Cold storage for a hot commodity

Jeff Baker and Mark Butts, McDermott's CB&I Storage Solutions, USA, discuss the growing small scale LNG market and a related code change permitting greater flexibility for LNG storage.

New markets for LNG are emerging due to the environmental benefits of natural gas (lower carbon and particulate emissions), LNG's low cost compared with competing fuels, and the continuing advancements in transportation. These new markets are leading to the development of small scale LNG plants, which generally have lower CAPEX requirements and can be built more quickly than typical baseload LNG facilities, often using modularised components. Additionally, small scale LNG is scalable; operators can add capacity as market demand increases.

A growing portion of the small scale LNG market involves end uses of LNG in its liquid form, rather than the traditional model of liquefaction, transport, and regasification into an existing pipeline distribution system. Small scale LNG plants

generally serve specific markets or industrial customers. Some of the key drivers of the small scale LNG market are outlined as follows:

- LNG is replacing diesel as fuel for high horsepower vehicular transport applications including locomotives, heavy trucks and fleet vehicles, and large mining trucks. LNG is the cleanest burning fossil fuel and hence is seen as more environmentally friendly and contributing to sustainability goals.
- Stricter environmental standards are driving the use of LNG as a bunkering fuel in the marine industry. LNG as fuel can compete economically with the cost of ultra-low sulfur fuel or the installation of scrubbers. Effective 1 January 2020, the International Maritime Organisation (IMO) implemented a new regulation mandating an 80% reduction in sulfur emissions from vessels operating in international waters. Under the IMO 2020 standard, ships are having to use marine fuels with a sulfur content of no more than 0.5% vs the previous limit of 3.5%.
- Use of LNG for power generation is growing in remote areas which lack an existing gas pipeline infrastructure, where LNG can be shipped or trucked to small utility customers (so-called 'virtual pipeline' or 'stranded demand' projects).
- The drive to reduce gas flaring, particularly in US shale oilfields, is prompting producers to monetise previously flared gas via LNG production.
- There is an increasing desire by utilities to provide back-up fuel storage via LNG to handle disruptions to the natural gas supply in the pipeline.

In addition to these newer applications, development of traditional LNG peak shaving facilities (which are in essence small scale LNG plants) is ongoing. Utilities use these plants to liquefy and store natural gas to meet seasonal demand peaks. Peak shaving is one of the most common uses of LNG in the US.

A new set of players

Unlike the large scale LNG industry, which is dominated by established producers in the oil and gas industry and utility companies buying under long-term contracts, the small scale LNG market is far more diverse, with a variety of players and applications. Owners/developers can include regional utility companies, port authorities, start-ups, private equity firms, venture capitalists, transportation companies, oilfield producers, and more. Examples of recent developments in the US include:

- A subsidiary of a large natural gas producer has developed a small scale LNG plant dedicated solely to the merchant market, including its own fleet of LNG tankers to deliver product to customers.
- The first small scale waterside LNG production facility in the US began operations in 2019 with both marine and truck-loading facilities. The plant will also serve rail, drilling, mining, power generation, and other industrial customers.
- At a drilling site in North Dakota, previously flared associated gas, co-produced from shale oil production, is being captured, treated, and liquefied for use as fuel for high horsepower applications. In addition to monetising a previously wasted resource, the process helps the producer meet gas flaring reduction targets.
- A midstream solutions company has partnered with a shipbuilding firm to form a marine transportation company that will use LNG bunker barges to transport and deliver LNG along the coastal and inland waterways of the eastern US. The LNG will be sourced from a small scale plant.

Figure 1. CB&I Storage Solutions is the EPC contractor for the Tacoma LNG facility in Washington, US, a small scale LNG project scheduled for completion in 2021.

Expanded options for small scale LNG facility storage

A recent change in one of the principal standards governing the production, storage, and handling of LNG offers an option for LNG storage that can provide owners with a lower pressure, smaller plot alternative to pressurised storage.

Issued in 2019, the latest edition of NFPA Standard 59A from the National Fire Protection Association contains a new chapter titled 'Requirements for Stationary Applications for Small Scale LNG Facilities.' The chapter establishes a framework under which low-pressure flat bottom LNG tank systems designed to API Standard 620 can be used safely for storage of up to 1 056 000 gal. (3997 m^3) at small scale LNG facilities.

Previously, pressurised storage vessels – usually pressurised blimps built to American Society of Mechanical Engineers (ASME) standards for pressurised storage – were the only permitted option for LNG storage utilising the code requirements for small scale facilities.

API Standard 620 governs the design and construction of large, welded, low-pressure storage tanks. For storage volumes of 500 000 gal. or greater, API 620 tanks can be built at a more competitive cost than pressurised storage, and they take up less plot space at the plant site. There are three styles of welded steel tanks for LNG storage:

- Single containment LNG tanks typically consist of a 9% nickel steel primary liquid containment inner tank, a carbon steel primary vapour containment outer tank, and an external dike for secondary liquid containment.
- Double containment LNG tanks have a secondary 9% nickel steel or concrete dike wall close to the vapour

containing outer tank of a single containment tank. This type is rarely used.

