GROWING AUSTRALIA'S **FLNG SUPPLY CHAIN**

POTENTIAL OPPORTUNITIES FOR THE AUSTRALIAN SUPPLY CHAIN TO PARTICIPATE IN SERVICING THE NEEDS OF FLOATING LNG FACILITIES.

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Executive Summary

With the first new build FLNG due to be installed in Western Australian waters in the near future, it is important to consider potential opportunities for both Western Australian and the broader Australian supply chain to participate in servicing the needs of this and future facilities.

While much of the design and construction of such a large, novel facility has, by necessity, been performed overseas, there remain entry points into both the overall design, construction and installation of a FLNG and, possibly more importantly, there will be ongoing ways for local businesses to be part of the FLNG industry for the entire operational life of each facility deployed into our waters.

In preparing this report, we have endeavoured to provide a broad perspective on the lifecycle of a FLNG, along with a series of insights into how the supply chain for such a facility is established, functions and can be accessed by businesses of all types. The report concludes by outlining some of the major challenges faced by the broader supply chain in servicing a FLNG in Western Australian waters, as well as offering some suggested areas where industry, academia and government may be able to better collaborate to ensure all possible opportunities are identified and exploited to their fullest.

The findings of the report are that the domestic market has most of the services and skills necessary to support the installation and operational phases of an emerging FLNG industry. With skills and experience developed over a quarter century of both offshore and onshore oil and gas production, the WA supply chain is able to play a major role in the support of FLNG operations.

While longer term opportunities resulting from the WA deployment of FLNG are still becoming clear, there are a number of medium term opportunities that will require some local investment in skills, facilities and research, plus there will remain some long term opportunities such as those deriving from data analytics that are as yet unimagined. Additionally, if Western Australia can mount a coordinated and collaborative effort to service as much of the FLNG supply chain as possible, we have the opportunities to build a body of knowledge that can then be exported to other regions to support the long term sustainability of both the region and the industry.

To assist in planning for our future opportunities following the arrival of FLNG, we make the following recommendations:

Potential suppliers need to fully understand their clients - Companies looking to be part of the supply chain to FLNG operations must fully understand the commercial and business drivers of their clients.

Build domestic collaboration at all levels of the supply chain - Collaboration and critical mass are key to the ability of the local supply chain to be effective and grow its penetration in FLNG.

Encourage businesses at all levels to look for new and innovative ideas - Innovation has long been one of the keys to success in developed economies, enabling them to maintain their competitive edge over emerging competition.

Encourage projects to establish their procurement offices in Perth - If the personnel placing the orders are based in Australia, they are more likely to place orders in the Australian market than if they were co-located, in another country, with the personnel undertaking the technical design work.

Encourage suppliers to establish local facilities - Use the developing critical mass of installed LNG plants and subsea equipment to encourage suppliers and maintainers to establish local facilities.

Provide government support for companies setting up facilities - It is recommended that some level of government assistance be provided to companies, both domestic and international, when they are establishing facilities in Australia to support both the FLNG and LNG industries strategically.

This could come in the form of tax incentives, deferred or reduced rent and rates for workshops or office buildings or similar incentives.

Ensuring a strong and effective domestic supply chain for both FLNG, and the broader LNG and Oil & Gas industry in Western Australia, is essential to maintain the viability of the industry. Every participant, both large and small, has their part to play. Without all facets of the supply chain working together in a collaborative manner, from the operators to small businesses, the industry will never reach its full potential, leaving it vulnerable to external forces and struggling to support its self into the future.

Introduction

This report has been prepared to provide insights into the functioning of the supply chain for a typical, generic, large new build FLNG designed and supplied to operate in Australian waters.

The report attempts firstly to outline the background to FLNG, setting the evolution of FLNG technology against the history of previous developments, and briefly explaining the different components of an overall FLNG operation. The report next introduces the development and operational phases of a FLNG, outlining how the supply chain evolves and how different types of organisation could gain entry to supply goods and services to such a facility.

The next section of the report considers the value of the supply chain, both during the design and construction of a new facility and then, perhaps more importantly, in the operating life of a FLNG. The final section of the report discusses the challenges faced, and opportunities available to the Australian market, and proposes some recommended actions for consideration.

This report is intended to consider the supply chain opportunities presented by a generic new build FLNG being designed, installed and operated in Australian waters, as such it does not directly discuss any actual or proposed project, other and to provide context or scale.

In preparing this report, consultation meetings were held with a number of potential suppliers of goods or services to such a facility, along with associated organisations and individuals. This was undertaken to collect a broad perspective of the way in which interested parties can approach the challenge of offering their goods or services to the operators of these facilities.

While discussions were also held with several potential operators of FLNG facilities, the report does not directly reflect their positions or views.

FLNG in Context

The arrival of FLNG technology on the world stage has, for some commentators, been treated as a completely new form of technology, standing separate to all that has gone before. This view of FLNG is largely unfounded. In reality, FLNG sits as one of the latest logical, evolutionary developments in the technological pursuit of efficient and practical methods to access, extract and deliver hydrocarbons to market.

As additional oil and gas reserves have been discovered further offshore, technology has continually evolved to pursue the most effective way to extract it. The offshore evolution began with the development of fixed platforms, built on jackets or similar sea bed based structures, with pipelines from subsea wells bringing the product onto the platform for initial processing before exporting it by pipeline to shore for processing.

As developments moved into deeper water, and at greater distance from shore, two further technologies were developed, floating production platforms and floating production, storage and offloading facilities (FPSOs). The former are similar to the earlier fixed platform facilities, only built on floating pontoons, the latter, the FPSOs are essentially tankers with minor processing, storage and offloading facilities added to allow oil to be collected on the vessel for periodic offloading to visiting tankers.

