitable for transportation to markets in Europe, South America, or many locations in the Caribbean.
- There are no ships capable of transporting CNG in bulk; whereas a large fleet is available for LNG. Custom ships would need to be designed and built for exporting large quantities of CNG.
- CNG bulk receiving facilities at the destination ports would also need to be designed and built as none currently exist. LNG receiving terminals already exist or are planned in most of the markets Corpus Christi Liquefaction intends to target.

Natural Gas Hydrates (“NGH”) are formed under certain conditions when methane is trapped within a crystal structure of water, forming a solid similar to ice. Large deposits of NGH are located in deep ocean deposits around the world, but an economical method for mining this resource has not yet been developed. NGHs are chemically stable at about -4°Fahrenheit (“F”) compared with -260°F for LNG. Corpus Christi Liquefaction concluded the production and export of NGH is not a suitable option to meet the purpose of the CCL Project for the following reasons:

- Generally, one cubic meter of NGH contains approximately 160 cubic meters of natural gas, while one cubic meter of LNG contains 600 cubic meters of natural gas, thus limiting the quantity of gas that can be transported with NGH technology;
- At this time no commercial facilities have been built to convert natural gas into NGH;
- Technology has not been developed to store, load, transport, unload, and process large amounts of NGH; and
- Conversion of power plants to be fueled by NGHs has not yet been attempted.

10.5 ALTERNATIVE SITES

The CCL Project will occupy the same site as the previously proposed Corpus Christi LNG Import Terminal Project site, which is located in an industrial area with access to a deep water channel. A thorough site alternatives evaluation was performed for the Corpus Christi LNG Import Terminal Project and was described in detail in filings made in FERC Docket No. CP04-37-000. A summary of the site alternatives process for the Corpus Christi LNG Import Terminal Project is provided in Section 10.5.1. New information regarding two previously evaluated sites is presented in Sections 10.5.2 and 10.5.3. Corpus Christi Liquefaction’s analysis and conclusion regarding alternative sites is presented in Section 10.5.4.
10.5.1 Previously Evaluated Sites

For the Corpus Christi LNG Import Terminal Project (FERC Docket No. CP04-37-000), a large number of alternative sites were evaluated along the length of the Texas coast. A total of 17 potential port alternative sites were evaluated for channel depth (>40 feet) and proximity to existing natural gas pipeline systems, criteria which are also applicable to the CCL Project. Five sites in the Corpus Christi Bay area were selected for further evaluation. These potential sites were evaluated for channel access, zoning/isolation, and availability of land. One site near Gregory and one site near Ingleside passed all of the selection criteria for the proposed LNG terminal. A detailed quantitative screening was conducted for these sites against criteria that included site specific factors (ease of acquisition, area available, and existing infrastructure), marine operations (traffic volume, channel access, and maneuvering area), access to natural gas pipeline systems (distance, take-away capacity, and consistent demand), ease of permitting, and economics. The Corpus Christi Gregory site was selected for the Corpus Christi LNG Import Terminal Project and is the same site being proposed for this CCL Project. The Corpus Christi Ingleside site was not selected because land was not available at the time of the application.

The FERC issued an Environmental Impact Statement for the Corpus Christi LNG Import Terminal Project in March 2005 and agreed with Corpus Christi LNG’s site selection and stated that the selected site offered several advantages including: being isolated and having an existing industrial area large enough for the proposed facilities and exclusion zones; having a willing seller; having an existing infrastructure on site and the adjacent La Quinta ship channel and turning basin; being located nearby intrastate and interstate pipelines; and having no residences within 1.6 miles.

Several years have passed since the site alternatives evaluation was performed and the CCL Project has a different purpose and need, so new evaluations of potential alternatives in the Corpus Christi area were performed and the results are presented in the sections below.

10.5.2 Corpus Christi Ingleside

The Corpus Christi Ingleside site was eliminated from the site selection process for the LNG import terminal because there was a lack of available land at the time. Since that time, Naval Station Ingleside (“NSI”) was designated for closure under the Base Realignment and Closure Act of 2005 and the U.S. Navy departed from the site by April 30, 2010. Ownership of NSI reverted to the Port of Corpus Christi Authority (“PCCA”) on that date.

