ALASKA NATURAL GAS
TRANSPORTATION PROJECTS
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FLNG drops anchor as industry moves production offshore

Billions of dollars are being committed to what could be the liquefied natural gas industry's next big trend: Producing LNG aboard giant vessels anchored in the ocean rather than piping the gas ashore for processing.

They're called floating LNG projects, or FLNG. Three of them are under design or construction — for offshore Australia, Indonesian waters and coastal Colombia.

The whole LNG world is watching to see how these projects work out. The first FLNG production could occur in 2014 or 2015.

Can they really cut costs and development time? Can the production vessels really be built to last decades without returning to port for dry-dock maintenance? Can they really withstand the worst fury an ocean can brew up? And — just as important for the LNG industry's future — can they really be the key to developing trillions of cubic feet of natural gas now locked far away at sea?

"There are more than 700 stranded gas fields between 0.5 tcf and 2 tcf and midscale FLNG can satisfy our clients' needs to monetize the gas from such fields," says a marketing flier from European engineering firms SBM Offshore and Linde.

At the recent LNG 17 conference, an industry executive trumped that. FLNG opens 800 fields to development totaling more than 1.5 tcf of gas, marveled Philip Oliver, president of GDF Suez-LNG.

FLNG was literally on display at the giant conference April 16–19 in Houston. At least 17 models of FLNG vessels were featured in different companies' exhibits on the trade-show floor.

Source: LNG 17

Philip Oliver
President
GDF Suez-LNG

Major oil and gas producers, multinational engineering firms and the world's biggest shipyards all are trying to position themselves for breakout growth of FLNG.

Consultancy Douglas-Westwood late last year forecast $28 billion in FLNG spending worldwide now through 2019.

The technology has never been done before, although a variety of corporate R&D skunk works have been mulling FLNG for years, in some cases dating back to the 1970s, when the commercial LNG industry was barely a decade old.

"One or two projects will need to be successful for the industry to embrace the technology and concepts," John White, with Baker Botts, a law firm that works with energy companies, said in a paper presented at LNG 17.

The projects afoot "are effectively de-risking FLNG, thereby potentially reducing future project development costs and lowering the barriers to entry" for a second phase of FLNG growth, he said.

Is FLNG the breakthrough that changes everything

that follows, as the iPhone did for communications, television for entertainment and moving assembly lines for manufacturing?

"That's a wildcard for the industry," said Joseph C. Geagea, president of Chevron Gas & Midstream, at LNG 17.

PIONEER FLNG PROJECTS

In a world where LNG demand is forecasted by some to double in the next 10 to 15 years from 2012's 240 million metric tons (32 billion cubic feet a day), FLNG joins a parade of possible new sources of gas supply.

These include more conventional liquefying of production from:

- New gas discoveries off East Africa.
- Australia and Southeast Asia fields.
- Arctic and eastern Siberia fields in Russia.
- Growing reserves of U.S. Lower 48 and Western Canada shale gas.
- Large conventional, stranded reserves such as those on Alaska's North Slope.

Three projects lead the pack in the FLNG approach to making money from distant gas resources.

Shell's Prelude

Shell was the first mover with its Prelude development 120 miles off Australia's northwest coast.

Prelude — a name that half foreshadows and half inspires a future path for the LNG industry.

Shell expects to produce 3.6 million metric tons of LNG a year for 25 years (about 480 million cubic feet a day of methane), as well as 1.3 million tons of valuable gas condensate and 400,000 tons of propane and butane each year.

The estimated $12.6 billion project could start production in 2017 from a massive floating factory — it will be the world's largest ship — now under construction at a Samsung Heavy Industries shipyard in South Korea.

The liquefaction vessel will be 1,601 feet long and 243 feet wide, and as a Shell executive has put it, "the heaviest thing man has ever built that floats." Shell describes it as "longer than four soccer fields and displacing six times as much water as the largest aircraft carrier."

Very big, in other words.

The ship will perform just about the whole value chain of natural gas, everything but delivering it to the burner tip. It will anchor over the field, produce the gas, separate gas liquids from methane, purify then liquefy the methane, store the production in giant chambers then offload it to LNG tankers.

Shell hopes to tow the vessel to the site — it won't have its own propulsion — and produce the first LNG cargoes by 2017.

Petronas' Kinawit field

Last year Malaysian national oil and gas company Petronas gave the OK to develop the Kinawit field as a FLNG project.

Petronas awarded a contract to Daewoo Shipbuilding & Marine Engineering to build the factory in South Korea. The vessel will be about 985 feet long with a production capacity of 1.2 million metric tons a year (160 million cubic feet a day).