The hydrocarbons collected by all of these different technologies are then processed at onshore facilities into saleable commodities, liquids refined into various products and gas processed into LNG for export to global markets. Where natural gas is processed into liquefied natural gas, the processing takes place in facilities known as liquefaction trains. These trains are built as modular facilities, designed to process a certain volume of LNG commensurate with the size and capacity of the field. Additional trains can be added incrementally to expand the capacity of the overall facility.

An example of this was the expansion phase of the Woodside operated Karratha gas plant, where 5 trains now operate. FLNG facilities are predominantly designed to accommodate a single LNG train, though dependant on the field characteristics and owner preferences there could be two train FLNG facilities on some developments.

With the arrival of FLNG, the existing technologies of FPSOs and onshore LNG processing plant have been combined into an evolutionary facility, one that allows the natural gas to be extracted from remote fields and converted to exportable LNG on board the one facility. Produced LNG is offloaded at sea to tankers for transport to market. As such, FLNG can largely be seen as the next logical step in the development of offshore technology.

FLNG is not, however, without its novelty. As with any new development there are facets of FLNG that are new and unique. Technology such as new design offloading arms, used to transfer cryogenically cold LNG from the FLNG to the tanker, have been developed. There are also layout requirements on an FLNG that differ substantially from what would be done in an onshore facility due to the limited space offshore.

Some of the biggest challenges with FLNG, however, have a lot of commonality to FPSOs and other offshore facilities, these are in the areas of logistics and maintenance, along with distance from shore and exposure to extreme weather events in their operating environment.

Facility Overview

An overall FLNG installation comprises a number of discreet components:

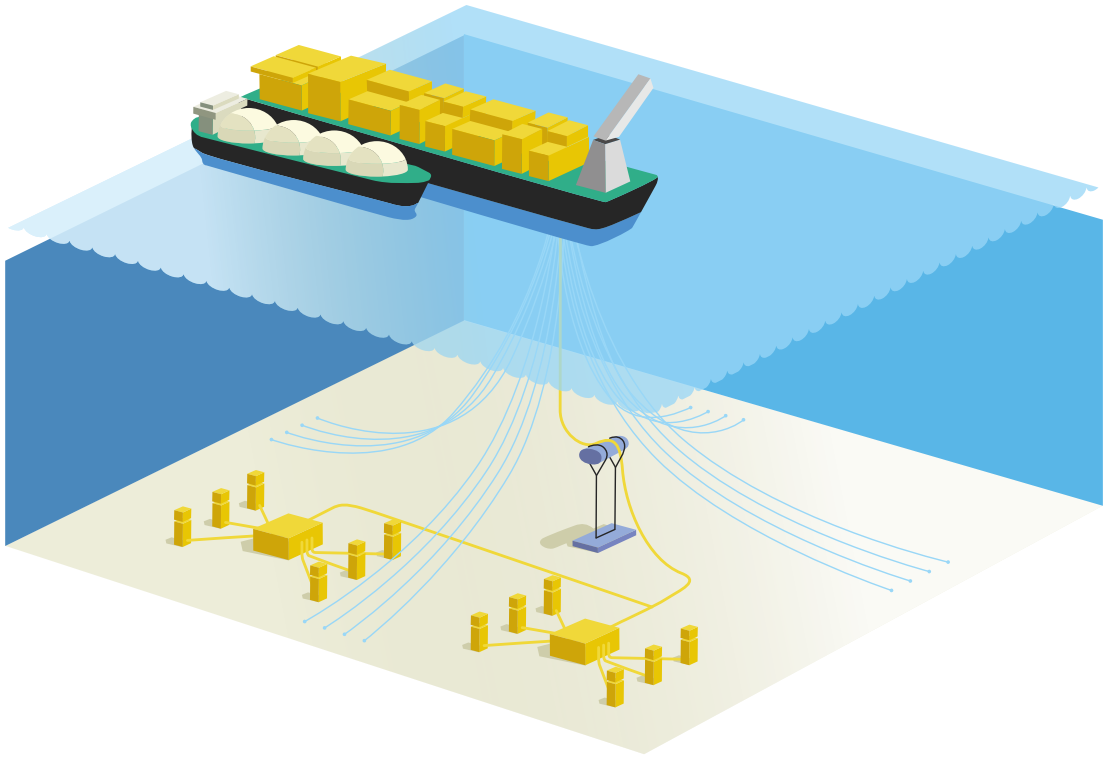
- wells,
- subsea equipment including well heads, manifolds, rigid pipelines, flexibles, risers and umbilicals connecting the wells to the FLNG facility,
- FLNG facility itself with all of its various components and facilities,
- supply base where goods and materials are stored for shipment to the FLNG,
- supply vessels which sail between the FLNG and the supply base,
- shore base where personnel are mustered for transport to and from the facility by helicopter and,
- home office, located in a main centre, where shore based personnel provide support to the facility and its personnel.

For the engineered parts of the overall facility, the opportunities to contribute to the design start at the concept level of the development. Some opportunities will end at the completion of manufacture and supply, while others will continue through the life of the facility as components are replaced due to wear and tear, age or during upgrade programs.

Each of these areas of the overall development offer different supply chain opportunities over the life of the facility. These opportunities range from highly technical, specialised engineering and manufacture, through to the supply of cleaning services, clothing and food.

Each has its own specific supply chain, with its own particular entry points, expectations and opportunities.

