

# Pearl GTL: Making liquids out of gas on a grand scale



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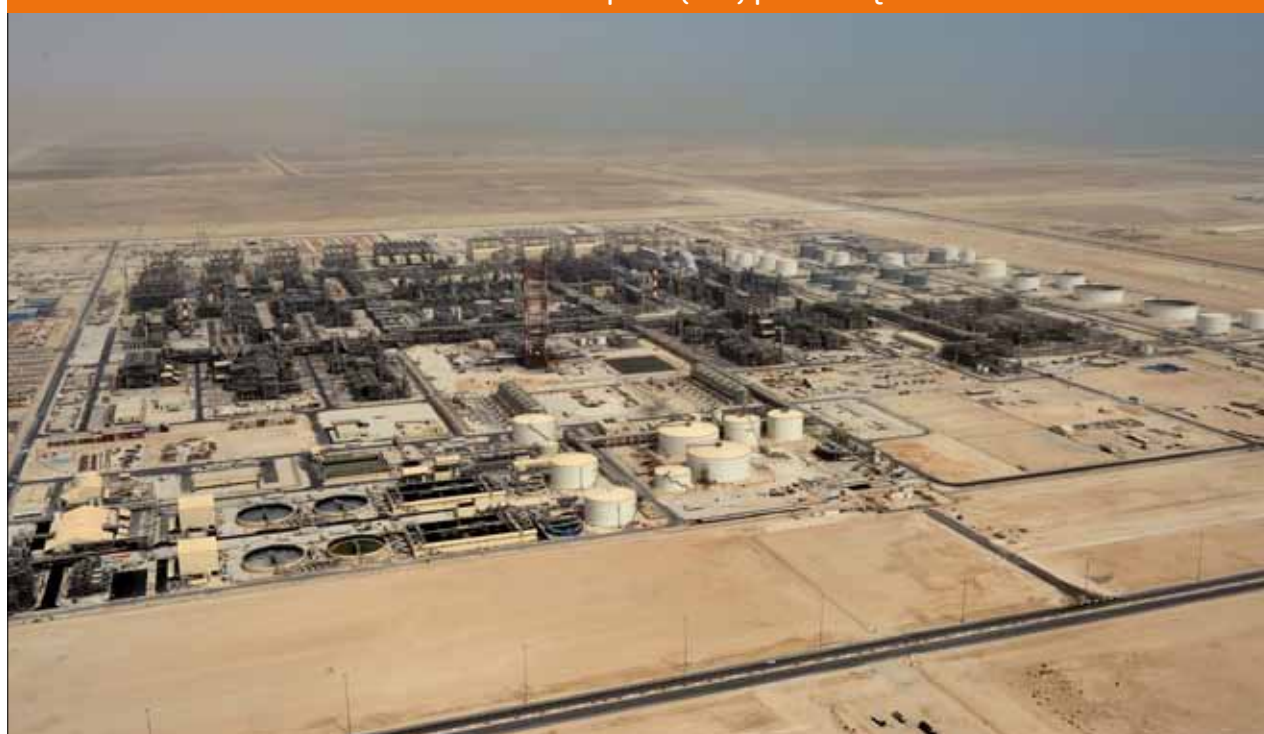
**P**earl GTL, the largest, fully integrated “gas to liquids” project, has risen from the sands of the Arabian desert under the Development and Production Sharing Agreement (DPSA) between the State of Qatar and Royal Dutch Shell. The project covers offshore and onshore development and operations, with Shell providing 100 per cent of the project’s US\$18-19 billion funding – the largest equity investment made by Shell in a single project. Pearl GTL will add around 8 per cent to Shell’s production worldwide and will be a major contributor to growth for the company in 2012 and beyond. It will also provide the state of Qatar an opportunity to generate large quantities of high quality liquid fuels and products from its abundant gas resources for many decades to come. From announcing Final Investment Decision (FID) on 27 July 2006, it has taken less than five years to see the first cargo leave the plant.

Pearl GTL is the largest and the most complex energy project launched in Qatar. At the height of construction, over 52,000 people were employed on site. Building QP and Shell’s biggest engineering project to date in Ras Laffan, a vast industrial zone on Qatar’s east coast, has been

a major achievement. Around two million freight tonnes of equipment and materials have been imported to the site, some 800,000 cubic metres of concrete have been poured, and 13,000km of cables have been laid. At the peak, piping and steel equivalent to two and a half Eiffel Towers were being erected every month. The project is not only the largest GTL plant, it also features the largest oxygen plant ever built, the largest hydrocarbon industry process water treatment facility with zero liquid discharge capability and the largest high quality baseoil plant in the world.

