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Sustaining impact from Australian LNG operations

McKinsey Australia April 2016

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Drilling at the Arcadia gas field, Queensland. Photo courtesy of Santos.

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Preface

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Much of Australia's LNG industry is now shifting its focus to operations, following a A$200 billion investment into the sector that is set to make Australia the biggest exporter of LNG globally. This operations phase is likely to last for the next three decades.

In this paper, we look at the Australian LNG sector's continued contribution to the economy, and how this contribution could be further enhanced through the growth of the local service sector. This research builds on previous publications, most notably our 2013 paper *'Extending the LNG boom: Improving Australian LNG productivity and competitiveness',* which outlined a series of measures to improve Australia's LNG capital productivity and competitiveness.

This paper contributes to McKinsey's mission to support the communities we operate in by addressing important, yet challenging issues. As with all research published by McKinsey, this work is independent and has not been sponsored in any way by any business, government or other institution.

This paper has benefited from many sources of data and insight, and the authors are grateful for perspectives from industry players, in particular, the secretariat and members of the Australian Petroleum Production & Exploration Association (APPEA). We also thank Santos and Woodside for the use of several of the images throughout this paper.

McKinsey Partners Michael Ellis (Sydney), Christiaan Heyning (Perth) and João Segorbe (Perth) led this project with co-authors Peter Lambert (Sydney), Andy Thain (Singapore) and Dumitru Dediu (Amsterdam). They were supported by a team consisting of Harrie Beek, Kai Graylee, Jan Tijs Nijssen and David Stastny. For editing, visual and graphics support we thank Therese Khoury, Clare Kitada, Alexa Guevara Lizano and Lisa Maconie.

We are grateful for advice from McKinsey's Energy Insights, and colleagues Marcel Brinkman, Anders Brun, Daniel Cole, Jad Dib, David Dyer, Stephen Hall, John Lydon, Rachid Majiti, Azam Mohammad, Svein Harald Øygard, Michael Phillips, Joe Quoyeser, Helen Seidel, Paul Sheng, Khalil Tayara, Charlie Taylor, Richard Ward, Otto Waterlander and Xiaoyun Yang.

The Woodside-operated Pluto LNG project. Photo courtesy of Woodside.

Executive summary

Australia's LNG construction is set to result in the largest installed capacity in the world

With the expected commissioning of current projects in the coming 2 to 3 years, Australia's LNG industry will have more than tripled its capacity since 2010. It is set to have the largest installed base in the world, with projected capacity of 86 million tonnes per annum (mtpa). Australia's LNG base would not only be the world's largest, it will also be technologically advanced.

LNG operations can generate wide-ranging, long-term benefits

The Australian LNG sector has already contributed significantly to the nation's prosperity, through the operation of its assets, and through the enormous construction effort over the past 5 years.

Based only on projects for which the final investment decision (FID) has been taken, 55,000 to 65,000 people are expected to be employed in the wider LNG industry and its direct supply chain during the operations phase. Most of these jobs are highly skilled and remunerated well above Australia's average wage. Throughout the 2020s and beyond, the LNG industry is forecast to add around A$30 billion per annum to Australia's GDP, equivalent to about 2 percent of the total. Depending on realised prices, LNG could contribute up to A$55 billion exports in 2020 – rivalling iron ore, Australia's biggest commodity export today.

A high performing service sector is an opportunity and a critical competitive advantage

The industry has worked hard to deliver productivity improvements over the last 2 years. Yet the goal posts have moved, as global gas prices have plummeted. Australia needs to be competitive across the entire LNG value chain to overcome its relative disadvantage versus some competitors in areas beyond its control, such as geology and remoteness.

A strong local service sector could play an important role in further improving the competitiveness of Australia's LNG industry. It would ensure high quality service provision to operators, and allow them to innovate faster to become first-movers in the deployment of productivity improvements.

Such a service sector could become an economic engine in its own right. The size of the prize is big: up to 45,000 jobs, many of them highly skilled and with a long-term outlook, and an annual export value of up to A$1 billion. This would require short-term concerted actions. Without these, the service sector would likely support 10,000 to 15,000 fewer jobs, with limited export and less industry-level innovation. Building a thriving service sector would be consistent with the agenda for an innovative and agile Australia, and, more importantly: it can be done.

Segments to start with would serve a large local need, and could have export potential

Australia could learn from the development of other regions, such as the North Sea, that have grown successful service sectors. Service sector growth can best start in segments for which local demand is present and which build on Australia's existing capabilities, such as remote operations and production in challenging geological conditions, while leveraging the capabilities from its skilled workforce.

Segments that fulfil these criteria include turnaround services, specialist engineering services (such as predictive maintenance), remote operation services, geotechnical services, and health, safety and environmental (HSE) services. A number of these segments could provide export potential beyond local needs.

Realising the gains

The question is – how to make this happen? Operators, service companies, and governments would need to collaborate. Building on the experience from other hubs, the following actions would be a good start:

1. **Make the demand for LNG services more transparent.** Forecasting demand for services as an industry rather than per operator, and standardising where possible, will ensure that the opportunity becomes more easily apparent. This will allow service providers (domestic and international) to better anticipate and respond to demand, and would allow de-risking of Australia-based business models.

2. **Create an 'open source' collaborative ecosystem around LNG operations.** Industry could pool downtime and efficiency-related experience, data, and where possible intellectual property, in a walled garden to create a second-to-none LNG knowledge base. By providing access to committed service companies, this could generate innovation at a scale and speed that operators cannot replicate individually.

3. **Co-invest in R&D in strategic topics that address Australian and global LNG issues.** Industry, government and universities could create centres of excellence in areas that can deepen the competitiveness of LNG operations. Potential topics could include, among many, remote operations, predictive maintenance and geotechnical services.

4. **Simplify and standardise to reduce barriers for local and global service companies.** Australia's regulatory burden is higher than in Singapore and Malaysia, other potential hubs. Operators could also contribute by aligning practices across all operations, such as standard contract terms, shared supplier qualification and certification, and industry standards for equipment.

5. **Continue to invest in talent.** Valuable skills from the construction phase could be retained through selective retraining and reskilling. Governments and academia could support the sector by ensuring continuous training in relevant technical and engineering skills.

No single player can grow the LNG service sector alone. However, coordinated action could accelerate growth. Timing is of the essence; growth will need to occur in the next 2 years, for two reasons. First, there is still a significant number of service companies in Australia involved in the construction of the remaining LNG projects. Once these start demobilising, it would be hard to reassemble them. Second, the world will not wait for Australia. Other countries in South East Asia and the Middle East are also prioritising development of their service sector, and could become the anchor of the oil and gas service sector in this part of the world.

Pluto LNG. Photo courtesy of Woodside.

Milestones of Australia's LNG development

1989:

Australia's LNG industry starts. The first LNG cargo is delivered to Japan from the North West Shelf.

2008:

The installed base grows to six trains in the North West Shelf and Darwin.

2008–16:

Six more trains move into operation. This includes Pluto in the Northern Carnarvon Basin, the first Gorgon train on the West Coast, and four trains to liquefy and process coal seam gas from the Bowen Basin on the East Coast.

2016–20:

Australia's LNG base is set to extend by nine additional trains, resulting in a total of 21 trains. Trains will be commissioned at Gorgon, Wheatstone, floating LNG Prelude on the West Coast, Ichthys in the North, and the second trains for both Australian Pacific LNG and Gladstone LNG on the East Coast.