Indicative FLNG development plan



FLNG Facility Lifecycle Overview

An overall Floating Liquefied Natural Gas facility (FLNG) will include the development of the reservoir, drilling and subsea completions, design and supply of subsea equipment, design and supply of subsea pipelines, risers and umbilicals, design and supply of the FLNG facility and any shore base development undertaken to support the facility.

PROJECT PHASES

Like any major new project, a FLNG development goes through a number of phases. During these phases the project progresses from a concept to a working plant, before finally being decommissioned and its field abandoned once production is complete. Each of these phases will have particular characteristics related to the size and diversity of its associated supply chain.

CONCEPT 〉 DESIGN 〉 FABRICATION 〉 COMMISSION 〉 PRODUCTION 〉 ABANDONMENT

Concept select - The process whereby an operator determines how they are going to develop their field, the technologies they intend to use and how the overall facility will be configured. Decisions to be considered during this phase include whether the development will be a conventional land based LNG, whether it will be a new, greenfield development or a brownfield development where, either an additional train is added to an existing facility or the gas is used to maintain production at an existing facility.

Concept development - The process followed by the operator, with assistance from specialist engineering houses, to develop the chosen concept to a higher level of maturity of design and cost estimate prior to commencing FEED

Front End Engineering Design (FEED) - The process followed by the operator and their chosen engineering contractors to develop the engineering design for the development prior to Final Investment Decision (FID), including the selection process for fabrication contractors. FID is the point in time when the operator will give final approval for the project to be developed. During FEED a baseline estimate and schedule will be developed for the project.

Detail Engineering and Procurement - The process of finalising the engineering design and procuring all of the equipment required for the construction of the facility, including the engagement of large numbers of sub contract engineering and manufacturing organisations globally to deliver their equipment to the fabricator.

Fabrication - Work undertaken by the chosen fabricator in and around their yard, including the fabrication and integration of multiple process modules.

Pre-commissioning - Testing and commissioning of equipment at the fabrication yard to ensure it is compliant with appropriate regulations and operates as designed. This phase includes the deployment of appropriately skilled technicians and operations personnel to undertake and supervise the works.

Transport and Installation - Transporting the completed FLNG facility to site and installing it *in situ*.

Subsea Installation - While the FLNG is being constructed, the subsea portion of the project must be completed so that everything is in place to connect the completed FLNG once it arrives at its location. This will include the placement of the subsea equipment, drilling and completion of the wells, installation of fixed and flexible subsea piping and the placement of anchors and anchor chains.

Hook up and Commissioning - Connecting the facility to the risers and undertaking commissioning, from initial post installation testing through to production of first gas.

Operations and maintenance - The whole of life operations for the facility, including all personnel on the facility, operations support personnel located on shore, sourcing and supply of all materials needed to support operations such as food, consumables and transportation, ongoing maintenance engineering by both the operator and any and all subcontractors and supply of maintenance and developmental spares and consumables.

Abandonment - Removal of the facility, in a manner acceptable to the regulator, for either redeployment or disposal.

Each of these phases will have its own workforce and each will place particular demands on the supply infrastructure.

DESCRIPTION OF PHASES

Concept select and **concept development** are both largely desk top design and engineering activities, requiring access only to the right skills and experience to develop the project to the appropriate level of technical and financial maturity to allow it to pass to the next stage.

Front End Engineering Design (FEED) is a more complex and involved phase of the project. During FEED, the scale and scope grows from the small numbers engaged in the concept phases, to teams of several hundred technical specialists, working together to each develop their portion of the project to its required level of maturity. At this stage, on large, new developments, particularly ones involving licensed technology and design, it is common for the design scope to be awarded to specialist technical contractors who will undertake the work in their offices. Toward the end of FEED and prior to a Final Investment Decision (FID) on whether to proceed with the project, commercial enquiries will be issued for some long lead technical equipment, this is undertaken to ensure the project is able to meet its overall target dates.

Detailed Engineering and Procurement is the phase of the project where the engineering design is completed and all of the materials required are purchased for delivery to the fabrication site. This phase uses large numbers of technical specialists along with procurement and logistics personnel, largely drawn from the FEED engineering companies.

During **fabrication** all of the components and modules are assembled to form the physical facility. In the case of FLNG, fabrication of the sub-assemblies takes place in a number of global locations, each suited to the part of the overall project being fabricated and its likely transport method to the field. The facility (hull including tanks and marine systems, LNG train and associated process plant and accommodation facilities) will be fabricated in one location, resulting in a complete FLNG, the subsea equipment fabricated in another, the turret fabricated in a third location etc. Due to the size and technical complexity of these assemblies, it is extremely difficult for an Australian fabricator to be involved, except where the component is being taken directly from the fabricator to the field.

Pre commissioning tests of each part of the facility will take place at the point of fabrication. Pre commissioning entails testing the equipment in as near live functioning conditions as possible, to ensure it works both as a discreet component and as part of its system. Pre commissioning is typically completed before the facility is shipped, delays to pre commissioning can therefore result in delays to shipping. The overall FLNG will be tested as much as possible before it leaves the fabrication yard. Often these tests are performed by the operator personnel, who will ultimately be responsible for the operations of the facility, with support from local fabrication staff and imported specialists.

Transport and installation is the process whereby each part of the facility is delivered to its final operational location. In the case of FLNG, that involves transporting the equipment from its land based location to the field and fixing it in position. The smaller discreet pieces, such as the foundations, subsea equipment, anchor chains etc. will be transported on barges or heavy lift vessels, the FLNG facility will be towed to the field by a marine spread comprising a number of tug boats. Once on location they will be installed in sequence to form the overall operational facility ready for hook up and commissioning.