Petronas hopes to start LNG production by the end of 2015.

Colombia's La Creciente

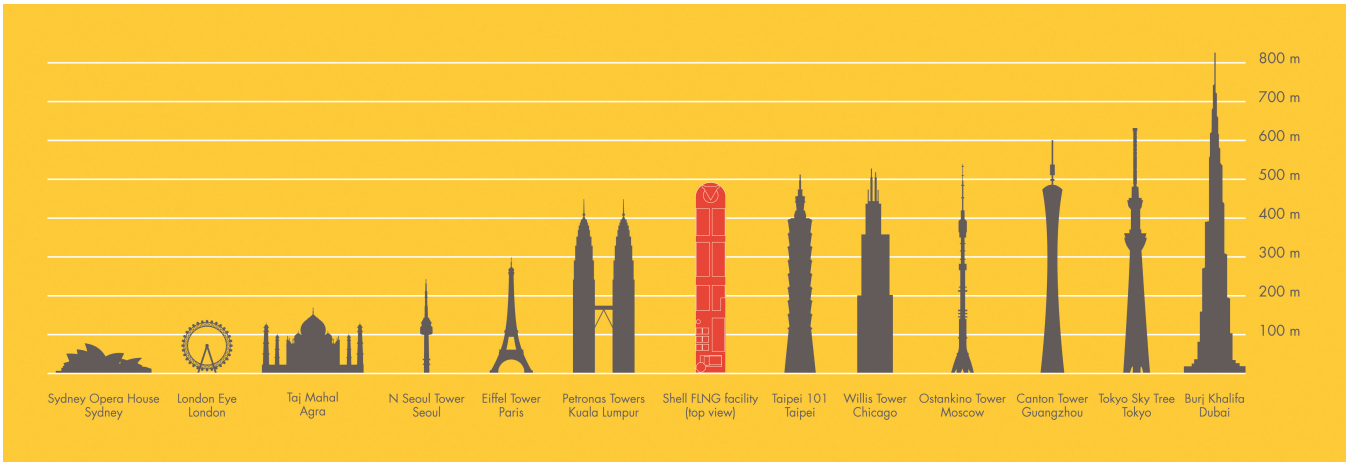
Colombian oil and gas producer Pacific Rubiales Energy and Belgium LNG-tanker company Exmar are working with Chinese shipyard Wison Offshore & Marine on construction of a small liquefaction barge.

In a reversal from FLNG targeting offshore fields, the gas would be piped from the onshore La Creciente field to the vessel moored along a jetty.

The barge would be 406 feet long. The plant would make about 500,000 metric tons of LNG annually (67 million cubic feet a day). Start-up could come as early as 2014.

THE SECOND WAVE OF FLNG

Hovering in the background are perhaps a dozen other projects whose sponsors are pondering the FLNG path to production.



Source: Shell

The length of Shell's FLNG ship, Prelude, as compared to famous landmarks.

These include several off Australia.

Getting the most fanfare among them is ExxonMobil and BHP Billiton's Scarborough field.

ExxonMobil said in March 2013 that FLNG preliminarily looks like the best way to develop Scarborough, whose reserves total an estimated 8 tcf to 10 tcf. The companies need to perform the nitty-gritty design and engineering work in advance of a final investment decision in 2014 or 2015.

As it stands now, ExxonMobil's concept for Scarborough calls for a 1,624-foot-long FLNG vessel. That would knock Shell's Prelude off its perch as the world's largest — by 23 feet. The floating factory would produce 6 million to 7 million metric tons a year (about 800 million to 900 million cubic feet a day).

Other Australian projects that could become FLNG projects include:

- The Browse project of Woodside Energy and Shell. Woodside in April 2013 agreed to use Shell's FLNG technology rather than pipe gas to an onshore plant, if the project goes forward.
- The Sunrise prospect of Woodside, ConocoPhillips and Shell. Deutsche Bank recently estimated Sunrise could cost $12.6 billion to develop.
- The Bonaparte project 155 miles west of Darwin. France-based GDF Suez and Australia's Santos are partners considering development of three remote offshore fields via FLNG.

In addition, Brazil's Petrobras has considered FLNG for several fields located about 225 miles from shore.

And among the proposed U.S. LNG export projects are a couple of FLNG possibilities.

One would be anchored in the Gulf of Mexico 16 miles beyond the Mississippi Delta.

