

# Gas Monetization

Keeping project cost, schedule  
and local requirements in line





Tangguh LNG turned to KBR's partnership, KJP, to deliver a highly efficient process, utilizing combined cycle gas turbine compressor main drivers to minimize CO<sub>2</sub> emissions.

# Upholding Reputations and Revenues

LNG facilities are complex. Risk can enter the picture at any time, anywhere – from politics and public relations to procurement and construction. External market factors can cause capital expenditures and operating costs to escalate without warning. This raises questions:

- Is the timeline realistic and feasible to meet production targets?
- Which issues are likely to impact risk of success?
- How will you economically balance technology, sustainable development and safety?

It's one thing to identify the issues that affect risk. It's another to understand and solve them. With over 30 years of project successes in the LNG industry, KBR mitigates risk from project concept, to design and through every detail of your implementation.

KBR has safely and successfully designed and constructed more than half of the world's operating liquefied natural gas (LNG) production capacity. And as an experienced EPC company, we have participated in all but one competitively bid grassroots LNG projects since 1976.

## Installing High-Performance Technology

Maybe you have researched the technology you want. But the one thing you avoid locking into an EPC contractor that only uses proprietary technology. Project bids today require international companies with global engineering capabilities, systems, procedures and communications to match the right process technology to your jobsite. While we have a number of proprietary technologies outside LNG that outperform competitive solutions in reliability and cost-effectiveness, we are neutral when it comes to LNG technology and are willing to work with all licensors and equipment suppliers.



Safety reached a record high at Tangguh LNG as the project reached 29 million work hours without a loss time incident.



Possessing a broad understanding of customer needs, and providing innovative solutions that reduce risk in LNG facilities around the world is a benefit that KBR brings to every project.



Securing Nigeria's future through technology transfer, ensuring sustainable development and using Nigeria resources to the greatest possible extent reflects our commitment to Bonny Island.

Flexibility and ingenuity is part of every project we take on. In fact, KBR was the first to use the GE Frame 7 as a mechanical driver in an LNG plant at the Malaysia LNG Dua Expansion Project. This foresight allowed the LNG train design to gain a significant increase in capacity and take advantage of economies of scale.

### Low Cost Proposals Can Be Deceiving

There is usually a reason why a bid is too good to be true. To put matters into perspective, the lost production costs of just one missed project milestone can easily outweigh the perceived savings promised by a low-bid contractor. Bids from KBR are competitive, so when you evaluate our quality personnel, expertise, training and exceptionally high safety record, there is

really no comparison. For example, our project team on Tangguh LNG turned 1,500 cost-saving ideas into 165 optimization points equaling 100 million dollars in cost savings over the life of the project. While some contractors may offer to build your project for less, we have built a reputation on delivering on time at reliable cost.

### Managing Execution Risks

With fast-tracked timetables, environmental compliance and tight capital budgets, effective project management and controls will take you seamlessly from an initial idea to first LNG. Averting risk during concept, feasibility, front-end engineering and design (FEED), detailed design, construction and commissioning is an area we are well equipped for after having led our JV partners in the FEED and EPC of the first 5 million tpy train in the world at the SEGAS (Spanish

Egyptian Gas) facility in Damietta, Egypt. This plant has one of the shortest project development schedules: 18 months from Concept to EPC award, achieving RFSU in only 35 ½ months for a grassroots LNG facility—amounting to two years less than the previous benchmark. Depending on the magnitude of your project, we can execute alone or in a joint venture. In fact, our 30 plus year joint venture alliance with JGC remains the strongest in the business.



Tangguh LNG is a hyper-efficient facility in that 20 percent of the total energy demand is supplied from waste heat recovery.



Rapid execution and no disruption to operations results from our comprehensive in-plant work knowledge. Integrating construction activities with commissioning activities provides better installation with fewer punch list items after construction is complete.