During **hook up and commissioning** the installed equipment is connected together and tested, firstly without introducing gas from the wells, then the gas from the well is gradually introduced into the facility until all of the facility is operational and producing

and storing LNG. At this point the FLNG is considered to be operational and enters production.

Once operational, the FLNG will become a live, working and producing plant, requiring 24-hour attendance by **operations and maintenance** personnel, along with constant monitoring of the condition of many components both on the facility and remotely. The demands of this 24-hour operation and the need to maintain as high an up time as possible mean that there will be a constant necessity to rotate personnel on and off the facility, to provide them with food, clothing and accommodation and to provide a continual supply of spares, consumables and replacement parts to keep the FLNG operating at its most efficient. This operational phase will last for upwards of 25 years and will provide an ongoing range of opportunities for local businesses to meet its needs.

Abandonment will take place when the reservoir the FLNG is exploiting ceases to be economically viable, in as much as when the ability to extract gas and liquids in commercially profitable quantities is no longer the case. At this stage, the wells will be closed down, subsea equipment will be recovered and the FLNG will be removed from its location. The present concept is that FLNGs will be capable of being redeployed to another field once they have been through a refit, but this is beyond the scope of this report.

Entry Points to the Supply Chain

ENGINEERING DESIGN

Each facet of an overall FLNG will have its own unique supply chain characteristics, starting with the engineering design services. While the specific skills of individual engineers are most definitely of a high enough level in Australia, the organisations who undertake the design of a facility as large and complex as a FLNG have global in house design centres, with core teams of engineers experienced in design of LNG trains, complex processing systems and storage, along with large hulls. Therefore, it is typical that when these companies tender for and win projects such as FLNGs, they will base the majority of the highly technical work in these centres.

The volume engineering work associated with detailing the complex engineering design is then, typically, assigned to what is known as high value engineering centres, owned or in partnership with the company undertaking the main design work. These engineering centres are typically located in countries where there are large numbers of skilled and relatively low cost engineering personnel, containing the costs associated with the large numbers of personnel required.

During the development of the engineering design, the entry point will be via the operator and their top tier, direct supply contractors. Suppliers wishing to provide major components to the initial development must deal with both the tier one engineer, who is responsible for the design of the overall FLNG, and the constructor of the facility, along with the operator.

PREFERRED SUPPLIER LISTS

The operator may well have preferred supplier lists, generated based on previous experience. These will identify preferred vendors, and often discreet products from each vendor. These vendors will typically have delivered their products to the operator on similar plant or duties and they are internally qualified to do so on future projects. For suppliers not already on these lists, entry can be a complex and time consuming activity. These prospective vendors must be prepared for the associated expense of qualifying. Those already qualified need to ensure they are maintaining their quality levels and staying in contact with the operator.

The highly technical and specialised material, such as subsea equipment, process plant, unloading facilities etc. have extremely tightly controlled supply chains. These controls are put in place by the industry to ensure that every component that goes into the overall facility is fully traceable, of known quality and origin, and has been specifically selected and supplied for its exact service. This oversight helps ensure the reliability of the equipment once deployed, allowing for enhanced diagnostics should a problem occur during its service life.

This rigour in the certification and verification of suppliers for 'mission critical' equipment means that there is an arduous qualification process aspiring suppliers must complete to be considered as capable of meeting the exacting requirements. The qualification process is both lengthy and expensive, but once a company qualifies, they can access the valuable supply chain for those materials. While it does not exclude any Australian companies from participating, the associated expense makes it hard for any but the largest organisations to participate.

SUPPLY OF COMMODITY ITEMS AND GENERAL SERVICES

For organisations supplying either less technically demanding equipment, or who supply consumable goods or services, the rigour of pre-selection to the supply process is less intensive. However, they must still compete with other aspiring suppliers of comparable services.

Typically, operators will consolidate similar services into larger aggregated contracts. For example, combining the provision of catering, cleaning, laundry, waste management and minor maintenance both offshore and onshore into one Facilities Management contract as is the case for the Shell Prelude FLNG (See Project Connect website)[1]. As such, those organisations wishing to supply into these consolidated contracts must negotiate with the successful tenderer to be considered, not necessarily with the operator (many of these suppliers contact details are available via either the operator's website or services such as Project Connect)

At the other end of the scale, supply of consumables, such as provisions to the kitchens, will require that the goods be of the right quality and quantity, but the barriers to entry to potential suppliers are much lower and easier to overcome.

TIERS OF THE SUPPLY CHAIN

Virtually any supplier of goods or services, whether to a conventional onshore LNG plant or an offshore facility such as a FPSO or fixed platform, will have a potential point of supply to a facility as large and complex as an FLNG with more than 25 years of operating life. There will be different ways for each category of supplier to determine how to gain entry, and it is critical that prospective suppliers consider how they should approach the opportunity.

1 http://www.projectconnect.com.au/uploads/956844557218.pdf

DESIGN AND CONSTRUCTION PHASES

Direct supply to the operator of the facility will typically be by what are referred to as tier one and tier two organisations. These are organisations which the operator has pre-approved following an extensive verification processes as being suitable, capable and reliable enough to supply goods and/or services directly to the facility. Typically, this list comprises the major engineering companies tasked with the initial design of the facility, the fabricators of the overall facility and the engineers and fabricators of many of the major sub-assemblies of the facility, along with suppliers of many of the components used.

During the design and construction phases of a project there are tightly controlled supply chain routes. These routes are different dependent upon whether the supplier is delivering services such as engineering or fabrication as compared to those supplying components and equipment.

Major engineering services companies deal directly with the operator during the early phases of the project to secure their contracts. Once the engineering companies for each aspect of the facility are appointed, additional engineering companies wishing to participate as subcontractors would have to negotiate with either the operator or their appointed engineer.

