

FLNG – operators step hard on the gas



**Chris Brown, Director –
Energy CT Adjusting**

+44 20 7015 2028
chris.brown@ctplc.com

With the demand for global energy expected to triple over the next few decades as emerging economies develop, oil and gas operators are looking toward innovative and pioneering technologies to open up new resources. The world's demand is not just for more energy, but for cleaner energy. Natural gas, the cleanest of all fossil fuels, offers an affordable and environmentally acceptable source.

Current offshore production facilities rely on expensive subsea pipelines to export natural gas to shore, either direct to the end user or to an onshore liquefaction plant. Liquefied natural gas (LNG) plants cool gas into its liquefied state, which enables it to be transported by sea in LNG carriers.

A new vision

Floating liquefied natural gas (FLNG) technology offers an effective solution to the problem of producing and exporting gas ashore. Floating above an offshore natural gas field, an FLNG facility produces, liquefies, stores and transfers LNG (and potentially Liquefied Petroleum Gas (LPG) and condensate) to shuttle carriers for export direct to market. Without the need for export pipelines, FLNG will enable the development of gas resources ranging from clusters of smaller more remote fields to much larger discoveries that could accommodate a number of FLNG units in production at any one time. In theory, the floating production facilities will be redeployable upon depletion of fields.

FLNG technology also provides a number of environmental and economic benefits. In addition to eliminating the need to lay long pipelines, there is no requirement for offshore compression units to pump the gas to shore or for the construction of coastal LNG facilities, which cause marine and coastal environmental disturbance. Combine the benefits and the result is new development opportunities for offshore gas fields that would otherwise remain stranded. There is currently estimated to be 60-70 trillion cubic feet (tcf) of stranded gas offshore East Africa, 40-50 tcf offshore

Norway, 30-40 tcf offshore Brazil and 100-110 tcf offshore Australia.

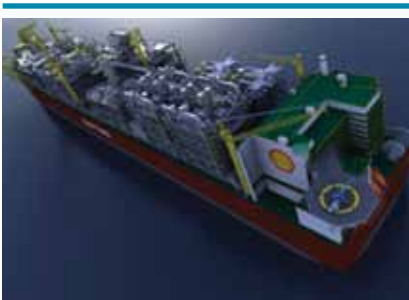
Research and development

FLNG is understandably a hot topic. However, the concept is not a new one. Studies into offshore LNG production, including research backed by experimental development, have been carried out since the mid-1990s. Shell has been conducting its own studies, simulations and testing for almost 15 years. This work has culminated in one of the first FLNG developments, Shell's Prelude FLNG, representing an estimated investment of approximately \$11bn. The hull will be 488m in length, 74m in beam, and when fully ballasted will weigh around 600,000 tonnes (roughly six times as much as the USS Nimitz aircraft carrier). The detailed design of the unit is being undertaken by a Technip Samsung Consortium in Paris, and is being built in Samsung Heavy Industries' Geoje yard in South Korea. Hull construction is expected to be completed by the end of 2013, but start-up in the field will not commence until 2017. The Prelude gas field was discovered by Shell in 2007, located 200km off Australia's north-west coast. The Prelude FLNG will produce at least 5 million tonnes per year of LNG, LPG and condensate at peak production, remaining in the field for 20 to 25 years before needing to dock for inspection and overhaul.

Despite the rapid progress being made by a number of consortia, FLNG is certainly not without its challenges. Only a few facilities worldwide are capable of fabricating the giant hull structures necessary to provide sufficient deck space for the liquefaction process facilities, even though current



**SBM's mid-scale FLNG concept
(Courtesy of SBM)**



Prelude FLNG artist's impression
(Courtesy of Shell)

designs enable the configuration of all LNG plant components into a relatively small area, roughly one quarter the size of a conventional onshore plant. FLNG units may be required to operate in hostile environments and understanding how a facility behaves, including how its process facilities perform, is required. Stability, structural integrity and safety are critical. Shell's Prelude FLNG and its mooring system have been designed to withstand a Category 5 cyclone. Although it is possible nowadays to design membrane type LNG containment systems for partial filling, tank sloshing due to hull motions remains a risk factor, requiring extensive modelling to fully understand the loads imposed on the hull structure.

New regulations?

The hazards associated with hydrocarbon leaks, whether gaseous or cryogenic liquid, need to be mitigated. Experience here in regard to the design of modules, the segregation of facilities and safety of equipment is no doubt being drawn from existing FPSO, LNG carrier and onshore LNG technologies. The certification of equipment with special attention to its application in the marine environment is also fundamental to mitigating this risk, and the application of existing relevant standards and codes will be strictly observed by regulators. One expects that it will not be long before specific rules and regulations are published.

Challenges and opportunities

Like an FPSO, the FLNG concept relies heavily on its ability to safely offload product onto shuttle vessels. Having large vessels in close proximity poses a significant risk and one which requires extensive modelling. With Prelude, for example, the LNG shuttle carriers will moor alongside the FLNG hull to allow the specially designed LNG and LPG loading arms to be connected – the FLNG hull will at least provide some

shelter to its shuttle. Other solutions may not offer this benefit.

The numerous challenges and risks have not discouraged other operators from selecting FLNG technology as the preferred option for developing remote gas fields. Current projects include:

- The Woodside-operated Browse LNG project located in the Indian Ocean, 425 km north of Broome in Western Australia (utilising Shell's FLNG technology).
- The Woodside-operated Sunrise LNG project in the Timor Sea, 450km north-west of Darwin (again, utilising Shell's FLNG technology).
- Petronas-operated FLNG destined for the Kanowit gas field offshore Malaysia, currently under construction in Daewoo's shipyard in Korea.
- Inpex Masela operated Abadi LNG project in the Masela block of the Timor Sea, currently in the FEED stage.
- Bonaparte FLNG project offshore Australia, in a joint venture between GDF Suez Bonaparte and Santos, awaiting final investment decision.

The selection process is likely to become easier as alternative FLNG solutions are developed. SBM is currently developing a mid-scale FLNG concept based on the conversion of two Moss LNG carriers that are joined together using a technique patented by SBM Offshore. The key advantages of this are claimed to be significant cost and schedule savings compared with new-build hull options. FLNG design and innovation will no doubt continue to be pushed.