AUSTRALIA'S EXPERIENCE IN DEVELOPING AN LNG EXPORT INDUSTRY

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EXECUTIVE SUMMARY

Australia has been a major Liquefied Natural Gas (LNG) exporter in the Asia Pacific region for 25 years. The challenges, risks, and opportunities experienced by Australia's LNG industry, especially over the past decade, provide valuable insights for prospective investors, project proponents, and governments in other countries interested in developing LNG export facilities. Canada is one such country, with at least 18 LNG projects currently under proposal. Given that Canada and Australia share many similarities in legal and governmental structure, Canada can learn from some of the policy mechanisms that Australia developed to spur its industry and to overcome challenges. Furthermore, proposed Australian LNG export projects are competitors with Canadian counterparts. It is therefore important for Canadian government and industry to understand the factors that have impacted and continue to impact the development of Australia's LNG export industry.

Australia is now the world's third largest LNG exporter after Qatar and Malaysia. Later this decade, Australia is positioned to overtake both countries to become the world's largest LNG exporter. The development and expansion of the Australian LNG industry may be seen primarily as an outcome of fortuitous circumstances – the discovery of large commercial gas resources coinciding with strong demand within the Asia Pacific region. This view is simplistic. Underlying the growth in LNG exports has been a range of initiatives between Commonwealth, state, and territory governments on the one hand, and the oil and gas sector on the other. These initiatives have enhanced the competitiveness of the industry and removed or mitigated impediments to its growth.

However, several factors have contributed to concerns over future investments in Australian greenfield and brownfield LNG projects.[1] First, the supply side of the LNG export market is becoming increasingly competitive, as large amounts of supply could come online from the United States, Canada, East Africa, Qatar, Papua New Guinea, and Russia. Second, LNG markets globally are becoming more interconnected, and more flexible contract arrangements are being adopted. These factors are jointly placing downward pressure on prices at a time when the cost of projects is increasing. Third, while Australia justifiably maintains a reputation built up over the last 25 years as a low-risk, reliable, and experienced supplier of LNG, it is now developing an unfavourable reputation as a high-cost location for investment in LNG projects. This paper discusses how Australia is responding both to increasing cost pressures in the industry and to growing community concerns about natural gas extraction and export.

COST PRESSURES

The high capital cost of projects, high value of the Australian dollar relative to the US dollar since 2010, and scarcity of skilled labour in Australia have contributed to a lowering of the competitiveness of new Australian LNG plants.

The critical factors that determine cost competiveness of LNG plants are their scope and location. Australia's high cost base for LNG projects is attributed to their complexity, remote locations, and exposure to some of the highest construction costs in the world. While the industry acknowledges the threat from increased international competition, it regards the main challenge for new investment in LNG projects to be spiralling development costs that, it claims, are associated with regulation or "red tape," comparatively low labour productivity, and extreme weather events.

The consequences for investment in Australian LNG plants arising from the escalation in project costs are varied

[1] Greenfield project requires investment in building new facilities, whereas brownfield project consists of expanding previously existing capacity.

and include project cancellations and delays and major concept revisions. Australia's response to the escalation in LNG project costs has been to diminish cost drivers through engineering/technology solutions (namely floating LNG), labour productivity improvements, and changes to the regulatory regime.

A) FLOATING LIQUID NATURAL GAS

Floating Liquefied Natural Gas (FLNG) refers to offshore vessels that produce LNG. The LNG is supplied directly to carrier vessels for transportation to customers. FLNG is a response by the sector to excessively high land-based LNG project costs, especially as the facilities can be manufactured in locations outside of Australia, such as South Korea. All currently proposed projects in the west and northwest of Australia are FLNG. This technology allows proponents to: "de-risk" potential labour productivity issues in Australia; avoid costly infrastructure such as pipelines, harbour facilities and roads, as well as the decommissioning costs associated with an onshore facility; and sidestep the environmental conditions imposed on land-based plants. In addition, FLNG located outside of state waters may be able to circumvent potential domestic gas reservation requirements of Western Australia. The downside to the adoption of FLNG, from an Australian perspective, is the loss of potential employment from the construction and operation of a land-based plant.

B) ADDRESSING LABOUR COSTS, WORKPLACE RELATIONS, AND TRAINING

From an investor and industry perspective, project proponents need the ability to set wages and conditions as part of enterprise agreements that cover the entire project construction period. While the Australian Government has chosen not to change existing industrial relations arrangements, which include enterprise agreements that are limited to a maximum of four years, it is endeavouring to make amendments to the principal piece of legislation relating to them – the *Fair Work Act 2009*. The government is also launching a Productivity Commission inquiry into industrial relations that will entail a comprehensive and broad review of the laws relating to workplace relations. Despite these initiatives, there is general agreement that the industrial relations framework is not the sole cause of the decline in competitiveness of the LNG export sector. Delays in planning approvals, as well as planning, design, scheduling, and procurement problems are also recognised as key contributing factors.

The skills shortage in the oil and gas sector is expected to continue for future projects and the operation of current projects because of increased requirements for skills and labour for projects globally. Proponents of Australian projects have attempted to deal with the skills shortage by employing overseas skilled workers under temporary work visas and by utilizing fly-in, fly-out (FIFO) arrangements for workers living in other states and regions of Australia. The oil and gas industry is also responding to the skills shortage through various training initiatives.

C) IMPROVING REGULATION

The other major area for reducing project costs is through more efficient and effective regulations. The "red tape" involved in the various stages of an LNG project has been viewed by the industry as costly and is, in part, attributed to the federal system of government in Australia. The development, assessment, and approvals process for projects is considered by industry to be overly complex, inefficient, unpredictable, and duplicative, and has contributed to project delays and compliance costs. To respond to these concerns, the Australian Government is attempting to implement a "one-stop shop" initiative that will create a single environmental assessment and approval process for nationally protected matters. This follows the government's establishment of a single agency responsible for the regulation of petroleum activities in Commonwealth offshore waters.

COMMUNITY CONCERNS

A key risk for proponents of Australian LNG projects is whether they can both acquire and maintain a "social licence to operate." This is of particular relevance to onshore projects, especially CSG to LNG projects where thousands of gas wells need to be drilled. A social licence to operate is also important for offshore developments that require onshore facilities, especially those located on or nearby environmentally sensitive or valuable sites. Building trust with the community is a key element in securing progress in gas developments. Differences in experiences in Queensland and New South Wales show that if widespread community trust is lost or never obtained, gas projects will not happen.

CONCLUSION

If there is a general insight to be gained from Australia's experience in developing an LNG export industry, it is the need for ongoing collaboration between governments and industry. Such collaboration must not only ensure a competitive fiscal and regulatory regime, but also generate an adequate return to the resource owners, facilitate investment in projects, and meet community expectations about risks, safety, and fairness.

INTRODUCTION

Australia is a major Liquefied Natural Gas (LNG) exporter in the Asia Pacific region with 25 years of experience in the production and sale of LNG. The challenges, risks, and opportunities experienced by Australia, especially over the past decade, provide valuable insights for prospective investors, proponents, and governments in other countries interested in developing LNG export facilities. Canada is one such country, with at least 18 LNG projects currently under proposal. Given that Canada and Australia share many similarities in legal and governmental structure, Canada can learn from some of the policy mechanisms that Australia developed to spur its industry and to overcome challenges. Furthermore, proposed Australian LNG export projects compete with Canadian counterparts. It is therefore important for Canadian government and industry to understand the factors that have impacted and continue to impact the development of Australia's LNG export industry. In this report, we provide an overview of the developments in the Australian LNG industry and evaluate the challenges facing the sector, most notably a decline in competitiveness and an increase in risks.

This report is divided into two parts. First, it highlights key issues that have affected, and are affecting, the development of Australia's LNG industry. Second, it analyses the factors that may have contributed to cost increases for Australian LNG projects, the consequences of cost pressures, and what has been done to respond to these competitiveness challenges (Floating Liquid Natural Gas (FLNG), improving labour productivity, and improving regulation), and to growing community concerns about natural gas extraction and export. Information about Australia's gas resources and gas markets can be found in the appendices.

FACTORS DRIVING THE DEVELOPMENT OF AUSTRALIA'S LNG INDUSTRY

Australia's large endowment of natural gas resources and its proximity to major LNG demand centres in the Asia Pacific market has attracted large investments from international petroleum exploration and development companies and contracts for offtake from large LNG customers. Historically, the major gas fields for LNG production have been in the conventional gas basins of Carnarvon and Bonaparte, situated off Western Australia and the Northern Territory coasts, respectively, in the northwest of the continent. Australia first began commercially producing LNG for export in 1989, from a two-train 5 million tonnes per annum (mtpa) liquefaction plant located at Karratha in Western Australia. This followed the North West Shelf Joint Venture[2]'s discovery in the 1970s of significant quantities of gas and condensate reserves in the Carnarvon Basin off the northwest coast. Two major factors spurred the creation of an LNG export industry in Australia: strong demand from Asia and support from the Australian government.

2.1 STRONG LNG DEMAND FROM ASIA

Insights into the factors giving rise to the creation of an LNG export industry in Australia are provided by Jensen.[3] Adopting Jensen's account of the changing dynamics in the Atlantic and Asia Pacific LNG markets from the early to mid-1970s, the North West Shelf Joint Venture may be seen as a commercial response to slowing demand in the Atlantic market and growing demand in the Asia Pacific region. During the period prior to 1996, the Asia Pacific demand for LNG grew as Korea and Taiwan joined Japan as importers. Although the Atlantic market's demand rebounded and grew significantly after 1996, the growth in demand from customers in the Asia Pacific region was also strong and was primarily satisfied by four main suppliers in the region: Indonesia, Malaysia, Australia, and Brunei.[4] The North West Shelf Joint Venture's initial decision to invest in the Karratha facility was underpinned by long-term LNG sale agreements with eight foundation customers in Japan. The facility, which is operated by Woodside Energy, was progressively expanded to five trains in three stages in 1992, 2004, and 2008 to its current nameplate capacity of 16.3 mtpa as a result of commercial arrangements with customers in Japan, South Korea, and China.[5]

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[2] North West Shelf Venture is Australia's largest resource development project based in Pilbara region of Western Australia where six companies (BP Developments Australia Ltd., Chevron Australia Pty Ltd, Japan Australia LNG (MIMI) Pty Ltd., Shell Development (Australia) Ltd., BHP Petroleum (North West Shelf) Pty Ltd. and Woodside Energy Ltd.) hold an equal share of the future gas sales.

[3] J.T. Jensen, *The Development of a Global LNG Market: Is it Likely? If so, When?* (Oxford, UK: Oxford Institute for Energy Studies/Alden Press, 2004), pp. 7–10.

[4] Ibid., p. 8.

[5] Woodside, "North West Shelf Project". http://www.woodside.com.au/Our-Business/North-West-Shelf/Pages/default.aspx.; Chevron Australia, "North West Shelf Venture". 2009. http://www.chevronaustralia.com/docs/default-source/publications/nwsv_6-page_brochure_updated_february_2009.pdf?sfvrsn=0

Table 1. Australian LNG projects operational as of September 2014

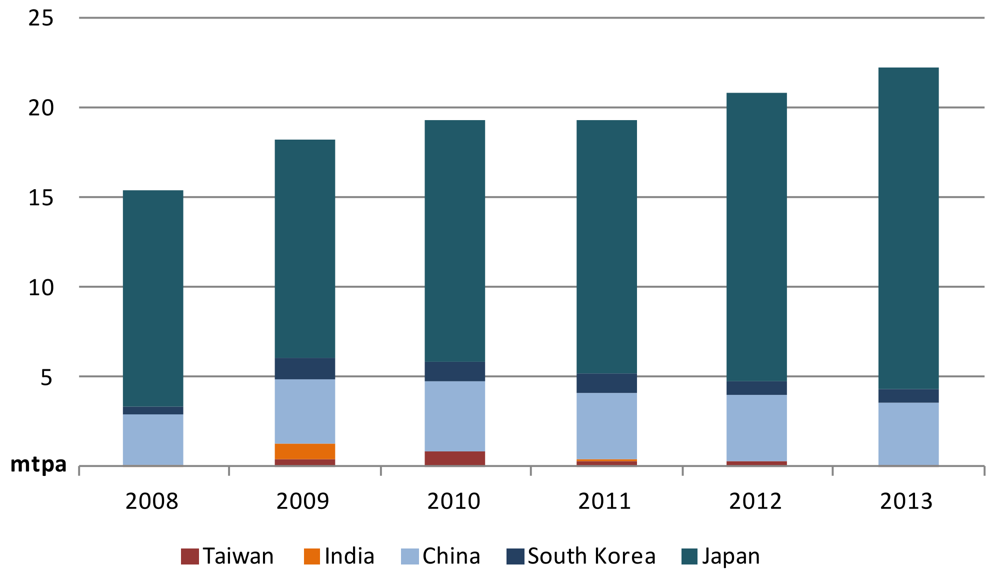
Operating Project	Ownership	Share	Operator	Nameplate Capacity	Trains	Basin
North West Shelf LNG Joint Venture	BHP Billiton Petroleum (North West Shelf) Pty Ltd	16.67%	Woodside Energy Ltd	16.3 mtpa	Train 1 – 2.5 mtpa 1989	Carnarvon
	BP Developments Australia Pty Ltd	16.67%			Train 2 – 2.5 mtpa 1989	
	Chevron Australia Pty Ltd	16.67%			Train 3 – 2.5 mtpa 1992	
	Japan Australia LNG (MIMI) Pty Ltd	16.67%			Train 4 – 4.4 mtpa 2004	
	Shell Development (Australia) Pty Ltd	16.67%			Train 5 – 4.4 mtpa 2008	
	Woodside Energy Ltd	16.67%				
Darwin LNG	ConocoPhillips	56.72%	ConocoPhillips	3.7 mtpa	Train 1 – 3.7 mtpa 2006	Bayu-Undan
	ENI	12.04%				
	Santos	10.64%				
	INPEX	10.53%				
	TEPCO	6.72%				
	Tokyo Gas	3.36%				
Pluto Project	Woodside Energy Ltd	90%	Woodside Energy Ltd	4.3 mtpa	Train 1 – 4.3 mtpa 2012–13	Carnarvon
	Tokyo Gas	5%				
	Kansai Electric	5%				

Source: Company reports

In response to the continuing favourable outlook for LNG in the Asia Pacific region, Australia's second LNG liquefaction project – the 3.7 mtpa Darwin LNG facility operated by ConocoPhillips in the Northern Territory – was commissioned in 2006. It is supplied with gas from the Bayu-Undan fields located in the Timor Sea. A third LNG facility, Woodside Energy's 4.3 mtpa Pluto LNG, was commissioned during 2012–2013 and is located on the Burrup Peninsula northwest of Karratha on the West Australia coast and sources gas from fields in the Carnarvon Basin. As was the case with the North West Shelf Joint Venture, investments in the Pluto LNG and Darwin LNG facilities were underpinned by long-term sales agreements with customers in the Asia Pacific region (Japan, South Korea, and China).

Over the period 2008–2013, Australia exported LNG to five countries in the Asia Pacific region (Taiwan, India, China, South Korea, and Japan). As shown in Figure 1, annual LNG exports from Australia have grown substantially over this period with much of the growth associated with increased exports to Japan.

Figure 1. Australian LNG exports by destination, 2008–2013



Source: R. Lambie, "The Asia-Pacific LNG Market: Recent Past and Medium-Term Outlook." *Resources and Energy Quarterly* (March Quarter 2014): 141–58.

