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Executive Summary

Mini / Micro LNG for commercialization of small volumes of associated gas

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The Global Gas Flaring Reduction Partnership (GGFR) provides its members with overviews of the potential solutions to recover and monetize the flared and/or associated gas.

This study analyses the LNG chain concept which can be used for the monetization of small volumes (1 -15 MMscf/d) of associated gas.

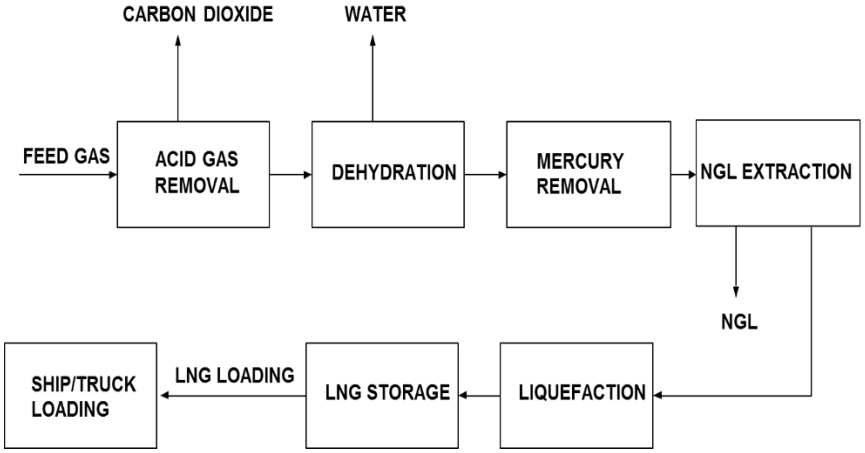
The LNG business background

While the LNG industry has traditionally focussed primarily on development of ever increasing plant capacities, the maturity of the technology has allowed development of technologies applicable for small volumes to be competitive and potentially economically attractive. The main challenge for small scale LNG applications is therefore not technical but economic.

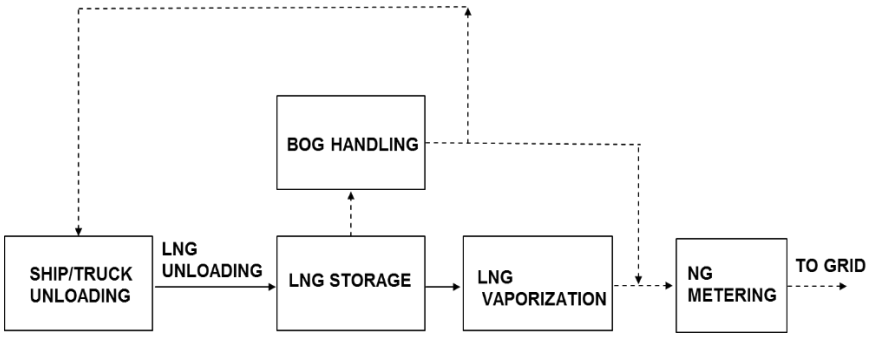
The LNG chain

Traditionally the LNG chain was composed of three elements: liquefaction plants, transportation by ship and receiving terminals. However, attention is now being given to the diversification of LNG to increase gas distribution flexibility and to reach new consumers through small scale facilities, LNG distribution by trucks, LNG refuelling stations, etc.

Natural gas liquefaction is a process which typically involves several steps: the various feed gas pre-treatments followed by liquefaction as shown in the block flow diagram below.



At the receiving end, facilities are required to store the received LNG and reconvert it back to gas for use by consumers.



Alternatively, where the LNG will be used as a fuel directly e.g. in trucks, only storage and a loading facility is required.

Mini/micro LNG liquefaction Technologies

Mini/micro LNG facilities currently mainly consist of LNG liquefaction plants supplying LNG satellite stations with annual LNG volumes up to 0.2 mtpa. As an indication, these LNG quantities correspond to the yearly LNG demand for a power plant up to approximately 100 MW.

The mini-LNG chain is virtually identical to the conventional LNG chain, differing only in scale. One difference is that for small gas volumes, LNG transport is feasible using trucks (onshore) or barges (offshore) rather than large marine carriers.

While the purpose of this study is not provide a tool to estimate the cost of the chain but to provide an overview of the main elements that should be taken into consideration when evaluating the potential for specific projects, it is important to give some indication of potential cost (capital and operating) of an LNG chain.

The sizing and cost of the different elements of the chain depend on the specific characteristics of each project such as: gas volume and composition, distance to consumers, storage and infrastructure requirements, geographical location etc..