The former NSI property is located approximately five miles southeast of the proposed CCL Project site and along the Corpus Christi Ship Channel near the intersection with the La Quinta Ship Channel. Figure 10.5-1 shows the location of the former NSI property in relation to the CCL Project. The former NSI property consists of approximately 483 acres and contains 70 existing buildings including warehouses, offices, barracks, recreation facilities, and a pier and wharf area. The site borders to the east of another undeveloped PCCA property that is approximately 435 acres in size. The PCCA has designated the NSI property and the adjacent undeveloped property as the “Ingleside Development
Project” and defines it as follows: “As a master-planned, technology-focused business park, the Ingleside Development Project provides first-class office and R&D space, light industrial and/or warehouse space with little to no upfront infrastructure cost” (Texas A&M University System and PCCA, 2012).

The location along the Corpus Christi Ship Channel is suitable, but the existing facilities on the former NSI property would not match up with the facilities needed for the CCL Project and would require significant demolition and construction.

10.5.3 Analysis and Conclusion

The existing Corpus Christi LNG Import Terminal Site underwent extensive environmental review, and Corpus Christi LNG received federal authorizations and permits for development of this site. Use of this same site for the CCL Project is the most suitable site alternative because it takes advantage of the previous evaluations and also satisfies the purpose and need for the CCL Project. Use of the existing, approved Corpus Christi LNG Import Terminal Site will also allow the CCL Project to utilize the Corpus Christi Pipeline, which was also previously reviewed and approved by the Commission. Development of
a new site would require the acquisition of a large amount of new land to site the CCL Project and associated infrastructure and would require approval of a new pipeline and potentially greater environmental impact. This would affect the CCL Project in-service date and result in increased costs for the CCL Project.

10.6 ALTERNATIVE ON-SITE CONFIGURATIONS

Corpus Christi Liquefaction evaluated configuration alternatives for the CCL Project layout and for liquefaction and vaporization methods to assess the potential for minimizing environmental impact and maximizing utilization. Several alternate configurations were compared and evaluated as summarized below.

10.6.1 Alternative Layouts

Plant Layout

The criteria for developing the plant layout of the Project (i.e., the location and configuration of the major Project components), is governed by those considerations prescribed in Code of Federal Regulations 49 Part 193 Subpart B and National Fire Protection Association (“NFPA”) 59A. Compliance with these Rules and Codes reasonably assures the public safety in the vicinity of the Project, provides design contingency, and provides adequate ingress and egress in case of a potential emergency situation. The most important criteria are the design of the LNG tanks and the position of LNG impoundments which are designed to contain possible LNG or refrigerant spills. Full containment tanks were selected for the CCL Project, eliminating the requirement for tank impoundment basins. Impoundments for potential leaks in the marine berth area or along the main piperack have been sized and located so that neither harmful fire radiation nor flammable vapor clouds would go off the site limits during defined failure scenarios.

Berth Location

The location and configuration of the berth was studied in detail for the Corpus Christi LNG Import Terminal Project. The configuration selected satisfies the following criteria:

- Maneuvering and docking of the LNG tankers can be accomplished with no more than three Z-drive tugs under most historical conditions of weather, current, tide, etc. The berth layout was first reviewed by experienced pilots, and changes were made based on their recommendations. The final berth layout was then successfully confirmed in computer simulations of the maneuvering and berthing, conducted at the U.S. Army Corps of Engineers Engineering Research and Development Center’s (“ERDC”) Ship and Tow Simulator located in Vicksburg, Mississippi. A full report on these simulations can be found in Resource Report 13 for the Corpus Christi LNG Import Terminal Project (FERC Docket No. CP04-37-000).
The LNG berth should be protected as much as practical from other ship traffic, particularly in the case of a ship becoming disabled while passing the CCL Project site. The location and configuration is such that the LNG berth is at enough of an angle and recessed enough to avoid this, while still maintaining sufficient maneuvering area in case a docked LNG ship needs to make an emergency departure. In addition, the CCL Project is located at the current terminus of the La Quinta Channel, which means other ship traffic passing the CCL Project site would be minimal. A container port called the La Quinta Trade Gateway is proposed to be built further west along the channel, immediately adjacent to the CCL Project site. However, container ships going to the container port would be slowly moving and under control of tugs at all times while passing the CCL Project site. Also, the presence of a dredge material placement island immediately offshore from the CCL Project site results in practically no current at the LNG berth area that could detour or affect the path of a passing vessel.