Japan remains the principal export destination for Australian LNG. Japan received just under 80 percent of Australia's LNG exports in 2013 (17.9 million tonnes). Between 2008 and 2013, Japan increased its purchases of LNG from Australia by about half. A key factor in this growth was the significant increase in demand for LNG following the Fukushima nuclear accident in 2011 and the resulting shut-down of 50 nuclear electricity generation plants that accounted for about 30 percent of the country's electricity generation capacity. Recent developments in the market, such as Japan's reliance on gas-fired electricity generation following the Fukushima incident and large growth rates in LNG demand from China, India, and Chinese Taipei (Taiwan), have seen Australia, Qatar, Russia, and Nigeria increase their exports to the Asia Pacific region.

2.2 GOVERNMENT SUPPORT AND REGULATION FOR INDUSTRY

The strong demand in the Asia Pacific was not in itself sufficient to bring about the growth of the LNG export industry in Australia. Rather, co-operation among all levels of government[6] and the industry has been necessary to improve the investment environment for LNG projects.[7] In the case of the North West Shelf, for example, the Western Australian government supported the viability of the project in the early 1980s through agreeing to 20-year gas supply contracts for the domestic market and providing funding for a 1,500-kilometre pipeline to transport gas to the southwest corner of the state. Pritchard (2007) draws on several major policy initiatives undertaken by government that were specifically aimed at supporting the development of the LNG industry in Australia:

- In October 2000, the LNG Action Agenda was launched in which the Australian Government expressed strong policy support for the development of Australia's LNG export industry;

[6] There are three levels of government in Australia: The Australian Government (also referred to as the Federal government or the Commonwealth government), state or territory government and local government.

[7] R. Pritchard, "How to Facilitate or Strangle an LNG Project," The Australian Petroleum Production & Exploration Association 2007 Conference, Adelaide, April 15–18, 2007, p. 10. http://www.resourceslaw.net/documents/APPEAConferenceLNG-Paper.pdf.

- In April 2001, the Australian Government along with state and territory industry ministers signed the Australian Industry Participation National Framework Agreement, which adopted a uniform national approach to major investment projects[8];

- In March 2006, the Resources Minister announced a strategic alliance between the upstream oil and gas industry and the Australian Government, state governments, and the Northern Territory Government that aimed to ensure that Australian LNG production exceeded 50 mtpa by 2015[9]; and

- At the 2007 Australian Petroleum Producers and Exploration Association (APPEA) conference the Resources Minister launched the Australian Petroleum Production and Exploration Association's Strategic Leaders Report, which canvassed options that need to be considered to unlock the potential of the oil and gas industry.[10]

The LNG Action Agenda is considered to be an important government initiative for the sector.[11] This agreement between the Australian Government and the LNG industry committed the Government to actions that would enhance the competitiveness of the industry and remove or mitigate impediments to its growth. The Agenda is considered to have been to a large extent "successfully and actively progressed" and has resulted in specific actions relating to greenhouse gas emissions, taxation, customs and tariffs, Australian industry participation, streamlining the approval processes for projects, and effective industry/government LNG marketing and promotion.[12]

These major policy initiatives either built on or enhanced broader measures implemented by the Australian and state and territory governments to facilitate the investment in, and development of, major projects that were not necessarily LNG-specific. The measures included the Australian Government's establishment of the Major Project Facilitation program[13] and, more recently, reforms by the states and territories to improve their major project approvals processes.[14]

In addition to the broad-based policy initiatives to improve the investment environment for LNG projects, the Australian federal, state, and territory governments also have regulatory responsibilities and other forms of direct involvement that affect investment in LNG projects. Thompson and MacClean (2006) identified the three most important roles of government in relation to investment in LNG projects in Australia as:

- The approval process for projects with foreign ownership;

- The role of state governments in facilitating projects; and

- The role of the Australian Government in creating favourable conditions for investment in projects.[15]

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[8] Department of Industry, http://www.innovation.gov.au/INDUSTRY/AUSTRALIANINDUSTRYPARTICIPATION/Pages/AustralianIndustryParticipationNationalFramework.aspx.
[9] Energy News Bulletin, "Govt-industry plan to boost oil and gas production". March 15, 2006. http://www.energynewsbulletin.net/storyview.asp?storyID=55562&section=Search&sectionsource=s90.
[10] Australian Petroleum Production & Exploration Association (APPEA), Platform for Prosperity, Australia's Upstream Oil and Gas Strategy (Canberra: APPEA, 2007).
[11] A.G. Thompson and D. MacClean, "The Regulation of LNG in Australia," Oil, Gas & Energy Law Intelligence 1, no. 4 (May 2006), pp. 6–7. http://www.ogel.org/article.asp?key=2104.
[12] International Energy Agency (IEA). Energy Policies of IEA Countries: Australia (Paris: OECD, 2005), 139.
[13] Department of Infrastructure and Regional Development. http://www.majorprojectfacilitation.gov.au/.
[14] Business Advisory Forum, "Major Projects Approval Reforms: Initiatives Implemented by States and Territories to Improve Their Major Project Approvals Process." Paper prepared by the States and Territories for the Business Advisory Forum, 2012. http://www.dpmc.gov.au/publications/baf/docs/Major-Projects-Approvals-Reforms.pdf.
[15] Thompson and MacClean, op. cit., pp. 4-6.

With respect to foreign ownership of the resource and of the upstream production facilities,[16] the approval or veto of investment by foreign entities in either Australian companies or assets ultimately resides with the Australian Government. The mechanism for granting approvals for investments by foreign interests is the Foreign Investment Review Board, which is responsible for administering the *Foreign Acquisition and Takeover Act 1975*. For most industry sectors, the key criterion considered by the Review Board is whether the proposed investment is in the national interest.

LNG project proponents may enter into agreements with a state government (state ratified agreements) to facilitate the development of the project.[17] Such agreements generally take the form of obligations on the proponent to meet a specific timeframe for completing the development, and provide opportunities for the State to benefit as much as possible from the development. In return, the proponent receives concessions from the state government relating to various fiscal charges imposed on the project and/or regulatory requirements, which may be ratified by an Act of the state parliament to provide greater certainty and security.

Further to performing these roles, the Australian federal, state, and territory governments play a crucial part in facilitating investment in the development of petroleum resources through the information they provide. Australia has a history of government providing pre-competitive geoscience information to attract investment in resource exploration and the responsible development of Australia's resources.[18] The Australian federal, state, and Northern Territory have a shared responsibility for collecting geoscience information through their respective geoscience organizations. The states and Northern Territory organizations each collect onshore pre-competitive geosciences information. The Australian Government agency, Geoscience Australia, is primarily responsible for offshore mapping and pre-competitive information, but also operates formally with the state and territory agencies under the National Geoscience Agreement to gather and assess onshore geoscientific information.[19]

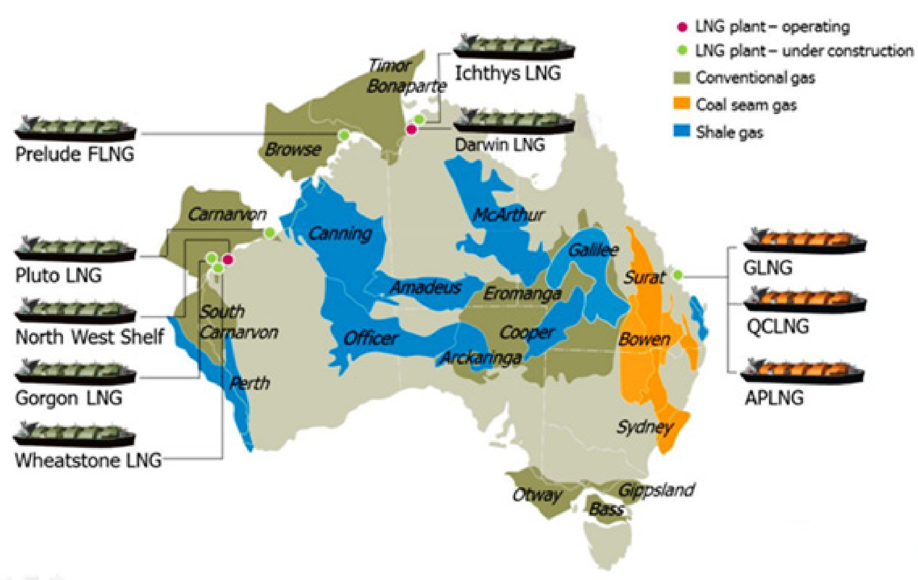
[16] Ibid., pp. 4–5.
[17] Ibid., pp. 5–6.
[18] Geoscience Australia, "Our History," http://www.ga.gov.au/about-us/our-history.html.
[19] Department of Industry and BREE, Eastern Australian Domestic Gas Market Study (Canberra: Commonwealth of Australia, 2014), p. 98. http://www.innovation.gov.au/Energy/EnergyMarkets/Documents/EasternAustralianDomesticGasMarket-Study.pdf.

OVERVIEW OF CURRENT LNG EXPORT FACILITY DEVELOPMENT IN AUSTRALIA

Australia is now the world's third largest LNG exporting country after Qatar and Malaysia, with capacity to supply 24.3 mtpa. This capacity is approximately 8 percent of the global LNG market. Australia is seen, alongside Qatar, as belonging to the second wave of LNG suppliers that dominated new capacity from the early 2000s to 2012. The first wave of suppliers, largely consisting of Algeria, Malaysia, and Indonesia, developed projects between 1964 and 2000.[20] In 2013, Australia's three operating LNG plants had only 1.6 million tonnes a year, or just over 6.5 percent, of their total capacity uncontracted.

Australia has in recent years experienced an unprecedented expansion in its potential LNG export capacity. In addition to the three existing LNG projects, there are seven liquefaction projects under construction, which represent almost 60 percent of the number of projects currently under construction globally. In the present wave of LNG project construction, the Gorgon Project in Western Australia was the first to reach final investment decision (FID) in September 2009. Between October 2010 and January 2012, six other projects reached FID. To date, all of these projects are yet to complete an LNG train. Queensland Curtis LNG (QCLNG) is expected to be the first train constructed and is scheduled to come online in the second half of 2014. Gladstone LNG (GLNG) and Australia Pacific LNG (APLNG), also in Queensland, are expected to have their first trains begin production in 2015, followed by the first LNG from the Gorgon and Wheatstone facilities of Western Australia in 2016, and Prelude FLNG and Ichthys LNG in the Northern Territory in 2017.[21] Figure 2 shows where the operating and under construction LNG facilities are geographically located and their proximity to major gas basins.

Figure 2. Australian LNG projects operating and under construction



Source: Adapted from address by John Anderson, Santos Vice President WA & NT at SEAAOC 2013, September 11, 2013

[20] EY, *Global LNG: Will New Demand and New Supply Mean New Pricing?* (2013), p. 8. http://www.ey.com/Publication/vwLUAssets/Global_LNG_New_pricing_ahead/$FILE/Global_LNG_New_pricing_ahead_DW0240.pdf.

[21] IEA, *Energy Policies of IEA Countries: Australia*, op. cit., pp. 151–52.

Table 2 details the seven LNG projects that are currently under construction. Collectively they include 14 trains with a combined capacity of 61.8 mtpa and involve at least A$180 billion of investment.[22] These projects include the first liquefaction plants in the world to source gas for LNG export from CSG (in Queensland) and the world's largest floating LNG plant (Prelude Project), which is being constructed in South Korea. By 2018–19 Australia is projected to export 79 million tonnes of LNG annually,[23] and could replace Qatar as the largest LNG exporter by the end of this decade.[24]

Table 2. Australian LNG projects under construction September 2014

Committed Project	Ownership	Share	Operator	Nameplate Capacity	Trains	Actual / expected operating date	Basin
Australian Pacific LNG (APLNG)	Origin	37.50%	ConocoPhillips	9.0 mtpa	Train 1 – 4.5 mtpa	H2 2015	Surat-Bowen
	ConocoPhillips	37.50%					
	Sinpoec	25%			Train 2 – 4.5 mtpa	H1 2016	
Gladstone LNG (GLNG)	Santos	30%	Santos	7.8 mtpa	Train 1 – 3.9 mtpa	H1 2015	Surat-Bowen
	Petronas	27.50%					
	Total	27.50%					
	Kogas	15%			Train 2 – 3.9 mtpa	H2 2015	
Queensland Curtis LNG (QCLNG)	BG	73.75%	BG	8.5 mtpa	Train 1 – 4.2.5 mtpa	H2 2014	Surat-Bowen
	CNOOC	25%					
	Tokyo Gas	1.25%			Train 2 – 4.25 mtpa	H2 2015	
Gorgon	Chevron	47%	Chevron	15.6 mtpa	Train 1 – 5.2 mtpa	H1 2015	Carnarvon
	ExxonMobil	25%					
	Shell	25%					
	Osaka Gas	1.25%			Train 2 – 5.2 mtpa	H2 2015	
	Tokyo Gas	1%					
	Chubu Electric Power	0.42%			Train 3 – 5.2 mtpa	H1 2016	

[22] Some estimates put the amount as high as A$200 billion (for example, J. Massola, "Oil, Gas Giants Pressure Abbott," *Sydney Morning Herald*, April 7, 2014. http://newsstore.fairfax.com.au/apps/viewDocument.ac;jsessionid=8A73F-C9A447B37DA8A7F9406DA76560C?sy=afr&pb=all_ffx&dt=selectRange&dr=1month&so=relevance&sf=text&sf=headline&rc=10&rm=200&sp=brs&cls=3310&clsPage=1&docID=SMH140407D87F35J2JOA.).

[23] Bureau of Resources and Energy Economics (BREE). *Resources and Energy Quarterly* (March Quarter 2014). http://www.bree.gov.au/sites/default/files/files//publications/req/REQ-2014-03.pdf.

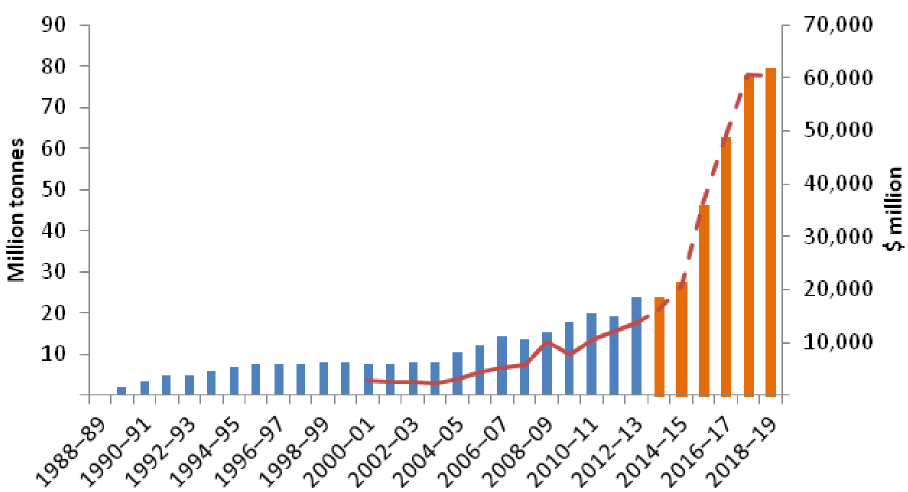
[24] Depending on the commissioning and ramp-up of new plants, this could occur as soon as 2018.

