Gas giants: the next wave

In the first of a four-part series on the future of gas exploration in Australia, ***we*** examine the multibillion-dollar investment in a revolutionary new approach for extracting gas from isolated parts of the ocean

By the numbers, the largest ocean-going vessel ever built is a mind-boggling beast. Stretching half a kilometre from bow to stern, and with a superstructure that will eventually soar 30 storeys above the waterline, the 600,000-tonne Shell Prelude displaces as much water as six aircraft carriers. But it is by its

ability, not its raw stats, that Shell hopes the outsized vessel will become best known. The reason? Prelude is in the vanguard of an ambitious new movement in natural gas production, one that – if it succeeds – will finally let energy companies tap hard-to-reach reserves of natural gas. To do so, Prelude will essentially carry an entire onshore gas plant out on to the deep ocean, where it will have to cope with everything the elements can throw at it, without returning to shore for at least 20 years.

Until now, energy firms have had to decide whether it is economically viable to run a submarine pipeline from a gas reserve far out at sea to a huge onshore factory called a liquefied natural gas (LNG) plant. At such plants, natural gas is scrubbed of impurities and water before being cooled to -162 °C, which liquefies it, reducing its volume by 600 times. It is then stored in insulated tanks until being transferred to LNG supertankers that ferry the liquefied gas round the world.

But when a seabed analysis shows that laying a pipeline from a gas field to an LNG plant will be uneconomic or too environmentally damaging, the gas reserve is said to be "stranded". There are many issues that can cause this stranding, says David White, who holds the Shell EMI Chair in Offshore Engineering at the University of Western Australia in Perth. "If the pipeline is to be subjected to strong storm loading, or if the seabed is hard and the pipeline doesn't get protected by being buried, the cost of stabilising the pipeline by dumping rock on it, for example, has an unacceptable cost and environmental impact."

Even so, energy firms have been loath to give up on such fields, and have long thought of placing an LNG plant on a ship moored above a stranded gas field and offloading liquid gas to visiting tankers. The Prelude is the first vessel designed to do just that.

Dubbed a floating liquefied natural gas (FLNG) platform, Prelude is huge because it incorporates all the components of a conventional onshore LNG plant – but in an area just one-quarter of a land-based plant. Within the next two years, Prelude will be securely anchored above one of Australia's many stranded gas reserves, 200 kilometres north of Broome, Western Australia, and plug into the gas well heads of two gas

fields, called Concerto and Prelude. It will then liquefy the natural gas in situ, store it in tanks equivalent in volume to 175 Olympic swimming pools – and transfer it via robotic arms to LNG supertankers that come alongside.

At least, that's the plan. Prelude (shown above in computer graphics) is currently being built at a Samsung Heavy Industries shipyard in Geoje, South Korea. The vessel's 488-metre-long hull is already afloat and the LNG plant infrastructure is being built on top by harnessing proven LNG-plant technologies.

"We've had to adapt our land-based LNG processes and change the layout of the plant so that some elements are stacked, say, rather than placed side by side, so we can reduce the overall size of the facility," says Marjan van Loon, an engineering vice-president at Shell, based in The Hague in the Netherlands.

That sheer size creates another problem: unlike regular ships, Prelude won't easily find a dry dock for refits and servicing. So the vessel is designed to remain anchored for an astonishing 25 years. "The hull is actually designed to have a 50-year life span," says van Loon. Shell is not saying what is producing this longevity, but Tony Regan, a gas industry expert with energy consultancy Tri-Zen International in Singapore, says the company appears to be doing it by ensuring that all maintenance can be done on board rather than back at a shipyard.

Prelude is breaking new ground in other ways too, says Regan. Gas processing systems are usually stationary, so Shell has worked out how the liquefaction of natural gas in a pitching and rolling ship can be performed despite that motion. New tank designs can now reduce the effects of "sloshing" of the stored liquid gas on the vessel's stability.

