

Has boutique LNG gone mainstream?



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development of LNG in
North America as both a
transportation fuel and
an alternative for flare gas
reduction/utilisation.

Part 1 of this article, (published in *LNG Industry*; May 2018), considered the development of the ssLNG business focussing on the development of virtual pipelines in Australia, China, and Argentina, where LNG was being used to transfer gas from stranded fields to remote power generation stations. The development of the use of LNG as a fuel for marine transportation was also examined focussing on the extensive developments in Europe. Part 2 will shift the focus to North America and examine the development of LNG as a transportation fuel in road, rail, sea transport, and as an alternative for flare gas reduction/utilisation from remote shale plays.

Road transportation

In North America, the development of LNG for transportation has been significant, largely driven by the abundance of shale



gas, and environmental pressures to reduce emissions. The natural gas/LNG transport industry in the US has over 1700 natural gas refuelling stations, many of which are open to the public. There are approximately 1640 CNG stations, and 123 LNG refuelling stations. The LNG for these outlets is supplied from a variety of sources including:

- The use of some of the more than 100 peak shaving plants.
- From large scale liquefaction plants/import terminals.
- Small scale liquefaction plants taking gas from pipelines.
- Small scale liquefaction plants located on small reserves or associated gas.



Figure 1. Raven Trucking LNG Trucks (courtesy of Florida East Coast Industries).



Figure 2. FEC Railway LNG fuel tender and locomotive (courtesy of Florida East Coast Railway).



Figure 3. New Fortress Energy LNG ISO container (courtesy of Florida East Coast Railroad).

The two largest LNG/CNG fuel producers and distributors are Clean Energy Fuels, and Applied LNG. Both companies market renewable natural gas that is collected in landfills, waste water treatment facilities, and anaerobic digestion plants, processed, and injected into the US natural gas transmission grid. The recovered greenhouse gases in RNG would have otherwise been vented to the atmosphere, making this option marketable as 'renewable' energy. The pipeline gas is then converted to LNG for refuelling stations at various locations around the US.

In addition, Shell and Prometheus Energy are establishing a network of LNG refuelling stations across the interstate highway network. According to the alternative fuels data centre, there are more than 150 000 vehicles in the US that are powered by natural gas.

Drilling rigs in North America are also being converted to use natural gas fuels. Back in 2005, Encana started testing natural gas to be used as an alternative fuel for their drilling rigs. They established that natural gas and LNG drilling rig options were both economically and, more importantly in the US, socially viable. In 2010, the company opened its first natural gas fuelling station in Louisiana. This was the first step in their multi-year plan to convert more than 1300 trucks and passenger vehicles in their fleet to run on natural gas. Since this pioneering effort led by Encana, many of the drilling rigs, heavy-haul trucks and passenger vehicles in North America are now fuelled by LNG and natural gas.

This has resulted in significant growth of small scale LNG facilities and projects in the US due to the demand in fleet transportation. Examples of companies converting to natural gas fuel alternatives include: FedEx, UPS (United Parcel Service), USPS (United States Postal Service), Ryder Hauling, Raven Transport, and multiple municipal public transportation networks and airports. As an example, Raven Transport, which services the Southeast, Mid-Atlantic, Mid-West, and Northeast, owns 500 trucks – the majority of which have been fully converted to run on LNG. Virtual pipelines, and multiple filling stations for LNG have been developed to meet the US market demand.

Rail

In 2016, the Alaska Rail Road Company (ARRC) transported the first LNG by rail in ISO containers in the US. This testing was done to demonstrate rail as a means of moving LNG from Anchorage to Fairbanks where the LNG can be used as fuel for road transportation and power generation. Even though LNG is commonly safely transported by rail in Canada, Europe, and Japan, there was much local resistance and opposition to the LNG rail transport in Alaska at that time.

In 2015, the Florida East Coast Railway began testing operations on LNG. In 2017, FEC Railway converted its entire line-haul locomotive fleet to run on LNG. The new 24-unit fleet consisting of 12 pairs of back-to-back GE ES44ACs, with a purpose-built Chart Industries fuel tender in-between, was rolled out. In addition to the LNG powered locomotives, FEC Railway is the first railroad to haul LNG as a commodity in the lower 48. FEC Railway owns and operates an LNG plant in Titusville, which provides the source of LNG for their operations.

The locomotives are EPA Tier 3 compliant and have dual-fuel capabilities. The engines can run on both diesel and LNG with up to 80% gas substitution and 100% diesel. The



Figure 5. Q-LNG Transport LNG Articulated Tug and Barge (courtesy of Harvey Gulf International Marine).



Figure 6. Bunkering of MV *Isla Bella* (courtesy of TOTE Maritime).

gas substitution method retains the diesel for compression ignition purposes, which eliminates the need for batteries for start-up.

Chart Industries designed and built the fuel tender that sets these units apart from conventional locomotives, as shown in Figure 1. They consist of a 150 m³ cryogenic tank permanently mounted in a railcar that has been designed to survive side impact and derailment scenarios. LNG content is determined by weight, not volume, thus scales are provided at each fuelling station. The tender car can be filled from empty in 90 minutes, providing the amount required for up to 900 miles of heavy haul service, with a maximum operating speed of 60 mph.

FEC Railway is also serving as a virtual pipeline for LNG by hauling LNG ISO containers for their affiliate, New Fortress Energy, between the New Fortress Energy's liquefaction plant in Hialeah and Port Miami and Port Everglades. FEC Railway own and operates an Intermodal Container Transfer Facility adjacent to Port Everglades.