Fabrication yards would typically deal with the operator, either directly and independently or as part of an engineering procurement and construction (EPC) consortia.

Suppliers of equipment for the initial build of the FLNG would deal with the principal engineering company and potentially with the operator. As mentioned above, there will be a preferred supplier list developed for the project, either pre-existing from the operator or project specific, which suppliers should aim to be included on.

Suppliers of fabrication consumables would deal with the fabrication contractor and, in a similar way to the suppliers of equipment, with the operator to ensure they are included on any approved supplier list.

Likewise, suppliers of smaller pieces of equipment and smaller, more specialised installation consumables would deal directly with the engineers and fabricators.

OPERATIONAL PHASE

In the operational phase, there are substantial opportunities for many different businesses to engage with the facility, supplying the goods and services needed to support the operation of the FLNG. These goods and services range from weather forecasting, training of personnel, transport of both personnel and equipment to and from the facility including various locations such as the supply base, the supply of clothing and laundry services, supply of food and drink and removal of waste from the facility, delivery of entertainment and communications and various other non-technical services. There is also the opportunity for businesses to supply to those supplying to the FLNG operator and so forth.

These broader, more diverse opportunities will be long lasting and provide multiple ways for non-resource based businesses to participate in FLNG. The ongoing demands for their services will endure for the operational life of the facility, providing a way for the businesses involved to invest in their own establishment and the development of staff and their community, including training of staff and awarding contracts to sub suppliers for their services and materials.

A supplier who has their equipment included on an FLNG must ensure they are able to support it in a way that is acceptable

to the operator. For some suppliers this may include establishing a local support centre to undertake maintenance, training and replacement of their supplied goods as needed. Others may be able to support their product more remotely, working from a central hub in the region.

In the case of many of the technology components, the selection of supplier will be made by the tier one engineering companies in consultation with the operator during the design of the facility. During the design and build of the FLNG, once a particular manufacturer and product range has been selected, that product range will most likely remain the chosen one for the facility for the rest of the FLNG's operational life, as long as it remains in manufacture or a suitable alternate is made available once the product becomes obsolete.

This 'locking in' of products and equipment allows the operator to standardise on spares and training for personnel across the facility, instead of having to maintain a broad range of spares and train their personnel to support a broader range. This locking in also gives the companies supplying their equipment the opportunity to invest in local support for their products, to establish a manufacture or maintenance facility or to ensure warehousing of spare parts.

Supply Chain Value

FLNG SUPPLY CHAIN VALUE PROJECTION

The anticipated annual value of the supply chain for an onshore LNG facility in 2013 was approximately A$49 million per million tonne of LNG produced (based on research published by ICN[2]).

Given that this figure is for a mature onshore LNG facility, one with a large offshore gas gathering infrastructure, the overall relative expenditure per year for a large scale FLNG is likely to be similar once the FLNG is in position and operating.

With an anticipated split of expenditure between domestic and international suppliers of around 70% domestic, with the balance being spent with overseas suppliers.[3]

The challenge for Australian business is then to be in a position to capture as large a part of this expenditure as possible.

For a FLNG producing 4 million tonnes per annum the annual supply chain expenditure would equate to approximately A$200 million per annum.

Planned LNG production figures for some previously considered, currently proposed or in execution projects are as follows:

Prelude	3.6MTPA
Greater Sunrise	4MTPA
Scarborough	6MTPA
Browse	3 FLNG at 3.9MTPA each

Therefore, with 70% of A$200 million equating to A$140million being spent per annum in the domestic market for each facility, these potential FLNGs represent a large, ongoing investment in local businesses, training and third party support.

With each proposed FLNG anticipated to remain in operation for between 25 years[4] and 40 years[5] the long term value is around A$3.5 Billion over a 25-year facility life for a single 4 million tonne per annum facility.

BROADER LNG INDUSTRY SUPPLY CHAIN VALUE

Above the value of the supply chain specific to FLNG developments sit the supply chain for the overall domestic LNG industry.

By around 2020 this industry will incorporate the projected total of 21 trains of LNG, where the overall annual expenditure is projected by Accenture to grow from the current levels of around $1.3 billion to reach $4.9 billion by 2020.[6]

The Accenture report also identified that this overall growth in value of supply chain will incorporate a number of major shifts in the nature of services required, with the industry moving from one focussed on engineering for new facilities to one which is more operational and maintenance focused.

This shift in market demand will mean that services companies will need to either reconfigure to make the most of the opportunities, or shift their focus to other markets and locations.

2 http://www.icn.org.au/sites/default/files/LOB%20final%20report%20-%20LNG%20Operational%20Supply%20Opportunities%2019-feb%202014.pdf
3 http://www.shell.com.au/aboutshell/who-we-are/shell-au/operations/upstream/prelude1/benefits-for-australia.html
4 http://www.shell.com.au/aboutshell/who-we-are/shell-au/operations/upstream/prelude1/benefits-for-australia.html
5 http://www.industry.gov.au/industry/IndustryInitiatives/AustralianIndustryParticipation/Documents/AIP%20Authority%20AIP%20plan%20Summaries/WoodsideBrowseAIPplan-Summary-OperationPhase.pdf
6 https://www.accenture.com/us-en/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Dualpub_14/Accenture-Australia-LNG-Report.pdf

Local Opportunities

In the immediate market there are a number of areas in the FLNG supply chain that are readily accessible to local companies, these opportunities exist regardless of the proximity to the field of construction of the FLNG facility. Chief among these are:

Engineering support and studies - as they come on line, the new FLNG facilities will require ongoing engineering services, generating a steady stream of small projects and engineering needs. The projects present an opportunity for local companies to deliver their services to the various facilities and as part of these services, to purchase both goods and services from the local market.

