

wood.

## Leaders in LNG

Turning vision into reality



Wood is a global leader in project delivery, engineering and technical services, providing efficient, integrated solutions across the asset life cycle in multiple sectors. We are proud of our rich heritage which underpins our unrivalled breadth and depth of capability. We employ people with the brightest minds and the sharpest skills, who use our leading-edge technology to help our customers succeed.

Our differentiators include our extensive range of services, the quality of our delivery, the passion of our people and our unique culture. True to our values, we work in an open and transparent way; a committed partner to our customers, supply chain and the communities we work with.

Our values set the tone for what is important in our business, they are the essence of our identity and fortify everything we do.

### Care

Working safely with integrity, respecting and valuing each other and our communities

### Commitment

Consistently delivering to all our stakeholders

### Courage

Pushing the boundaries to create smarter, more sustainable solutions

160+  
year heritage

60,000  
employees

60+  
countries

"Each and every individual in our business has the ability to make a significant impact to our safety delivery. Safety is what we care about most and being safe means looking out for yourself and showing care for your colleagues. Keep safety at the heart of every conversation you have."

Robin Watson,  
Chief Executive

Wood has a proven track record for 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 upstream gas field development, we can design and execute the entire development and monetization project, from wellhead to regasification terminal, and from concept to start-up and beyond.

We add value at every stage:

- Technical due diligence services
- Concept and feasibility studies
- Site selection studies
- Pre-front-end engineering design (Pre-FEED)
- Front-end engineering design (FEED)
- Engineering, procurement & construction (EPC)
- Operational readiness
- Commissioning & start-up
- Ongoing asset support
- Operations and maintenance



# Turning vision into reality

**We have the skills, experience and creativity to add value throughout the LNG asset lifecycle. From the earliest screening or conceptual phases through to establishing a robust basis of design in the pre-FEED stage, ready for FEED execution and the final investment decision, we also provide ongoing asset support and improvement.**

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

Our experts work closely with our clients to develop, analyse 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 recognize the growing importance of non-technical factors in project development and we have significant expertise in overcoming environmental issues and meeting local content requirements.

Our consultancy groups play a major role in shaping LNG investments at early stages in the project lifecycle when key strategic decisions are required. From the earliest stages of feasibility studies, our expertise in technical aspects of LNG processing is combined with conceptual innovation and constructibility aspects for major developments in remote locations.

As a result, our studies and pre-FEEDs deliver robust solutions which can be built upon during the subsequent project development phases. By combining our LNG and upstream gas expertise, we are able to produce integrated gas development studies and pre-FEEDs covering the whole gas monetization chain.

Our gas monetization expertise includes:

- LNG liquefaction and re-gasification
- Overall gas monetization planning
- Onshore and offshore project solutions
- Monetizing unconventional gas reserves
- Onshore and offshore project solutions
- Process and technology selection
- Plant layout/modularization
- Constructibility in remote and challenging locations
- Environmental, permitting and local content solutions
- Modularisation of liquefaction trains
- Liquefaction technology evaluation
- Driver Selection
- LPG extraction
- Cooling media
- Heat integration
- Platforms and gravity-based structures

## Onshore LNG, Timor-Leste LNG

We completed the detailed Pre-FEED for a 5 to 20 MTPA liquefaction plant and associated infrastructure located at a remote greenfield site on the southern coast of Timor-Leste with scope including:

- Concept selection studies
- Development of technical design
- Development of procurement and construction strategies
- Project implementation plans
- ±25% capital cost estimate
- Schedule for the overall project
- Local content plans.

Wood also executed the FEED for the offshore pipeline from the Greater Sunrise fields to Timor-Leste.

## FLNG, Shell g-FLNG

We completed the Pre-FEED for the Shell g-FLNG facility design based on a 25 year design life and 10,000 year environmental conditions. We leveraged our experience and capabilities in LNG, FPSO topsides design and integration and SURF to deliver the technical optimization studies, the engineering and execution planning and surveillance services, the general design specifications and weight control for the generic FLNG design including both LNG and LPG storage and offloading.

The design benefited from our offshore topsides knowledge base from all types of floating production systems (oil, gas and water) in water depths from 10 to 7,000ft ensuring that the weight distribution, space limitations, safety and evacuation routes, operations and maintenance and were addressed in the topside layout.