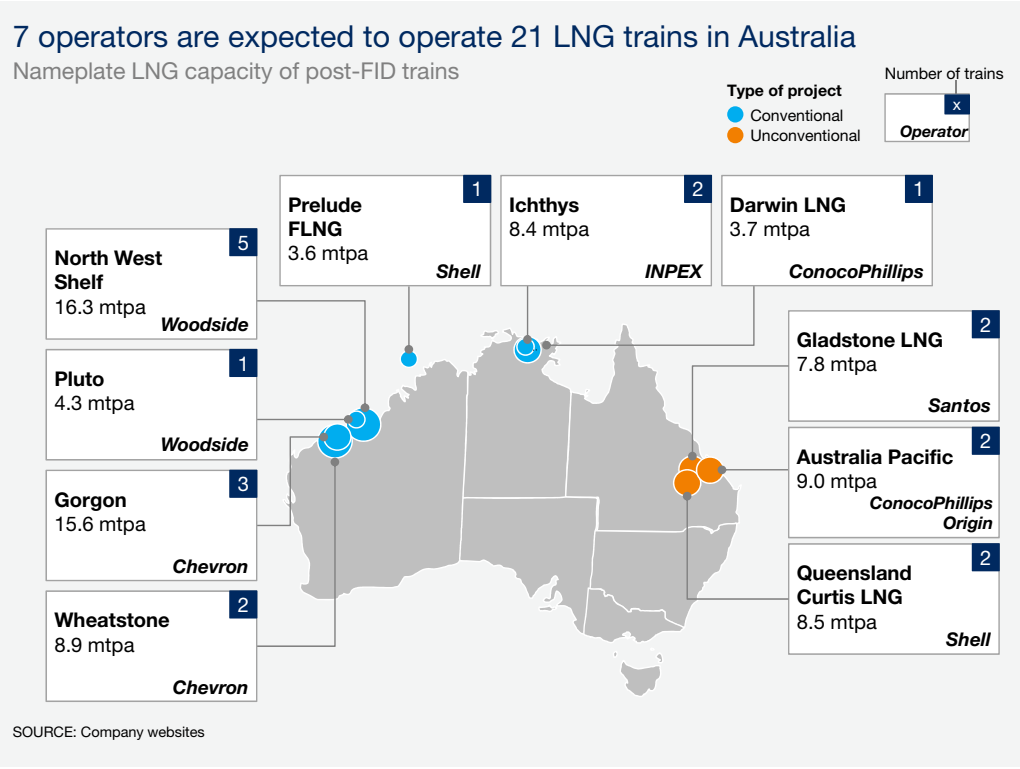
1. Australia: The world's largest LNG operator

Australia's construction boom is set to result in the largest installed LNG base worldwide, putting Australia in the global top ten of gas producers

By 2020, Australia will have more than tripled its LNG capacity

Since 1989, when the first LNG cargo was delivered out of Australia, there have been a number of important milestones in the growth of the LNG industry (see opposite). The last 5 years have seen unprecedented construction activity, with more than A$200 billion invested in LNG projects. With this construction successively reaching its completion, the industry in Australia is rebalancing the focus towards operations. By 2020, there are expected to be seven operators, with 21 LNG trains operating in ten projects across the country (Exhibit 1).

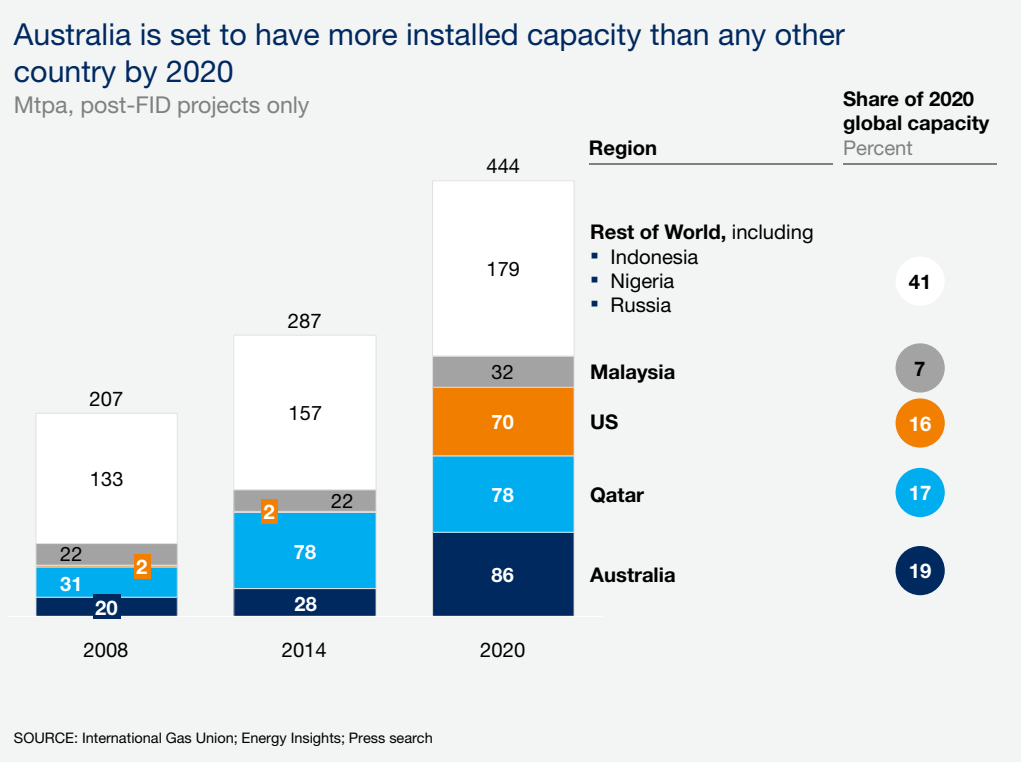
Exhibit 1



SOURCE: Company websites

Australia's LNG projects commissioned between 2008 and 2020 account for more than 25 percent of global growth in LNG capacity over this period. Once all projects currently under construction are in operation, Australia is set to have the world's largest installed LNG base, at 86 mtpa (Exhibit 2). By 2020, the three other largest players will be Qatar (with 78 mtpa), the US (70 mtpa) and Malaysia (32 mtpa).[1]

Exhibit 2



Australia is expected to become one of the global top ten gas producers

With all projects in operation, Australia is on track to become the seventh largest gas producer globally, after the US, Russia, Iran, Canada, Qatar and China.[2] Australia's projected gas production in 2020 would be sufficient to fulfil the electricity needs of more than 250 million people.[3]

LNG exports are likely to represent more than 60 percent of Australia's total hydrocarbon production (gas and liquids). Australia's hydrocarbon production will be similar in size to two regions with thriving service sectors, the North Sea and the Gulf of Mexico (Exhibit 3). As early as 2020, Australia's hydrocarbon production is projected to have overtaken that of the Gulf of Mexico, which for years has been the most prolific basin in the US.