Wheatstone	Chevron	64.14%	Chevron	8.9 mtpa	Train 1 – 4.45 mtpa	H2 2016	Carnarvon
	APACHE	13%					
	KUFPEC	7%					
	Shell	6.40%					
	Kyushu Electric Power Company	1.46%			Train 2 – 4.45 mtpa	H1 2017	
	PE Wheatstone Pty Ltd	8%					
Ichthys	INPEX	66%	INPEX	8.4 mtpa	Train 1 – 4.2 mtpa	H1 2017	Browse
	Total	30%					
	Tokyo Gas	1.60%					
	Osaka Gas	1.20%					
	Chubu Electric	0.70%			Train 2 – 4.2 mtpa	H2 2017	
	Toho Gas	0.40%					
Prelude	Shell	67.50%	Shell	3.6 mtpa	Train 1 – 3.6 mtpa	H2 2017	Browse
	INPEX	17.50%					
	Kogas	10%					
	CPC	5%					

Source: BREE, Resources and Energy Quarterly (March Quarter 2014), p. 32, and company reports

Figure 3 puts Australia's projected increase in export volumes and values attributable to the current wave of expansion into historical perspective. For the first 20 years, from 1989–2008, LNG export volumes grew at a compound annual growth rate of 10.7 percent. In the following 5 years up to 2012–13 the annual growth rate was 9.0 percent. For the five year period ending in 2018–19, the annual growth rate is projected to be 23.4 percent.

Figure 3. LNG exports (million tonnes) and value (A$million – nominal)

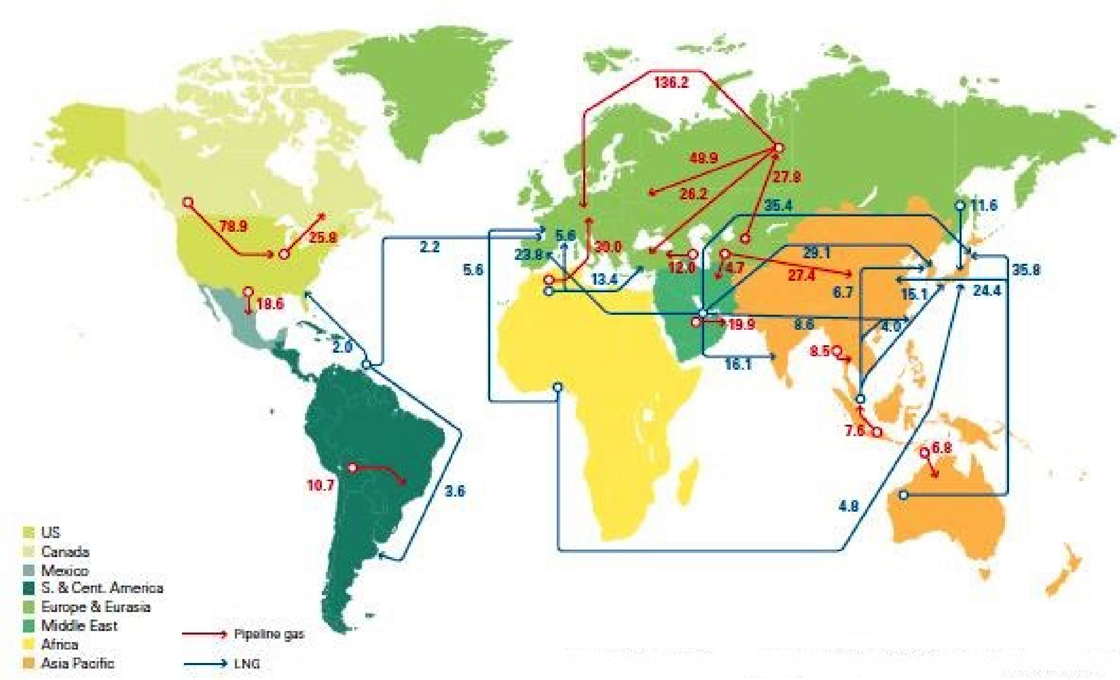


Source: Data from Bureau of Resources and Energy Economics[25]

[25] *Resources and Energy Quarterly*, Previous data files. http://www.bree.gov.au/publications/resources-and-energy-quarterly/previous-data-files.

Figure 4 shows major trade movements of gas via pipelines and LNG that occurred globally in 2013. It illustrates the relative importance of Australian LNG exports and highlights that Australia does not have any pipeline connections to other countries for the export of gas. Thus, all natural gas exports from Australia are in the form of LNG.

Figure 4. Major trade movements of natural gas, 2013 (billion cubic metres)



Source: BP Statistical Review of World Energy, June 2014, p. 29.

A NEW ERA IN LNG SUPPLY AND DEMAND[26]

About 80 percent of the 61.8 million tonnes a year of liquefaction projects under construction in Australia is already contracted to customers in the Asia Pacific region. While there are proposals for investment in another 60 million tonnes a year of liquefaction capacity, it is highly uncertain as to whether these projects will actually proceed.

Australia's LNG sector currently faces a new set of challenges from those experienced in the past as supply and demand conditions in regional markets undergo significant changes. Recent long-term projections show natural gas continuing to substitute for coal and oil in the global energy mix and the Asia Pacific region becoming the major centre for international trade in gas.[27] The scenarios portrayed in these projections suggest that a range of factors related to total energy demand and energy intensity drive ongoing demand in the region as countries transition economically and respond to concerns over energy security and environmental objectives.

Demand and supply conditions for LNG are presently tight in the Asia Pacific region as indicated by high gas LNG gas prices. Over the medium term, as additional gas supply becomes available from Australia and other exporters including imported pipeline gas, prices may soften. Despite increases in supply, LNG imports are expected to remain an important and growing source of gas centred on demand in Japan, China, South Korea, and India. The import and gas supply policies adopted by these four countries will, therefore, play an important role in the development of the LNG export sector in Australia and elsewhere over the next two decades or so.

4.1 THE SUPPLY SIDE OF THE LNG EXPORT MARKET

Depending on market expectations and demand, there is a huge amount of potential LNG supply that could enter the Asia Pacific market in the medium to long term. The main countries that will be exporting LNG to the Asia Pacific region over the next ten years are Australia, the United States, Canada, East Africa, Qatar, Papua New Guinea, and Russia.[28] Australia and the United States are presently in a race to develop liquefaction projects. Papua New Guinea has very recently begun supplying LNG. While projects proposed in Canada, Russia, and East Africa (Mozambique and Tanzania) are not as advanced, they have the potential to substantially add to the competition for supply. In addition to these LNG supply factors is a major "wild card" in the form of China's ability and desire to meet its gas demand through pipeline imports and domestic production. The recent announcement of a Chinese-Russian agreement to supply pipeline gas to China is potentially a "game changer" in terms of how much gas the Chinese will import via LNG rather than by pipeline.

The International Energy Agency (IEA) in its *World Energy Outlook 2013* highlights the comprehensive changes that are taking place in regional gas markets. This *Outlook* highlights the implications for new supply of gas in general, and new LNG supply in particular. Under their "gas price convergence scenario," regional gas markets become more flexible and interconnected, which decreases the cost of moving gas between them and leads to a narrowing in the differences between regional gas prices. Market developments include an increase in spot and short-term trading and/or the move away from oil indexed pricing in the Asia Pacific.

The gas price convergence scenario is illustrated in Figure 5 along with the IEA's "illustrative projections" for prices under their "New Policies Scenario" in which the conditions for convergence do not eventuate.[29] Under the price

[26] This section draws on R. Lambie, "The Asia-Pacific LNG Market: Recent Past and Medium-Term Outlook," Resources and Energy Quarterly (March Quarter 2014): 141–58.

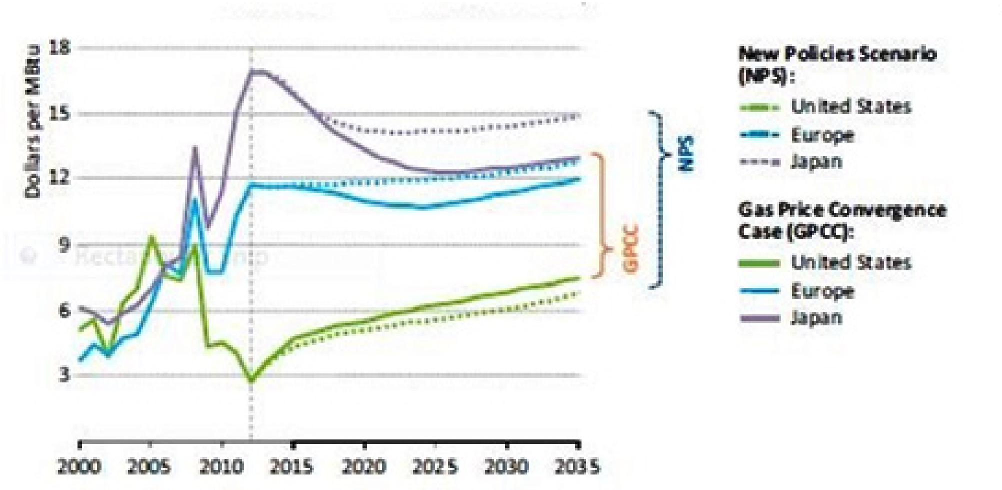
[27] BP, BP Energy Outlook 2035, August 2014, http://www.bp.com/energyoutlook; IEA, World Energy Outlook 2013 (Paris: OECD, 2013).

[28] Other LNG exporters that could also enter the market include Indonesia, Malaysia, Algeria, and Yemen.

[29] IEA, World Energy Outlook 2013, op. cit., pp. 132–36.

convergence scenario, there could be a substantial narrowing of the differences in regional gas prices over the medium term.

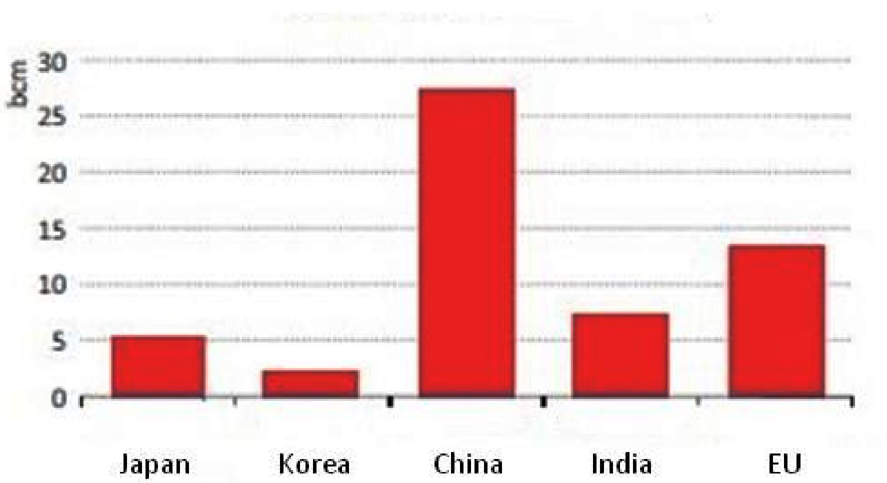
Figure 5. IEA's regional gas price convergence scenarios



Source: IEA, World Energy Outlook 2013, p. 134

The effects on natural gas import volumes from a convergence in the prices of regional gas markets are illustrated in Figure 6. This figure reproduces the IEA's results for selected economies in 2035 and shows that import volumes could change significantly in the longer term if prices converge. In 2035, the total demand for imported gas would be about 55 bcm higher across all five economies, or about 42 bcm higher for the four Asia Pacific region countries, than would occur under the scenario where there were no factors driving regional convergences in gas prices.

Figure 6. Change in import volumes for selected economies under gas price convergence, 2035



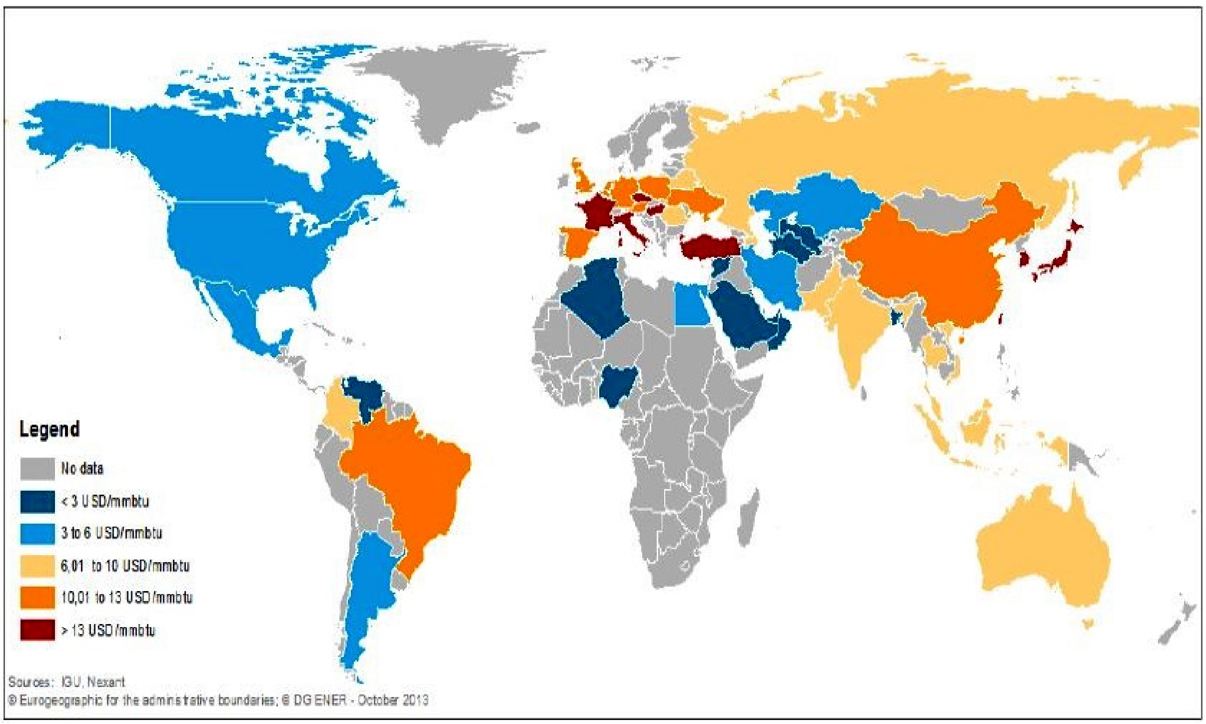
Source: Adapted from IEA, World Energy Outlook 2013, p. 136

4.2 DEMAND FLUCTUATION

LNG demand projections need to be considered in terms of developments outside of LNG markets. These other factors include the relative costs of alternative sources of energy, opportunities to develop indigenous gas resources and import pipeline gas, government policies and regulations, and geopolitical drivers.

Due to its high price, LNG demand is more susceptible than pipeline gas to changes in availability or pricing of competing energy sources and in overall energy demand. Figure 7 shows that in 2012 countries in the Asia Pacific region, for which data were available, had relatively high average wholesale gas prices (in excess of US$ 6 per mmbtu) compared to other regional natural gas markets.

Figure 7. Average wholesale gas prices, 2012 (US$ per mmbtu)



Source: International Gas Union and Nexant, cited in European Commission, Energy Prices and Costs Report. p. 172.

China's wholesale price was ranked in the second highest category at over US$10 to US$13 per mmbtu (coloured orange), while Japan, South Korea, and Taiwan had average wholesale prices in the highest ranked category – exceeding US$13 per mmbtu (coloured red). In 2012, these four countries imported 91 percent of the total LNG imports for the Asia Pacific region (152 mtpa out of 167 mtpa), and just under 64 percent of global LNG imports.[30]

Figure 8 shows reference LNG spot prices for the first half of 2013 at various LNG import locations. Consumers in the Asia Pacific region have been willing to pay significantly higher spot prices than other regions, with the exception of South America (Brazil and Argentina). In this context, LNG is a "balancing" energy source that is used to satisfy what would otherwise be unmet energy demand due to physical or technological constraints on the supply or use of other energy types. The balancing role of LNG makes it difficult to project LNG demand and price in the longer term as it depends greatly on developments in other energy markets, and not just natural gas.

