



Floating Liquefaction (FLNG): Potential for Wider Deployment

Executive Summary
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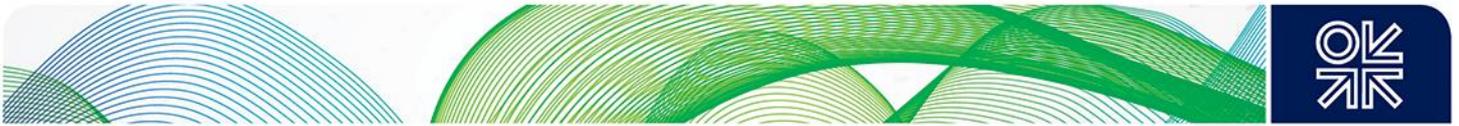
The concept of floating liquefaction plant (FLNG) has been studied since the mid-1970s but made very slow progress until May 2011, when Shell announced their decision to proceed with the development of Prelude FLNG, to be located in the Timor Sea. Since then six further projects have been approved and most are in construction. The Caribbean FLNG facility is complete and waiting for a new field assignment as gas is no longer available at the original location. None of the vessels is yet in operation but the Petronas FLNG Satu is expected to be the first with start-up scheduled for late 2016 or early 2017.

The concept of floating liquefaction development follows closely behind the successful deployment of floating storage and regasification units (FSRUs) which have been accepted by the industry at an impressive pace. The first FSRU vessel was installed in the Gulf of Mexico in 2005 and by mid-2016, 19 vessels were in operation with many more on order. Such a rapid take up of a new enabling technology in the LNG industry is quite unprecedented. It will be interesting to see if FLNG progresses at the same rate. Currently 24 FLNG developments are in progress – 7 in construction and 17 in the planning/pre-engineering stage.

FLNG offers many advantages for the development of remote offshore gas reserves which are often referred to as 'stranded' gas. FLNG production costs should be lower than the equivalent onshore development by eliminating the cost of the pipeline to shore and the need for a tanker loading jetty and, where required, a breakwater. Further cost reductions will apply where onshore construction costs are high e.g. Australia. A recent demonstration of this was the decision by Woodside to develop the Browse field in Australia as an FLNG and not an onshore plant, albeit this has now been shelved due to current low energy prices. Similarly ENI is considering FLNG for offshore Mozambique as an early production system due to expected high construction cost of an onshore LNG plant.

In addition to lower cost, FLNG offers a much higher confidence in meeting the delivery schedule and production date by using a shipyard rather than onshore construction in remote and challenging areas which frequently experience major delays. First production date is critical to project profitability and very important to lenders on financed projects. FLNG also lends itself well to inshore developments for the same reasons of lower cost and on time delivery for projects located in areas where onshore construction is difficult or expensive, or land is not readily available, or permitting is very difficult. Simple FLNG facilities (liquefaction only) are typically in the cost range of \$700-800/tpa which is similar to the onshore plants currently under construction in the USA reflecting the cost effectiveness of shipyard fabrication.

However there are disadvantages. The main one currently is that offloading has until recently been restricted to relatively benign ocean conditions due to the need to use proven offloading arms which have a limit of 2.5 m significant wave height. Cryogenic hoses and other concepts that can employ tandem loading have now been developed and qualified and will open the operating window for



offloading in more harsh environments. As with any new technology the operators have selected the least demanding projects for the first deployment of this approach and will leave the more challenging developments to a later date when more experience has been gained. The other disadvantage is the very limited local employment content with FLNG which is often a major political consideration.

From a commercial standpoint FLNG has opened the opportunity for energy companies to obtain liquefaction facilities on a leased or tolling basis from the FSU and FPSO contractors. Further the approach of these companies is quite different from the major energy companies in that they are looking to supply relatively standard designed vessels using functional specifications that can be reused on other fields. This is very different from the energy company approach to design on a project bespoke basis and follow the exacting design methods and specifications developed over many years. Most vendors would say that this approach adds considerable cost. However, both Shell and ENI have stated that they are seeking a 'design one and build many' philosophy for future developments. This functional approach would appear to reduce the development cost considerably based on the costs currently being quoted by the leasing companies. This will be tested over the next few years as the first developments become a reality and the actual costs are established. It must be stated that these same companies introduced leased FSRUs into the terminal market and their success has been unprecedented in what is a conservative LNG business. The industry is waiting to see if the same will happen with FLNG. As a further step one major FLNG contractor has just announced a joint venture with a major down-hole company which will enable this partnership to offer the complete offshore scope – both supply and operation – including project finance. This will likely be a great interest to the smaller energy companies who have limited financial and technical resources.

Golar LNG and Exmar are also looking to build vessels on a speculative basis. This has proved very successful in the FSRU market by reducing project lead times and enabling earlier production and revenue and the same would apply here for the liquefaction market. It is likely that these speculative vessels would need some project specific modifications before delivery but would likely be delivered far more quickly than a project specific new build vessel or onshore plant.

Many in the LNG industry view FLNG as a 'game changer' for the development of offshore gas fields in the same way that FPSOs enabled oil production for remote & deep water fields. However their success will depend on the performance of the projects currently in construction – performance not only in terms of reliable LNG production but whether the expected cost and schedule savings can be realised. The industry is waiting with interest, particularly in the current low cost energy market where lower production costs and earlier revenue would offer a major advantage over onshore plants.