It should be noted that historically an operator will engage either a single engineering organisation or a panel to perform most of this work, but there are still opportunities for others to participate from time to time.

Remote operations - Western Australia, through its experience in both its remote mining and oil and gas sectors, is a recognised world leader in remote operations of complex industrial facilities. From controlling and automating mine fleets in the Pilbara to providing remote operations of not normally manned offshore facilities, the skills and experience are here to ensure the remote support of a new, large and complex FLNG are developed, deployed, optimised and maintained into the future.

Geotechnical and geophysical surveys - as part of the development and operational phases of any oil and gas facility, including FLNG, there is a continual need for geotechnical and geophysical services. Many operators will aim to keep much of this work in house but there are equally a number of facets that will require the assistance of external contractors and specialists.

Data analytics - One of the emerging opportunities for all industries is that of data analytics. Facilities such as FLNG will generate substantial volumes of data during their daily operations which can now be stored, filtered, manipulated and analysed to provide insights into operational conditions, generate operational insights to improve process productivity and help optimise maintenance regimes. As the techniques and capabilities for this data analytics advances there will be a growing demand for skills and services in this area.

Air, road and sea logistics - materials handling, transportation and storage. This is an ongoing requirement for both the onshore transport of materials and the transfer of personnel and materials to and from the FLNG.

Drilling and completions - materials and equipment supply, completion services and materials

Subsea structures installation and associated logistics - During the construction and installation phases of an FLNG there is an ongoing need for the logistics handling and installation of the subsea equipment, risers and umbilicals. While this demand will be at peak during the initial installation phase of a project there will also be an ongoing demand for the availability of suitably qualified services to support operations and changes to the subsea architecture of the facilities.

FLNG ancillary equipment and material components - The operations, maintenance and ongoing development of FLNG in Australian waters will open up supply chain opportunities for businesses to provide both new components and small modules along with spares and replacement parts for Original Equipment Manufacturer (OEM) materials.

In some instances, the OEMs will have local representation and may provide the service direct to the operator themselves, including sourcing bought in equipment from local and international sources, in others, the OEM may not be locally represented and there may be opportunities for the local suppliers of the original components to provide local support either direct to the operator or to organisations contracting to the operator.

Consumables, spares, fuel, lubricants and chemicals - All forms of consumables will require replenishment during the operational life of a FLNG, some of these will be specialised components only available from the original manufacturers and supplied directly under contract others will be manufacturer recommended components, such as lubricants which must meet the recommended specifications to maintain warranty.

There are opportunities in all of these for local businesses to assist in the supply and delivery of these consumables but expectations need to be realistic as to where some of the specialised materials will be sourced.

Challenges and Opportunities

Operational expenditure on FLNG, along with the existing and under development onshore LNG facilities and offshore FPSOs, represent a substantial volume of revenue for businesses in Australia as a whole and for both Western Australia and the Northern Territory specifically.

The annual flow of monies from the operators of these facilities to their suppliers and their sub suppliers is large and, for many businesses will represent a major proportion of their annual revenue.

Yet there are a number of ways in which the opportunities could be enhanced and the level of service provided to the operators of the facilities and the communities closest to their facilities could be expanded. To grow this local proportion of local opportunities the following challenges must be addressed by industry and government together.

LACK OF DOMESTIC MANUFACTURING

Australian manufacturing of industrial technology has been hampered for a number of years by the small local market, distance to global markets and lack of local innovation driving the development of local technology.

Without a real financial and technological driver to establish and build a vibrant domestic culture of innovation and manufacturing, the Australian Oil & Gas industry will remain dependant on overseas developments and, may never build the technology export capabilities seen in countries such as The United States of America and Norway.

Large numbers of overseas technology manufacturers are, however, represented in Australia, making it relatively straight forward to obtain new equipment, spares and maintenance support for equipment installed in the facilities.

DISTANCE BETWEEN OFFSHORE FACILITIES AND RESIDENTIAL CENTRES

Unlike many other oil and gas regions such as the UK and Norwegian sectors of the North Sea and the Gulf of Mexico, the large Australian offshore gas fields are located at a great distance from the centres of domestic population, with their associated workforce critical mass.

This tyranny of distance results in extremely long logistics routes to move personnel and materiel to the facilities and to return equipment for maintenance to the centres of population (and the maintenance facilities located there).

The North Sea, for instance, is no more than 580 kilometres at its widest and has large population centres, with facilities to support heavy industry at numerous locations along its East and West shores, such as Aberdeen in Scotland and Norway's Stavanger. This close proximity of service facilities means that no point is greater than around 290km from shore.

Whereas Australia's reserves being considered for FLNG developments, such as those located in the Browse basin, are:

- over 200 kilometres from the nearest land,
- over 450 kilometres from the nearest population centre which is Broome, a small coastal tourist town with little in the way of industrial support,
- around 800km from Darwin, the nearest city with a supply base and technical workforce and,
- over 2,000 kilometres from Perth, the largest 'local' population centre and home of much of the current support infrastructure.

LACK OF SUPPORTIVE INNOVATION REGIME

Historically, innovation in Australian manufacturing has been left very much to individual companies, with few domestic businesses having the financial strength or client drive to invest heavily in the development of new technology.

It has also been very common for the Australian oil and gas sector to look overseas for proven technology developments rather than work with local businesses to develop local technologies. This low level of local innovation could, potentially, hamper the ongoing development of FLNG as the technology matures and more becomes known about how the facilities operate.