## Protecting Lives and Environment

LNG facilities are not just about the product; they represent people and the local community. Creating an incident and injury free organizational climate that practices safe behaviors, rewards safe performance and minimizes environmental and social impact are differentiators when choosing an EPC contractor. Achieving project success means safeguarding lives and improving safety. For example, while working on Nigeria LNG Train 3 in 1999, we reduced the total recordable incident rate by 70 percent and lost time incident rate by 75 percent compared to Train 1 and 2 base project in 1995. Train 4 and 5 in the Plus project further improved recordables by another 30 percent and LTI's by another 50 percent over the Expansion project. NLNG 6 lowered the recordables even more by over 50 percent and LTI's by 33 percent over the Plus project. Achieving superior safety statistics each year that ranked well below the industry standard resulted in earning Most Outstanding Multinational Contractor in 2006 and 2007.

| PROJECT   | SCOPE     | NUMBER OF TRAINS |
|-----------|-----------|------------------|
| Base      | FEED, EPC | 2                |
| Expansion | FEED, EPC | 1                |
| Plus      | FEED, EPC | 2                |
| Six       | FEED, EPC | 1                |
| SevenPlus | FEED      | 2                |

Each year our commitment to health, safety and the environment is evident as we implement our proven and leading standards and processes, uphold ISO 9001, ISO 14001 and OHSAS 18001 certifications and continue our world-class record of training, inoculations and disease control.

Whether safeguarding the largest remaining mangrove forest in Bintuni Bay, Papua or implementing comprehensive CO<sub>2</sub> capture solutions for enhanced oil recovery, we continually put lives and the environment first.

## Maintaining Cost and Schedule

Risking a massive LNG project with the wrong EPC contractor could cost you your reputation. The fact is, 99 percent of the criteria affecting your ability to achieve monthly objectives depends on having the right systems in place and a strong EPC team aligned with your vision and focused on your goals. KBR will assemble the right team to safely meet production targets and local requirements. That's the reason Nigeria, Algeria, Malaysia and Australia have turned to KBR repeatedly for LNG plant project execution.

## Improving efficiency of operations, conserving natural resources, safeguarding lives and reducing emissions is how we operate on a daily basis



The result: we achieved over 140 million work hours without a lost time incident across 16 projects in the last six years.



BP challenged KBR's partnership, KJP, to design a hyper-efficient facility that would have the least amount of impact on the remote environment of Papua, and the team responded.

## Maximizing Local Content

Reputable EPC contractors consider themselves trusting partners interested in creating job opportunities for the betterment of your community. Besides being an industry leader with a spotless safety record, the contractor you hire needs experience training workforces of all sizes and must have an in-depth understanding of cultural issues to work well with various governments and communities. Not only do we train thousands of workers at every LNG

project site, our record of hiring local employees and contractors is impressive. All trains at Nigeria LNG were constructed using 90 percent local labor, and we have managed as many as 18,000 people from 47 countries on a single worksite during the first phase of construction on NLNG. Knowing that hiring locally sustains a country's economic growth, it is no surprise that we hired virtually all local labor for our projects in Egypt, Malaysia, Indonesia, Australia and Algeria.

## Tangguh required a labor force of 8,660 and of that number, 98 percent were Indonesian



KBR's partnership on Tangguh LNG began with engineering design and procurement work in Jakarta before relocating the project management team to the site. The team utilized 450 Indonesian engineers, designers and specialists in Jakarta to design and execute two LNG trains totaling 7.6 million tpy that minimized the footprint, facility maintenance and material costs.

## Managing Geopolitical Issues

Different countries, different cultures; and with each comes unique political challenges. Our expertise in maneuvering through these murky waters is unrivaled. Reacting to changing political and cultural environments swiftly is a core attribute we bring to every job.

Identifying and responding rapidly to situations that might stall production allows us to continue working and stay on schedule. Whether it's overseeing permits, visas, managing contractors, gaining security clearances or an array of other sensitive governmental, land, environmental or cultural issues, we manage these jointly to meet your production goals

## Getting Materials and Teams to Jobsites

Navigating the logistics of buying, shipping and controlling a massive amount of equipment, materials and people help determine the success of your LNG project. Obtaining information and approvals from government authorities for handling project materials can be an involved process. Every country has its own set of regulations for importing materials and equipment, overseeing port congestion and taking safety precautions. Getting project members and materials through the point of entrance and into the job site safely is an integrated task our experienced teams perform well.