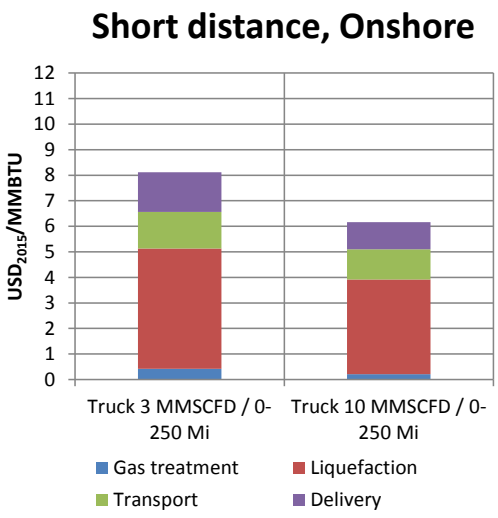
The unit cost (capital and operating) for four scenarios have been evaluated: Gas volumes of 3 and 10 MMscf/d, and short and long distances to customers. It must be noted that these cost estimates are only indicative as specific circumstances (e.g. a challenging physical environment, high labour costs in an overheated business environment such as the Bakken in N. Dakota, high import duties), can affect the costs and hence economics significantly.

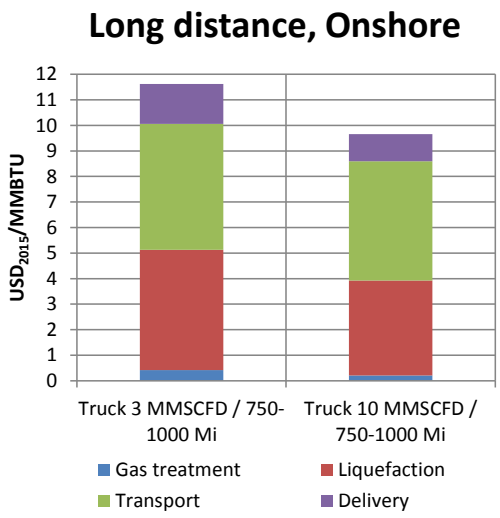
Transport method	Short distance		
Offshore	Capital & Operating cost, USD_{2015}/MMBTU		
	Item	**Marine 3 MMSCFD / 55-150 MN**	**Marine 10 MMSCFD / 55-150 MN**
	Gas treatment	0.42	0.21
	Liquefaction	4.71	3.71
	Transport	2.36	1.86
	Delivery	1.56	1.06
	Total	**9.05**	**6.84**

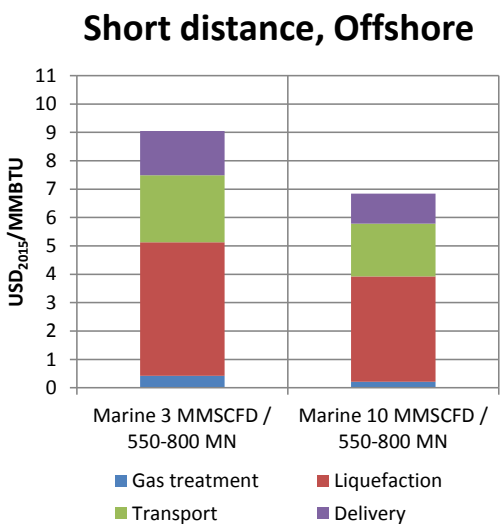
Onshore	Capital & Operating cost, USD_{2015}/MMBTU		
	Item	**Truck 3 MMSCFD / 0-250 Mi**	**Truck 10 MMSCFD / 0-250 Mi**
	Gas treatment	0.42	0.21
	Liquefaction	4.71	3.71
	Transport	1.43	1.18
	Delivery	1.56	1.06
	Total	**8.12**	**6.16**

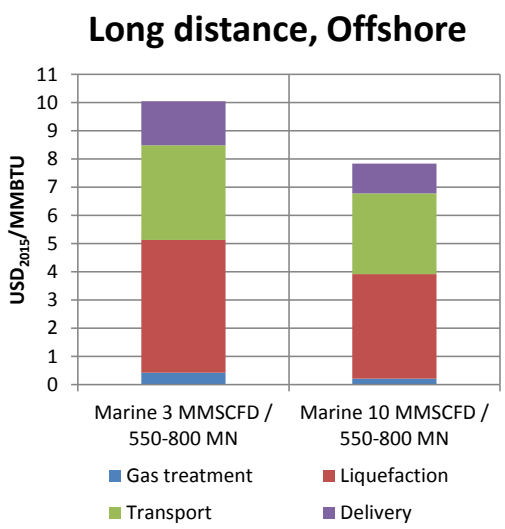
Transport method	Long distance		
Offshore	Capital & Operating cost, USD_{2015}/MMBTU		
	Item	**Marine 3 MMSCFD / 550-800 MN**	**Marine 10 MMSCFD / 550-800 MN**
	Gas treatment	0.42	0.21
	Liquefaction	4.71	3.71
	Transport	3.36	2.86
	Delivery	1.56	1.06
	Total	**10.05**	**7.84**