There are, however, changes occurring in the sector that may help improve the situation. Research organisations and academia are improving their linkages with industry through organisations such as WA:ERA[7] to become more focussed on the challenges and opportunities associated with emerging technologies such as FLNG.

Also, the Australian Federal Government has recently established a number of industry growth centres to support innovation, productivity and competitiveness. Two of these growth centres are of particular relevance to this report - the Advanced Manufacturing Growth Centre (AMGC)[8] and the Energy Resources Growth Centre (NERA)[9] .

7 http://www.waera.com.au/
8 http://www.amgc.org.au/
9 http://www.nera.org.au/

LACK OF INTEGRATED SUPPORT FACILITIES

The combined coastline of Western Australia and Northern Territory has only a couple of established centres where modules could be readily loaded and unloaded and maintenance and fabrication can be undertaken.

Principal among these facilities is the Common User Facility located at Henderson in WA. The Henderson facility, while highly flexible and with a large range of fabrications and equipment supply facilities on its doorstep, is over 2,000 kilometres from the Browse basin, while Singapore with all of its integrated manufacturing and shipbuilding industries is less than 3,000.

With Singapore also being a major support hub for Asian offshore facilities, it is therefore as convenient for facilities located in the Browse basin to utilise Singapore (and other similar Asian facilities) for some aspects of support as it is to use the facility at Henderson.

At time of writing, a new light industrial park has been approved for pre sales in Broome[10] and there is consideration being given to establishing supply base facilities at the James Price Point site North of Broome where[11] the previous Browse onshore LNG development was proposed. However, as yet these facilities are not yet established. There is also a facility under development in Darwin at East Arm Wharf[12].

EXPERIENCE FROM EXISTING FACILITIES

Australia is fortunate, however that it has in place, a substantial level of experience of supporting existing offshore facilities.

With approximately 8 FPSOs operating in Western Australian waters and some 20 years of experience, the domestic market has an understanding of the needs of such complex offshore facilities. Similarly, with in excess of 25 years of experience in operating, maintaining and serving the needs of onshore LNG facilities such as the Karratha gas plant, there is substantial domestic experience in supporting these complex industrial facilities.

The challenge will be to bring this experience and skill to bear on the new FLNG technology, to combine the experience of supporting offshore facilities such as FPSOs and fixed assets with the technological challenges of an LNG plant.

HIGH BARRIERS TO ENTRY FOR NEW COMPANIES

As discussed earlier in this report, the cost to enter the oil and gas market as a supplier of even the simplest equipment is typically very high. The costs of establishing, operating and maintaining a quality system that is acceptable to an Oil & Gas operator, along with the ongoing development costs of technology and equipment, means that only those organisations with sufficient capital are able to participate.

Even understanding the tender process for lower criticality items can be onerous and complex, meaning that many local organisations will either choose not to tender or will withdraw early in the evaluation process.

While support in addressing some of the complexity of developing appropriate systems and the tendering process is available through the CCI, the process is still a lengthy one and the combination of the time and cost with the relatively small market once approved is still a hurdle for many local businesses.

RESEARCH AND DEVELOPMENT OPPORTUNITIES

With Western Australia being the home of the first purpose built FLNG, with potentially further facilities under consideration, there is an opportunity for local businesses and academic institutions to undertake substantial research and development activities around the novel challenges encountered by the technology.

This could range from purely academic research through to the development and deployment of new technology. Research in this area is currently being performed by organisations such as the Centre for Offshore Foundation Structures (COFS)[13] and the Australian centre for LNG futures[14].

Properly supported and coordinated, a substantial focussed research program could lead to the development of new advances that may have a global market and help to place WA based institutions and businesses more firmly on the international map.

BARRIERS TO COLLABORATION

Historically those participating in the supply chain to the existing and emerging resource sector operators have operated independently, often being called upon individually by prospective or current clients for specific pieces of work.

The traditional tendering processes also mean that most companies have been reluctant to or even discouraged from broad collaboration, except in areas where the scale of the project may have been too large for any one of them to pursue or execute the work alone.

There are, however, as identified by the reports issued both Accenture[15] and Engineers Australia[16] real advantages to be gained from more open and proactive collaboration between both horizontal and vertically matched supply chain participants.

10 http://www.mediastatements.wa.gov.au/pages/StatementDetails.aspx?listName=StatementsBarnett&StatId=9087
11 http://www.landcorp.com.au/Industrial-and-Commercial/Browse-LNG-Precinct/
12 http://www.darwinport.nt.gov.au/port-trade-development/east-arm-wharf
13 http://www.cofs.uwa.edu.au/
14 http://lngfutures.edu.au/
15 https://www.accenture.com/us-en/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Dualpub_14/Accenture-Australia-LNG-Report.pdf
16 https://www.engineersaustralia.org.au/sites/default/files/shado/Resources/our_flng_future_engineering_opportunities_and_challenges_december_2014.pdf

Recommendations

Looking to the future, it is apparent that there are substantial opportunities in the broad overall supply chain in the LNG industry in Australia and specifically in the supply chain for FLNG.

Australia in general and Western Australia specifically is emerging from a position of being a globally large but not dominant LNG supplier to be potentially the world's largest supplier of LNG. This growth in capacity brings with it a growth in demand for services to support the industry.

The next decades will see a stable domestic LNG industry, one which has achieved critical mass as far as being able to support a continuous demand for skills and services which had previously only been needed occasionally.

Those operators deploying FLNG facilities within Australia as part of their portfolio will be able to benefit from this overall growth. In the same way, businesses supplying into the overall LNG supply chain will, where their products and services are required by the FLNG industry be able to benefit from the broader marketplace being established.