10.6.2 Alternative Liquefaction Methods

The selected liquefaction method is the ConocoPhillips Optimized CascadeSM process. Although several processes exist to liquefy natural gas, this process was chosen for the following reasons:

- The Optimized CascadeSM process uses a Template Design adaptable to a variety of conditions and compressor configurations. This simplifies the design process and reduces risk of systems underperforming.
- The process was selected for Cheniere’s Sabine Pass Liquefaction Project based on both cost and ability to readily turn down production to meet needs, which in turn results in lower overall emissions.
- The process has been successfully used for over 40 years at the Kenai Alaska LNG facility.
- The process has also been used successfully at the following overseas facilities:
  - Atlantic LNG Trains 1, 2, 3 and 4, 2005
  - Egyptian LNG Trains 1 & 2, 2005
  - Darwin LNG, 2006
  - Equatorial Guinea LNG, 2007
  - Angola LNG, under construction and expected to be in-service in early 2012

Once the liquefaction facilities are constructed, the CCL Plant will be capable of both importing and vaporizing LNG and liquefying natural gas to produce LNG for export. This bi-directional capability requires a liquefaction process that is very flexible and reliable. The ConocoPhillips Optimized CascadeSM process meets these requirements for the following reasons:

- Reliability is high since the design is based on two 50 percent capacity compressors for each refrigeration cycle. If one compressor fails, LNG production can be maintained at 60 percent to 80 percent of nameplate production.
• Turndown capabilities are good since the two-in-one concept provides for maximum fuel efficiency even at 60 to 80 percent utilization.
• Start up is quick and operation is easy since the process uses pure refrigerants rather than mixed refrigerants whose composition must be carefully balanced.
• Cool down is quick since the equipment used in the cryogenic exchangers are simple, well proven brazed aluminum exchangers.
• Fuel efficiency is excellent since the compressor drivers chosen are aero derivative type gas turbines.

ConocoPhillips has had a collaboration agreement for over 40 years with Bechtel to design and build LNG facilities using the ConocoPhillips Optimized Cascade Process®. Bechtel was the main contractor for the design of Cheniere’s Sabine Pass LNG Import Terminal and the Sabine Pass Liquefaction Project, and is thus well qualified to design and construct the ConocoPhillips liquefaction process facilities for the CCL Project.

10.6.3 Alternative Vaporization Methods

The previously approved Corpus Christi LNG Import Terminal Project planned to use submerged combustion vaporizers (“SCVs”) to regasify LNG. For the CCL Project, ambient air vaporizers (“AAVs”) have been evaluated and selected. An early pilot program for AAVs was installed at Cheniere’s Sabine Pass LNG Terminal and the AAVs are working satisfactorily. Based on this favorable operating experience, as well as the energy efficiency and elimination of all emissions, CCL has selected AAVs over SCVs for the CCL Project.

10.7 CONCLUSIONS

For the above identified reasons, the proposed site is the most appropriate location for the CCL Project, and the proposed technology is the most appropriate method to accomplish the Project objectives. Further, because the proposed site was a previously disturbed site and the area has been previously reviewed for environmental impacts, and because use of the proposed site will allow use of the approved Corpus Christi Pipeline, the location of the liquefaction facility results in minimal new environmental impacts. The proposed location is the best site for a proposed CCL Project.

10.8 REFERENCES