KBR and JGC were the main contractors in a Joint Venture agreement. The JV was awarded contracts to provide the Basis of Design (BOD) / Basis Design Package (BDP), Front-End Engineering Design (FEED), project management and start-up support of the overall onshore complex, along with engineering, procurement and construction management of the GTL synthesis, utilities and infrastructure sections of the complex. But many other major contractors from the US, Europe and the Far East were also involved. During detailed design, 13 design offices in 10 different countries were designing different sections of the plant. By the end of 2010 major

The Pearl Gas-to-Liquids (GTL) plant in Qatar





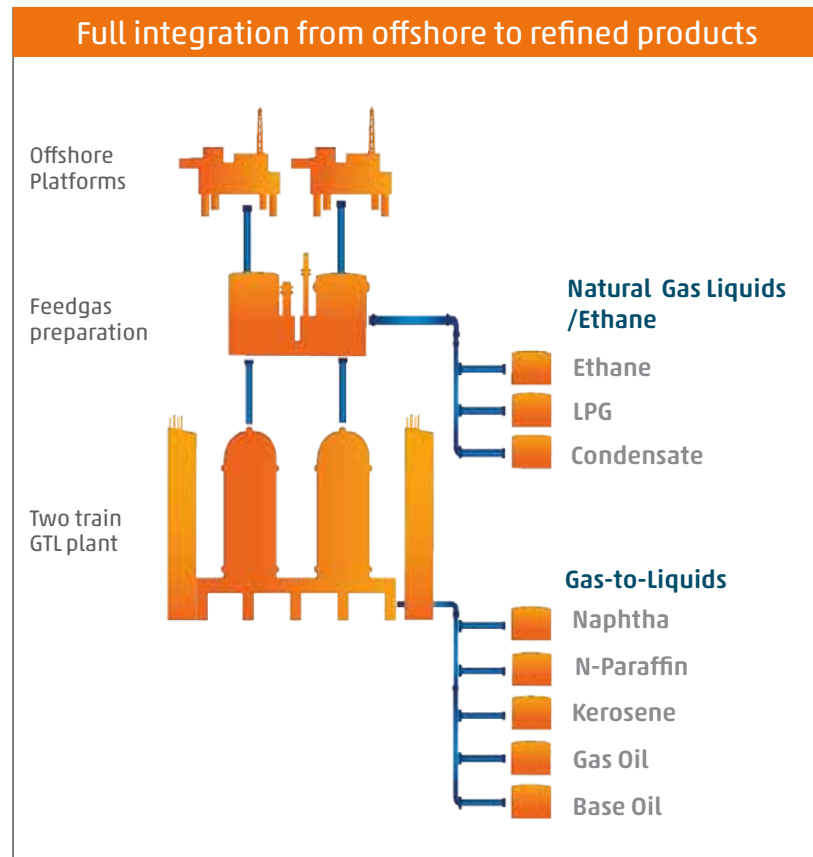
construction was complete. On 23 March 2011 the wells, 60km offshore, were opened and gas began flowing into the plant. 13 June saw the first cargo of on-spec GTL gasoil sail away from Ras Laffan Port.

When fully operational, the integrated project will produce 1.6 billion cubic feet of gas per day from the North Field, considered to be the largest single non-associated gas reservoir in the world with estimated recoverable resources in excess of 900 trillion cubic feet.

Once onshore the gas will then be processed into 140,000 barrels a day (b/d) of GTL products, comprising mainly GTL gasoil which is clear, odourless, has low emissions and can be used in modern diesel engines; GTL kerosene for aviation fuel; high quality baseoils for advanced lubricants; GTL naphtha used in the production of plastics and normal paraffin for detergents. The plant will produce enough diesel fuel to fill over 160,000 cars a day and enough synthetic oil to make lubricants for more than 225 million cars every year. Additionally, Pearl will produce 120,000b/d of upstream products including ethane, sulphur, LPG and condensate.

The technology which supports the two train Pearl GTL plant is called Shell Middle Distillate Synthesis (SMDS). In the 1920's, German scientists Franz Fischer and Hans Tropsch invented a chemical synthesis process to convert syngas into liquids. Some 50 years later, Shell developed this into an advanced proprietary version – SMDS. This technology was tested and proven at the SMDS GTL plant in Bintulu, Malaysia in 1993 and has evolved over three decades of research and development. The Bintulu plant has a capacity of 14,700b/d and is operating reliably and profitably.