Another would be anchored to the Texas coast on a 1,100-foot vessel. Texas-based Excelerate Energy is sponsor. Excelerate already makes floating vessels that warm LNG from a liquid to a vapor — called regasifying — at LNG import terminals.

FLNG is a new opportunity for Excelerate, chief executive Rob Bryngelson said in an LNG 17 presentation.

This project would be kind of a hybrid FLNG compared with Prelude. Other companies would produce the gas from onshore U.S. fields and pipe it to the vessel. Excelerate would purify the gas onshore, not on the vessel, at a plant on company land nearby.

Bryngelson said he wants to move the gas purification off the vessel to make room to produce more liquefaction machinery.

Excelerate has an application to export LNG pending before the U.S. Department of Energy.

LNG event alternates between importers and exporters

LNG 17, which was held April 16–19 in Houston, is short for the 17th International Conference & Exhibition on Liquefied Natural Gas.

The conference is held every three years, alternating between a LNG importing country and an exporting country.

Six years ago, when Houston was selected as this year's site, the United States was expected to be a major importer. Didn't happen.

In a sign of how much the LNG world has changed, the United States is on the cusp of becoming a major exporter due to an abundant supply of shale gas that was not foreseen six years ago.

The 2016 conference will be held in Australia, an exporter, followed in 2019 by China, an importer. The United States has hosted the conference four times, including this year's event and the inaugural meeting in 1968. The other two times were in 1972 and 1986.

IN THE SKUNK WORKS

To paraphrase Albert Einstein: If you want different results, don't so the same things.

FLNG is a different thing, and there isn't just one way to do it.

Other oil companies and engineering firms are watching Shell and Petronas' progress while their own R&D arms refine their own FLNG concepts.

France's Total presented a paper at LNG 17 about how its design for a 1.2 million metric ton per year FLNG plant would differ from a twice-as-large plant the company also has conceived.

Statoil said it can apply lessons to FLNG from its compact Snohvit LNG onshore plant in Norway's Arctic. As its engineers worked through possible designs, they concluded that 3 million to 3.5 million tons per year is the sweet-spot capacity for a FLNG plant, Jostein Pettersen of Statoil said at LNG 17. Larger would be too risky. Smaller would be uneconomic.

In a March 2013 article in LNG Journal magazine, U.S. -based engineering firm Black & Veatch described its designs of two barge-based micro-FLNG plants. The projects have "completed front-end engineering and design and are ready to move into the project execution."

"Barge units tend to target smaller gas production locations and areas with limited impact from ocean movements," Black & Veatch engineers wrote. "The first projects to move forward involve 0.5 to 0.75 mtpa designs" (67 million to 100 million cubic feet a day). The company has been involved in the rapid build out in China of small-scale onshore LNG plants.

ONE-SIXTH THE SPACE OF AN ONSHORE PLANT

Shell is getting a reputation for pioneering work to expand its natural gas businesses.

FLNG is one such effort. There are others.

In Qatar, Shell opened a plant in 2011 that converts natural gas into such liquid products as clean diesel and jet fuels. Shell also is partner in a proposed U.S. LNG export project near Savannah, Ga. Further, Shell is leading an effort to boost natural gas as a fuel for trucks and ships.

Source: LNG 17

Anders Ekvall
Shell's vice president for LNG America

"It's not often you get to participate in a paradigm shift in an industry, and I think we are doing that now," Anders Ekvall, Shell's vice president for LNG America, said at LNG 17.

Everyone is watching how they're doing it for Prelude.

The Prelude plant will cram gas production, processing, separation, liquefaction, storage and tanker berthing into one-sixth the footprint of a typical LNG onshore plant.

Add to that the complexity of a plant whose equipment needs to withstand motion stresses as the vessel pitches, yaws, rocks and turns; that corrosive salty ocean spray will pelt for decades, that must weather the ferocity of a 10,000-year cyclone.

As the saying goes: Nothing is big on the ocean.

Add to that the need to separate people aboard Prelude from such flammable and explosive chemicals as methane, propane and butane, among others. If the LNG storage tanks leak, the vapors could burn if an ignition source is nearby.

The engineers have thought about these risks.

Total in its design for a FLNG plant said it would precool methane using carbon dioxide, an inert gas, and superchill it into a liquid using nitrogen, another inert gas. A typical onshore plant might use flammable ethane and propane for these steps.

Total said its design moves the living quarters away "from the process facilities and any source of ignition." Methane flaring and venting would occur downwind on the vessel's stern. Housing would be upwind on the bow.

Electric motors would provide power rather than direct-drive gas turbines to remove a potential ignition source.