1 McKinsey analysis based on Energy Insights, press search and International Gas Union, *World LNG paper - 2015 Edition*

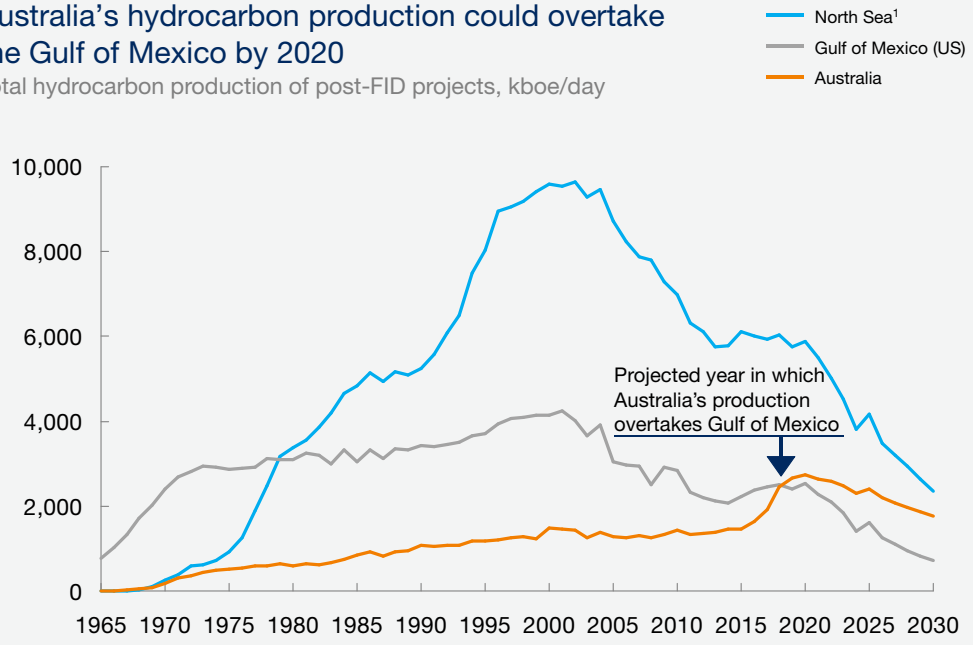
2 Rystad Energy

3 Based on global electricity consumption of 3,026 kWh per capita (EIA Key World Statistics) and a gas-to-power efficiency of 60 percent

Exhibit 3

Australia's hydrocarbon production could overtake the Gulf of Mexico by 2020

Total hydrocarbon production of post-FID projects, kboe/day



1 Total offshore production from Denmark, Netherlands, Norway, United Kingdom
SOURCE: Rystad Energy

LNG assets now in place are technologically advanced

Australia's LNG projects are among the largest integrated projects in the world. For example, Gorgon in Western Australia includes one of the world's largest subsea gathering systems and the largest CO_2 injection facility in the world. Ichthys will have the largest central processing facility with a semi-submersible platform. Prelude will become the world's first large-scale floating liquefied natural gas platform, and the largest offshore facility ever built of its kind. In the East, the three Queensland coal seam gas to LNG projects are among the first in the world.[4]

4 Websites Chevron, GE, INPEX, Shell

Gladstone LNG. Photo courtesy of Santos.

2. The benefits of LNG operations

LNG is likely to remain an important contributor to Australia's regional and national economies, generating high quality employment opportunities and significant GDP

As a result of gas production and LNG-related activities, the economies of Queensland, the Northern Territory and Western Australia have been transformed. In Queensland, LNG developments over the past 5 years have contributed billions of dollars to regional economies. They have resulted in direct employment opportunities, the development of skills and capabilities, investment in regional transport infrastructure, and the development of community and social infrastructure.[5]

Natural gas has long been relevant to local development. It has provided energy at a competitive price for mining and for the transformation of raw ore into a saleable product. Beyond this impact, an ecosystem of companies dedicated to serving the industry has grown in Perth, Brisbane and regional centres. Over 50 internationally recognised LNG-related service companies have offices in Australia. Many community, infrastructure and environmental improvements have taken place in Broome, Darwin, Karratha, Roma and other locations.

LNG operations can deliver wide-ranging employment and economic benefits

The operations phase of LNG facilities is expected to last for over 30 years, with recurring annual operation expenditures of A$8 billion to A$9 billion. These expenditures include manpower, logistics, maintenance, purchase of fuel and chemicals, licence fees, and well workovers associated with existing reservoir zones. In addition, average annual capital expenditures of A$6 billion will be required from 2020 to 2030. These include exploration, and the development of upstream reserves, liquefaction, storage and loading facilities.[6]

Employment benefits

The expenditures related to the confirmed 21 LNG trains are estimated to sustain a base of 55,000 to 65,000 jobs in the LNG industry and its supply chain (Exhibit 4).[7] Around 10,000 of these jobs would be directly in production, operations and maintenance of the LNG plants. Of those jobs, 3,000 jobs are expected to be filled by the service sector, with the remaining 7,000 jobs filled by operator staff.[8] To illustrate the type of employment in a typical LNG project, Box 1 provides an overview of a conventional and a coal seam gas project with a single LNG train.

5 Office of the Chief Economist, *Review of the socioeconomic impacts of coal seam gas in Queensland*, 2015; Santos, *GLNG Social Impact Management Plan*; QGC Social Impact Management Plan; APLNG Gas Stream, Feb 2014

6 McKinsey analysis based on Wood Mackenzie with an exchange rate of A$ versus US$ of 1.28

7 Estimates using multiplier analysis on the industry's projected capital and operation expenditures. Multipliers based on the World Input-Output Database

8 Estimates based on bottom-up analysis of illustrative projects

Adding to the 7,000 jobs in direct production and operations, operators and their joint venture partners are expected to employ an additional 5,000 to 8,000 people in their headquarters for managerial and technical functions supporting subsea development, brownfield modifications and turnarounds.[9] As a result, the total number of jobs at operators and their joint venture partners is estimated to be 12,000 to 15,000 (Exhibit 4).

To support this, the local service sector would need to fill an estimated 25,000 to 30,000 jobs, which includes 3,000 jobs in direct production and operations. The remainder would primarily support LNG operations, but could also provide services to other oil and gas production. Chapters 3 and 4 outline how more ambitious growth of the oil and gas service sector could increase its size to 45,000 jobs. Further employment in the industry's and service sector's supply chain, such as the provision of chemicals and kerosene, could generate 18,000 to 20,000 jobs.

Jobs in the oil and gas sector are typically well paid. In the fiscal year 2013-2014, the average annual salary in the oil and gas extraction industry in Australia was the highest of all sectors, peaking at A$200,000 per employee, four times the national average.[10] Wages are expected to moderate during the operations phase, however international examples show that a differential continues to exist into more mature phases of the industry. In Norway, the UK and Houston, wages in the oil and gas industry remain at least 50 percent higher than national and regional averages.[11]

Oil and gas jobs are typically long term and require above average technical expertise. As plants are expected to operate at a minimum technical life of 30 years, most jobs would have a similar life span. Qualifications count – oil and gas industry employees typically have higher levels of education than employees in other sectors. Fifty-four percent of employees have at least a diploma or an advanced diploma, against 37 percent in the total workforce.[12]

Economic benefits

Analysis suggests that throughout the 2020s and beyond, the LNG industry could add up to A$30 billion to Australia's GDP, equal to around 2 percent.[13] This includes the industry's direct value add, and the effect of increased consumption and government spending. In terms of exports, LNG contributed A$17 billion export value in 2015 and, depending on realised prices, is expected to contribute up to A$55 billion in exports in 2020, rivalling iron ore as the largest commodity export product.[14, 15]

9 Estimates based on relative headquarter size of sample operators

10 Australian Bureau of Statistics, Industry employment and wages and salary 2013-14

11 UK Office of National Statistics, Statistics Norway, Moody's, OANDA

12 Australian Bureau of Statistics, Census 2011

13 Estimates using multiplier analysis on the industry's projected capital and operational spend. and projected government revenues at a Brent oil price of US$65 per barrel in 2020. Multipliers based on the World Input-Output Database. Percentage of GDP calculated using OECD outlook for Australian GDP