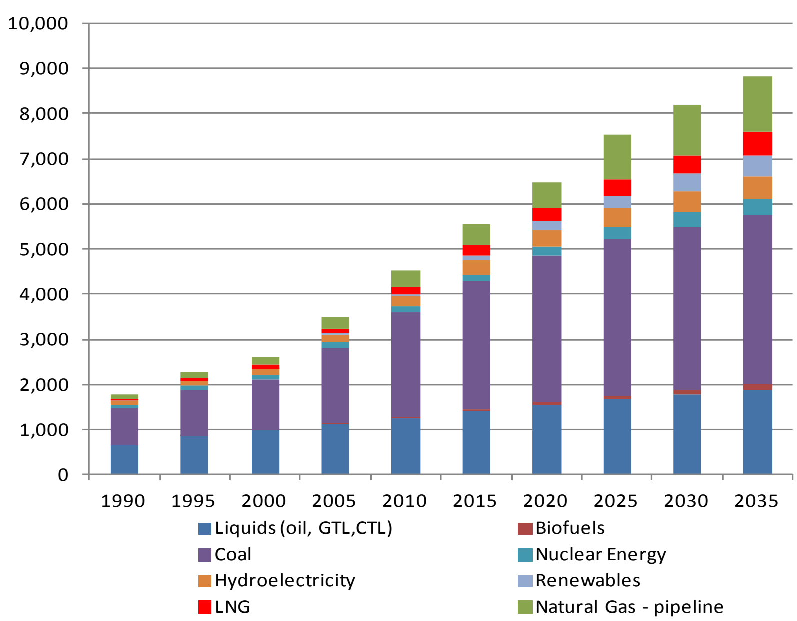
[30] GIIGNL, *The LNG Industry 2012*. http://www.giignl.org/publications.

Figure 8. Global spot prices for LNG, first half of 2013 (US$ per mmbtu)

Source: Thomson-Reuters Waterborne, cited in European Commission, Energy Prices and Costs Report, p. 173.

Figure 9 puts into perspective the susceptibility of LNG demand to changes in overall energy demand and the demand for competing energies. It is based on information of historical and projected energy demand, and the supply of different types of energy used to satisfy that demand in the Asia Pacific region. The demand forecast to 2035 is based on BP projections. Figure 9 shows that, although growing, LNG makes only a relatively small contribution to satisfying total energy demand in the Asia Pacific region.

Figure 9. Asia Pacific energy demand by energy type, 1990–2030* (million tonnes oil equivalent)



*Forecast LNG demand is based on a 4.3 percent compound annual growth rate.

Source: Data from BP Energy Outlook 2030 (2013) and Energy Outlook 2035 (2014), Jensen (2004), ABARE (2005), BREE (2014)

In summary, given the high price of LNG in the Asia Pacific market, any change to overall energy demand or to the availability and/or relative prices of competing energy sources is likely to have a significant effect on LNG demand. How LNG demand and supply conditions in the Asia Pacific region will play out over the medium term is, therefore, subject to very dynamic and uncertain factors. This is illustrated by the 2011 Fukushima incident, and by the 2014 announcement of a 38 billion cubic metre per year agreement between Russia and China for pipeline gas from Russia's Siberian gas fields.[31]

While Australia is likely to become the world's largest exporter of LNG, this will occur in a period of increasing competition from new entrants into the Asia Pacific market. Australian LNG producers have, and are, responding to large increases in demand for gas in the region, and demand is projected to continue to expand well into the future. This projected demand has underpinned the substantial liquefaction capacity in Australia that is due to come online within the next three years.

Expected increases in LNG supplies from projects currently under construction are likely to have implications for future investment in LNG projects in Australia. Project proponents seeking to enter the Asia Pacific market have several options as to where to develop LNG liquefaction facilities. If demand and/or price uncertainties persist and cause delays in FID, this may shift the location of proposed LNG plants across potential supplying countries and away from Australia.

[31] C. Russell, "Russia-China Gas Deal More a Threat to LNG Pricing Than Volumes." *Thomson Reuters*, May 22, 2014. http://uk.reuters.com/article/2014/05/22/column-russell-china-gas-idUKL3N0O80TF20140522.

THE CHALLENGE OF ESCALATING COST PRESSURES

Project development costs are the most important factor in determining future LNG export investments. The challenge for Australia is that some of the country's liquefaction projects currently under development have construction and engineering costs as high as 50–60 percent of total project costs, which is considerably higher than the 30 percent share typically incurred by projects elsewhere.

Given the current state of affairs in 2014 it is instructive to return to 2007, toward the beginning of the most recent phase of investment in new LNG capacity. At this time Robert Pritchard highlighted some key lessons from almost 20 years of experience in developing an LNG industry in Australia.[32] In particular, the paper identified "five ways of strangling an LNG project in Australia" that consisted of the following:

- Failing to control costs;
- Allowing cycle times and commercial and legal complexity to increase;
- Increasing the risk of project approval and delays;
- Failing to specify environmental standards; and
- Imposing non-binding government policies.[33]

More recently, the IEA has highlighted the main factors likely to affect further investment in Australian LNG projects as follows:

- The outlook for development costs (taxation, regulatory, construction and engineering), which have been substantially higher than originally expected for current projects;
- The viability of alternative technologies that may lower costs, such as floating LNG; and
- The degree of competition from other export countries, mainly from North America.[34]

The expansion of LNG production capacity in Australia over the medium term greatly depends on it remaining a competitive destination for global investment, despite the large uncertainties facing the Asia Pacific LNG market and alternative opportunities for developing supply. Notwithstanding the issues of cost and competiveness, Australia does have a very good reputation as a location for LNG production due to its large gas reserves, low sovereign risk, proximity to the largest LNG markets, reliability and extensive contact and market experience. [35, 36]

Fereidun Fesharaki, Chairman of the consulting group Facts Global Energy, recently warned Australian LNG exporters that their assumptions regarding Asia Pacific demand are "radically over-optimistic" and they "need to slash costs to have a chance of further plants going ahead."[37] The challenge for LNG project proponents is, therefore, not so much identifying where potential competitors are located and their relative cost of delivering LNG to Asia Pacific customers, but rather making sure the proposed project is developed and delivered at the lowest cost possible.

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[32] Pritchard, op. cit.

[33] Ibid., pp. 6–9.

[34] IEA, *Medium-Term Gas Market Report 2013*. Paris: OECD, 2013.

[35] KPMG Global Energy Institute, *Major LNG Projects: Navigating the New Terrain*. KPMG International, 2014, p. 11. https://www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/Pages/major-LNG-projects-navigating-new-terrain.aspx.

[36] Appendix B provides further details on Australia's current LNG projects under construction and projects at the feasibility and proposed stages of investment.

[37] A. Macdonald-Smith, "New LNG Projects 'Locked Out'," *Australian Financial Review*, June 3, 2014: 2.

The IEA has identified competitiveness and cost challenges in its contemplation of the comprehensive changes taking place in regional gas markets and the implications for new supply of gas in general, and new LNG supply in particular.[38] As more competitive and flexible market conditions develop in regional markets there is increasing pressure on proponents of LNG projects in Australia and elsewhere to focus on reducing project costs if they are to achieve a favourable FID. It is insightful to note that no project has reached FID in Australia since the APLNG 2nd train in June 2012.

5.1 LNG PLANT COSTS OVER TIME AND PLACE

FACTS Global Energy commented in 2014 that the unprecedented investment activity in LNG projects from 2009 to 2012, which was "buoyed by an optimistic view of the market along with a healthy dose of euphoria," is now being replaced by a "much more cautious and conservative consideration for LNG developments, plus a dash of pessimism."[39] As a result, proponents of potential LNG projects have become more careful about new investment. Global resource majors are applying even greater scrutiny to LNG project approvals and foregoing projects with marginal returns as they seek out higher returns on their capital expenditure.[40]

The amount of capital expenditure required for LNG projects is a key challenge for the LNG sector globally.[41] Although it is difficult to source up-to-date and directly comparable estimates of capital expenditure on particular LNG projects, there is some publicly available information that gives guidance on their relative differences at various locations and over time. In providing such figures we note that in most cases the reported estimates do not clearly define the scope of the projects to which costs are being attributed nor whether the reported costs relate to the plant expenditure, total gross capital costs, or full cycle gross capital costs, which makes it difficult to compare capital costs across different projects.[42]

Over the three successive waves of new LNG suppliers, it is estimated that the capital cost for an LNG plant has risen from less than US$200 per tonne per annum (tpa) during the first, to between US$500 and US$1,500 per tpa for the second wave, and has escalated in the current third wave to an average in excess of US$2,600 per tpa.[43]

Songhurst (2014) analyses capital expenditure data for 36 liquefaction projects consisting of both liquefaction trains and complete facilities between 1965 and 2013. He shows that up to about 2005 there was a downward trend in the capital cost of LNG plants as a result of economies of scale and learning, which has since been followed by a substantial upward trend.[44] Songhurst's findings, illustrated in Figure 10, show that the cost of an LNG plant quadrupled from US$300 per tpa to US$1,200 per tpa in real terms between 2000 and 2013.[45] The following section will provide an overview of the factors contributing to these increases.

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[38] IEA, *World Energy Outlook 2013*, op. cit.

[39] FACTS Global Energy cited in C. Smith and W. True, "LNG Update: Global LNG Supply Demand Remains Tight," *Oil & Gas Journal*, April 7, 2014. http://www.ogj.com/articles/print/volume-112/issue-4/special-report-lng-update/lng-update-global-lng-supply-demand-remain-tight.html.

[40] A. Macdonald-Smith, "Capex Crunch to Hit 'Marginal' LNG," *Australian Financial Review*, May 7, 2014. http://www.afr.com/p/business/companies/capex_crunch_to_hit_marginal_lng_PUKTXPjPkiO0kSAxcz89cM.

[41] B. Songhurst, *LNG Plant Cost Escalation*, OIES Paper, NG 83, Oxford Institute for Energy, 2013. http://www.oxfordenergy.org/wpcms/wp-content/uploads/2014/02/NG-83.pdf.

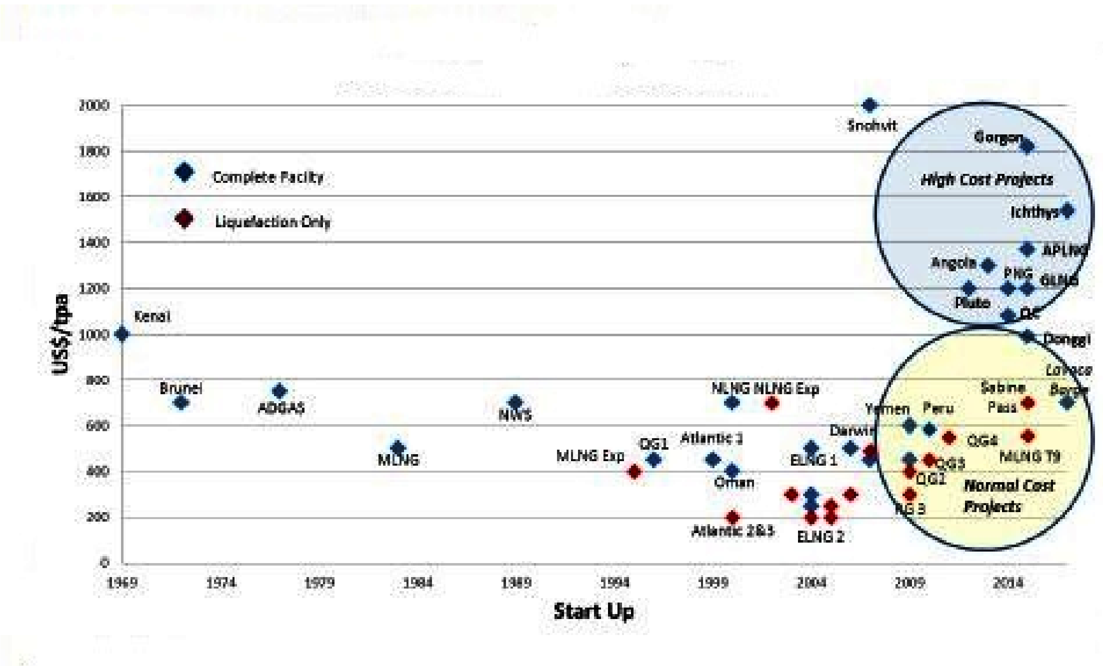
[42] Gross capital costs do not include a deduction for depreciation of fixed assets. Full cycle gross capital costs include an estimate of the project's decommissioning cost.

[43] EY, op. cit., p. 12.

[44] Songhurst, op. cit., p. 2.

[45] Ibid. (Costs expressed in $2008.)

Figure 10. LNG plant cost – (US$/tonne per annum, real 2008)*



Source: Songhurst, LNG Plant Cost Escalation, p. 23

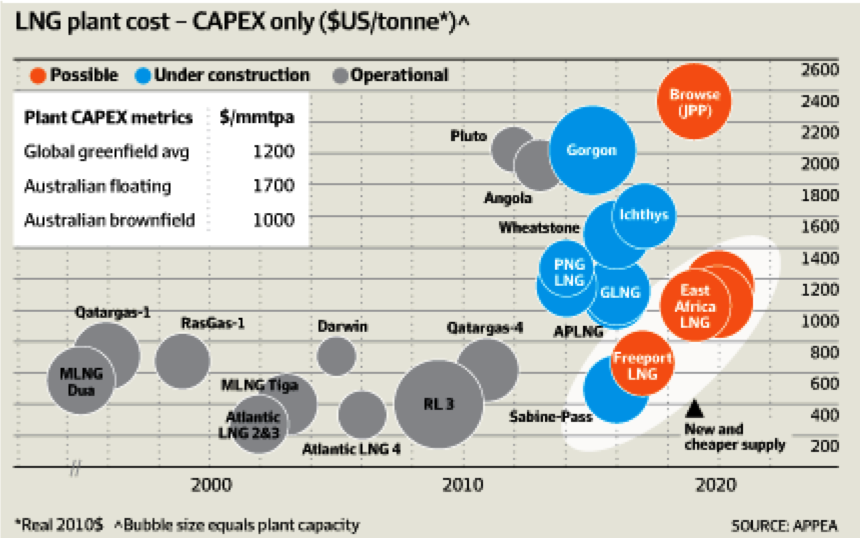
Also highlighted is the relatively high cost of the current Australian projects compared to projects being undertaken in many other parts of the world.[46] The relatively high cost of Australian LNG projects is a major concern for Australia remaining a destination for further LNG investment. Songhurst's LNG plant cost estimates are broadly consistent with those made in recent Australian media reports, which state that capital expenditure on LNG projects has increased from US$225 per tpa in 2000 to around US$2,000 per tpa for current projects.[47]

Figure 11 is obtained from a recent media report and illustrates the increase in capital expenditure requirements for LNG plants since the early 2000s. It also shows the relative differences in the cost of plants currently under construction and being considered, and highlights the potentially cheaper new sources of supply in East Africa and the US Gulf of Mexico.

[46] Both Gorgon and SnØhvit use carbon capture and storage technology.

[47] Macdonald-Smith, "Capex Crunch to Hit 'Marginal' LNG," op. cit.; J. Greber, "Costs, Rivals Cloud Resources Outlook," *Australian Financial Review*, April 7, 2014. http://www.afr.com/p/business/resources/costs_rivals_cloud_resources_outlook_PTQqnpzyRP97W7ulrqMXDL.

