

# LEADERS IN LNG







# LEADERS IN LNG

**We are a global EPC contractor with a proven track record of safely and successfully delivering world-scale projects, including LNG facilities.**

We are a key player in the LNG industry. We have demonstrated our ability to deliver high quality LNG facilities which meet our clients' objectives.

We have also pushed the boundaries of LNG, pioneering modularization of liquefaction plants, working on ever-increasing LNG train sizes, applying creativity to solve technical challenges, developing innovative offshore options, overcoming environmental issues and meeting local content requirements.

As we're also experts in onshore and offshore upstream development, we can design and execute the entire gas field development and monetization project, from wellhead to terminal, and from concept to start-up.

From studies to commissioning, we add value:

- Concept development
- Front-end engineering design (FEED)
- Engineering, procurement & construction (EPC)
- Commissioning & start-up

Delivering your LNG project,  
anywhere in the world.



# LNG LIQUEFACTION

## Concept Development

Fundamental to the success of any project is the right start. We work with our clients from the earliest stages of their LNG project development to help shape their planned LNG investment in line with their objectives. This early development stage is where our proven study capability and extensive EPC experience combine to add significant value.

Our specialist consultancy teams combine the skills of our highly qualified LNG experts with the benefits of our extensive in-house cost and schedule information and our project execution know-how based on successful delivery of thousands of projects around the world.

Our experts work very closely with our clients to develop, analyze and evaluate a wide range of concepts, plant configurations, technologies and execution strategies to arrive at optimum solutions.

We have executed a wide and diverse range of LNG studies and pre-FEEDs for both onshore and offshore plants covering most liquefaction technologies and plant configuration options.

We have optimized liquefaction plant concepts for hundreds of capacity and location combinations.

We have also been instrumental in developing methodologies for early assessment of constructability issues to support strategic execution decisions such as the degree of modularization and optimum module sizing.

#### We add value

- Feasibility and pre-FEED studies
- Configuration studies
- Technology evaluation
- Risk-management assessment
- Pioneering modularization concepts
- Real cost and schedule data benchmarks
- Carbon capture and storage solutions

## First CBM to LNG

### Santos GLNG® Australia

We completed a detailed pre-FEED concept selection study for a 3-4 mtpa liquefaction plant and associated infrastructure, planned to be one of the first LNG facilities in the world to use coal-bed methane as a feedstock for LNG production.

We also executed the FEED for the extraction, collection, compression and transportation of coal-bed methane to the transmission pipeline, and associated infrastructure and services, including power generation and water treatment facilities.

## Modularization

### Pluto LNG Project Australia

We started the massive Pluto Train 1 project with feasibility and pre-FEED studies undertaken by our specialist consultancy team, combining the team's LNG study capability with the extensive modular design and construction expertise of our EPC organization to implement a modular approach. Having completed the FEED for the foundation project, we are now executing the EPCm phase with our JV partner, and we are progressing a FEED study for the Pluto Train 2 and Train 3 expansion.

## Offshore LNG

### Browse LNG Australia

We completed detailed concept studies for a planned facility to produce LNG from the Browse Basin, off the coast of Western Australia, developing a number of both onshore and offshore concepts, including:

- input to site selection
- modularization
- liquefaction technology evaluation
- driver selection
- LPG extraction
- cooling media
- heat integration
- platforms and gravity-based structures

# LNG LIQUEFACTION

## Execution & Delivery

We enjoy a challenge! LNG liquefaction facilities are large, complex developments, frequently in remote and challenging locations. Our track record demonstrates our ability to deliver entire liquefaction projects, including all offsites and infrastructure.

With our in-depth technical expertise, global EPC experience and particularly our proven ability to execute large and complex projects successfully and safely, we are a key player in the LNG market.



*Images: Courtesy of Woodside Energy Ltd*



## World-class Safety

We strive continuously to improve our already world-class safety record. We have received over one hundred safety awards from clients, safety and industry organizations, and government bodies around the world.

## Delivering Local Content

We have proved that we can deliver our projects in line with our clients' local content objectives, whether it involves local execution, local partners, local materials and equipment supply, matching export credit needs, or training a local workforce.

### North West Shelf Venture Phase V Expansion Western Australia

We led the JV executing the EPC contract for the construction of a fifth LNG processing train of up to 4.4 mtpa capacity at the Woodside-operated Karratha gas plant. Our in-depth modular design and construction experience was pivotal to this ground-breaking project, the first onshore liquefaction plant in the world to be designed and built in modules. In all, there were 75 separate modular structures, the largest of which contained the majority of the liquefaction process equipment.

### PETRONAS MLNG Dua Malaysia

We were FEED and EPC contractor on a debottlenecking project to increase LNG production by 1.2 mtpa. A new extended end flash unit was added to each of the three Dua trains, the existing gas turbines upgraded and two new Frame 5 gas turbine generators installed.

We have a long track record with Malaysia's LNG facilities, having been project management consultant for both the Dua and Tiga developments, which were two and three-train expansions at the Bintulu LNG facility.