14 Australian Bureau of Statistics, Merchandise Exports

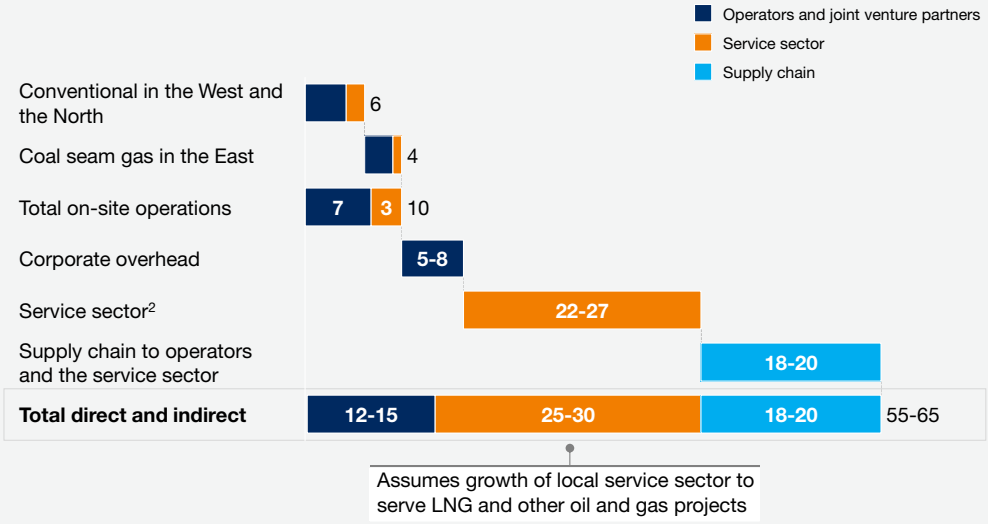
15 Estimates based on World Bank outlooks on commodity prices (US$11 per mmbtu Japan LNG and US$51 per dry metric ton), LNG volumes based on projected nameplate capacity at 90 percent utilisation and iron ore export volume forecast from BREE

Once projects have reached their full production potential after 2020, at a Brent oil price of US$65 per barrel, annual government revenues from LNG could equal A$10 billion.[16] This number is highly sensitive to commodity prices, which since 2008 have proven particularly volatile.

Exhibit 4

LNG operations could sustain up to 65,000 jobs in the industry and its supply chain, with a service sector of up to 30,000 jobs

Thousand full time equivalent (FTE), average 2020–30



1 Accounting for economies of scale for multiple trains
2 Excluding ~3,000 service sector jobs in on-site operations
SOURCE: McKinsey Global Institute; World Input-Output Database; Industry data; Expert interviews

16 McKinsey analysis based on Wood Mackenzie and a Brent oil price of US$65 per barrel in 2020 and 2 percent annual increase afterwards. Government revenues stated include federal and state taxes, levies and royalties, as well as corporate income tax of joint ventures

Box 1: Examples of LNG operations

A conventional project with a single LNG train is expected to generate an average of 500 to 600 jobs in production, operations and maintenance. Economies of scale would apply for multi-train projects such as the North West Shelf and Gorgon.

- *Central Processing Facility:* Receives gas from a number of wells connected via a flowline and makes the gas suitable for transmission onshore. It extracts condensate and removes impurities. Operations can be unmanned or manned, and may work in fly-in fly-out shifts.
- *Floating production storage and offloading:* Processes and stores condensate and offloads it to carriers. It is only required where condensate production is in sufficiently large quantities to require separate processing.
- *Onshore LNG terminal:* Refrigerates gas to minus 160°C to liquefy, with volume-reduction by a factor of 600. The terminal includes utilities, a jetty and a supply base for offshore.
- *Rotary wing:* Pilots and technical support are required to support operations by transporting crews and materials, and to assist in emergencies.
- *In-field support vessels:* A single train project could have up to three types of in-field support vessels. Tugboats assist mooring and unmooring of LNG and condensate carriers, provide emergency response, HSE watch and security patrols. Other vessels transport food and spare parts to the offshore platforms.
- *Central functions:* Each LNG project requires dedicated management and functional support to oversee operations, ensure compliance, facilitate procurement and provide other functional support, such as IT, HR and Finance.

A conventional project with a single LNG train would employ 500 to 600 FTE in direct operations, excluding drilling campaigns

FTE per typical 1-train conventional LNG project

		x FTE
1	**Central Processing Facility**[1] ▪ Production and operation ▪ 25-40 FTE per shift	50–80
2	**Floating Production, Storage and Offloading Facility** ▪ Operations and maintenance	50–60
3	**In-field support vessels** ▪ 3 vessels ▪ 2 crews per vessel	40–70
4	**Rotary wing** ▪ 3 aircraft, 2 crews each ▪ On-shore maintenance crew	20–30
5	**LNG terminal** ▪ LNG plant operations in 100 FTE shifts ▪ Core supply base of 40-50 FTE	240–250
6	**Central functions** ▪ Contracting, procurement and commercial staff up to 30 FTE ▪ HSSE staff of 20 FTE ▪ Engineering support staff of 35 FTE ▪ Project functions[2] up to 25 FTE	100–110
	Total	500–600

1 Only 8-12 FTE if unmanned
2 Project functions include IT, Legal, HR, Finance

(Box 1 continued)

For most elements above, projects with multiple trains would benefit from significant economies of scale.

Coal seam gas operations. The geology of coal seam gas formations requires many more wells to be drilled compared to conventional LNG operations, due to the lower production rate per well and shorter lifetime.

A coal seam gas project with a single LNG train provides 700 to 900 jobs in operations, 200 to 300 more jobs than a conventional project with a single train, due to more intense well drilling and maintenance. Additional jobs are dedicated to reservoir monitoring and analysis, well maintenance, and drilling.

A coal seam gas project with a single LNG train would employ 700 to 900 FTE in direct operations including drilling

FTE per typical 1-train unconventional LNG project

	x FTE
1 **In-field operations** ▪ Well and reservoir management[1] ▪ Drilling ▪ In-field logistics	250-350[1]
2 **LNG terminal** ▪ Production ▪ Maintenance ▪ Offloading	350–430
3 **Central functions** ▪ Contracting, procurement and commercial staff up to 40 FTE ▪ HSSE of 20 FTE ▪ Engineering support staff up to 35 FTE ▪ Project functions[2] up to 25 FTE	100–120
Total	700–900

1 Dependent on wells distribution and reservoir type; subject to emerging automation technologies
2 Project functions include IT, Legal, HR, Finance

Sources: Expert interviews

Gladstone LNG. Photo courtesy of Santos.

3. A local service sector to enhance competitiveness

Expected low oil and gas prices will put revenue pressure on Australian LNG operators; a high performing service sector is part of the solution

The productivity imperative has increased in urgency

With existing and projected gas prices, revenues for LNG operators are under pressure. This is expected to continue until 2022, based on global LNG oversupply.[17] The resulting competitive market will require Australian LNG operators to outperform on reliability and productivity in operations, as many competitors enjoy structural advantages due to geological and other factors beyond the control of local operators.[18]

A high performing local service sector is essential to industry

Australia has a strong reputation for reliable operations, built largely on the track record of the North West Shelf venture. The industry will now need to maintain this reputation over a much larger installed base. At the same time, there is a need to continuously innovate to support ongoing productivity improvements.

A thriving local service sector could support the core of this dual mission: top reliability and productivity. First, it needs to grow to serve an installed base of significantly greater proportions. Second, a sophisticated local service sector would mean faster response times to the needs of the LNG industry, with the best available know-how. Third, an expanded and enhanced local service sector would provide a competitive base to foster innovation.

An example of innovation requiring a high performing local service sector is the application of digital technology and advanced analytics. McKinsey's Oil and Gas Practice estimates that digital technology and services in upstream could potentially reduce capital expenditures by 7 to 14 percent, and operational expenditures by 3 to 5 percent, through advanced analytics in predictive maintenance, digitised procurement processes and remote tracking and management of workforce and assets.[19] However, to develop and commercialise such technologies and services, a rich and wide local network of companies will be required in areas such as advanced analytics and software development.

