Gas Strategies

Trends in FLNG: A maturing industry

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Executive Summary

- Floating LNG (FLNG) projects are increasingly competitive with greenfield onshore liquefaction and the technology is allowing an increasingly diverse set of players to enter the LNG market
- As the FLNG industry matures there is a trend towards simpler modular designs which are more likely to be redeployed – a key enabler for unlocking previously dismissed upstream resources and challenging project financing
- The FLNG engineering, procurement and construction (EPC) market is increasingly competitive and we are likely to see FLNG units sanctioned with larger still throughput and storage capacities

A maturing industry

Floating LNG (FLNG) is now a mainstream technology and, driven by increasingly efficient shipyard construction practices, public data suggests FLNG projects are increasingly cost competitive with greenfield onshore liquefaction and even brownfield onshore liquefaction expansion. Given this reality, debate should focus on how FLNG will evolve over time and whether FLNG capacity will remain relatively modest compared to onshore plants. This Perspective explores four nascent trends in FLNG, their drivers and potential consequences.

FLNG simplification

Two distinct types of FLNG units have emerged. Those capable of processing wellstream fluids ('floating production, storage and offloading-type, FPSO-type'); and units which receive processed or semi-processed gas ('liquefaction-only type'). The former are designed to process raw hydrocarbons from a specific reservoir making them more complex; they are expensive to construct and operate and are more challenging to redeploy as they are location / resource-specific in design.

To date just three FPSO-type FLNG units have been sanctioned, Shell's Prelude (Australia, 2010), Petronas' PFLNG Dua (Malaysia, 2014) and Eni's Coral Sul (Mozambique, 2017). The Dua and Coral Sul units have been more successful than the Prelude unit which suffered delays in construction and subsequently major operational