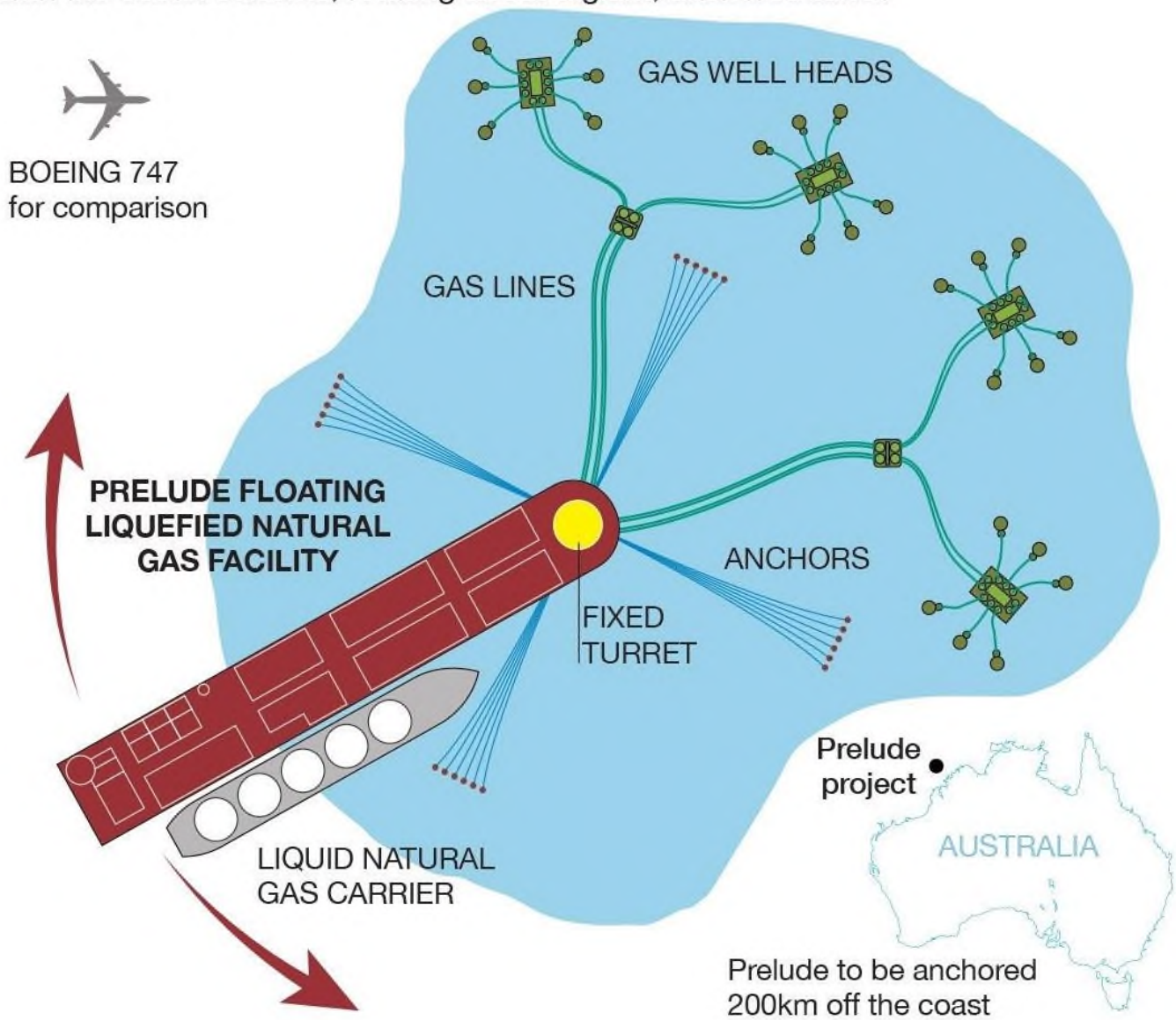
Shell says its anti-sloshing techniques include the use of membranes, barriers and baffles inside the LNG storage tanks to dampen the movement of the liquid gas and to spread the resulting forces that might otherwise, at their worst, cause the vessel to list or capsize.

One of the most challenging technologies is that of anchoring the 600,000-tonne Prelude, which, perhaps surprisingly, will be allowed to rotate freely, or "weather vane", around its anchor point at the whim of the winds, waves and ocean currents. This

will be made possible by a vast turret – like a giant bearing, but one that is 93 metres high and 30 metres across – shot right through Prelude's bow. Chains fixed to the turret will be secured to 16 steel piles, each 65-metres-long and 5.5 metres wide, driven into the seabed (see diagram).

King of the swingers

The 600,000 tonne Prelude floating liquefied natural gas facility will swing freely with the ocean currents, rotating about a giant, anchored turret



“Aligning with the prevailing wind, waves or current, while the turret moorings remain fixed to the sea floor, ensures Prelude can remain safely at its location through the most powerful cyclones,” says van Loon.

While the technology has been decades in the making, it was only in 2011 that Shell felt confident enough to invest $12 billion in Prelude. If it succeeds, the prize could be huge: “The facility could meet the annual gas demand of a city of more than 7 million people, like Hong Kong,” says van Loon.

But bringing FLNG online hasn’t been without controversy. Because it will work in place of an onshore LNG plant which would otherwise employ local people, all paying local taxes, the Parliament of Western Australia is concerned about its potential economic impact. They have a point, says Regan – because jobs will indeed be displaced. “During the construction phase, for instance, the bulk of the jobs are in Korea rather than Australia.” But in the long term, the engineers, the pilots, the cooks and so on required to service a nearby FLNG plant should involve more economic activity for Australia, he says.

Others are not waiting to see how Prelude fares before following suit: Regan says there are at least 28 plans to develop FLNG vessels by nations including the US, Namibia, Nigeria, Papua New Guinea and Iraq. But only Shell, Petronas of Malaysia and a joint venture of Exmar and Pacific Rubiales in Colombia have actually begun construction. Shell’s Prelude is by far the most advanced, and the largest, he says.

Shell won’t reveal the date on which Prelude will begin extracting gas from the fields off Western Australia, because there will be a learning process associated with operating the vessel safely. “We are not sharing details on the schedule,” says van Loon. “Our aim is to do it safe and do it right.”

The topics in this series were developed by *New Scientist* in conjunction with the Australian Petroleum Production & Exploration Association.