Efforts have already been made to drive innovation. For example, National Energy Resources Australia (NERA) aims at driving sector competitiveness and productivity through collaboration, innovation and knowledge sharing.[20] But much more could be done.

17 Energy Insights

18 McKinsey, *Extending the LNG Boom: Improving Australian LNG productivity and competitiveness*, May 2013

19 McKinsey study on Digital Opportunities in Oil and Gas (to be published in 2016)

20 NERA website

A strong local service sector would bring additional employment benefits

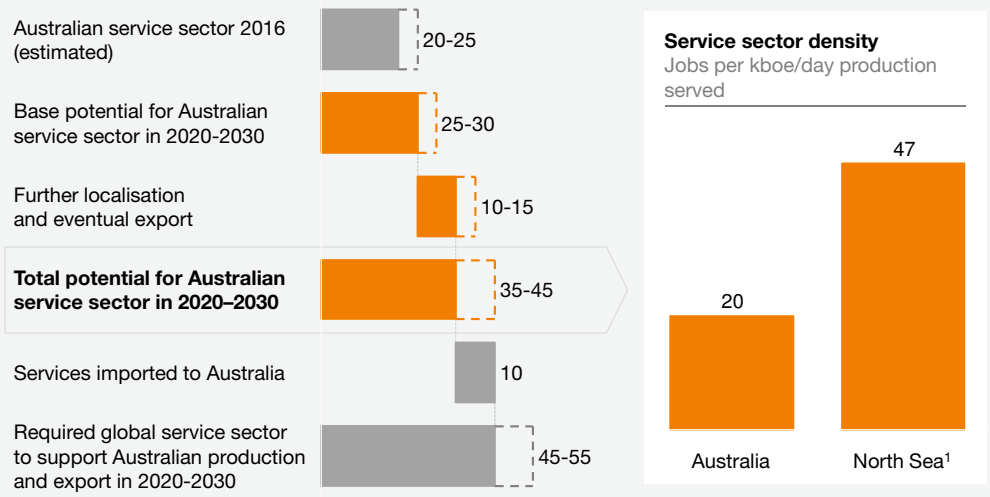
The size of the Australian oil and gas service sector today is estimated at 20,000 to 25,000 jobs.[21] International firms with operations in Australia, such as GE Oil and Gas, Halliburton and Intertek, provide about 70 percent of these jobs. Australian companies like Monadelphous and Easternwell, and several smaller niche companies like Intrepid Geophysics and ERGT, have developed to serve the local market. Many are based in Perth or Brisbane.

Chapter 2 outlined the base potential for the service sector during the operations phase at 25,000 to 30,000 jobs. These numbers assume that Australia's LNG industry would rely on the import of services from the global market place for a large number of services. However, potential exists to further grow the local service sector, with 10,000 to 15,000 jobs to reach 35,000 to 45,000 jobs (Exhibit 5).[22] This assumes further localisation and eventual export potential for services for which Australia could be competitive. The annual export value of this service sector could be up to A$1 billion.[23] Australia would continue to import services for which localisation in Australia is unlikely, such as the fabrication of commodity products. This import of these services is equivalent to approximately 10,000 jobs.

Exhibit 5

Growing Australia's service sector to 45,000 jobs in 2020–30 would still result in a significantly less dense service sector than the North Sea

Service sector size; thousand full-time jobs, average 2020–30



1 Norway, UK
SOURCE: Rystad Energy; Expert Interviews

21 Estimates based on presence of major and local oilfield service companies in Australia

22 Estimates based on projected spend per segment in UK and Australia (Rystad Energy) and size of the UK service sector

23 Estimates for maximum localisation potential of each segment; size of segments based on Rystad Energy

Taking into account the relative size of the service sectors in the North Sea, a local service sector of 35,000 to 45,000 jobs is a sound ambition for Australia. For every thousand barrels of oil equivalent produced per day, the local service sector would employ 20 people. This is less than half the density of the North Sea's service sector, which employs 47 people per thousand barrels produced per day (Exhibit 5). The lower density for Australia is due to the comparatively young age and larger scale of its assets, versus the North Sea, and higher exports from North Sea hubs than assumed for Australia.

Timing is of the essence in the endeavour to establish an enlarged Australian service sector. There is currently a significant pool of highly skilled companies and associated workforce present in Australia, attracted by the construction boom. As the remaining LNG projects are commissioned in the next 2 to 3 years, the service sector may lose many of these companies and skilled workers if they are not actively retained. Moreover, Australia's regional competitors may acquire an unsurpassable head start.

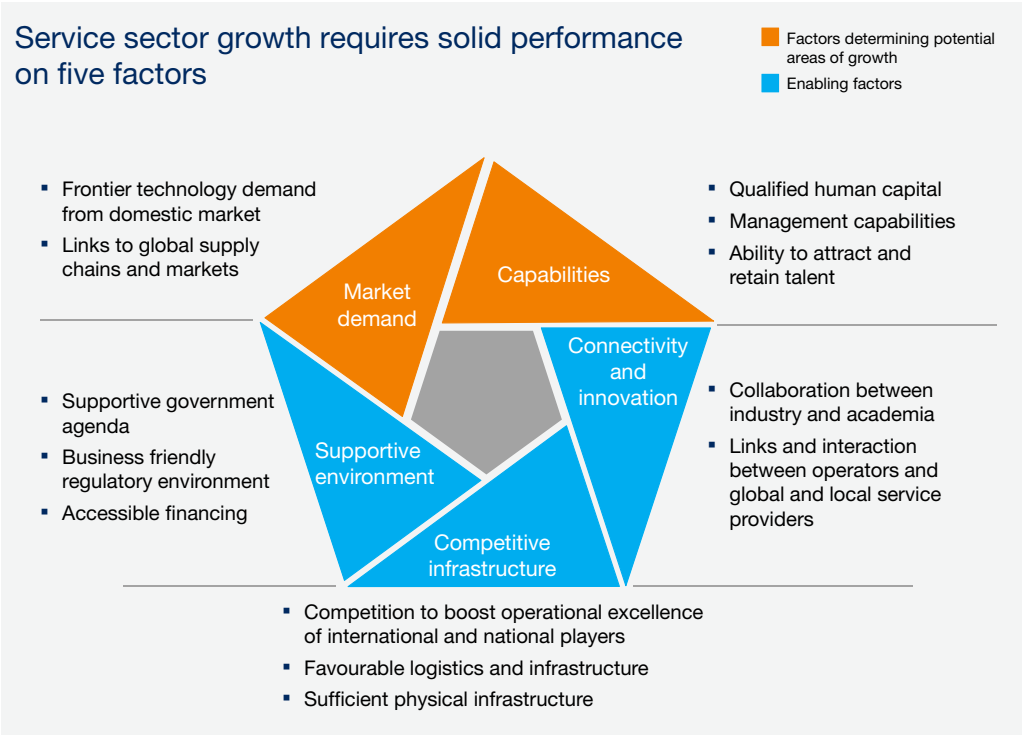
4. The most promising service sector segments

Australia's capabilities, combined with the LNG industry's demand for services, indicate the most promising growth segments

Five factors drive and enable service sector focus and growth

Evaluation of the development of service sectors, including the UK and Norway, suggests five factors are important to foster service sector growth (Exhibit 6):

Exhibit 6



- **Market demand.** The local demand for services forms the basis for service sector development. This holds particularly true if exploration and production of domestic oil and gas requires development and deployment of frontier technologies. Export of these services, once developed, can reinforce the local market; but on its own, export is unlikely to form the basis of service sector development.