Nigeria LNG has achieved an unprecedented rate of growth through four successive engineering, procurement, construction and commissioning projects delivered by KBR and its JV partners.

# Liquefaction Plants

## Major Presence in Nigeria

The Energy Information Administration ranks Nigeria as the seventh largest natural gas reserves holder in the world. Our ability to respond to the increasing global demand for LNG and our customer requirements is evident by our ongoing presence in Nigeria

for more than 20 years, resulting in the design and construction of six LNG trains, and the FEED of a seventh and eighth. Once completed, Trains 7 and 8 will be the largest capacity LNG trains in the world.

## First LNG Plant in Yemen

The decision to launch Yemen's first LNG plant was an important one, and KBR was one of three JV partners executing the EPC scope of a two-train LNG facility for Yemen LNG Company Ltd. The project consists of two liquefaction trains with a combined capacity of 6.7 million tpy, and is expected to contribute significantly to the economic growth of the region.



Besides playing a critical role in monetizing the country's natural gas resources, KBR and its JV partners will provide numerous job opportunities in Yemen during the EPC scope.

## Largest LNG Complex in the World

Malaysia LNG chose KBR's JV when needing design, procurement, construction and commissioning for grassroots or revamp work for eight separate trains over a 20-year period. Our JV completed the original three trains, MLNG Satu, in 1983; a three-train expansion, MLNG Dua, in 1995; and a two-train expansion, MLNG Tiga, in 2004.



Malaysia LNG site ranks as the world's largest single complex with a total production of 24 million tpy.



SEGAS's landmark 5.0 million tpy LNG train set new standards across the industry. The majority of the gas exported from SEGAS supplies new 'cleaner' gas-fired power stations in Spain.

## Record Firsts in Design, Size and Schedule: SEGAS

SEGAS is the largest train in operation and first operating LNG facility in Egypt, which became the thirteenth nation to export LNG. Not only did KBR and its JV raise the industry standard by achieving RFSU in only 35 ½ months, we set yet another industry benchmark LNG plant capacity. The project is a differentiator for KBR in that the project team built it to industry standard not client specifications, and it was a single train versus a two train base project. Completing a benchmark project like SEGAS in less than 3 years from EPC award to RFSU is a testament to the innovative spirit, talent and dedication KBR brings to every project.



The benchmark performance at the SEGAS facility continues to reaffirm KBR's position as the industry leader in LNG. Egypt expects the facility to generate substantial export earnings for the country.



The SEGAS LNG complex in Damietta came on-stream in the fourth-quarter of 2004 and is exporting LNG to the Spanish market.



Significant experience in developing dynamic simulations, both for process design and operator training and focusing on advanced engineering tools helps differentiate KBR from our competitors.



**“There was nothing on site when we first showed up. We arrived on a Zodiac, walked up the mud flats and entered a jungle and then had the daunting task of planning how to move five million cubic meters of soil, 100,000 cubic meters of concrete and 1,400 kilometers of cable as well as house and feed a 9,000 person workforce...that’s not something just anyone can do.”**

John Baguley  
KBR Project Manager,  
BP Tangguh LNG Project



### Smart Optimizations in Tangguh

This project required innovative ways to save Tangguh LNG money so KBR optimized the project to reduce overall costs, maximize and guarantee local content, reduce environmental impact and mitigate overall project risk. The project team met all of these objectives including overall health, safety, security, constructability and operability targets. Tangguh LNG is the largest capital development project

underway in Indonesia, and we are involved in the EPCC joint operation, which includes construction of a two-train LNG processing plant each at 3.8 million tpy of LNG with associated support facilities. Besides saving more than 100 million dollars over the life of the project, Tangguh LNG has one of the lowest rates of CO<sub>2</sub> emissions of recent grassroots projects.

**Reliable, cost effective designs are the norm at KBR. Our innovative plot plan in Tangguh saved BP 30 percent in bulk materials**



The work scope of this two-train LNG processing plant in Tangguh included development of extensive infrastructure including marine facilities, product storage, utility support systems and housing and administrative facilities for the plant staff.