Figure 1: **Cumulative global FLNG capacity (excluding redeployments)**

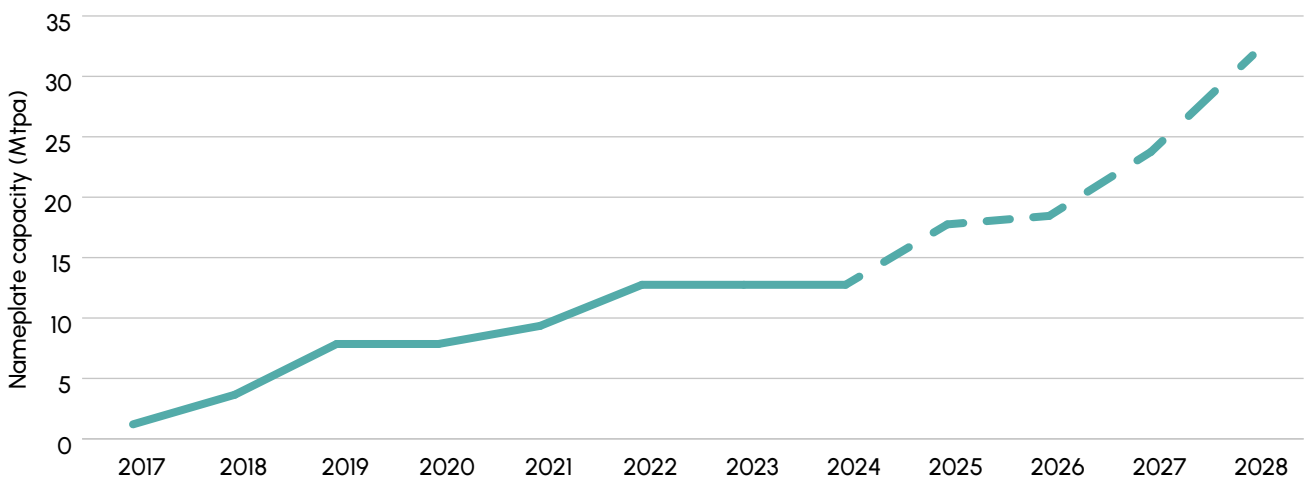
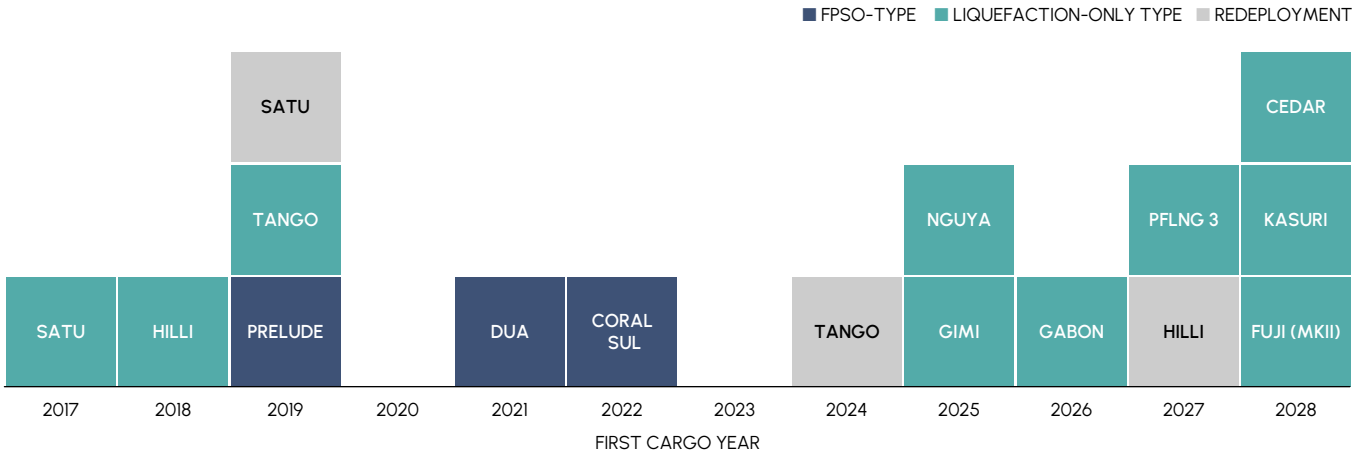


Figure 2: **Sanctioned FLNG units by type**



downtime. All seven FLNG units sanctioned subsequent to the Coral Sul are liquefaction-only type and, furthermore, six are barge-type, not ship-shape, hulls designed for operation in relatively benign near shore environments.

The trend towards liquefaction-only type FLNGs has been driven by efforts to simplify upstream development concepts, thereby lowering capex and increasing optionality. The physical separation of gas processing equipment from the hull hosting the liquefaction trains simplifies topside engineering and can therefore reduce capex and opex. Diverse development concepts deploying simple FLNG units are exemplified by Petronas' Kumang cluster development (Malaysia) which uses a fixed processing platform; BP's Greater Tortue Ahmeyim (GTA) project (Senegal/Mauritania) which deploys an FPSO; and Genting Energy's Kasuri block development (Indonesia) which will process gas onshore. The BP-led GTA project illustrates the benefits of near-shore operations compared to deepwater engineering and mobilisation to remote locations.