Pearl GTL will use technology to limit its environmental impact. It features one of the largest steam systems in the oil and gas industry which will circulate 8,000 tonnes/hour of steam, capturing as much heat as possible from the chemical reactions to reuse the energy to drive the large quantity (1.2 GW) of rotating equipment on the



plant. In addition, the water processing plant allows all the water produced to be recycled, giving it a zero liquid discharge capability.

The process on Pearl GTL begins with two 30 inch pipelines carrying the natural gas onshore from the two platforms standing in water up to 40 metres deep. On reaching the plant it enters the gas separation unit which extracts all the naturally occurring hydrocarbons such as natural gas, ethane and condensate. This separation process also removes contaminants like metals and sulphur.

The pure methane that remains will then flow to the GTL section of the plant where it will be converted to wax. Finally, the liquid hydrocarbon wax is upgraded using specially developed catalysts into a range of high quality gas to liquid products.

**Making syngas:** In the gasifier at around 1,300°C, methane and oxygen from the air separation unit are converted into a mixture of hydrogen and carbon monoxide called synthesis gas (syngas). The reaction →



→ produces heat which is recovered to produce steam which in turn powers the process via the large steam turbines.

**Making liquid waxy hydrocarbons:** The next stage in the process sees the synthesis gas entering one of 24 reactors in the plant. Each reactor holds tens of thousands of tubes containing a Shell proprietary cobalt synthesis catalyst. The surface area of the catalyst used in the plant would cover an area equivalent to 18 times the surface area of the State of Qatar, and if the tubes were laid end to end they would stretch from Qatar to Japan. The catalyst serves to speed up the chemical reaction in which the synthesis gas is converted into long chained waxy hydrocarbons and water. Shell has filed over 3,500 technical patents for its GTL process. For the Pearl GTL project, Shell will have spent approximately four years using dedicated facilities in full-time production to provide the thousands of tonnes of catalysts required.

**Making GTL Products:** Using another Shell proprietary catalyst, the long hydrocarbon molecules from the GTL reactor are fed into the hydrocracker where they are cut (cracked) into a range of smaller molecules of different lengths and shape. The process changes the molecular structure of the very heavy long chained hydrocarbons into products with lighter, shorter chains. They are then fed into a distillation column to separate the various components. In liquid form they are safe, ready to be used and easily distributed around the world.

Despite the massive number of workers involved and the complexity of the construction of Pearl GTL, a strong and focused safety culture has helped Qatar and Shell achieve a record-breaking 77 million hours onshore without injuries leading to time off work.

A benchmark for worker welfare has been set on Pearl with the introduction of Pearl Village, a 170 acre residential area that was specifically built to house construction workers. It was designed to meet rigorous standards in sanitation, health, safety, catering, recreation, IT, multi-faith worship, and banking facilities. Central to the Pearl Village is “Al Muntazah”, the Arabic word for park.

This recreation area forms the backbone of the village and provides extensive sports facilities including cricket, football and baseball pitches, an outdoor cinema, safety training centre and shaded seating areas.

The ethos of the facility is to create a “home away from home” where the welfare of each and every worker is looked after holistically. A community environment has been formed with a Mayor and a dedicated team who are responsible for welfare, cultural festivals and act as advocates within the community. To overcome communication barriers, courses have been given at the onsite training centre in seven languages including Hindi, Arabic and Tagalog. By early 2011, workers had participated in some 367,500 training sessions. At the peak of construction, it took a huge workforce of over 1,800, including 500 cleaners and over 1,000 kitchen staff, to ensure that the village ran smoothly.

Research demonstrates that this unique village community has greatly helped to consolidate, motivate and focus the workers and in doing so increase productivity, efficiency and output. Qatar Shell’s commitment and focus on safety was recognised by HE Dr Mohammed Al-Sada, Minister of Energy and Industry, on 16 May 2011, when it was awarded the inaugural Oil and Gas Industry Gold Award for Safety.

In terms of advances in new technologies, the number of new patents raised, the magnitude of the scale of construction, significant developments in worker welfare, outstanding health and safety records, Pearl GTL is a colossal and remarkable achievement by all those involved. ■

## Safety