- **Capabilities.** Local existing technical and managerial capabilities, including those from other industries, can form the foundation for local development of high quality services in response to market demand.

- **Connectivity and innovation.** Strong collaboration and connectivity within the industry, as well as between industry and research institutions, enables hubs to develop, share and deploy innovations, and push the frontier of productivity.

- **Competitive infrastructure.** Favourable logistics and infrastructure, and healthy competition, provide a basis for a cost effective service sector.
- **Supportive environment.** A stable and supportive regulatory environment and accessible financing facilitate long-term investments in service development.

The first two factors above (market demand and capabilities) determine which service segments could be particular areas of growth. The other three factors (connectivity and innovation, competitive infrastructure and a supportive environment) are enabling factors, which describe the conditions needed for the high-potential service segments to grow. Box 2 outlines an example of how Norway grew its local service sector successfully as its oil and gas operations developed.

Box 2: Development of the service sector in Norway

The specific story of the development of the oil and gas service sector in Norway is instructive. First came strong local demand, stemming from the need to address the challenges of exploring the continental shelf. In response to this demand, the emerging service sector built on capabilities from other industries to develop new capabilities, in particular topside construction, subsea technology and off-shore support.

For example, Aker built on its capabilities in shipbuilding and engineering to convert offshore rigs to operate in the harsh conditions of the North Sea. It then started to develop its own rigs to serve deepwater fields and difficult reservoirs, including the Aker H-3 self-propelled semi-submersible rigs. Today Aker Solutions is a global services company with a presence in 20 countries.

This organic development of Norway as a hub, and Aker Solutions as an example, was grounded in favourable conditions for service sector growth, in particular a supportive environment and high connectivity and innovation. The Norwegian government adopted the 'Ten Oil Commandments' which affirmed oil and gas as a strategic growth sector. This was underpinned, among other things, by a supportive fiscal regime, tax incentives for R&D and an award scheme for R&D investments that provided companies an advantage during licensing. In 1997, the industry and government jointly established INTSOK, a vehicle to promote Norwegian offshore service capabilities to international markets.

On top of the innovations by individual companies, high connectivity and innovation was demonstrated through multiple state research programs with private player involvement. The national oil company, Statoil, granted service companies the rights of international use of intellectual property developed for Statoil. As a result, service companies were attracted to working with Statoil, and could export new technologies, once proven, to the rest of the industry.

This chapter focuses on the first two factors that determine the most promising service segments for Australia. For the remaining three factors Australia has a good starting point, but there remain challenges to overcome. These include the need for increased collaboration between industry players, and, according to the World Economic Forum's Global Competitiveness Index, a regulatory burden higher than in Singapore and Malaysia.[24] Australia will also face inherent challenges, such as the dispersed nature of operations

24 World Economic Forum, *Global Competitiveness Index 2015-16*

across the country and high labour costs compared to the rest of the Asia-Pacific region. While these three enabling factors are not discussed in further depth in this paper, they have been taken into account in the recommendations.

Australia's LNG industry can draw on emerging and existing capabilities

As highlighted in our 2013 paper, Australia has a less favourable starting point than some of its competitors, given its scale, geology, remoteness and high labour costs.[25] Successfully managing under these constraints has given the Australian oil and gas industry unique strengths, which it can draw upon for further growth:

- **Building and operating large and complex assets.** Most projects have set engineering records in design or construction, for example in the size of assets or the concept used.

- **Dealing with tough meteorological and geological conditions.** Projects in the Northern Territory and Western Australia must be prepared for the probability of cyclonic weather and manage challenging sea floor conditions. Coal seam gas projects in Queensland are among the first large scale coal seam gas to LNG operations globally, and as such require the operators to be first-movers in developing technically and commercially viable technology and practices.

- **Operating in remote locations.** Most of Australia's LNG projects require long-distance supply lines, leading to challenges in both supply chain management and cost. In response, both Australia's oil and gas sector and mining sector have developed good capabilities in the management of remote operations.

- **Optimising manning levels.** Australia's labour costs are higher than those of almost all competitors, sometimes significantly so. Developing and adopting innovative processes and technologies to reduce the impact of labour costs and increase labour productivity remain important. Australia has successfully developed high productivity work execution methods, remote operations, and automation. These strengths represent a source of competitive advantage going forward.

Experience in providing services under these conditions could provide the service sector with world-leading capabilities and subsequently, export opportunities. The mining service sector in Australia offers a useful example of how Australia's strong skill base could be the basis for successful export. The sector has developed strong capabilities in producing and operating in remote locations and under technically challenging conditions. Mining equipment, technology and services provide export potential around A$15 billion (Box 3).

To develop new capabilities in the service sector, Australia's high-quality education system for key skills like engineering and trades provides a strong foundation. Seven of its universities are ranked as global top 100 engineering and technology universities. Globally, industry players refer to Australia as a country with well regarded talent.[26]

25 McKinsey, *Extending the LNG Boom: Improving Australian LNG productivity and competitiveness*, May 2013

26 Times Higher Education World University Rankings, *2015-16 Engineering and Technology Top 100*

Box 3: Growing service sector exports in the mining sector

Australia is a leader in the development and provision of mining equipment, technology and services (METS). The drivers of innovation and development originate from the unique Australian mining conditions, including the demand for improved safety and greater productivity. A survey by Austmine in 2013 estimated METS-related exports at over A$15 billion, primarily from specialist engineering services, information technology, contract operations and services (such as supply and servicing of equipment and components).

The success of METS is underpinned by significant investments in research and development of about A$2.8 billion annually. This includes R&D at the organisational level, across government agencies, in universities and across industry. Education and training also contributes to METS competitiveness.

To promote the commercialisation of Australia's METS expertise globally, the sector has established the Australian Mining Equipment and Services Export Association.

Furthermore, Australia has a strong academic standing and a sound research track record. In the Global Competitiveness Index 2015, the quality of Australia's scientific research institutions scores 5.8 out of 7, higher than, for example, Norway and Singapore. As to availability of research and training services, Australia scores as high as Norway and the UK.[27] In geosciences, Australia's academic excellence is widely recognised.[28]

Market demand and capabilities guide which segments have further localisation potential

The particular areas of growth for Australia's local service sector could be built around local demand and leverage the competitive advantage that Australia's emerging and existing capabilities offer. Exhibit 7 provides an overview of those service sector segments for which local demand is expected to be substantial, and where, given Australia's relative capabilities, there is potential for further localisation. A description of each column follows:

- **Australia's market demand.** Average annual expenditure by Australia's industry in 2020-2030 is used as an indicator for domestic market demand. For certain segments, such as geotechnical services, annual expenditure is not the most important indicator as expenditure does not reflect the potential revenue and productivity benefits of these services.

- **Capability requirement.** This is an assessment of the extent to which a workforce with high capabilities is required. The assumption is that a high capability requirement is in Australia's favour, given the country's strong capability base and a lower sensitivity to relatively high labour costs.

- **Localisation potential.** This is an assessment of the degree to which, given Australia's relative capabilities, there could be a business rationale to largely fulfil domestic demand from within Australia, rather than importing from overseas.