The EPC award demonstrates KBR's ability to solely execute major, grass-roots LNG projects and its commitment to achieve Sonatrach's and Algeria's goals for increased LNG production.

### Sonatrach Skikda LNG in Algeria

When Sonatrach, Algeria's national oil and gas company, needed a new LNG train at Skikda they turned to KBR. We signed the EPC contract on July 7, 2007 for Skikda's 4.5 million tpy LNG train along with the associated LPG and condensate recovery facilities, and are handling the pre-commissioning and commissioning part of the contract. This project needed a flexible and innovative contracting approach in a market where escalating costs and lack of resources were creating delays. Understanding the changing market, our team came up with an economical solution that prevailed. On completion, Sonatrach will add a world-class facility to their portfolio.

**More than anything else, our repeat LNG business – six trains in Nigeria, eight trains in Malaysia and four trains in Australia – show that customers rely on KBR for liquefaction expertise**

### Four LNG trains for Woodside Energy, Ltd.

Woodside Energy Ltd. turned to KBR's JV when they needed a two grassroots LNG trains followed by two separate LNG train and another two-train LNG expansion projects, totaling resulting in 4 liquefaction trains with a total capacity of 10.7 million tpy. The services provided include engineering, procurement and construction management

services for one of Australia's most important resource development projects - an LNG production facility on the Burrup Peninsula, Western Australia. KBR's JV created about 9,000 direct and indirect jobs across Australia during the peak construction period, and its Perth headquarters became home to a staff of 400 as part of the engineering design team.



Trains 1 & 2 of Woodside's North West Shelf LNG's production facility hailed as the world's first fully air-cooled liquefaction plant.



Energy companies rely on our expertise delivering nearly 50 LNG terminals when selecting an EPC contractor for their grassroots, expansion or conversion LNG terminal. Extensive experience with feasibility studies, basic design engineering, FEED and EPC onreceiving terminals and storage tanks sets KBR apart from our competitors.

# LNG Receiving Terminals

## Delivering the Optimum Solution

LNG producers have relied on our expertise with receiving terminals for more than 30 years. They count on our vast experience to develop fresh concepts for grassroots regasification facilities, both onshore and offshore, and for expansions, including technical innovation and design, cost, permitting, legislation, project execution and consulting services. Other services we deliver include systems such as jetty and marine facilities, cryogenic piping and insulation, LNG interchangeability, vaporization systems, and storage and loading facilities.

## Constructability in Every Design

Matching your receiving terminal needs with our LNG experience allows us to tailor solutions to a broad spectrum of project sizes and concepts. This synergy results in optimal schedules and cost effective designs. To date, we have executed over 45 LNG terminal projects in our Houston office and MWKL office in London.

**Designing over half of the grassroots LNG receiving terminals in operation outside of Japan – more than any other contractor – provides communities with greater access to needed energy resources**



Trunkline LNG Company in Lake Charles turned to KBR when they needed design and EPC for their terminal constructed 25 miles inland from the Gulf of Mexico on an industrial canal.



With KBR's involvement in the Enagás terminal designs in Huelva and Cartagena, these projects stand out as the lowest cost terminals in the world.

# LNG Receiving Terminals

## Grassroots and Expansion Projects

### Enagás – Spain

When Spain's Enagás needed design services for two of the lowest cost LNG terminals in the world, they turned to us. In just 36 months, we provided the basic design package and project execution advisory services during the grassroots and subsequent expansion phases for two terminals located in Huelva and Cartagena, Spain. Both terminals receive, regasify and distribute Algerian LNG to nearby communities in Spain and provide feed gas to a neighboring ammonia plant.

### Kogas – Inchon, South Korea

Kogas enlisted KBR to provide FEED, EPC and advisory services for their grassroots LNG receiving terminal that included storage, and a jetty and unloading system. The site now delivers over 14 million tpy to the Seoul metropolitan area.