These benefits will not automatically flow to local businesses however, there are a number of actions that need to be considered that will enhance the probability of success. Key among these recommendations are those discussed below.

POTENTIAL SUPPLIERS NEED TO FULLY UNDERSTAND THEIR CLIENTS

Companies looking to be part of the supply chain to FLNG operations must fully understand the commercial and business drivers of their clients, both the operators and the large service companies holding term contracts to supply aggregated goods and services. Chief among these are that the need for their suppliers to demonstrate a high level of commitment to health, safety and the environment, in both the level of documentation but most particularly in their behaviours, suppliers also need to offer goods and services that meet the very exacting quality and reliability criteria demanded for a major offshore installation and to do so at a competitive price.

Additionally, suppliers should be encouraged to understand that the LNG industry in general and, in the context of this paper, FLNG facilities, will be in production for upwards of 25 years and as such, will provide a long term, generational opportunity for the building of business relationships.

This longevity means that businesses have the opportunity to invest for the long term, with appropriately scaled, domestic support facilities for their business. This is very much a given for most domestic suppliers, but for many international businesses considering their long term investment strategy, the knowledge that they can be part of the supply chain to a 21 train world scale LNG and FLNG industry should help them in understanding the benefits of investing in Australian infrastructure.

BUILD DOMESTIC COLLABORATION AT ALL LEVELS OF THE SUPPLY CHAIN

Collaboration and critical mass are key to the ability of the local supply chain to be effective and grow its penetration in FLNG. While it is likely that there will be organisations in the domestic market capable of servicing virtually every need of a FLNG, having the financial capacity, experience and ability to tender effectively for the associated contracts varies substantially, particularly where the contracts may include activities outside of the scope of individual companies.

As such, it is recommended that local organisations seek to collaborate broadly within the industry, to build networks of skills and capacity that will allow them to tender as a collective for the contracts as they come available.

For many domestic businesses, the concept of collaboration is one that historically they preferred to avoid, during the recent boom times it was not necessary to build relationships as there were more opportunities than there were companies. Times have changed and these same businesses now need to collaborate to compete.

ENCOURAGE BUSINESSES AT ALL LEVELS TO LOOK FOR NEW AND INNOVATIVE IDEAS

Innovation has long been one of the keys to success in developed economies, enabling them to maintain their competitive edge over emerging competition.

It is a recommendation of this report that businesses of all sizes and roles in the FLNG supply chain look for innovative and new ways to deliver their services, perform their business and offer different products to their customer base. Businesses should also work collaboratively with developers of new enabling technology to help bring these new ideas to the market.

ENCOURAGE PROJECTS TO ESTABLISH THEIR PROCUREMENT OFFICES IN PERTH

While the majority of major capital investment projects for the broader LNG industry are now nearing completion, there remains a substantial pipeline of smaller operations and maintenance projects, a pipeline that will run for the entire life of each of the facilities.

For the operators of the facilities these projects are undertaken for, their local office will be the headquarters for their own work, however, the companies undertaking the work on behalf of the contractors may be based either domestically or internationally.

While the technical work undertaken in any given project will almost always be performed in a location with the best skills pool for the task, history has shown that the location of the personnel performing the actual procurement and contract placement for any equipment, goods or services will have a major impact on the level of local content.

Simply put, if the personnel placing the orders are based in Australia they are more likely to place orders in the Australian market than if they were co-located with the personnel undertaking the technical content of the task.

ENCOURAGE SUPPLIERS TO ESTABLISH LOCAL FACILITIES

Use the developing critical mass of installed LNG plants and subsea equipment to allow suppliers and maintainers to establish local facilities.

This extends beyond and outside of the oil and gas industry to allied businesses whose services are also relevant to FLNG, such as logistics companies, marine services organisations and maintenance and repair workshops, all of which serve both the oil and gas industry and the broader business community.

With the rapid growth of both the LNG industry and the mining industry in Australia in the past decade it is now easier for businesses to find sufficient local work to justify establishing local facilities and to keep those facilities busy.

In support of this however, the businesses must offer services of the right quality and responsiveness for their clients and those same clients need to look favourably on companies making these substantial investments when seeking suppliers.

PROVIDE GOVERNMENT SUPPORT FOR COMPANIES SETTING UP FACILITIES

Establishing an Australian presence, particularly if that includes a logistics centre, workshop, fabrication facilities or similar is an expensive and relatively high risk undertaking for many businesses, even globally significant players.

To support the commitment required it is recommended therefore that some government assistance be provided to companies, both domestic and international, when they are establishing facilities in Australia to support both the FLNG and LNG industries strategically.

This could come in the form of tax incentives, deferred or reduced rent and rates for workshops or office buildings or similar incentives.

SOURCES OF AUSTRALIAN INDUSTRY PARTICIPATION PLANS

Industry Participation Plans - As part of the Australian Jobs Act 2013 and the Enhanced Project By-law Scheme (EPBS), all major projects must submit and have approved an Australian Industry Participation Plan listing the opportunities available for Australian businesses. These plans are published by the Department of Industry and Science on their website.[17]

ICN report - The Industry Capability Network produced a report titled "Opportunities for Small to Medium Enterprises for companies interested in operations, maintenance and facilities management of onshore LNG facilities[18]" which gives a good overview of the types of work which may come available in the onshore LNG industry, it has a large level of relevance to FLNG.

17 http://www.industry.gov.au/industry/IndustryInitiatives/AustralianIndustryParticipation/Pages/PublishedExecutiveSummariesofAIPPlans.aspx
18 http://www.icn.org.au/reports/western-australia/opportunities-small-medium-enterprises-lng

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