27 World Economic Forum, *Global Competitiveness Index 2015-16*

28 QS World University Rankings by Subject 2015 - Earth and Marine Sciences

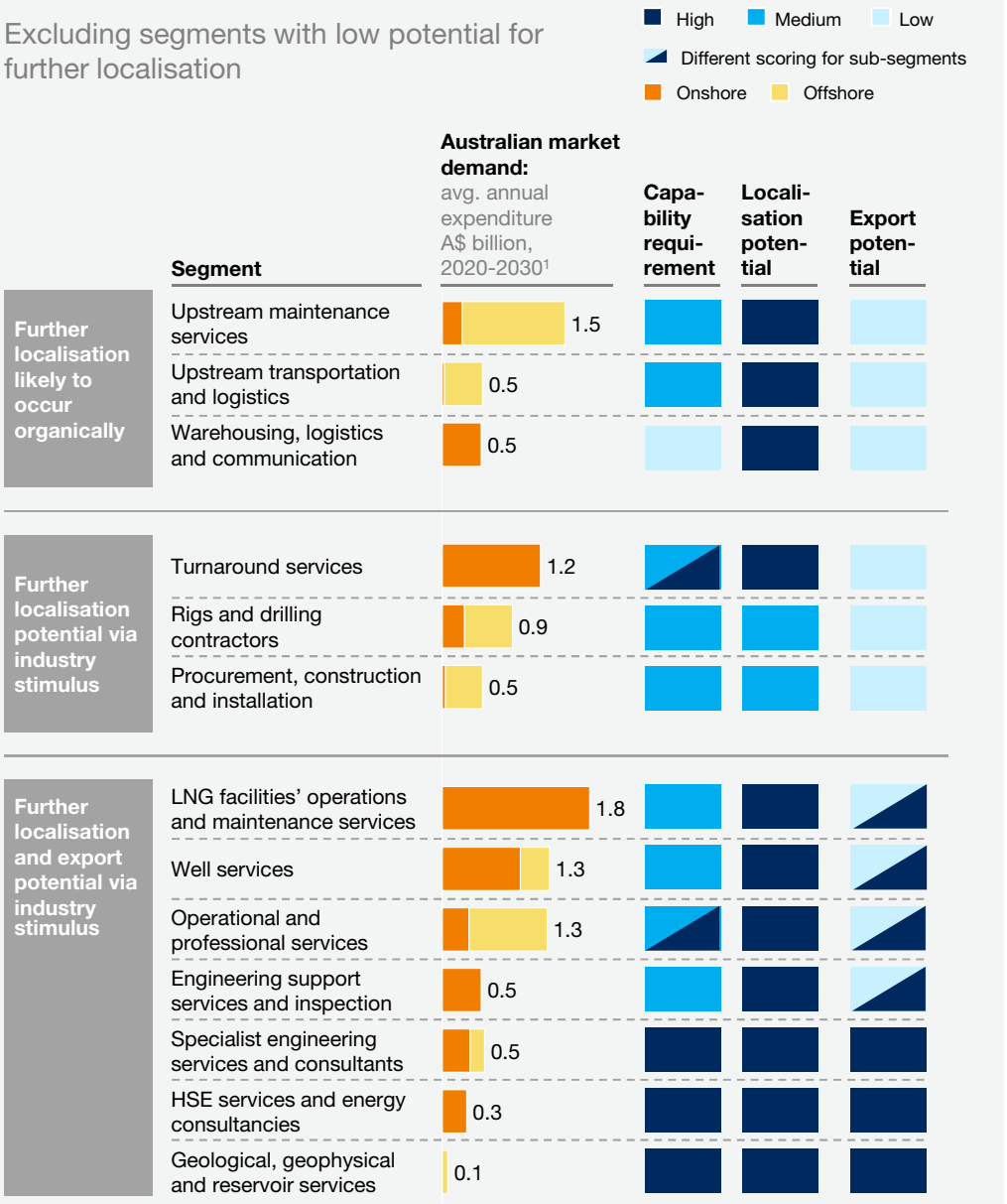
- **Export potential.** This is an assessment of the extent to which Australia's capabilities, relative to global capabilities, could form the basis to export services to other regions in response to global demand.

Exhibit 7 excludes segments for which the global market place is relatively well established, which would make further localisation of these services in Australia unlikely.

Exhibit 7

Overview of segments with potential for further localisation and export

Excluding segments with low potential for further localisation



1 Post-FID projects only

SOURCE: Rystad Energy; Expert interviews

Not all segments shown in Exhibit 7 will require the same degree of stimulation to further localise. Therefore, the segments have been further grouped into three categories. In the first category are segments for which localisation is likely to occur organically, without much concerted effort. For service segments in the second category, additional localisation potential would require industry stimulus to develop. For service segments in the third category, industry stimulus is also essential and could open up the possibility for export.

Segments where localisation is likely to occur organically

The top section of Exhibit 7 displays segments, such as warehousing, logistics and recruitment, for which a local service sector is likely to occur more organically as industry develops. These are mainly services that require a physical presence. Nonetheless, industry could enable further localisation, for example by providing a transparent pipeline of work for service companies.

Segments with further localisation potential via industry stimulus

The middle section of Exhibit 7 displays segments that may require industry stimulus to achieve further localisation. While LNG operations and the economy would benefit from increased localisation, without coordinated industry stimulus operators are likely to continue to rely on the global service sector to provide part of these services. These segments include:

- **Turnaround services.** Turnarounds occur periodically, but require a large workforce. Without coordination in timing, these labour resources would need to be sourced internationally if turnarounds significantly overlap. Conversely, developing a world class pool of experienced turnaround labour could become a source of competitive advantage for Australia.

- **Rigs and drilling contractors, in particular onshore.** Land rigs tend to be locally owned and provided. Offshore rigs operate in a global market but are costly to move between regions so have the potential to be locally provided.

- **Procurement, construction and installation services for brownfield facilities.** Although procurement and construction are increasingly becoming globally provided, installation services need to be provided locally. Therefore, there is potential for local service growth if the required skills can be developed at a competitive cost.

Segments with further localisation and export potential

The bottom section of Exhibit 7 displays segments that, with industry stimulus, have further localisation potential and could offer export opportunities. These segments would build on Australia's capabilities, and on the intellectual property that arises from innovations in response to domestic demand. In addition, they would build on Australia's relative proximity to new developments and growing markets, such as South East Asia. These segments include:

- **Operation and maintenance of LNG facilities.** Australia is set to operate and maintain technically advanced assets over their 30 year lifespan. The practices and skills associated with operating these services efficiently can form the basis for further localisation and export opportunities.

- **Well services.** Well surveillance and reservoir optimisation services in Australia need to be world class to maximise productivity. These capabilities could be transferred to, for example, potential future coal seam gas developments in China.

- **Remote operational services.** Building on the capability base already present in the mining and LNG industries, Australian services could increasingly support oil and gas companies elsewhere with similar remoteness challenges, for example, in East and West Africa.

- **Engineering support and inspection services.** Particular areas that provide export potential include remote and unmanned inspection capabilities, for example using drones, as well as rotatable asset management services.

- **Specialist engineering services.** High labour costs and skills make Australia's service sector a natural first mover in technology-based approaches. For example, production optimisation via advanced analytics can help maximise competitiveness of local LNG assets. In addition, floating LNG and long subsea tiebacks create demand for specific specialist services, such as mooring analysis for floating LNG and well/pipeline surveillance for subsea tiebacks.

- **HSE services.** Australia's oil and gas industry and mining industry have a reputation as global leaders in HSE. The export potential arises from an increased demand for operational safety in countries with less mature safety practices.

- **Geotechnical and geophysical services.** The complex geological features of Australian operations provide an ideal testing ground for advanced geotechnics and geophysics. These services could build on Australia's academic excellence in geosciences.[29]

29 QS World University Rankings by Subject 2015 - Earth and Marine Sciences

There is competition for the role of service sector hub

Singapore, Malaysia and several Middle Eastern countries are also prioritising the development of their service sectors. Malaysia already has a sizable oil and gas service sector, mainly focused on manufacturing and manpower services.[30] This reflects local market strengths. Singapore's service sector revolves mainly around exploration and evaluation, marine construction, conversion and servicing, again reflecting local strengths. Australia's much larger installed LNG base and high capabilities could allow it to create a competitive service sector.