Figure 11. LNG plant capital expenditure only (US$/tonne per annum, real 2010)*



*Bubble size equals plant capacity

Source: APPEA, cited in Australian Financial Review, April 7, 2014

Based on these comparisons of the capital cost of liquefaction plants, the Australian projects under construction and under consideration are around twice the cost of brownfield developments in the US Gulf of Mexico,[48] and at best are similar to the cost of a greenfield development in East Africa. It is generally reported that the costs of Australian plants are up to 30 percent more than the next closest rivals in Mozambique and Canada.[49] A recent media report stated that Chevron's Gorgon project is about 40 percent more expensive than comparable projects in the Gulf of Mexico.[50]

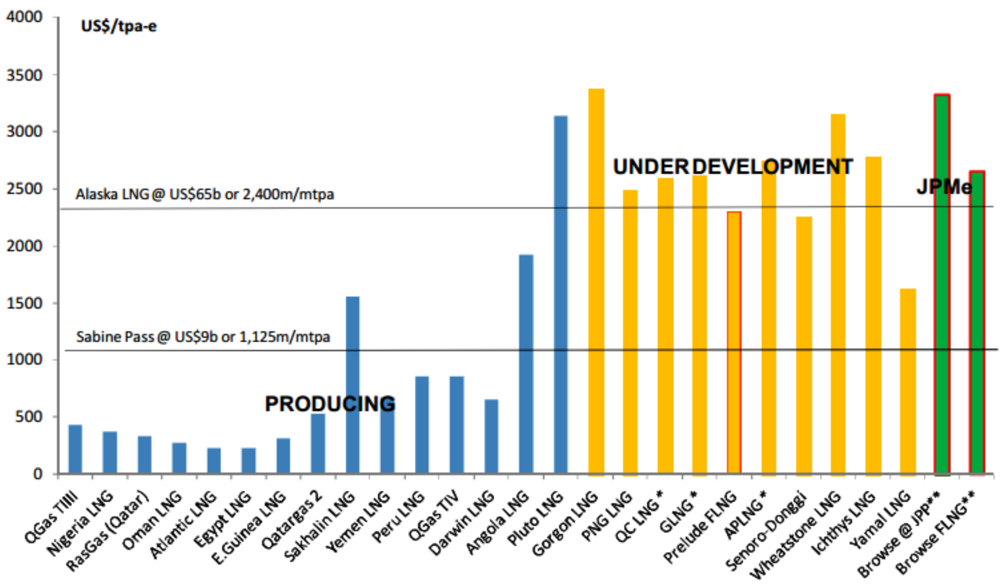
As another recent cost estimate shows (see Figure 12), when LNG plant costs are measured on an integrated basis and hence include upstream and midstream capital costs, all the Australian plants under construction (with the exception of Prelude FLNG) are uncompetitive with the breakeven LNG production costs of competing plants in Alaska and the US Gulf of Mexico.

[48] Songhurst, op. cit., p. 27.

[49] Greber, op. cit.

[50] Australian Associated Press, "High Costs Weigh on Gorgon Expansion," *Herald Sun*, April 7, 2014. http://www.heraldsun.com.au/business/breaking-news/high-costs-weigh-on-gorgon-expansion/story-fni0xqe4-1226876967051.

Figure 12. LNG integrated project costs (US$/tonne per annum)



Source: J.P. Morgan, cited in Macrobusiness.com.au, April 14, 2014, The LNG Cost Curve.

5.2 DECOMPOSITION OF LNG PLANT COSTS

The key drivers of LNG plant costs, some of which are interrelated, are ranked in order of significance as:

- Project scope;
- Project complexity;
- Location (infrastructure and construction costs);
- Equipment and materials;
- Engineering and project management;
- Contractor profit and risk;
- Owner's costs;
- Contract strategy; and
- Currency exchange risk.[51]

The cost of a liquefaction train (gas treatment, fractionation, liquefaction and refrigeration) is, typically, about 50 percent of the total plant costs (see Figure 13), but does depend greatly on the scope of the project.[52] The scope of a project may be relatively narrow, consisting of an LNG plant that is a repeat liquefaction train, through to a broader scope that involves extensive infrastructure requirements in addition to the liquefaction train (storage, jetty, utility systems worker accommodation, seismic protection, and soil improvement),[53] and may include expenditures on

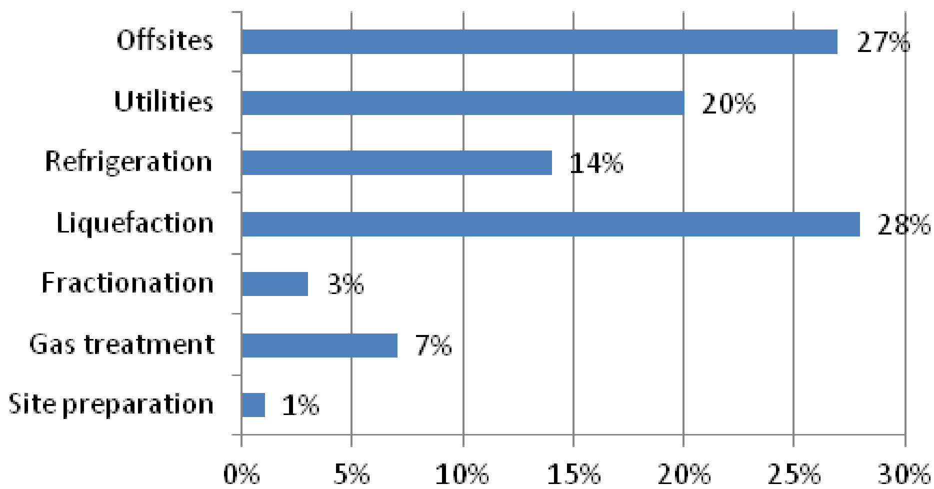
[51] Songhurst, op. cit., p. 9.

[52] Ibid. pp. 8–9.

[53] C. Caswell et al., "Additional Myths About LNG." *KBR* (October 2012). http://www.kbr.com/Newsroom/Publications/Technical-Papers/Additional-Myths-about-LNG.pdf.

major upstream gas gathering infrastructure.[54] Site-specific factors are important in terms of the size of civil and infrastructure costs, which have jointly been growing as a proportion of total plant costs since 2000.[55] Given that the civil and infrastructure costs required for each plant may vary greatly, caution is required when comparing the typical plant breakdown of costs to a particular plant.[56]

Figure 13. Typical total plant cost share breakdown by expenditure area*



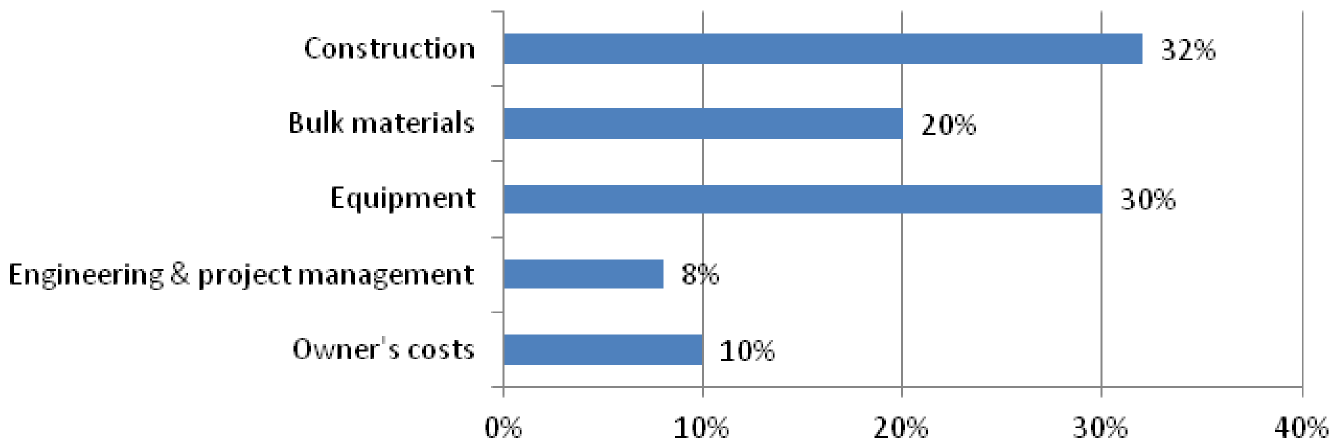
*Based on average cost calculations from project data.

Source: Songhurst, LNG Plant Cost Escalation, p. 8

Figure 14 presents Songhurst's results on the separation of LNG plant costs into the various cost categories. Construction has historically been the largest component and has averaged about one third of a typical plant's total cost.

[54] Songhurst, op. cit., pp. 3, 10.
[55] Caswell et al., Additional Myths About LNG, op. cit., p. 7.
[56] Ibid., p. 7; H. Kotzot et al., "LNG Liquefaction – Not all LNG Plants are Created Equal – The Sequel." *KBR*. Presentation at GasTech May 25–28, 2009.

Figure 14. Typical total plant cost share by cost category*



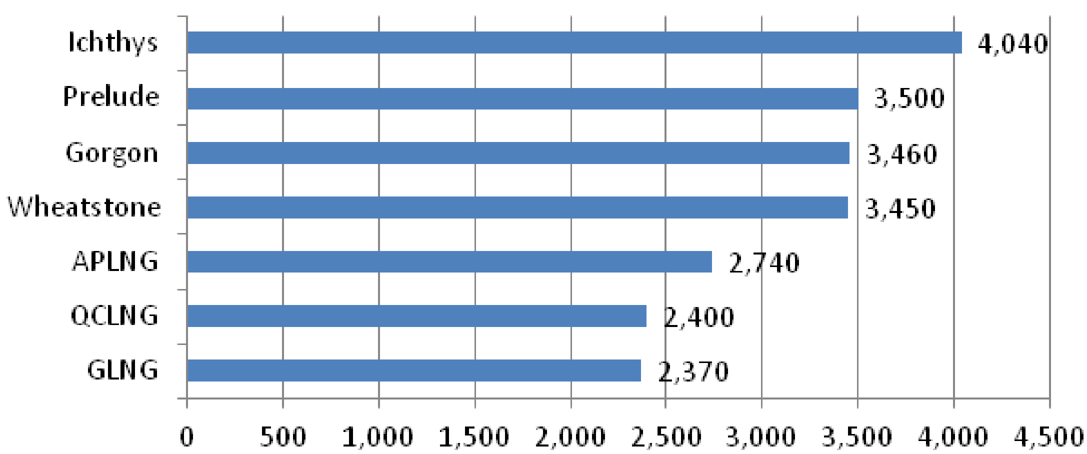
*Based on average cost calculations from project data.

Source: Songhurst, LNG Plant Cost Escalation, p. 9

5.3 LNG PROJECT COSTS IN AUSTRALIA

Between September 2009 and June 2012 seven Australian LNG projects received FID approval, but since then there have been no further approvals of LNG projects.[57] The last Australian greenfield project to achieve FID was the Ichthys venture with an estimated capital cost per tonne of LNG of A$4,040 in 2012.[58]

Figure 15. Capex comparison for Australian LNG plants under construction (A$/tonne per annum)*



*Not stated whether values are nominal or real.

Source: Russell, "Floating LNG is Australia's Future, But Not A Miracle Cost Cure," Thomson Reuters, May 9, 2014.

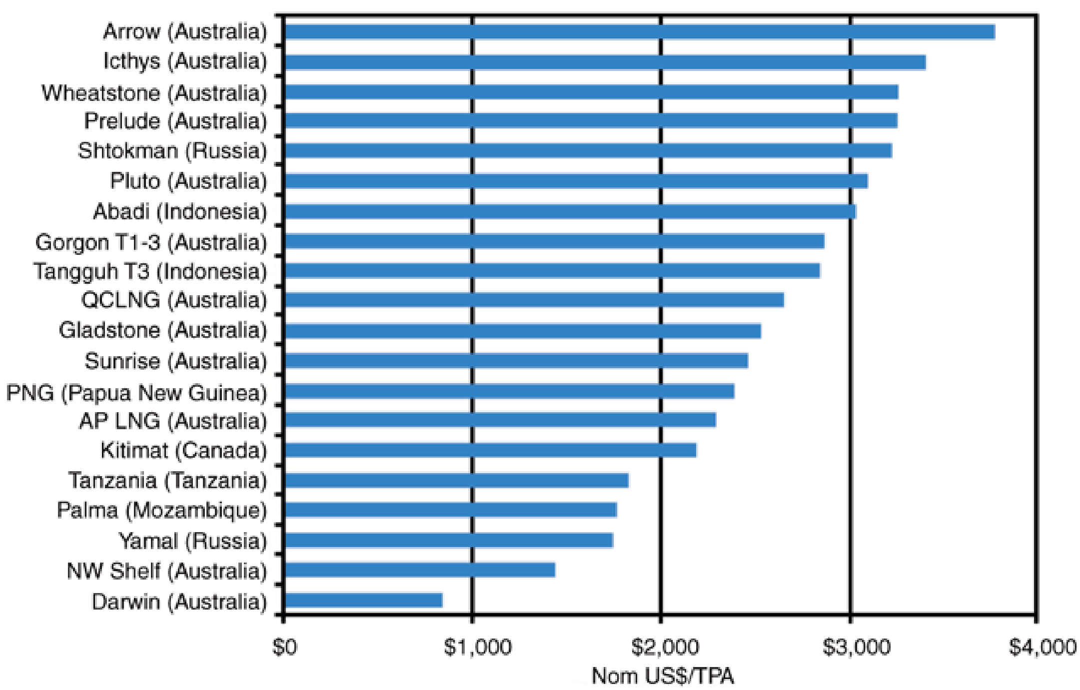
[57] A. Macdonald-Smith and E. Parkinson, "LNG Boom Poses Dilemmas," *Australian Financial Review*, April 7, 2014. http://www.afr.com/p/lng_boom_poses_dilemmas_for_australian_Se8yNK50ERPFQLxodC1toK.
[58] C. Russell, "Floating LNG is Australia's Future, But Not A Miracle Cost Cure," *Thomson Reuters*, May 9, 2014. http://www.reuters.com/article/2014/05/09/column-russell-lng-floating-idUSL3N0NT0WE20140509 .

As shown in Figure 15, the Ichthys project is reported to have the highest capital cost compared to recent estimates for the other Australian projects in construction. The three projects under construction on Curtis Island in Queensland have a cost range from A$2,370 to A$2,740 per tonne of LNG capacity. While the Queensland average capital costs are significantly lower in terms of their reported costs compared to the West Australian projects, they are higher than their estimated greenfield rivals in Canada and East Africa (see Figure 16).

A challenge with cost comparisons across plants is that outputs, operating costs, and returns differ by plant. For instance, the Ichthys LNG project is expected to produce 8.4 mtpa of LNG, 1.6 mtpa of liquefied petroleum gas and about 100,000 barrels of condensate per day at its peak.[59] The additional source of value from the associated products will add to the project's returns and is a value stream not available to the Queensland CSG to LNG projects.

Figure 16, based on estimates by ICF International, provides another perspective on the cost of Australian LNG plants. It compares the total cost to supply LNG for selected projects, both existing and proposed. Figure 16 highlights the relatively high cost of LNG projects located in Australia compared to other locations during the most recent wave of new supply. Australia has moved from being among the lowest cost locations for LNG projects (NW Shelf, Darwin) to being one of the highest. This is attributed to the substantial escalation over recent years in both construction and natural gas production costs.[60] Based on Songhurst's analysis, construction costs for Australian LNG plants are as much as 50 to 60 percent of total plant costs, almost double the share for a typical LNG plant in many other locations.[61]

Figure 16. LNG projects total capital cost to supply (US$/tonne per annum, nominal)



Source: ICF International, cited in American Oil & Gas Reporter, October 2013

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[59] INPEX, *Ichthys Project – Securing the Future*. August 2012. http://www.inpex.com.au/media/34891/ichthys%20project%20fact%20sheet%20-%20september%202012%20final.pdf.