Nearshore Platform LNG, Honghua Group LNG21

Wood has developed the FEED for the world's first offshore platform-based natural gas liquefaction and storage development in the West Delta area of Gulf of Mexico for the Honghua Group. The scope included onshore gas pre-treatment plant configuration and layouts, general utilities, feed gas processing and compression, and transportation and delivery via re-purposed pipelines from the existing onshore Toca and Venice, Louisiana, facilities to the LNG facility 10 miles offshore. Wood compiled and developed the necessary technical documentation for a Deep Water Port (DWP) permit application to United States Maritime Administration (MARAD). This includes designing onshore, pipelines and offshore elements of the facility in sufficient detail to satisfy the MARAD. The facility is designed to produce up to 4.2 million tonnes per year of LNG and to store 300,000 cubic meters of LNG.





# LNG liquefaction

**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.**

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.

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.

## **Port Arthur LNG, USA**

Wood supported the development of the 11.6 MTPA greenfield Port Arthur LNG liquefaction plant, including two liquefaction trains, three LNG storage tanks and two product export ship berths, and associated infrastructure located in Texas. Our scope included :

- Pre-FEED, value engineering and integrated PMC
- Pre-FEED studies to determine plant configuration
- Process and engineering deliverables for the FERC application
- Preparation of the ITB package for EPC bidding
- Value Engineering
- IPMC

## **Cameron LNG, USA**

We were appointed owner's engineer for a new LNG liquefaction facility planned to export up to 12 mtpa of LNG. Our scope included technical assistance for project development, FEED work to support permit applications to the US Federal Energy Regulatory Commission, support for EPC planning activities, and technical reviews.

## **Pluto LNG, Australia**

We started the greenfield Pluto Train 1 project with feasibility and pre-FEED studies undertaken by our specialist consultancy group, combining the team's LNG study capability with the extensive modular design and

construction expertise of our EPC organization to implement a modular approach. Following execution of the FEED for the Pluto foundation project, we then led the JV executing the EPC phase and supported start-up and commissioning of the completed plant. We also undertook the FEED for potential future Pluto Train 2 and Train 3 expansions.

## **North West Shelf Venture Phase V Expansion, Australia**

We led the JV executing the EPC phase 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 de-bottlenecking project to increase LNG production capacity 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 contractor for both the Dua and Tiga developments, which were two- and three train expansions at the Bintulu LNG facility.

## **Oman LNG, Oman**

We designed and delivered this stick-built 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 then recorded for any construction project in the Sultanate. It also achieved a truly world-class safety performance of 20 million man-hours with no lost-time incidents.

# 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 and operational solutions to meet our clients' objectives, and to overcome the challenges that they face.

## Onshore solutions

In Australia, we pioneered the modularisation approach to LNG plants, on the North West Shelf Venture Phase V Expansion, using all of the modularisation experience we have gained over the last 25 years. During this time we have designed and constructed more than 30 modular projects around the world comprising more than 1,500 modules.

We led the study, pre-FEED, FEED and EPCm phases for the onshore component of this 4.3 mtpa LNG

facility with our JV partner. The plant was built in modular form. Around 260 modules and pre-assembled racks, the largest of which contained the majority of the liquefaction process equipment, were 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.

## Nearshore Solutions

### FLNG Solutions

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Petronas FLNG: Detailed Feasibility Study for a 2.0 MTPA plant in Malaysia. (water depth 200ft)

- Knudsen FLNG: Pre-FEED for a 2.0 MTPA plant on Brazil (water depth 7200ft)
- Teekay FLNG conversion: Pre-FEED of Topsides, inlet gas treating, liquefaction facilities and NGL recovery & utilities

## Operational Readiness

Wood is an industry leader in OMS/ Training competence services:

- Exxon PNG LNG
- Chevron Wheatstone
- Cameron LNG

## Asset Support

Wood is currently providing process design support at site in different plants including:

- Cheniere Sabine Pass LNG
- Cheniere Corpus Christie LNG

As well as Asset Integrity including: vibration analysis, predictive maintenance, maintenance optimisation.