### NLNG SevenPlus Nigeria

We delivered the FEED for a new natural gas liquefaction train, producing 8.5 mtpa of LNG, the largest planned LNG train in the world. The design and execution planning for this mega-train presented unique challenges in terms of remote location and scale of development.

### Qalhat LNG Oman

We designed and built this LNG facility, with our JV partner, ahead of the target 34-month schedule and within budget. With the close co-operation of Oman's Ministry of Manpower, the project achieved its local content 'Omanization' target of 38%, the highest recorded for any construction project in the Sultanate. It also achieved a truly world-class safety performance of 20 million manhours with no lost-time incidents.

Located in a desert area on the coast of the Gulf of Oman, the project included marine facilities consisting of seawater inlet and outfall pipelines, seawater intake and weir box structures.

We set our own high benchmark. The 3.3 mtpa liquefaction train was built to the same specifications and similar technical design and stick-built construction as the two existing LNG liquefaction trains, also designed and built by the JV team on a fast-track schedule, safely and with a fault-free start-up.

**"My sincere congratulations to you and your teams in Oman for delivering a world-class project ... achieved through overwhelming dedication and commitment ... some 17 days ahead of the guaranteed date of 34 months from contract award, which was itself a tough timeframe."**

Executive Director, Shell

# PUSHING THE BOUNDARIES

For us it's not just about setting new benchmarks for cost, schedule, safety, quality and train size. It's also about developing innovative new technical solutions to meet our clients' objectives, or to overcome the challenges that they face.

## Modularization

In Australia, we pioneered the modularization approach to LNG plants, using all of the modularization experience we have gained over the last 20 years. During this time we have designed and constructed more than 30 modular projects around the world comprising more than 1,500 modules.

**"Train 5 has been safely and successfully completed on time and at a highly competitive cost in an environment of extremely constrained resources. This remarkable achievement is testament to the focus and commitment of the project team in delivering this additional production infrastructure."**

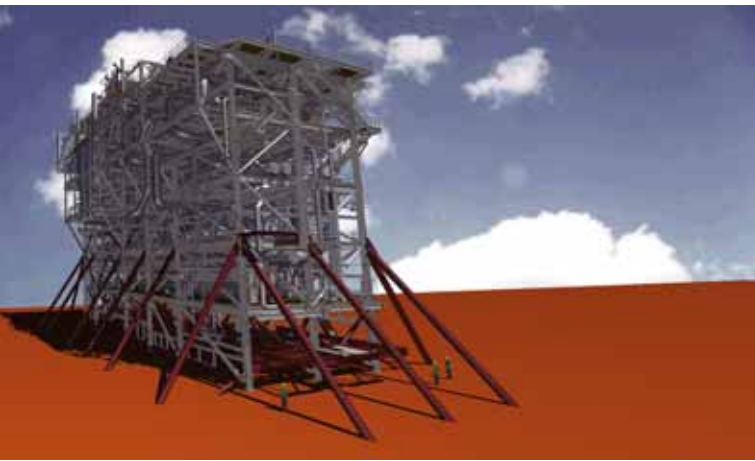
Eve Howell  
Executive VP North West Shelf  
Woodside Energy Ltd

## Pluto LNG Australia

We are leading the FEED and EPCm phases for the onshore component of this 4.3 mtpa LNG facility with our JV partner. The plant has been designed and is being built in modular form. Around 250 modules and pre-assemblies, the largest of which contains the majority of the liquefaction process equipment, have been fabricated in Thailand.

This greenfield project includes a single LNG production train, a fractionation unit, an acid gas recovery unit, gas purification units, tank storage facilities, a boil-off gas compressor, loading berths, gas turbine power generation units, utilities, a jetty, and supporting infrastructure.

We have subsequently been awarded a FEED contract for Trains 2 and 3 of this ground-breaking project.



## Offshore & Floating LNG

### Browse LNG Australia

The gas fields within the Browse Basin, some 300km off the coast of Western Australia, are located in relatively deep water. We explored the feasibility of a grounded offshore LNG solution and executed detailed evaluation of environmental, safety, technical, economic and constructability aspects in order to determine a credible offshore LNG concept. The conceptual base case involved jacket-based platforms for gas reception, utilities and accommodation. The main LNG process trains, associated LNG tanks and jetties would be supported by concrete gravity structures, floated to their final location.

## Arctic & Remote Regions

### Statoil Norway

Our study for the Snøhvit LNG Train II at Melkøya brought many interesting challenges, not least that the site was 450km north of the Arctic Circle. The world's northernmost LNG plant, it has a design capacity of 4.2 mtpa and processes gas transported through a 143km pipeline from subsea facilities. Melkøya experiences long periods of darkness and low temperatures, with storms blowing in sea spray that freezes as it hits structures. So our study focused on minimizing the work required on site, with maximum modularization in the fabrication yard.

## Carbon Capture & Storage

We have already worked on a wide range of planned projects for the capture and storage of CO<sub>2</sub> and believe we are at the forefront of this emerging area of strong focus for our industry.