[60] A.D. Weissman, "U.S. Natural Gas Industry Positioned for Dominant Role in Global LNG Markets," *The American Oil & Gas Reporter* (2013). http://www.aogr.com/magazine/editors-choice/u.s.-natural-gas-industry-positioned-for-dominant-role-in-global-lng-market.

[61] Songhurst, op. cit., p. 8.

Australia's reputation as a high cost location for investment in LNG projects[62] has negative implications for both greenfield developments and also the competitiveness of investment in Australian brownfield expansions[63]

5.4 COST PRESSURES

The Economics and Industry Standing Committee of the Western Australian Parliament stated in their report on the economic impact of Floating Liquified Natural Gas (FLNG) on the State, that:

> [w]hile the Committee accepts that oil and gas development is a high cost industry and that there are particular cost pressures on Western Australia (WA), statements that "Australia is a high cost country" do not in themselves reveal the complexity of the situation. General statements such as these need to be considered in the context of what it means to develop an oil and gas project in WA.[64]

Australia's high cost base for LNG projects is attributed to their complexity, remote locations, and exposure to some of the highest construction costs in the world – in other words, and consistent with Songhurst's finding, an LNG project's cost is driven by the scope and location of the project.[65]

McKinsey and Company reports that an Australian LNG project using coal seam gas is likely to be 20 to 30 percent more costly than a Canadian project based on unconventional gas, and this higher relative cost also applies to an Australian conventional offshore project compared to a similar type of project in Mozambique (see Figure 17).[66]

Figure 17. McKinsey and Company's breakdown of costs differences between an Australian and Canadian unconventional LNG project (%)

Cost driver	Percentage higher (lower)
Incompressible/Uncontrollable	
Reservoir characteristics	24–36
Inflation rates	12
Climate related plant efficiency	8
Shipping distance	(4)
Compressible/Controllable	
Tax regime and royalty payments	32
Project optimisation—project management practices*	12
Labour productivity	8
Service market maturity, including supply chains, logistics and infrastructure	4
Regulatory approvals efficiency and delays	1.2

* via lean design engineering and production, best-in-class contract management and best-in-class claims management.

Source: McKinsey and Company (2013), cited in Parliament of Western Australia, The Economic Impact of Floating LNG on Western Australia Volume 2, p. 298

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[62] Greber, op. cit.
[63] A. Macdonald-Smith, "US LNG to Undercut Gorgon by 30pc: JPMorgan," *Australian Financial Review*, April 11, 2014. http://www.afr.com/p/business/companies/us_lng_to_undercut_gorgon_by_pc_47fLxmIwHhsoV2ERY7UU8N.
[64] Parliament of Western Australia, *The Economic Impact of Floating LNG on Western Australia Volume 1*. Economics and Industry Standing Committee, Legislative Assembly May 2014, pp. 296–97.
[65] Songhurst, op. cit., p. 23.
[66] McKinsey & Co., *Extending the LNG Boom: Improving Australian LNG Productivity and Competitiveness*. 2013. http://www.mckinsey.com/global_locations/pacific/australia/en/latest_thinking/extending_the_lng_boom, p. 10.

McKinsey's assessment shows that 40 to 50 percent of the cost difference between an Australian and Canadian project is due to cost factors that are not under the technical or managerial control of a proponent or policy maker. These "incompressible" costs include inflation rates, pipeline length, reservoir characteristics, climate-related plant efficiency, and shipping distance.[67]

McKinsey and Company find that reservoir characteristics account for a significant proportion of the overall cost difference (24 to 36 percent). Based on their estimates, 20 to 30 percent more wells are required per million tonne of annual production in Australia. Lower turbine efficiency due to higher air temperatures in Australia and a higher inflation rate account for 8 percent and 12 percent of the cost differential, respectively. The only advantage in Australia's favour is that the closer proximity to Japan reduces estimated costs by 4 percent.

The remaining differences in cost, which may be under either the proponent's or a policy maker's control (compressible costs), are attributable to the following main cost areas:

- Tax, including royalties, duties and tariffs, depreciation, capital allowances, and the carbon tax;
- Regulatory approval time expended, driven by tiers of compliance, approval process efficiency, etc.;
- Labour productivity, driven by availability of skilled personnel, work patterns, etc.;
- Service market maturity, including local supply chains, logistics and infrastructure; and
- Project optimization via lean design engineering and production, best-in-class contract management and best-in-class claims management.[68]

In Queensland, the cost increases for the LNG projects on Curtis Island have largely been attributed to expenditure on significant upstream gas gathering infrastructure required to source gas from inland coal seam fields.[69] Factors contributing to these costs are greater than originally anticipated and arise from poorer than expected well performance and larger costs associated with obtaining a "social licence to operate" and a mutually satisfactory land access arrangements with land owners.

There has also been costly plant duplication in the early planning and construction phases of the three Queensland projects that could have been avoided had proponents been prepared to negotiate in the lead-up to the FID on developing shared infrastructure such as jetties, pipelines, and storage facilities.[70] It has been suggested that because the proponents needed to approve projects with at least two trains to capture economies of scale in infrastructure sharing, there is an additional train being constructed on Curtis Island than is necessary to utilize gas reserves.[71] To what extent this has raised costs is unknown as none of the proponents has discussed the cost consequences of failing to better co-ordinate planning and construction at the three plants.

On the west coast, the cost of constructing facilities in environmentally sensitive areas has added significant costs to Australian projects. For example, the Gorgon project is located in an A Class nature reserve requiring strict adherence to environmental conditions, and the Wheatstone project is expected to incur A$1.5 billion in dredging cost due to the scale of the work required to meet strict environmental conditions.[72]

While the scope and location of plants are essentially the main drivers of high plant costs, an extensive range of factors has been put forward to explain why the costs of LNG projects have increased so much in Australia relative to elsewhere. These factors include the following:

[67] Ibid., p. 15.
[68] Ibid. pp. 13–14
[69] Songhurst, op. cit., p. 10.
[70] M. Chambers, "LNG Waste is Good for Bechtel," *The Australian*, May 8, 2014. http://www.theaustralian.com.au/business/lng-waste-is-good-news-for-bechtel/story-e6frg8zx-1226909484098#.
[71] Ibid.
[72] Songhurst, op. cit., p. 12.

- High level of the Australian dollar relative to the US dollar;
- High labour and material costs;
- Environmental regulations compliance and retrospective changes in requirements;
- Private, heritage and indigenous land rights;
- Poor reserve conversion and well productivity;
- Public opposition;
- Industrial relations and productivity issues;
- Taxation changes; and
- Resource nationalism.[73]

The Western Australian Parliamentary inquiry into FLNG categorized the reasons for the high costs of LNG projects differently. While in agreement on the relatively high Australian dollar, they found the high costs of projects were due to the following factors:

- Reservoir characteristics and climate-related plant efficiency;
- The remote and environmentally sensitive nature of development areas;
- The high cost of project engineering and management;
- The lack of supporting infrastructure; and
- Labour scarcity created by multiple projects being developed at the same time.[74]

The main challenges for new investment in LNG projects in Australia are seen by the sector to be spiralling development costs and associated issues of "red tape" and labour productivity, and increased international competition.[75] Another factor that has also had a significant bearing on project costs on the east and west coasts, but is not often referred to in discussions on factors contributing to the high cost of LNG projects, is the impact of extreme weather events (cyclones and bad weather) to which Australia is exposed. For example, extreme rainfall in late 2010 and early 2011, and in early 2013 led to slippage in project timelines for LNG projects at Gladstone in Queensland.[76] The Gorgon project on Barrow Island has also been subject to significant delays due to major weather events.[77]

[73] FACTS Global Energy cited in Smith and True, op. cit.

[74] Parliament of Western Australia, *The Economic Impact of Floating LNG on Western Australia Volume 2*, Economics and Industry Standing Committee, Legislative Assembly, May 2014, p. 311. http://www.parliament.wa.gov.au/parliament/commit.nsf/(Report+Lookup+by+Com+ID)/7852DE98B147B37748257CD9000883B6/$file/20140515+EISC+FLNG+Inquiry+Report+Volume+2.pdf.

[75] Macdonald-Smith and Parkinson, op. cit.

[76] Wood Mackenzie, "Wood Mackenzie Analyses Effects of Australia's Extreme Rainfall on Coal and Upstream Industries." Press Release, Energy, February 4, 2013. http://www.woodmacresearch.com/cgi-bin/wmprod/portal/corp/corpPressDetail.jsp?oid=11082752.

[77] Parliament of Western Australia, op. cit., pp. 299–300.

5.5 CONSEQUENCES OF COST PRESSURES

The most important consequences of project cost escalations include project cancellations and delays, and major concept revisions. Some of the more notable recent examples include:

- The planned fourth train expansion of Chevron's Gorgon project in Western Australia has been shelved.[78] The capital expenditure on the project has increased twice from an original US$37 billion to US$43 billion and is now estimated to be US$54 billion.[79] The plant is not expected to be producing LNG until the middle of 2015, which is almost a year later than planned.[80]
- Shell and PetroChina have indefinitely deferred their US$20 billion Arrow LNG Project in Queensland.[81]
- ExxonMobil Corporation and BHP Billiton received government approval in the fourth quarter of 2013 for an FLNG project for the Scarborough field offshore Western Australia.[82] BHP is reconsidering its support for the project.[83]
- Woodside Energy has delayed the start of the Browse venture in Western Australia to the second half of 2015 and switched to FLNG in response to a projected US$80 billion development cost for the originally planned onshore plant at James Price Point.
- Santos and GDF Suez have abandoned their proposed Bonaparte FLNG development in the Timor Sea. They are now considering brownfield options for gas in the Petrel, Tern, and Frigate fields in the Bonaparte Basin. Two of the most likely options are piping gas to Conoco Phillips' Darwin LNG or to the Ichthys LNG plant in Darwin.[84]
- BG Group's expansion of its QCLNG project in Queensland has been put on hold.[85]

In Table 3, the KPMG Global Energy Institute provides a useful perspective on the major cost issues in the Australian LNG sector and the potential opportunities to address them. Although the cost drivers identified by KPMG may all be categorized under Songhurst's main higher-level drivers – project scope and location – KPMG mainly focuses on factors more specific to issues relating to infrastructure, productivity, and government regulations and involvement.

While KPMG's "potential solutions" to these drivers are important at reducing costs, solutions in the form of changes in engineering approaches and technologies can play an important role. For example, there are specific opportunities to address the issue of high LNG plant costs that include:

- Selecting barge mounted liquefaction plant that is constructed in a low cost and highly productive shipyard;
- Adopting alternative liquefaction processes and engaging new engineering, procurement, and construction contractors;
- Reducing the number of contracts by simplifying contracting strategies;
- Supporting competition in the provision of refrigeration compressors and drivers; and
- Collaborating on infrastructure provision and use, and taking advantage of synergies where projects are being developed in close proximity.[86]

[78] Songhurst, op. cit., p. 25.
[79] P. Klinger, "Minister Says Unions Forced LNG Offshore," *West Australian*, April 9, 2014. https://au.news.yahoo.com/thewest/business/wa/a/22491379/minister-says-unions-forced-lng-offshore/; J. Hewett, "LNG Calculations May be Costly," *Australian Financial Review*, April 7, 2014; Macdonald-Smith, "US LNG to Undercut Gorgon by 30pc: JPMorgan," op. cit.
[80] Macdonald-Smith and Parkinson, op. cit.
[81] Macdonald-Smith, "US LNG to Undercut Gorgon by 30pc: JPMorgan," op. cit.
[82] FACTS, cited in Smith and True, op. cit.
[83] Macdonald-Smith, "US LNG to Undercut Gorgon by 30pc: JPMorgan," op. cit.
[84] P. Klinger, "GDF, Santos Go Cold in Bonaparte," *West Australian*, June 20, 2014, p. 81.
[85] Macdonald-Smith, "Capex Crunch to Hit 'Marginal' LNG," op. cit.
[86] Songhurst, op. cit., p. 27.

Table 3. KPMG Global Energy Institute framing of Australian LNG issues and potential solutions

Issue	Cost driver	Potential solution
Escalation of workforce cost – 50 percent increase in cost per hour from FID to completion	• Skills shortage • Remote location • Poor labour contracts and union relations	• Workforce planning • Change management • Productivity analysis and management • Long-term union agreements
Contractors' inability to deliver requirements in a cost effective and timely manner	• Complexities of project • Size of contracts • Local content requirements	• Due diligence of contractors • Collaborative contracting model • Real time cost audits
Supply chain/logistics challenges are underestimated	• Remote locations • Lack of infrastructure to support • Multiple users	• Stakeholder engagement • Effective upfront planning
Regulatory burden	• Federal/state duplication • Multiple approvals between agencies • Environmental concerns	• Co-ordinated government management plan • Lobby government for efficiencies
Lack of infrastructure	• Complexity (ports, roads, rail, pipelines, storage, etc.) • Multiple ownership and responsibility	• Co-ordination between different joint ventures/projects • Government engagement to drive common infrastructure
Passive government engagement on key issues	• Slow approval process • No "big picture" plan on multiple user facilities and field development • Community has difficulty understanding project implications • Underestimation by project proponents of scale of engagement required	• Government management plan • Better upfront community engagement

Source: KPMG Global Energy Institute, Major LNG projects: Navigating the New Terrain, p. 11

AUSTRALIA'S RESPONSES TO COST PRESSURES

Australia's response to the escalation in LNG project costs has mainly focused on trying to address cost drivers through engineering/technology solutions, activities to enhance labour productivity, and changes to the regulatory regime.

6.1 FLOATING LIQUID NATURAL GAS

LNG Floating, Production, Storage, and Offloading vessels (LNG FPSO) or, alternatively, Floating Liquid Natural Gas plants (FLNG) are offshore vessels that produce LNG. The LNG is supplied directly to carrier vessels for transportation to customers. FLNG is a response by the sector to excessively high land-based LNG project costs, especially as the facilities can be manufactured in locations outside of Australia, such as South Korea. There are currently no FLNG liquefaction plants in operation anywhere in the world. However, a 0.5 mtpa FLNG plant is scheduled for operation off the coast of Colombia in mid 2015, followed by a 1–2 mtpa plant off the coast of Malaysia in late 2015, and the 3.6 mtpa Prelude plant off the coast of Western Australia is planned to begin operation in 2017.[87]

FLNG potentially provides greater flexibility in developing gas resources, which may in turn allow some costs to be reduced and, therefore, may be more cost effective than a land-based project.[88] It can also avoid costs associated with "securing land such as native title, environmental and other approvals."[89] While FLNG may be advantageous to the sector, the Western Australian inquiry into FLNG found that its adoption would have a significant detrimental impact on employment in oil and gas construction activities.

Although some proponents of investment in Australian LNG plants have become more cautious about adopting FLNG, [90] it is being seriously considered as an option for reducing the cost of projects. All currently proposed projects in the west and northwest of Australia are FLNG:

- Shell's US$12 billion Prelude venture, Australia's first FLNG plant, is due to open in 2017.
- Woodside's Browse project, with FID expected in the second half of 2015.
- PTTEP (PTT Exploration and Production – Thailand's national petroleum exploration and production company) is considering FLNG for the Cash Maple venture.
- ExxonMobil and BHP Billiton are tentatively considering FLNG for the Scarborough reserve.[91]

While the Prelude FLNG project is as competitive as the Gorgon and Wheatstone onshore plants in Western Australia and is more competitive than the Ichthys plant in the north, it is not as competitive as the plants being

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[87] S. Weeden, "Shell's Prelude Development Opens FLNG Floodgate," *E&P*, April 2, 2014. http://www.epmag.com/Technology-Operations/Shells-Prelude-Development-Opens-FLNG-Floodgate_131704.