- Full containment LNG tanks are typically designed and constructed as a 9% nickel primary liquid containment inner tank and a concrete outer tank, which serves as primary vapour containment and secondary liquid containment. In certain cases, a 9% nickel steel outer container could be considered, in lieu of concrete.

Small scale LNG project considerations

With new owners/developers entering the market, some of which may not have extensive experience in the LNG industry, it is important to select suppliers with the requisite technical know-how and track record when developing a small scale LNG project. Because of the unique requirements for storing, handling, and transporting LNG, specialised engineering capabilities are critical. Experience is essential in fluid dynamics; cryogenics; metallurgy; process piping and equipment; process hazard analysis; civil, structural, and mechanical systems, along with knowledge of the numerous industry standards governing the construction and operation of LNG facilities.

One option is to engage a technical consulting firm with expertise in small scale LNG to assist with design, permitting, and construction management. This approach frequently involves interfacing with multiple entities (consultant, equipment suppliers, fabricators, contractors, etc.) during the course of the project.

An alternative is to work with an engineering and construction contractor that offers a single-source, self-perform engineering, procurement, fabrication, and construction (EPFC) approach. This business model translates into a simplified client interface that reduces the complexity and total cost of the project. This approach can reduce project schedules, minimise the owner's risk, and maintain rigorous quality control through every step of the project. With a single point of responsibility, the owner can avoid the delays, inefficiencies, and duplication of effort that can occur when multiple contractors are involved.

Additionally, flexibility in the contractual structure can facilitate project development. A phased contracting approach, where the contractor works with the owner to select the facility design and supply options concurrently with final contract development, often can result in a shorter schedule. The project can be built at lower cost and brought online sooner, thereby starting its revenue stream earlier.

LNG experience

CB&I Storage Solutions has a strong track record of innovation and experience in the LNG industry, having designed and built more than 225 LNG storage tanks and more than 90 peak shaving-related projects. The company's work includes:

- Pioneered the process of air-raising LNG tank roofs in the 1950s.
- Designed and built the world's first double wall LNG storage tank in 1958.
- Designed and built the first LNG peak shaving facility in North America in 1965.
- Designed and built the world's first full containment LNG storage tank in 1986.
- Developed the proprietary mixed refrigerant loop (MRL®) liquefaction process.

CB&I Storage Solutions is an active participant in more than 25 US and international code committees and LNG industry organisations. The company works closely with national regulatory agencies, such as the US Federal Energy Regulatory Commission, to ensure compliance with applicable codes and standards.

Project progress

Currently, CB&I Storage Solutions is the EPC contractor for the Tacoma LNG facility in Tacoma, Washington, US, a small scale LNG project scheduled for completion in 2021. The customer is Puget Sound Energy (PSE), the state's largest utility.

The facility incorporates feed gas pretreatment, mixed refrigerant liquefaction, marine and truck loading stations, and an 8 million gal. LNG storage tank. Tacoma LNG has 250 000 gal./d liquefaction capacity and 60 million ft^3/d regasification capacity. The company's scope includes client support for FEED and permitting, fabrication, EPC, and commissioning and start-up.

Tacoma LNG will ensure a consistent gas supply for residential and industrial users during peak demand periods and will also provide LNG bunkering fuel for containerships travelling between Tacoma and Alaska. A primary customer will be TOTE Maritime, which is converting its entire Alaska fleet to LNG propulsion.

Conclusion

Growing demand for cleaner burning natural gas and the emergence of new markets for LNG as fuel should continue to bolster development of small scale LNG facilities.

For example, the export of LNG for electrical power applications is growing, particularly from the US to Central America and the Caribbean. Facilitating this increase in trade, in 2018 the US Department of Energy finalised a rule to provide for faster approval of small scale exports of natural gas to non-free trade agreement countries. Many countries in the region are making the move to convert from fuel oil and diesel-powered electric generating plants to cleaner gas burning plants in order to lower costs and reduce emissions.

Stricter environmental emissions limits are pushing many public companies to adopt sustainability strategies aimed at reducing their environmental impact. As a result, a number of over-the-road carriers and public transit authorities are converting their fleets to natural gas-powered vehicles. The infrastructure to support use of LNG as a transportation fuel continues to be built out, with China and Europe leading the way in the development of LNG refuelling stations and LNG bunkering services. In late 2018, Carnival Corporation commissioned the world's first LNG-powered cruise ship, and the company plans to take delivery of a total of 10 LNG-fuelled cruise ships between 2019 and 2025.

The move is on to expand the use of LNG in both traditional and new applications. Small scale LNG plants, with lower capital requirements and shorter development times than traditional baseload plants, offer both established and new market participants the opportunity to take advantage of this growing opportunity. **LNG**