

FSRU Concept Paper – Government of Pakistan

A paper prepared by QED Consulting

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Background

FSRUs were first implemented by Exceleerate Energy in the US Gulf of Mexico (2005 – now decommissioned), US North East Coast (2008) and at Teesside in the UK (2007), as the company looked to profit from potential spikes in winter gas prices in the US and the UK's liquidly traded gas markets.

Since mid-2008 global demand for FSRUs has increased as countries with rapidly growing economies, unable to meet demand for gas, started to turn to FSRUs rather than building conventional/onshore LNG terminals as a means to import gas more quickly. It usually takes a minimum of three years to build and bring a conventional/onshore terminal online but can take as little as one year for an FSRU, subject to the vessel being available.

Brazil and Argentina were quick to invest in two FSRUs each – Argentina's YPF bought two FSRUs along with Repsol and ENARSA (2009 and 2011) and Brazil's Petrobras chartered two FSRUs from Golar on a long term basis (in 2009). Dubai and Kuwait followed shortly after – Dubai's DUSUP under a long term charter from Golar (2010) and Kuwait's KNPC as a purchase from Exceleerate (2009). Over 2009-2010 Höegh partnered with GdF Suez to develop the two vessel Neptune LNG Port on the US North East Coast. Since 2011, only one FSRU has come online which was in Indonesia and supplied by Golar, although over eight orders have been placed.

Stationary FSRUs and Ship-To-Ship (STS) LNG Transfer

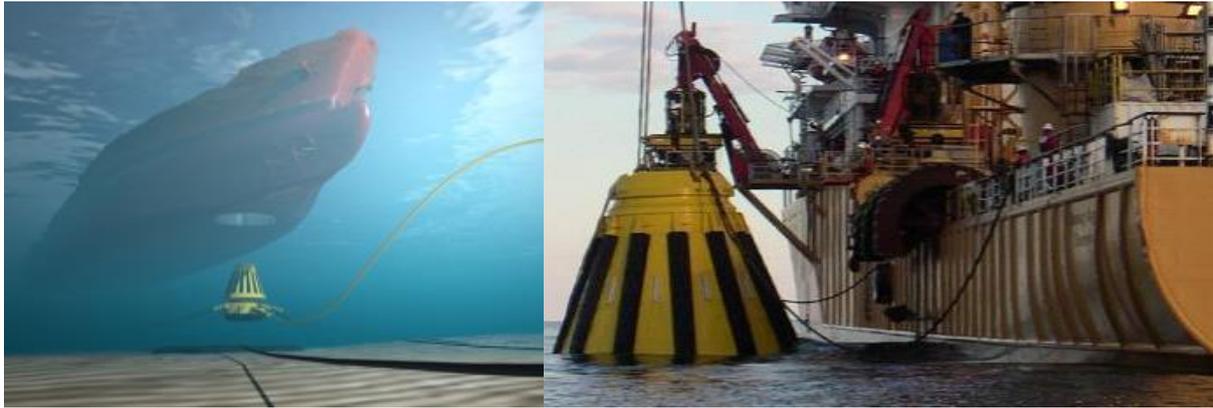
Though FSRU's are flexible in that they can operate as conventional LNG carriers and lift cargoes from supply sources, most are stationary over their charter period/lifetime (other than being moved to dry dock once every 5 years or so). Stationary FSRUs allow gas to be continuously delivered into the domestic market without the FSRU having to mobilise to lift the next cargo. This means that conventional LNG carriers moor alongside the FSRU and transfers its cargo at sea or at the port using flexible cryogenic hoses. Sufficient onshore LNG, underground gas storage or alternative gas supplies with a source of LNG supply relatively nearby may more easily allow a flexible use of the FSRU. Flexible use would also be possible with more than one FSRU, as employed by GdF Suez/Höegh at Neptune LNG in the US with 2 SRVs going back and forth from Trinidad simultaneously. This concept is often employed in fast track projects; Exceleerate specialise in this type of solution.

FSRU Concepts

There are two main concepts for an FSRU depending on whether it is located offshore or dockside:

1. **Offshore:** In most cases an FSRU is connected to a Single Point Mooring (SPM) mechanism, usually a Submerged Turret Loading (STL) subsea buoy, which is drawn into the hull of the ship and is linked to a subsea pipeline through which regasified LNG is delivered to shore. Ship-to-ship transfer happens offshore. In some emergency situations LNG is delivered through a single FSRU which both transports the LNG and regasifies it into the natural gas network via the SBM (e.g. Israel).