[88] INPEX Operations Australia Pty Ltd, cited in Parliament of Western Australia, *The Economic Impact of Floating LNG on Western Australia Volume 2* (Economics and Industry Standing Committee, Legislative Assembly May 2014), p. 293. http://www.parliament.wa.gov.au/parliament/commit.nsf/(Report+Lookup+by+Com+ID)/7852DE98B147B37748257CD9000883B6/$file/20140515+EISC+FLNG+Inquiry+Report+Volume+2.pdf.

[89] Department of State Development, cited in Parliament of Western Australia, *The Economic Impact of Floating LNG on Western Australia Volume 2* (Economics and Industry Standing Committee, Legislative Assembly May 2014), p. 293. http://www.parliament.wa.gov.au/parliament/commit.nsf/(Report+Lookup+by+Com+ID)/7852DE98B147B37748257CD9000883B6/$file/20140515+EISC+FLNG+Inquiry+Report+Volume+2.pdf.

[90] Macdonald-Smith, "US LNG to Undercut Gorgon by 30pc: JPMorgan," op. cit.

[91] E. Chantiri, "Floating LNG Comes of Age," *Australian Financial Review*, April 7, 2014; Russell, "Floating LNG is Australia's Future, but Not a Miracle Cost Cure," op. cit.

constructed on the east coast in Queensland.[92] A key advantage of FLNG, as the Prelude project demonstrates, is that gas located in smaller, stranded fields may be competitively commercialized through this technology. Thus, FLNG offers options that might otherwise not be realized if a conventional platform and extensive pipeline infrastructure to an onshore plant were constructed.[93] The consideration of an FLNG option by the Scarborough venture reflects this important attribute of the technology. In the case of the Browse project, the motivation for considering FLNG is more likely to be underpinned by the large cost escalations and environmental objections relating to the land-based option.[94]

There are many reasons put forward for why FLNG should be adopted in Australia to address the LNG project cost issue. FLNG allows proponents to de-risk potential labour productivity issues as they can be built in labour cost-effective countries. Notwithstanding the relative newness of the technology and its complexity, which should reduce overtime, it avoids costly infrastructure such as pipelines, harbour facilities, and roads.[95] As well as avoiding the expensive construction of onshore plant and the many environmental conditions of a land-based plant, FLNG may also avoid domestic gas reservation requirements[96] and the eventual decommissioning costs associated with an onshore facility.[97] Woodside Petroleum chairman Michael Chaney recently stated that the adoption of FLNG would allow capital expenditures to be phased in, reduce construction costs by containing most of them in the shipyard, and improve returns and tax revenues through earlier and more certain cash flows.[98]

While many solutions have, and are, being proposed to deal with cost pressures, it is insightful to reflect on a comment from the West Australian inquiry into FLNG:

> It is unfortunate that, for commercial confidentiality reasons, companies did not feel able to provide the Committee with evidence of their own costs of doing business in Australia. This has made it difficult for the Committee to make detailed assessments of statements relating to the cost drivers affecting development decisions.[99]

As evidenced by Santos and GDF Suez abandoning their proposed Bonaparte FLNG development, the viability of FLNG will depend on how cost effective it is compared to a brownfield development.

Notwithstanding the difficulty in identifying "actual" cost drivers, two areas in addition to FLNG that are being given prominence in reducing LNG project costs are improvements in labour productivity and regulatory regimes.

6.2 ADDRESSING LABOUR COSTS, WORKPLACE RELATIONS, AND TRAINING

Skilled labour scarcity due to the large number of projects under development at once, together with substantial construction activity in the mining sector, has affected the productivity of the LNG sector.[100] It has been stated that to deliver a LNG project in Australia requires 35 percent more labour inputs than in the US.[101] Furthermore, McKinsey and Company indicated that project management practices account for 12 percent of cost gap between and Australian and Canadian unconventional gas LNG project (refer to figure 17). Overlaying the challenge of managing labour costs is the issue of labour and industrial relations and workplace flexibility.

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[92] Russell, "Floating LNG is Australia's Future, but Not a Miracle Cost Cure," op. cit.
[93] Ibid.
[94] Ibid.
[95] Macdonald-Smith, "US LNG to Undercut Gorgon by 30pc: JPMorgan," op. cit.
[96] E. Chantiri, "Jobs Under Threat from Liquid Boom," *Australian Financial Review*, April 7, 2014.
[97] Gray, op. cit.
[98] A. Burrell, "FLNG Will Deliver on Costs: Chaney," *The Australian*, April 8, 2014. http://www.theaustralian.com.au/business/mining-energy/flng-will-deliver-on-costs-michael-chaney/story-e6frg9df-1226877193518#.
[99] Parliament of Western Australia, *The Economic Impact of Floating LNG on Western Australia Volume 2*, op. cit., p. 295.
[100] Ibid., p. 311.
[101] Chamber of Minerals and Energy of Western Australia, cited in Parliament of Western Australia, *The Economic Impact of Floating LNG on Western Australia Volume,* op. cit., p. 297.

LABOUR COSTS

Labour costs are seen as an important determinant of the viability of future LNG projects globally.[102] Hays Oil and Gas Global Salary Guide 2013 placed Australia and Norway first and second, respectively, for both local average annual salary and imported average annual salary in the sector in 2013.[103] High labour costs in both countries were attributed to "limited skilled labour pools and significant workloads." LNG proponents argue for the scope to set wages and conditions that reflect changing investment conditions and, hence, the competitiveness of a project.[104] In particular, project proponents would like labour agreements that cover the life of the project, thus avoiding the need for renegotiation, which can be problematic as the relative negotiating position of labour and unions increases the closer to the completion of the project. Such long-term agreements cannot take place under current workplace arrangements in Australia and the Australian Government has undertaken not to change existing arrangements.[105]

The Australian Worker's Union has responded to claims that salaries and conditions in the sector are too high by pointing out that cost "blowouts" attributed to labour arise from increases in the numbers of employees required on projects above what was originally expected.[106] Further, the Business Council of Australia acknowledges that planning, design, scheduling, and procurement problems have affected labour costs and resulted in unsatisfactory productivity for Australian projects.[107] They partially attribute the cause of inadequate project execution to overly optimistic project scheduling and scarcity of suitably qualified and experienced project managers, engineers, and other key occupations.[108] The BCA stated:

> The upshot is that Australian oil and gas companies, in particular, had to employ more engineering and project management people to correct for early mistakes. This led to more reworks in the construction phase, which partly explains why construction labour costs have been higher in Australia than elsewhere.[109]

The current skills shortage in the oil and gas sector is expected to continue due to increasing requirements for skills and labour for projects globally.[110] A shortage in skills and an aging workforce are the two main factors giving rise to risks associated with workforce services during a major LNG development project.

WORKPLACE RELATIONS

The workplace relations framework, established by the *Fair Work Act 2009* and other workplace laws, are often seen by industry as adding to the challenges and costs encountered in operating in remote locations.[111] This framework sets out minimum terms and conditions of employment, a system of enterprise-level collective bargaining, the provision of flexibility arrangements for individuals, protections for unfair or unlawful dismissal, and the protection of the freedom to choose or not a third party representative for workplace matters.[112] Enterprise agreements

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[102] Macdonald-Smith, US LNG to undercut Gorgon by 30pc: JPMorgan, op. cit.

[103] Hays, Oil & Gas Global Salary Guide 2013, p. 6. http://www.hays.com.au/cs/groups/hays_common/@au/@content/documents/digitalasset/hays_089071.pdf

[104] Greber, op. cit.

[105] Burrell, op. cit..

[106] Stephen Price, Australian Worker's Union, cited in Parliament of Western Australia, *The Economic Impact of Floating LNG on Western Australia Volume 2*, , op. cit., p. 306.

[107] Business Council of Australia, *Securing Investment in Australia's Future: Managing the Economic Transition. Report of the Project Costs Task Force*, August 2013, pp. 23–24. http://www.bca.com.au/publications/securing-investment-in-australias-future.

[108] Ibid., p.23.

[109] Ibid., p.24.

[110] K. Becker and M. Smidt, *Workforce Related Project Risks: Findings Report*. Air Energi and Queensland University of Technology, January 31, 2014. http://www.airenergi.com/sites/default/files/brochures/prep.pdf.

[111] Business Council of Australia, op. cit., pp. 35–36.

[112] Maher, S. "Resource deals 'will make us miss out'". The Australian, April 7, 2014. http://www.theaustralian.com.au/national-affairs/industrial-relations/resource-deals-will-make-us-miss-out-says-industry/story-fn59noo3-1226876176743.

covering employment and workplace conditions are only permitted to run for maximum of four years, which is less than the time taken to complete a LNG project.[113] The average construction time for a LNG project in Australia is more than five years.[114]

The sector's industry representative body, the Australian Petroleum Production and Exploration Association (APPEA), considers Australia's industrial relations legislation a problem. APPEA proposes that enterprise agreements should take account of each project's economic circumstances and be benchmarked for international competitiveness, as these measures would prevent the most recent deal struck from automatically becoming the minimum standard for the next negotiation.[115]

The Australian Government is endeavouring to make amendments to the *Fair Work Act 2009*. The proposed amendments encompass some of the outstanding recommendations from a previous review of the Act in 2012 and implement election commitments made by the Liberal-National Coalition prior to last year's election. The main amendments concern "greenfield agreements, union right of entry and individual flexibility arrangements in modern awards and enterprise agreements" that may go some way towards meeting the changes desired by industry.[116] Further, in response to concerns, the Australian Government is launching a Productivity Commission inquiry into industrial relations that will entail a "comprehensive and broad review of the laws" relating to workplace relations,[117] and that is expected to report in 2015.[118]

Related to both labour costs and workplace relations is the extent to which Australia allows overseas skilled persons entry to work for an approved employer. The present program allows for a temporary work visa (subclass 457) of up to four years. The 457 program provides employers with the ability to employ overseas workers on a temporary basis in cases of genuine skills shortages (where there is no suitably qualified Australian worker available) at the prevailing conditions under existing workplace agreements. The large number of capital projects under construction in the Australian resources sector in recent years, the small size of Australia's labour market and lack of people with specialist skills, such as program managers and engineers, has made the 457 visa program an important means to deliver on project deadlines and required work standards.[119] As of September 30, 2013, almost one percent of the total Australian labour force comprised primary 457 visa holders.[120]

The Australian Government is seeking to repeal legislation concerning offshore oil and gas workers (the *Offshore Resources Activity Act*) that came into effect at the end of June this year.[121] The Act requires all foreign workers employed in offshore oil and gas activities to have a 457 visa. Although the Department of Immigration and Border Protection is streamlining the 457 visa process, the oil and gas industry has expressed frustration with the length of time required for processing visa applications.[122]

In terms of domestic labour demand, the Australian Workplace and Productivity Agency has observed that:

> There is a high level of demand for technical personnel in oil and gas plant process operations and maintenance, and for supervisors with appropriate levels of technical and safety experience and front-line management skills,

[113] Hewett, op. cit.
[114] Maher (2014).
[115] Ibid.
[116] Department of Parliamentary Services, *Fair Work Amendment Bill 2014*. Bills Digest 52, 2013–14. Canberra: Parliamentary Library, p. 2.
[117] http://www.abc.net.au/am/content/2014/s3958635.htm.
[118] Maher, op. cit.
[119] Business Council of Australia, op. cit.
[120] G. Larsen, *The Subclass 457 Visa: A Quick Guide* (Place: Parliamentary Library, November 11, 2013). http://parlinfo.aph.gov.au/parlInfo/download/library/prspub/2840657/upload_binary/2840657.pdf;fileType=application/pdf.
[121] Australian Workforce and Productivity Agency. Resource Sector Skills Needs 2013. (2013). http://www.awpa.gov.au/publications/Documents/Resources%20sector%20skills%20needs%202013%20final.pdf.
[122] APPEA (2013), p. 36.

> but these skills are difficult to source, especially in the domestic labour market. One estimate suggests that between 180 and 500 process operators are currently available in Australia, and this number will have to increase to between 1,500 and 3,000 over the next 10 years. A range of approaches will be required to access these skills.[123]

Fly-in, fly-out (FIFO) arrangements have increasingly been used in the sector to contribute to greater flexibility in managing the workforce and as a "largely effective" solution to satisfying labour requirements in remote locations during the project construction phase.[124] Flexibility is also achieved through shift lengths and patterns, which vary considerably among projects. Historically, oil and gas extraction projects have sourced their operational workforces mostly from local regional communities. FIFO camps are "now being utilised to provide a permanent operational workforce adjacent to established regional towns" as sites become more remote and "the number of skilled, professional and middle management workers becomes more difficult to source."[125] While FIFO workers help overcome labour shortages, there are downsides to not investing in housing and community services. First, in communities close to large projects housing costs have increased dramatically that impose substantial burdens on those who need to rent or buy accommodation and are not associated with the gas projects; second, many workers fail to actively engage in the communities nearby in ways they would if they lived at the location; and third, the workers themselves, their families, and their communities can suffer from the dislocation caused by FIFO arrangements.[126]

TRAINING

Industry is tackling the skills shortage through up-skilling the workforce, removing inefficiencies, and providing world-class training and research.[127] There are several firm-specific initiatives aimed at increasing skills in the workforce:

- Woodside Energy has an academy that provides technical training to safety critical operations and maintenance roles across onshore and offshore production facilities.
- Santos has a training centre specializing in coal seam gas and transmission pipelines in Queensland (Coal Seam Gas and Gas Transmissions Pipeline Operations Training Centre).
- Chevron Australia in partnership with Challenger Institute's Australian Centre for Energy Process Training runs a "Women in Engineering" program to transition women into the energy sector.
- GE Oil and Gas established the GE Skills Development Centre in Western Australia to deliver engineering and leadership training.[128]

Industry has also collaborated with other parties to improve skills in the sector. Maritime employers and the Maritime Union of Australia jointly established Maritime Employees Training Limited, which provides training for workers in the maritime sector who want to work in the oil and gas industry. An example of a collaborative between industry and governments is the establishment of the Australian Centre for Energy and Process Training, which includes a fully operational process train that has plant, equipment, and expertise that meet industry standards.[129]

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[123] Australian Workforce and Productivity Agency (2013), p. 152.
[124] Ibid. p. 164.
[125] Skills Australia, 2011, cited in ibid. p. 165.
[126] V. Meredith, P. Rush, and E. Robinson. "Fly-in Fly-out Workplace Practices in Australia: The Effects on Children and Family Relationships," Child Family Community Australia, Paper no. 19 (2014). http://www.aifs.gov.au/cfca/pubs/papers/a146119/cfca19.pdf.
[127] APPEA (2013), op. cit., p. 5.
[128] Australian Workforce and Productivity Agency, op. cit., p.148.
[129] APPEA (2013), op. cit p. 5; Australian Workforce and Productivity Agency, op cit., p. 151.

The oil and gas industry has also collaborated with the tertiary education sector to deliver industry specific qualifications:

- Woodside sponsors the University of Western Australia's School of Oil and Gas Engineering.
- Santos sponsors the University of Adelaide's Australian School of Petroleum.
- Shell has an FLNG Training Consortium initiative with Curtin University and the Australian Centre for Energy and Process Training.[130]

In addition to these collaborations with educational providers, vocational and higher education skills are provided by the University of New South Wales School of Petroleum Engineering and the North Australian Centre for Oil and Gas at Charles Darwin University. The North Australian Centre for Oil and Gas was established to provide cutting-edge research relating to the oil and gas sector.[131]

Cross-state training initiatives are important for labour mobility and to make as effective as possible the federal funding per student provided to state institutions. In an attempt to improve the efficiency of the industry, two programs have been developed to standardize outcomes and eliminate duplication in safety training across Australia: the Common Safety Training Program and the Safe Supervisor Competence Program.[132] Both initiatives are intended to overcome state-level regulations that make it difficult for skilled labour to work across states and territories.