In terms of size, the Middle East could rival Australia as a service hub supporting LNG operations, with 78 mtpa installed in Qatar, and proximity to planned and speculative East African and Iranian LNG projects. Oilfield services possess a significant market in Qatar and the other Gulf states. Large oilfield services players typically import capabilities from outside the region to complement a local workforce employed in local entities. However, that trend may be shifting, as indicated by the opening of Schlumberger's Middle East Center for Reliability and Efficiency (dedicated to advanced maintenance).[31]

30 Malaysia Petroleum Resource Corporation, *MPRC 100 2014*

31 Press releases

5. Realising the potential for the service sector

Actions in five areas could help the development of a strong and thriving local service sector

The size of the prize of actively developing Australia's service sector is big: up to 15,000 additional high quality, long-term jobs, up to A$1 billion per annum in export potential, and a more innovative LNG industry. This is likely achievable with appropriate actions and support from industry and government.

How to make it happen

Three complementary actions supported by two enabling measures would support accelerated growth of Australia's service sector (Exhibit 8).

Exhibit 8

Three actions and two enabling measures would support accelerated growth of the Australian service sector

Actions to consider

1. Make demand for services more transparent

More stable and transparent demand could help attract service companies to set up or expand their presence in Australia. Offering a complete picture of the potential pipeline of work relevant to each segment of the service sector increases transparency. While demand from each individual operator might not unlock sufficient value to justify the establishment of a new company in Australia's service sector, demand from the industry as a whole may do so. Similarly, synchronisation might give service providers a more stable demand profile, and thus avoid peaks and troughs.

Across Australia efforts are already under way in this area. However, the speed of implementation could be increased significantly, and the level of ambition in many areas remains far below what is already common practice in the North Sea and Gulf of Mexico. For example, some North Sea operators, led by Premier Oil, are in discussions to move

beyond demand synchronisation, potentially consolidating parts of their operations, such as procurement, logistics and finance.[32]

2. Create an 'open source', collaborative ecosystem around LNG operations

Innovation is supported by an environment with competitive pressure, the sharing of ideas, and the ability to test and improve new concepts continuously. To create such an environment, operators could set up a walled garden in which participants share anonymised data and best practices, for example, related to downtime reductions and efficiency improvements. Selective access could be provided to the service industry and academia in return for a commitment to invest in solutions to common issues. The goal would be to stimulate innovation at an ecosystem level, achieving more results, and faster, than operators could individually.

Norway implemented a system that went one step further. Statoil granted service companies the rights of international use of intellectual property developed for Statoil. As a result, service companies were attracted to working with Statoil, as they could test and prove new technology with them, and, when successful, export these to the rest of the industry.

A possible 'open source' set up would require careful design to comply with antitrust legislation. Regulators could lead this process with input from industry bodies, and could build a platform to enable sharing in a controlled environment under a code of conduct.

3. Co-invest in R&D in strategic topics that address Australian issues and have global relevance

Together, industry, government and universities could create centres of excellence around the strategic topics as listed in Chapter 4, such as specialist engineering and remote operations. These centres would deepen the competitiveness of the Australian LNG industry, and provide a platform for the export of services.

Operators and service providers could lead by selecting topics to focus on, and work with Australian research and education providers to co-invest. All parties could pledge and co-locate resources for R&D in physical centres of excellence. Academia could develop a stable stream of talent and knowledge for these centres of excellence through the development of supporting curricula and relevant PhD research. Governments could support these R&D centres through specific policies and fiscal incentives promoting R&D, as for example seen in Norway.

Such centres could build on existing initiatives, such as the Western Australia Energy Research Alliance (WA:ERA) and the recently established National Energy Resources Australia (NERA). These initiatives notwithstanding, collaboration in R&D between industry, universities and other research institutions could be further improved.

Enabling measures

4. Simplify and standardise to reduce barriers for local and global service companies

Further standardisation and simplification would make it easier and cheaper to serve Australian operators, thereby increasing the attractiveness to service providers.

32 *Financial Times*, North Sea explorers in talks to merge operations, March 6 2016

The industry could standardise and modularise technology and systems, adopt a common set of terms and conditions for standard contracts, and harmonise vendor qualification and training requirements. Regulators could adopt global standards where possible to allow easier import and export of equipment and people.

The UK and Norway provide examples of success in these areas. In the early 1990s, UK operators developed standardised working practices, contracting and equipment under the flag of CRINE, which reduced the costs of development by as much as 30 percent.[33] Much like CRINE, the Norwegian petroleum industry in 1994 introduced a set of industry standards, named NORSOK, to ensure safety and cost effectiveness.[34]

The government also has an important role to play by improving the ease of doing business in Australia. In the World Economic Forum's *Competitiveness Index 2015-16*, Australia's burden of government regulation scored 3.3 out of 7 versus 5.4 and 5.0 respectively for Singapore and Malaysia, which are potentially competing hubs.[35]

5. Continue to invest in talent

As the LNG industry transitions into the operations phase, people and skills related to construction will be absorbed into other industries, or will move overseas if they are not actively redeployed. This could erode the skills base for Australia's LNG sector and jeopardise its success.

Industry could identify which of the required skills are likely to be in short supply, either due to growth of demand or the retirement of existing staff. It could also support the development of a 'skills conversion matrix', which would identify skills from the construction phase that could be converted into skills needed during operations.

Governments as well as academia could support this by continuing to offer and promote more general skills like STEM and by developing relevant training programs based on the projected industry needs (for example, a degree in 'LNG engineering').[36] As an example, in 1977 the UK Government established an industry training board, today known as OPITO, to address skill gaps in the industry. In 1999, OPITO launched the first version of today's Oil and Gas Technical Apprentice Programme (OGTAP), which provides young talent the opportunity to take an apprenticeship in maintenance and production at participating oil and gas companies.[37]

Operators and the service sector could also jointly invest in training to re-skill existing talent, and develop new talent. A (conditional) commitment to a minimum number of hires based on projected labour needs could support individuals to make long-term career decisions.

33 Cost Reduction Initiative for the New Era, UK Department of Trade and Industry, *The Brown Book*

34 NORSOK website, www.standard.no

35 World Economic Forum, *Global Competitiveness Index 2015-16*

36 STEM: Science, technology, engineering and mathematics

37 Websites OPITO, OGTAP

Conclusion

Australia's LNG industry and economy could benefit from a larger and more vibrant service sector. There is a strong foundation to build on: the sheer scale of operations, the unique strengths resulting from the challenging conditions under which local industry operates, and its highly skilled workforce.

The prize is significant. With a vibrant service sector, Australia could become a world leader in LNG operations, with reliable plants that are leaders in the application of innovative technology and processes. Further, a competitive LNG service sector could deliver significant benefits to the Australian economy – potentially creating up to 45,000 jobs and up to A$1 billion per annum export potential from services.

Timing matters – the next 2 years are critical. After that period, the service sector may have lost many of the companies and skilled workers attracted by the construction boom, and Australia's regional competitors could have developed an unassailable lead as service hubs.

There is much work ahead to develop a strong and innovative Australian service sector, which can support the LNG industry for the decades to come. Collaboration between industry players, drawing in academia and government, is key to achieve this – all working together to agree the best way forward. The construction phase is reaching completion. It's now time to ensure the success of the upcoming 30 years of operations.

McKinsey Australia
April 2016

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