We have developed a real in-depth understanding of the many capture options, including pre- and post-combustion, and storage options, the technical challenges and their potential solutions.



# LNG RECEIVING TERMINALS

We have worked with a wide range of clients around the world, delivering expert services for new terminals, both onshore and offshore, and for expansions, including technical development and design, cost estimating, permitting and project execution. We have particular expertise in optimizing an entire facility, and integrating the regasification element with other facilities such as power generation.

## Send-Out Gas

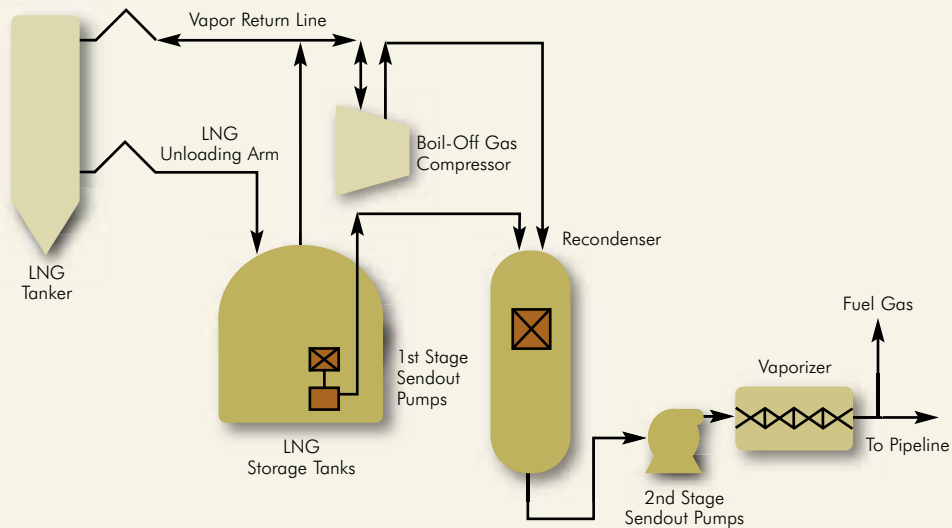
For LNG receiving terminals serving the North American market particularly, the C2+ content and heating value specifications for send-out gas are lower than most natural gases and most existing LNG baseload plants.

Cost-effective management of these components enhances the LNG value chain, increasing flexibility in sourcing LNG cargoes. Our cost-effective process design manages the C2+ content of send-out gas at the LNG receiving terminal, coupling Foster Wheeler's C2/C3 terminal extraction process with a pre-reformer that produces a low calorific substitute natural gas for re-injecting into the LNG terminal send-out gas.

## Vaporization

We have developed a process that uses the waste heat from either power plant or industrial facilities for LNG vaporization. By using the LNG as both a working fuel and a heat sink, this new configuration efficiently eliminates fuel requirements while reducing or eliminating emissions and improving the plant's thermal efficiency and overall profitability.

## REGASIFICATION FLOW SCHEME



### Singapore LNG Singapore

We are project management consultant for Singapore's first LNG terminal, which will have an initial capacity of 3.5 mtpa with provision for expansion to 6 mtpa. This prestigious project, which will help ensure the security of Singapore's energy future, is targeted to be ready for start-up in 2013.

### Petronet LNG India

We were project management consultant for this new 5 mtpa receiving terminal at Dahej, comprising two 140,000m<sup>3</sup> above-ground cryogenic containment tanks with associated process facilities for the storage and handling of LNG.

### Enagás Spain

We have enjoyed a significant level of repeat business with Enagás, carrying out three LNG terminal expansions in Barcelona, performing basic design and EPCm, or EP, and civils work. In Cartagena, we have worked with Enagás for more than ten years, undertaking four expansions, and at Palos de la Frontera, we have completed two expansions.

### Confidential Client North America

We were project management consultant for an LNG regasification terminal. We also provided technical advisory services during the detailed EPC commissioning and start-up phases.

### Polskie LNG Poland

We designed this regasification terminal for the reception and storage of LNG. For phase 1 of the study, up to 385,000 Nm<sup>3</sup>/h LNG will be pumped out from storage tanks, vaporized and sent to a natural gas transmission system. Two further expansions are planned, 570,000 Nm<sup>3</sup>/h in phase 2 and 800,000 Nm<sup>3</sup>/h in phase 3. We also studied the possibility of installing a combined system to use the boil-off gas produced in the terminal as fuel gas. Following our conceptual study, we executed the basic design and part of the FEED.

### Castle Peak Power Hong Kong

Our study scope included expansion of the existing LNG terminal and power plant, and integration of the new facilities to enhance the efficiency of the combined-cycle plant.

Delivering regasification projects around the world



contact us at:  
[lng@fwc.com](mailto:lng@fwc.com)    [www.fwc.com](http://www.fwc.com)

## LEADERS AT EVERY STAGE



Upstream Oil & Gas  
Gas Monetization  
LNG  
Carbon Capture & Storage