"The vessel confines make it difficult to separate the sections of the facility containing flammable inventories and those locations which are frequently occupied by personnel," wrote a team of engineers with Air Products and Chemicals Inc., in a paper for LNG 17. Air Products is supplying the liquefaction machinery that will chill Prelude's methane production until it becomes liquid at minus 260 degrees.

"This and the desire to minimize the risk of catastrophic loss therefore suggest that flammable inventory on the vessel should be minimized," the engineers wrote.

Salt-water spray is another issue. "While land-based cryogenic equipment may be constructed from aluminum, FLNG equipment may use other chloride-resistant materials such as grade 316L stainless steel," the Air Products engineers wrote.

IS FLNG CHEAPER?

The oil and gas industry knows a thing or two about working at sea.

For decades the industry has planted exploration rigs and production platforms offshore. For many years it has used FPSO — floating production, storage and offloading — vessels to handle oil production.

The LNG industry has been liquefying, storing, shipping and — at destination ports — regasifying methane since the 1960s. Eleven of the world's 93 regasification terminals are floating structures, according to the International Group of Liquefied Natural Gas Importers.

This first generation of FLNG largely builds on this history and modifies the operation to address weight, space, motion, corrosion, durability and safety issues, a variety of speakers at LNG 17 said.

"There is lots of engineering. Hundreds of things have to be done differently," said Charles Durr of Wood Group Mustang, a U.S.-based engineering firm.

All this engineering adds costs to FLNG projects that might not be present for an onshore plant. Some say that cost is offset by not needing long, undersea pipelines to shore, and by sidestepping such onshore issues as nearby community opposition or altering sensitive environments.

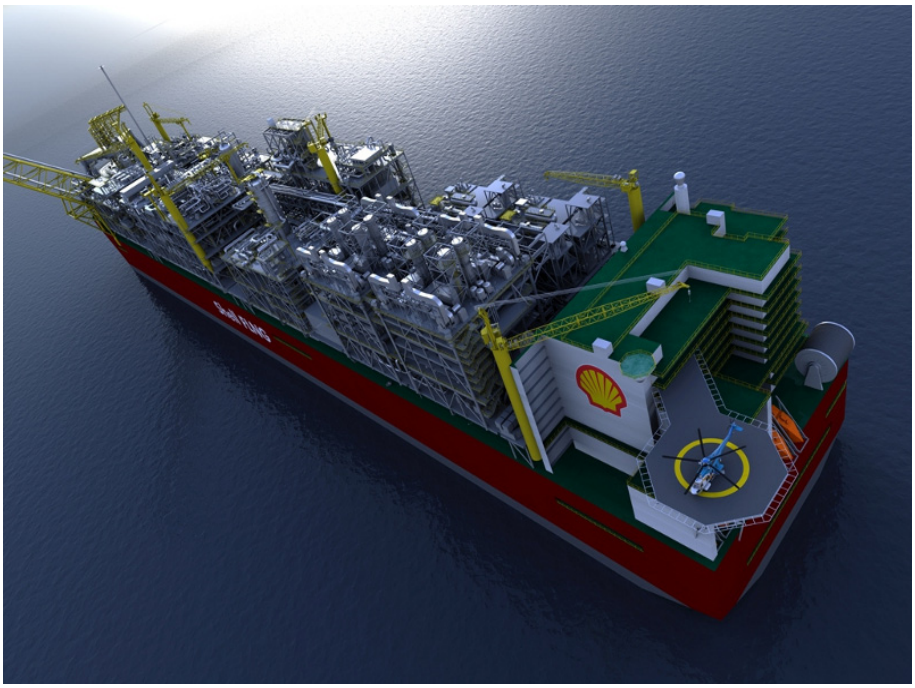
In addition, for Australia, where remote-site labor costs can be stratospheric, savings could occur by outsourcing work to South Korea, China or other foreign shipyards.

A Deutsche Bank analyst estimates developing the Browse project off Northwest Australia would cost $35 billion as FLNG compared to $43 billion for new onshore development.

The next generations of FLNG will benefit from the first generation under construction now, Shell's Neil Gilmour, general manager FLNG, wrote in a paper presented at the Gastech 2012 conference in London last October.

Shell already has modified its Prelude design so that the vessel could produce LNG from a gas stream that contains a different mix of gas liquids at a site with different ocean conditions.

Gilmour looked into the future this way in his Gastech paper: "By building on the same roots, we believe our next facilities after Prelude will benefit becoming cheaper and faster — as with anything you do for a second, third, fourth time, etc."



Source: Shell

Shell's Prelude

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