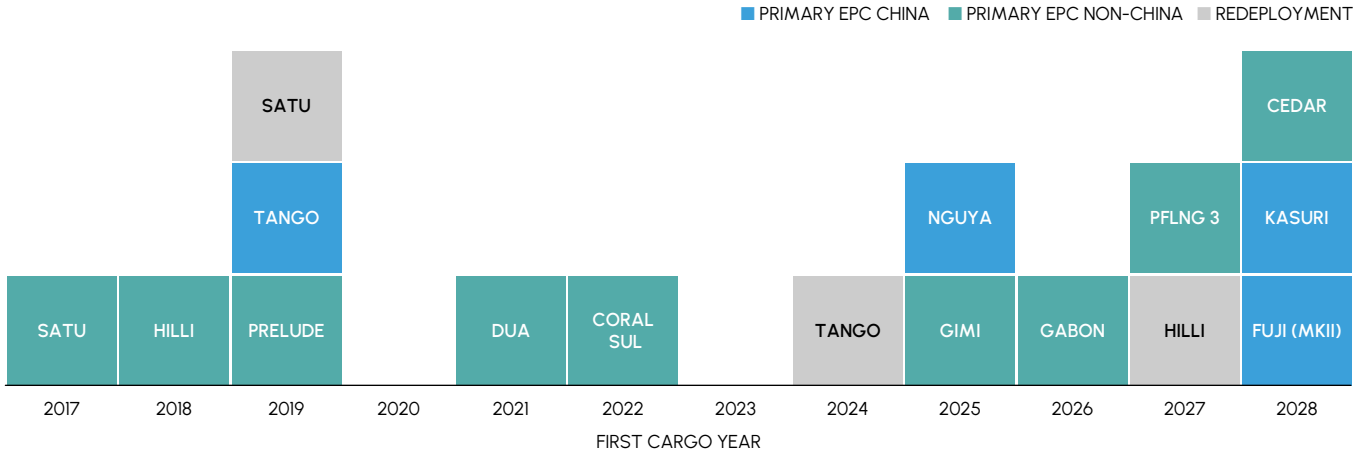
Liquefaction-only type FLNGs are also increasingly deployed to maximise value from existing infrastructure. When redeploying the PFLNG Satu to Kebabangan (Malaysia), Petronas utilised existing processing capacity, whilst Eni utilised existing production facilities in its deployment of the Tango FLNG offshore Congo. Both the Cedar FLNG project (Canada), owned by the Haisla Nation and Pembina Pipeline Corporation, and Delfin LNG's proposed US FLNG project will rely at least in part on existing pipeline infrastructure capacity.

Separate storage

An increasing number of liquefaction projects are utilising floating LNG storage, some in conjunction with separate FLNG units. Two floating storage units (FSUs) are currently deployed, one alongside the 16,000 m^3 Tango FLNG unit (Congo) and one alongside New Fortress Energy's fixed platform-based Fast LNG 1 project (Mexico). Two further FSUs are under conversion to serve liquefaction projects, one for Perenco's Cap Lopez project in Gabon and one for the Woodfibre LNG project in Canada which will employ onshore liquefaction.

As with the physical separation of gas processing equipment, separate floating LNG storage can simplify engineering designs and allows the repurposing of existing infrastructure, in turn reducing capex and construction timelines. As nimble players such as New Fortress and Perenco continue to expand their footprint in LNG, the implementation of such innovative concepts is likely to proliferate.

Figure 3: **Sanctioned FLNG units by EPC geography**



Enter China

The FLNG engineering, procurement and construction (EPC) market was initially dominated by Samsung (Korea) and Daewoo (Korea) for hulls and TechnipFMC (US), Black & Veatch (US) and JGC (Japan) for topsides. However, increasingly dominant in both hull and topside design and construction is Chinese company Wison New Energies. Wison has been awarded three newbuild FLNG contracts and is understood to be extremely cost competitive. The company's competitive position is also likely to have been enhanced by the prevailing tight market for LNG vessel construction slots.