## Plant Operations

Wood is a reference contractor for O&M operations in LNG plants. Wood provides operational expertise in different plants:

- Nigeria LNG
- Equatorial Guinea LNG
- Angola LNG
- Peru LNG
- Atlantic LNG
- Cheniere Sabine Pass LNG



# LNG import, storage and regasification 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 re-gasification element with other facilities such as power generation.

## Send-Out Gas

For LNG receiving terminals serving certain markets, 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.

## Vaporisation

We have developed a process that uses the waste heat from either a power plant or industrial facilities for LNG vaporisation. 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. In addition Wood has developed the LNG Smart® Air Vaporization (SAV) regasification technology

## KNPC/KIPIC LNG Terminal project, Kuwait

Our scope included DFR, pre FEED, FEED, EPC technical tender evaluation and PMC for this world class LNG import facility with a maximum sustainable re-gasification capacity of 3,350,000 Nm<sup>3</sup>/h.

This will be the largest grass-roots LNG re-gasification terminal ever constructed in a single attempt. It includes eight full containment LNG storage tanks with a working capacity of 225,000 m<sup>3</sup> each as well as two berths for simultaneous unloading of large LNG carriers. The whole plant will be erected on reclaimed land formed by hydraulic filling.

## Singapore LNG, Singapore

We played a key role as project management contractor for the S\$1.7 billion Singapore LNG terminal, a key infrastructure development in Singapore's energy diversification strategy. The first phase of development comprised two 180,000 m<sup>3</sup> LNG tanks, a jetty and re-gasification facilities, giving an initial re-gasification capacity of 3.5 mtpa. The second phase included a third LNG tank, additional re-gasification facilities and a secondary berth to increase re-gasification capacity to 6 mtpa.

## Lake Charles regasification

Scope included concept studies, FEED, FERC and EPCs. First use of the Wood LNG Smart® Air Vaporization (SAV) regas technology at this terminal.

The facility has a total send-out capacity of 2.1 BCFD using the SAV process. The SAV process reduces the amount of fuel gas needed for regasification; thereby significantly reducing operating cost at the plant.

## 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.

## LNG Bunkering, Naples, Italy

## Polskie LNG, Poland

We designed this LNG re-gasification terminal in Świnoujście. 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.

## Ennore LNG, India

Our scope of work for IOCL's new LNG receiving terminal to be built in the state of Tamil Nadu, includes basic design, FEED, the preparation of capital and operating cost estimates and PMC for the new LNG import, storage and re-gasification terminal, which will be designed to process 5 mtpa of LNG.

## PGN, North Sumatra

We supported PGN's plans to establish a floating LNG terminal, including an LNG floating storage and re-gasification unit (FSRU), mooring, subsea and onshore pipeline, onshore

receiving facilities, and off-take station. We executed the conceptual design of the FSRU mooring and berthing system, and basic design of the subsea and onshore pipeline, onshore receiving facilities and off-take station.

## Promigas/SPEC Cartagena's Terminal

Designed by Wood for an onshore configuration covering the early studies and basic engineering and FEED. During the EPC tender stage the decision was made to change the configuration to an Offshore (FSRU).

For the FSRU Wood was awarded the detailed design of the marine import facilities, jetty topsides, onshore receiving facilities (ORF's) scope and natural gas pipelines.

## Gas Atacama, Chile

We won an owner's engineer contract for a new floating LNG receiving and re-gasification terminal to be built in Bahía de Mejillones, the first floating LNG terminal in Chile, with an initial

send-out capacity of approximately five million nominal cubic metres per day of gas. Our scope of work covered technical assistance during the development of the project, including technical evaluation of the bids.

## SASOL Terminal

## Nearshore and offshore solutions

Regasification projects include:

- Chevron Texaco Port Pelican LNG import in US Gulf Of Mexico using GBS structure
- Samsung C&T FSJURU (Floating Storage Jack-Up Regasification) pre-FEED of concept which obtained "Approval-in-Principle" by DNV
- GEI Pakistan Regasification on fixed offshore platform





Wood is a global leader in the delivery of project, engineering and technical services in energy, industry, and the built environment. We operate in more than 60 countries, employing around 60,000 people. We provide performance-driven solutions throughout the asset life cycle, from concept to decommissioning across a broad range of industrial markets, including the upstream, midstream and downstream oil & gas; power & process; environment and infrastructure; clean energy; mining; nuclear and general industrial sectors.

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