Marine

The establishment of Emission Controlled Areas (ECAs), along both the East and West coast of the US, has resulted in significant activity to develop LNG fuelled marine transport; particularly for inter-coastal traffic. The Jones Act, which

determines that coastal marine traffic should be US built and crewed has led to significant ship building activity to construct small container ships, ferries, Offshore Supply Vessels (OSVs), and small LNG carriers to be bunker ships.

Shell Offshore Inc. has three LNG powered OSVs in Port Fourchon, Louisiana. The *Harvey Liberty*, *Harvey Energy*, and *Harvey Freedom*, to support their deep-water operations in the Gulf of Mexico. The *Harvey Liberty* runs on 99% LNG fuel, and can operate for up to 15 days before refuelling. The vessel is 302 feet long and operates on three dual-fuel Wartsilla engines. In 2015, the first truck-to-vessel transfer occurred in Pascagoula, to the *Harvey Energy*, representing the first LNG ship bunkering in North America.

The ships were provided by Harvey Gulf International Marine, and are refuelled at Harvey Gulf International's LNG marine fuelling facility in Port Fourchon, LA. This was the first marine LNG fuelling facility in the US, with a final design storage capacity of 1000 m³ of LNG, and capable of transferring 114 m³/hr of LNG to not only marine vessels, but also over-the-road vehicles. Shell, Q-LNG Transport, and Harvey Gulf signed a long-term LNG transport contract in the fall of 2017 to deliver LNG as a fuel source to various ports in Florida and the Caribbean.¹

Q-LNG has contracted with VT Halter Marine for the construction of America's first offshore LNG Articulated Tug and Barge (ATB).¹ This LNG bunker barge will have the capacity to carry over 4000 m³ of LNG fuel. As the first of its kind vessel to be based in the US, the LNG bunker barge will supply LNG to marine customers along the southern East Coast of the US and support growing cruise line demand for LNG marine fuel. The LNG bunker barge will be owned and built by Q-LNG Transport and operated by Harvey Gulf International Marine.

TOTE Maritime owns the world's first LNG powered container ship, the MV *Isla Bella*. During the initial voyages of the ship from Florida to Puerto Rico, 400 m³ of LNG were bunkered from multiple TOTE-owned LNG ISO containers in 2015. Since the initial voyage, more than 114 000 m³ of LNG have been successfully transferred from truck to the ships fuel tanks.

TOTE's *Isla Bella* and *Perla del Caribe* each use 25 ISO containers trucks to refuel each week in Jacksonville (approximately 900 m³). JAX LNG, the partner and supplier of LNG to TOTE Maritime operations, is constructing a small scale LNG facility and marine loading jetty at Dames Point, on the St. Johns River. This facility is North America's first small scale waterfront LNG production facility. TOTE Maritime has committed to converting their entire fleet to running on LNG, with conversions for their vessels operating in Alaska to be completed by 2021.

Another example of innovative project development has been used by New Fortress Energy, a US based energy company, to develop projects in Jamaica that they have funded and supplied LNG for. The projects include three LNG power plants purchased by Jamaica Public Service Company. The location of one of the power stations in Montego Bay is not accessible by standard LNG carriers (LNGCs) and a large LNGC has been chartered from Golar to act as an FSU moored on the other side of the island in an industrial area of Kingstown harbour. The LNG cargo is then bulk-broke into small parcels of 6500 m³ and transported to Montego Bay in a small LNGC, the *Coral Athena*. This interim measure has enabled the



Figure 7. Galileo Cryobox® installation in the Bakken for flare gas reduction (courtesy of Galileo Technologies).

power station to operate on gas earlier whilst an FSRU will eventually be located to supply additional gas supplies.

Flare gas reduction

The Galileo Cryobox technology has also been deployed in the USA for the Terra Energy Group in North Dakota to reduce gas flaring at the wellhead. The process includes a Galileo ZPTS® Gas Conditioning Plant, and a Cryobox® Nano LNG station. The station converts natural gas into 13.6 – 14.8 tpd of LNG based upon well production. The LNG is stored on-site, with the boil-off gas being recovered and re-liquefied. The LNG is transported and consumed for drilling rig power generation, and frac-water heating for Terra Energy's operations in the Bakken play.

Dresser-Rand commissioned the first micro scale LNG facility in Pennsylvania's Marcellus Shale in late 2017. The unit was installed at the Ten Man LNG facility in Tioga County. This unit allows Frontier Natural Resources (the operator) to monetise stranded gas assets in the Mainesburg field. The scope of supply included four different modules and requires a footprint of roughly 508 m².

Conclusion

The innovative application of small scale LNG technologies is enabling great progress to be made in improving the environment. Using LNG as a fuel for marine, rail, and road transportation reduces the emissions from diesel and oil fuelled engines and is being demonstrated to do this in a safe and economic manner, for multiple years in the US. In addition, using small scale LNG as an option to reduce well-site flaring, and recovering otherwise stranded gas in North America provides additional market opportunities, reduces emissions in a cost-effective manner. The Global Demand of the small scale LNG market is projected to grow to at a compound rate of roughly 7% per year from 2017 – 2023 to around 50 million tpy. Much of this growth will occur in North America where the enhanced supply of natural gas will ensure a wide range of opportunities to be developed. [LNG](#)

References

1. 'Shell, Q-LNG Transport and Harvey Gulf sign long-term LNG transport contract', Q-LNG Transport, LLC/Harvey Gulf International Marine, LLC, Nov. 2017.