Onshore	Capital & Operating cost, USD_{2015}/MMBTU		
	Item	**Truck 3 MMSCFD / 750-1000 Mi**	**Truck 10 MMSCFD / 750-1000 Mi**
	Gas treatment	0.42	0.21
	Liquefaction	4.71	3.71
	Transport	4.93	4.68
	Delivery	1.56	1.06
	Total	**11.62**	**9.66**

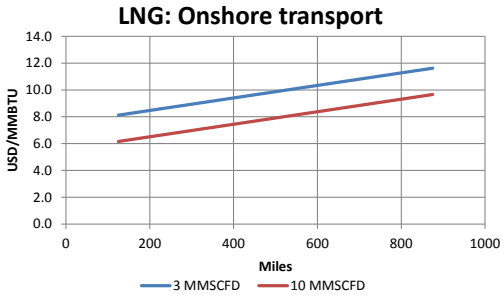


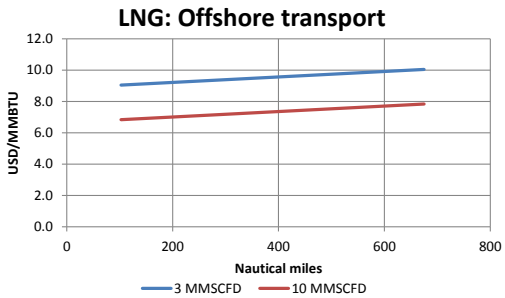






The above examples can be summarized as follows:

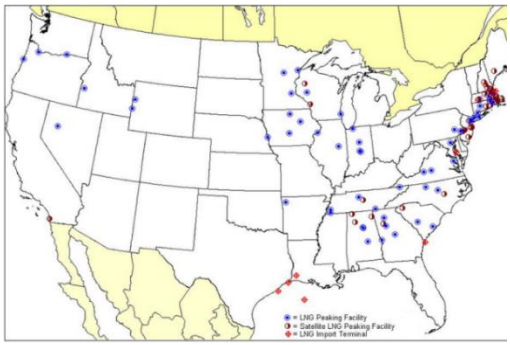




In summary, where specific circumstances do not adversely affect cost, for gas volumes between 3 and 10 MMscf/d and distances up to 800 MN/1000 miles, total unit costs (capital plus operating) for mini/micro LNG projects range from 12 to 6 US$/MMBTU.

Mini/micro LNG market overview

An analysis of the market for mini LNG facilities in the US and China has been performed in order to explore potential opportunities to commercialize small LNG volumes from associated gas in low and middle-income economies in economically beneficial ways.



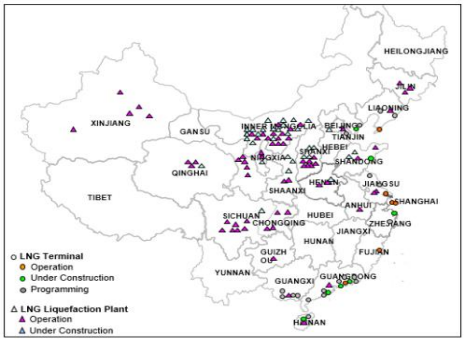


Figure 1: LNG Plants in USA and China

Small-scale LNG solutions have been implemented in the following situations:

- Restrictions of infrastructure:
- In USA, peak shaving was used to solve pipeline network restrictions or deficient storage capacity.
    - In China, domestic gas demand had a boom which could not be matched by the required infrastructure development (gas transportation and transmission). LNG virtual chain provided a transitional solution to solve the gap.
    - Demand does not reach the minimum volume required to invest in traditional gas infrastructure transportation.
- Emission reduction policies (already implemented in China and expected in USA in the near future).
- More competitive prices of natural gas in the transportation sector against petroleum derivatives.

Similar small scale LNG models could be implemented in countries such Nigeria, Iraq and Indonesia among others, which have high flaring levels.

Nigeria and Iraq present some similarities to the aspects which made China and the USA consider small scale LNG: restrictions on power supply & transmission and security issues hindering the development of the most economically suitable infrastructure for large scale flaring solutions. Also, Indonesia offers further opportunity for economic use: LNG as fuel for ships.

Conclusion

LNG technologies are readily available making it possible for “fast-track” implementation of mini LNG facilities with relatively low investment (compared to pipelines or large scale facilities).

Small-scale LNG can enable rapid establishment of power plants or industries (fertilizers, food industry, ceramic, etc.) in areas limited by lack of infrastructure.

Use of small-scale LNG as a fuel for the transportation sector - trucks, buses, ships - is increasing, stimulated by the increasing cost of conventional fuels and environmental concerns.