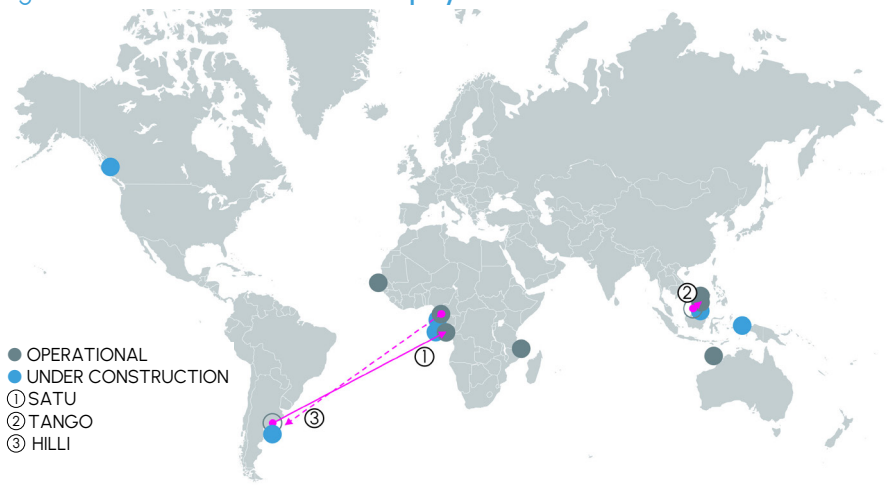
It is noteworthy that the first FLNG conversion by a Chinese yard was sanctioned in September 2024. Chinese yard CIMC Raffles is working alongside US-based Black & Veatch to deliver Golar LNG's MKII FLNG (Fuji LNG conversion) ahead of its deployment offshore Argentina.

Chinese yards have the lowest construction costs and the experience of the LNG carrier EPC market suggests that the entry of Chinese yards into FLNG serves to significantly increase capacity and competition. If lower Chinese labour costs continue to drive FLNG EPC costs lower, a greater number of larger FLNG units are likely to be sanctioned. Golar has reported plans to sanction a FLNG unit with capacity up to 5.4 Mtpa and Argentina's YPF is working with Eni on plans to deploy two 6.0 Mtpa vessels. The largest units currently operational have capacities around 3.5 Mtpa.

The availability of larger storage volumes at lower cost is also likely to help mitigate the issue of cargo scheduling which has historically been a major challenge in FLNG.

More cost competitive newbuild prices may also make FLNG conversions less attractive. Perenco is currently converting a barge to serve its 0.7 Mtpa Cap Lopez FLNG project (Gabon) but Golar LNG, the leading player in FLNG conversions, has indicated that its MKIII design will be a newbuild, likely because the suggested liquefaction capacity cannot be accommodated on a converted hull.

Figure 4: **FLNG unit locations and redeployments**



Redeployment proven

Two FLNG redeployments have now been completed and a third has been sanctioned meaning redeployment is now a real and significant advantage rather than just a theoretical upside. Redeployment can improve overall project economics for the benefit of both vessel owners and resource holders and is especially important for unlocking smaller gas resources which cannot underpin traditional decade-plus financing periods seen in LNG.

In the case of the PFLNG Satu and the Hilli, redeployment was motivated by a decline in upstream resource. The PFLNG Satu unit was initially deployed to better access marginal and stranded gas fields and delivered 19 cargoes from the Kumang Cluster development before being redeployed to the Kebababgan field in 2019 without drydock. The two developments are located 250 nautical miles apart offshore Malaysia. Perenco's lease contract with Golar for the Hilli FLNG expires in 2026 at which point Golar will redeploy the unit from Cameroon to Argentina under a 20-year charter with Pan American Energy.

The PFLNG Satu, Tango and Hilli units were the first three liquefaction-only type FLNGs to be commissioned suggesting that as time goes on more recently commissioned units are also likely to be redeployed. Moreover, as energy transition pressures continue to drive up the perceived risk of stranded fossil fuel assets, the ability to redeploy FLNG units is likely to be of increasing comfort to financiers. Finally, in a world approaching peak LNG where timing of supply is key to project competitiveness, the ability of redeployments to hasten development timelines will be increasingly advantageous.

The way forward

FLNG is playing an increasingly important role in the LNG industry as demonstrated by the number of projects being progressed towards a final investment decision (FID).

Simplification in FLNG design, an increasingly competitive EPC market and further redeployment activity will all serve to reduce costs and thereby further lower the barrier to entry into LNG.