### DEPA – Revithoussa Island Greece

DEPA turned to KBR for FEED and EPC advisory services and various study reports for their grassroots LNG receiving terminal. The project included storage and a jetty and unloading system, with the ability to handle LNG vessels with capacities from 25,000 cubic meters to 135,000 cubic meters. Peak send out rate is 750,000 cubic meters of natural gas per hour.

### Distrigaz S.A. – Zeebrugge, Belgium

Distrigaz awarded KBR the FEED and EPC for their grassroots LNG receiving terminal located on reclaimed land. The site delivers 670,000 cubic meters of send out per hour, with 260,000 cubic meters of storage.

## Conversion Project

### Lattice – Isle of Grain, Kent UK

Lattice turned to KBR for pre-engineering and conceptual design conversion of their peak shaving plant, now the main source of LNG import for the United Kingdom. This site has a capacity of 3.3 million tpy of LNG.

### Kogas – Tongyeong, South Korea

Kogas awarded KBR the FEED and EPC advisory services for their grassroots LNG receiving terminal, with a peak sendout capacity of 990 tons per hour.

### Sempra LNG – Cameron, Louisiana

Sempra LNG enlisted KBR to build a base LNG terminal followed by an expansion. Project management activities included technical reviews and studies through estimating and schedule studies as well as field staffing during the construction phase. Once completed, the LNG terminal capacity would expand to 2.6 billion cubic feet per day.

## Offshore/Floating LNG

Reducing cost and shortening the supply chain from well to liquefaction facility is a common concern. When gas is so far offshore that the economics of piping it onshore become prohibitive, then offshore LNG can be a solution. Floating LNG is currently in development, and we have actively participated in over 15 key studies dealing with floating liquefaction and regasification designs. These studies include GURF (Gas Utilization Research Forum), Statoil (Hammerfest LNG Plant) and Project Azure, the "Full Floating LNG Chain." Expertise in offshore LNG makes KBR best positioned to integrate LNG with the design and construction of FPSOs. Unlike other EPC companies, we have extensive engineering,

procurement and construction management (EPCm) experience in FPSOs spanning decades including Hibernia, Agbami, Plutonio and others. In addition, we have been a member of the Azure consortium, a program funded by the European Union to advance the development of floating LNG supply chains.

Reducing risk in offshore LNG concepts is an area in which KBR has a great deal of expertise. When a JV between operator Woodside, BP, BHP Billiton, Chevron and Royal Dutch Shell needed expert help for their "Browse to Burrup" Development, they enlisted KBR to develop their floating LNG concept. This project included 20 trillion cubic feet of gas located offshore Western Australia.

## Leading the GTL Market

GTL facilities are now in progress or under consideration in gas-rich countries such as Algeria, Australia, Columbia, Nigeria, Qatar and Russia. The sheer magnitude of GTL projects in equipment, scale and resources is a first in the engineering and construction industry. At peak, these technically challenging projects require a workforce of 30,000 to 50,000.

Along with our gas alliance partner, JGC, we have established ourselves as leaders in the GTL market as we are involved in two of the three ongoing GTL projects around the world, Escravos in Escravos, Nigeria and Pearl in Ras Laffan, Qatar.

In Escravos, KBR along with our JV are delivering EPC services for Chevron Nigeria Limited. And in Pearl, KBR and JGC are providing project management and cost-reimbursable EPCm services for Qatar Shell GTL Limited, a company of the Royal Dutch/Shell Group.



In February of 2007, HRH Prince of Wales visited Pearl GTL to help lay the foundation stone to mark the beginning of construction. Located in Qatar, Pearl GTL is one of the largest construction and engineering projects in the world today.

## Reduce Cost. Maintain Schedule. Minimize Risk. Safeguard Lives.

Mitigating risk on your multi-billion dollar LNG project is a joint effort best led by industry experts. A proven EPC partner who has amassed more than half of the world's operating LNG production capacity since 1976. An EPC company known for LNG innovation, quality and execution: KBR.

To learn more, visit: [www.kbr.com/lng](http://www.kbr.com/lng) or e-mail [lng@kbr.com](mailto:lng@kbr.com)



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