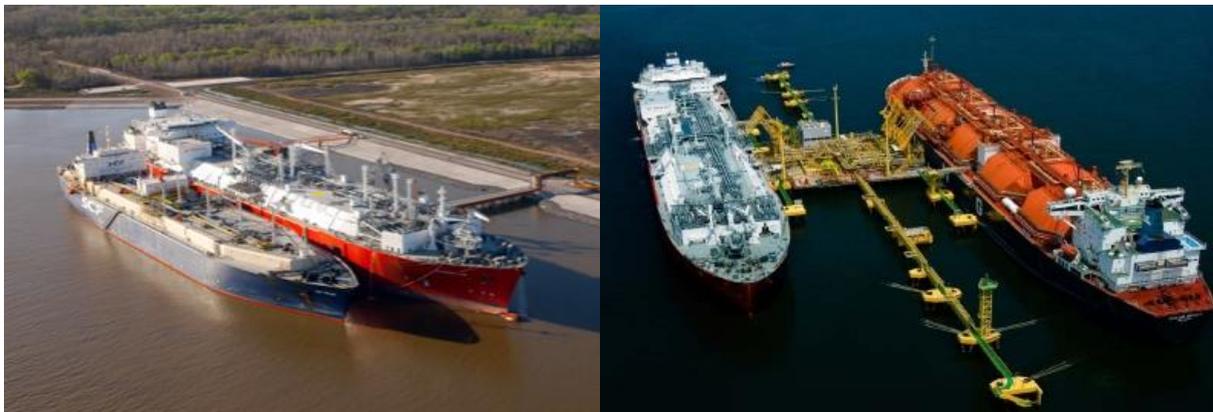
Figure 1 Offshore transfer: STL subsea buoy drawn into hull and STL being deployed



Source: Höegh, Excelerate Energy

Dockside: The FSRU is connected directly to a high-pressure gas-offloading arm near the loading arms, with gas being sent straight into the local network. Ship-to-ship transfer can either be alongside the FSRU or across the jetty. Again, fast track projects may use only a single FSRU which both transports and regasifies the product into the local network (e.g. Teesport, UK).

Figure 2 Dockside transfer: Alongside FSRU and over the Jetty



Source: Golar, Excelerate Energy

Note: Excelerate refer to the offshore concept as 'Gateway' and dockside as 'GasPort'.

Deciding between offshore or dockside LNG transfer/unloading is largely dependent upon having access to a deep water port/jetty which is also close to demand centres. Congested ports may also be a reason to have the FSRU located offshore. The potential downside of offshore FSRUs includes a potentially longer implementation process and higher associated costs.

FSU + Regas versus FSRU

There is an option to go for an FSU with a separate regasification unit which can be either platform or shore based. There appears to be a trend for such a solution given that it can be beneficial both in terms of being brought online faster than a FSRU and also because of the ease of finding an alternative FSU when dry docking is required for maintenance. Some of the key benefits of a FSU + R solution include:

- A FSU (essentially a conventional LNG carrier) can be chartered at any time and can easily be changed for another FSU if required (e.g. providing a constant gas supply during maintenance periods).
- A regas plant can be sourced separately as a platform, barge configuration or onshore as it can be skid mounted. Lead time will depend on availability of the equipment (e.g. vaporisers, compressors etc.) but is likely to be shorter than waiting for an FSRU build slot at a shipyard.
- The build, supply and tender process for a FSU and regas unit could be much shorter than for a FSRU, particularly if an existing FSU/LNG carrier can be easily found.
- There is an option to own the regas unit and just charter the FSU as the cost of regas unit is significantly less.

Business Models and Order book

Golar's business model is based on converting existing LNG carriers into FSRUs, whereas Excelerate and Höegh have ordered new builds. However, Golar also now have four new builds on order. Other providers of FSRUs include Norwegian company BW Gas which has just ordered its first FSRU from Samsung Heavy Industries.

There are currently ten FSRUs on order and a few more in a late planning stage. Of the ones on order:

- Excelerate is supplying one to Puerto Rico (2015);
- Höegh currently have four coming online in 2014 – all chartered on a long term basis to Indonesia, Lithuania, Chile and potentially UK;
- Golar has four new build FSRUs coming online in 2014/15, one to Chile, one to Jordan and the other two still potentially available;
- FSRU ordered by BW Gas is still potentially available.

Höegh's new vessels are all sourced from Hyundai Heavy Industries (HHI) and Golar's new vessels are all from Samsung Heavy Industries (SHI). Excelerate has an agreement with Daewoo Shipbuilding and Marine Engineering (DSME) for the option on delivery of as many as eight FSRUs between 2015 and 2017. DSME has recently expressed an interest in supplying a FSRU directly to Pakistan.