Six broad categories of workforce risk have been identified during the various phases of a major LNG project:

- Compliance – includes meeting the legal requirements of local, national, and international legislation, as well as internal organizational policies;
- Recruitment – accessing and securing the appropriate talent efficiently and systematically;
- Onboarding and induction – encompasses a wide range of tasks such as introductions and general orientation and also transmission of company culture;
- Reassignment and demobilization – the most fragile and highest risk area in terms of resources and time invested, relying as it does on contract workers to effectively complete a project;
- Retention – vital for a variety of reasons, such as justifying training expenditure, nurturing expertise and retaining knowledge; and
- Project appeal – factors such as project duration, remuneration and benefits, location, employer brand, roster, and project phase can all have a major impact.[133]

These workplace or "people" risks are seen as major challenges for Australian oil and gas projects across most professional and managerial roles. While this situation is not unique to Australia, the relatively small amount of domestic expertise in the domestic oil and gas sector can have a major impact on schedules and costs.[134] Addressing these risks will be important for improving the productivity of future projects.

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[130] Australian Workforce and Productivity Agency, op cit.. pp. 151, 165.

[131] APPEA (2013), op. cit., p. 5.

[132] Ibid.

[133] M. Smith, "Understanding People Risk – Part Two." *LNG Industry*, June 13, 2014. http://www.lngindustry.com/news/special-reports/articles/Understanding_people_risk_Part_Two_759.aspx#.U56JeT5--Uk; Becker and Smidt, op. cit., p. 16.

[134] Becker and Smidt, op. cit., p. 4.

6.3 IMPROVING REGULATION

The regulatory regimes applying to resource development activities have a strong impact on the investment environment for Australian LNG projects. Some of these regulations include:

- Schemes for the licensing of applicants to explore for, and to produce, the state's resources;
- Environmental, planning, and occupational health and safety regulation; and
- Taxation of the resource development.[135]

Australia's mineral and petroleum resources are owned by the state, which, on behalf of the community, exploits and administers the property rights it grants to the private sector to undertake exploration, development, and production activities.[136] Australia's federal system of government divides powers between the Australia's federal, state, and territory governments. With respect to petroleum resources, the state and territory governments are responsible for decisions concerning the release, award, and management of oil and gas acreage and tenements located onshore and in coastal waters up to three nautical miles offshore.[137] Consequently, there is a range of regulatory systems and a disparity of regulations across state and territory jurisdictions relating to onshore and coastal waters petroleum exploration and development activities.[138]

Among the key challenges to competitive project development raised by the sector are:

> delays and failures in long approvals processes, ongoing compliance requirements, and increasing levels of duplication in approvals processes across the different levels of government (or "red tape").[139]

The recent inquiry into FLNG in Western Australia received "considerable evidence" from the oil and gas sector that Australia's development assessment and approval (DAA) processes were "overly complex, inefficient, unpredictable and duplicative."[140] The Chamber of Minerals and Energy of Western Australia stated that:

> inconsistency and inefficiencies in environmental approval requirements "add significant uncertainty around the approval processes, and it can also have a significant impact on project economics through project delays, production delays and ongoing compliance costs."[141]

The DAA regulations aim to promote the safe and orderly development of projects and mitigate and manage any impacts on community wellbeing, including environmental, heritage, and amenity values.[142] The Australian Productivity Commission reviewed the regulations in depth last year. The Commission's report on *Major Project Development Assessment Processes* identifies 19 Commonwealth laws administered by six federal agencies or authorities that affect major projects. This legislation relates to the following areas:

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[135] A. St John, *Resource Development and Landowners' Rights: A Quick Guide*. Parliamentary Library, Department of Parliamentary Services, Research Paper Series, 2013-14, March 5, 2014, p. 1. http://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/rp/rp1314/QG/ResourceDevelopment.

[136] T. Hunter, "The Offshore Petroleum Regulatory Frameworks of Australia and Norway," *Oil, Gas & Energy Law Intelligence* 8, no. 4 (2010): p. 3.

[137] Department of Industry and BREE, op. cit., p. 98.

[138] See for example, N. De Silva, "Shale Gas Development Challenges and Policy Implications." Presentation. http://www.pir.sa.gov.au/__data/assets/pdf_file/0009/214938/UCL_-_Navinda_De_Silva.pdf; Victorian Gas Market Task Force, *Supplementary Report*. Place: Victorian Government, October 2013. http://www.energyandresources.vic.gov.au/__data/assets/pdf_file/0018/205470/Victorian-Gas-Market-Taskforce-Supplementary-Report-October-2013.pdf.

[139] Chamber of Minerals and Energy of Western Australia, citied in Parliament of Western Australia, *The Economic Impact of Floating LNG on Western Australia Volume 2*, op. cit., p. 294.

[140] Australian Productivity Commission. Major Project Development Assessment Processes. Canberra, 2013. http://www.pc.gov.au/projects/study/major-projects/report.

[141] Ibid. p. 323.

[142] Australian Productivity Commission (2013), p. 85.

- Six, environmental;
- Five, heritage;
- Four, petroleum and pipelines;
- Two, native title and land rights;
- One, airports; and
- One, fisheries management.

Duplication is seen as a general problem with approval processes given the division of responsibilities between different levels of government. The Productivity Commission outlines the division of responsibilities for major projects between governments as follows:

While the precise division of responsibilities between levels of government varies between jurisdictions, broadly speaking:

- The Australian Government regulates matters of national environmental significance, certain heritage matters, developments on Commonwealth land (such as some airports and defence facilities) and waters beyond the three nautical mile limit, and certain actions by Commonwealth agencies.
- State and Territory Governments have the ability to legislate on a broad range of matters, including the environment and cultural and natural heritage.
- Local governments normally implement and enforce much of the state planning and development legislation. Major projects are usually assessed and approved at the state level, bypassing local government. However, local governments often have a range of other responsibilities, such as granting permits (including "secondary approvals") within their jurisdiction.

This division of responsibilities broadly reflects the subsidiary principle. This principle states that "policy development, program delivery and decision making should be the responsibility of the level of government best placed to deliver agreed outcomes." [143]

The primary piece of Commonwealth legislation that covers matters of national environmental significance is the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and subsequent amendments.[144] The Australian Government is taking measures to reduce duplication relating to environmental approvals for projects in state and territory jurisdictions through a commitment to a "one-stop shop" that will "create a single environmental assessment and approval process for nationally protected matters."[145] This is strongly supported by the Mineral Council of Australia, which, based on evidence from a study it commissioned, claims that a one-year reduction in delays in processing approvals for resources projects would raise Australia's GDP by $160 billon and create an extra 69,000 jobs by 2015.[146] An amendment bill to the EPBC Act is currently before the Australian Senate that would allow states and territories to approve "large coal seam gas developments likely to have a significant impact on a water resources" under bilateral agreements with the Commonwealth.[147]

[143] Ibid. p. 66.
[144] Department of the Environment, "EPBC Act – Frequently asked questions," Commonwealth of Australia, 2013. http://www.environment.gov.au/system/files/resources/0de020d9-1c03-40d3-adb2-54710b97dbac/files/epbc-act-fact-sheet_2.pdf.
[145] Department of the Environment, "'One Stop Shop' for Environmental Approvals," http://www.environment.gov.au/topics/about-us/legislation/environment-protection-and-biodiversity-conservation-act-1999/one-stop.
[146] BAEconomics, *The Economic Gains from Streamlining the Process of Resource Projects Approval*, August 18, 2014. http://www.minerals.org.au/file_upload/files/reports/BAEconomics_Gains_from_reduced_delays_18_Aug_2014.pdf.
[147] Parliament of Australia, *Environment Protection and Biodiversity Conservation Amendment (Bilateral Agreement Implementation) Bill 2014*. http://www.aph.gov.au/Parliamentary_Business/Bills_Legislation/Bills_Search_Results/Result?bId=r5231

The possible effects of the one-stop shop initiative are highlighted by the "bund wall" incident in Gladstone Harbour where the three Queensland LNG facilities are under construction. Gladstone Ports Corporation has approvals for the Port of Gladstone Western Basin Strategic Dredging and Disposal Project, which will remove and dispose of a maximum of 46 million cubic metres of dredge soil both offshore and within a constructed reclamation area.[148] The project is being undertaken to facilitate increased shipping associated with increasing industrial activity in the area, including three LNG projects.[149] This project was approved under Queensland law, and under the EPBC Act.

Between June 2011 and July 2012 concerns emerged about the health of the Gladstone Port and the performance of the bund wall that was built to hold dredged soil. In response to a request from the World Heritage Committee, the Australian Government commissioned an independent review of the environmental management and governance of the Port of Gladstone. The review, released in 2014, found several deficiencies in the Australian Government's actions that were compounded by a fragmented framework of Australian and Queensland government regulation. These deficiencies included:

- Inconsistencies in decision-making processes;
- Inadequate resources applied to compliance monitoring, including poor record keeping and Inadequate follow-up when breach allegations persisted; and
- Lack of coordination between the jurisdictions, particularly on compliance monitoring.[150]

The one-stop shop initiative, with appropriate resourcing and oversight, may address these types of issues. It is also seen by industry as an important step in reducing duplication,[151] and it is consistent with the Australian Government's establishment of NOPSEMA as the agency solely responsible for petroleum and greenhouse gas environment regulation in Commonwealth offshore waters.[152]

Of the many regulatory systems relating to petroleum exploration and development activities across Australia's states and territories, South Australia's is regarded as a "best practice" legislative and regulatory frameworks for petroleum exploration and development.[153] Goldstein et al. (2013) state that, "leading practice regulation starts with well-considered legislated objectives that drive the behaviour of both industry and regulators."[154] They identify six principles that provide the "foundations for regulation that consistently meet community expectations":

- Certainty: the regulatory objectives are uniform, clear, and predictable for all stakeholders;
- Openness: Stakeholders are appropriately consulted on the establishment of the regulatory objectives and information on outcomes is publicly available;
- Transparency: The regulatory decision-making processes are visible and comprehensible to all stakeholders and industry performance in terms of compliance with the regulatory objectives is clear to all stakeholders;
- Flexibility: The level of regulatory scrutiny, surveillance and enforcement needed to ensure compliance is determined on the basis of individual company compliance capability and the outcomes to be achieved;

[148] Department of the Environment, *Independent Review of the Bund Wall at the Port of Gladstone* (2014), p. vii.
[149] Department of the Environment, *Independent Review of the Port of Gladstone* (2013), pp. 9–10.
[150] Department of the Environment, *Independent Review of the Bund Wall at the Port of Gladstone*, op. cit., p. viii.
[151] Parliament of Western Australia, *The Economic Impact of Floating LNG on Western Australia Volume 2*, op. cit., p. 326.
[152] Ibid. p. 327.
[153] Australian Productivity Commission, op. cit., p. 286; T. Hunter and M. Taylor, *Regulatory Best Practice for Coal Seam Gas in Queensland: A Briefing Paper* (Place of publication: Centre for International Minerals and Energy Law, University of Queensland, 2013).
[154] B. Goldstein, M. Malavazos, and A. Wickham, "Leading Practice Gas Regulation." *Bureau of Resources and Energy Economics Gas Market Report* (2013): 67–84.

- Practicality: The regulatory objectives are achievable and measurable. Hand in hand with the flexibility principle and the objective based legislation this also means that licensees are able to innovate to use the most effective technologies and practices to achieve the best outcomes; and
- Efficiency: The compliance costs imposed on both government and the licensee by the regulatory requirements are minimized and justified. Negative impacts on communities are minimised, and licensees remain liable for the cost of their impacts. Furthermore, an appropriate rent (royalty) is paid to the community from the value realized from the development and production of its natural resources.[155]

South Australia's legislative and regulatory frameworks for petroleum exploration and development encompass a range of initiatives that most closely align with these principles. The Department of State Development (DSD) is responsible for administering petroleum exploration and development activities in South Australia.[156] The *South Australian Petroleum and Geothermal Energy Act 2000* is the legislation applicable to onshore activities. It possesses the following high-level objectives that aim to increase certainty for business and satisfy public expectations that community interests are being protected:

- Sustain trusted practical, efficient, effective and flexible regulation for upstream petroleum, geothermal and gas storage enterprises, and the construction and operation of transmission pipelines in the state;
- Encourage and maintain competition in the upstream petroleum and geothermal sectors;
- Minimise environmental damage from activities and protect the public from risks inherent in petroleum and geothermal operations;
- Sustain effective consultation processes with people affected by regulated activities, and the public in general; and
- Ensure as far as reasonably practicable the security of supply of natural gas.[157]

DSD has gained some key knowledge from its experiences.[158] Investigating serious incidents has shown that "regulators must have relevant and up-to-date capabilities (competence and capacity) to be trusted to act in the interests of the public in protecting natural, social and economic environments during upstream petroleum industry activities." Further, regulators must effectively manage the risks of regulatory capture. DSD has found that a one-stop shop or lead agency approach that is properly resourced enables a more effective approvals process for applications, and that "transparently facilitate[s] the delivery of all co-regulatory objectives and requirements."[159] This approach has been important for producing the necessary collaboration and working arrangements between government agencies. It has also helped to achieve consistency between the regulatory objectives concerning the Statements of Environmental Objectives and the relevant objects of 13 pieces of legislation.[160]

There has also been considerable work undertaken by Australian governments collectively in developing leading practice regulation. For example, The National Harmonised Regulatory Framework for Natural Gas from Coal Seams provides guidance on best practice legislative and regulatory settings underpinned by a shared commitment..."between the resources industry, other land users, local communities and governments to multiple, merit-based and sequential land use that provides certainty for industry and improved community confidence in land use decision-making."[161]

[155] Ibid., p. 67.
[156] This department changed its name from the Department for Manufacturing, Innovation, Trade, Resources and Energy (DMITRE) on July 1, 2014.
[157] Goldstein et al., op. cit., p. 68.
[158] Ibid., p. 69.
[159] Ibid.
[160] Ibid.
[161] Standing Council on Energy and Resources, *The National Harmonised Regulatory Framework for Natural Gas from Coal Seams* (Place: Publisher, 2013), p. 6. http://www.scer.gov.au/files/2013/09/National-Harmonised-Regulatory-Framework-for-Natural-Gas-from-Coal-Seams.pdf.

COMMUNITY CONCERNS

The principle of co-existence recognises that if Australia is to gain the benefits from the extraction and export of natural gas, the industry's social licence and community confidence must be secured. In 2011, conflict over the impact of coal seam gas (CSG) activities on existing land use reached such a level in New South Wales that the Government imposed a 60-day moratorium on issuing CSG licences to allow for guidelines relating to CSG activities to be tightened up.[162] An illustration of the community concerns over CSG development in New South Wales is shown by the events surrounding the planned drilling at Bentley in May 2014 by the gas junior Metgasco. Some 1,000 protesters manned a continuous blockade on the property where the drilling was planned. To allow the drilling, the New South Wales Police had planned to deploy 800 officers. However two days before the drilling was to take place the New South Wales government withdrew the drilling approval, citing that the company had failed in its obligations to properly undertake community consultations. As noted by Matthew Stevens of the *Australian Financial Review*,

> the fragility of the drillers' grip on any sort of community mandate was highlighted in a telling recent analysis…by Credit Suisse. The report concluded that…negative sentiment over the potential [that] drilling might damage local water systems continued to grow and that "widespread organised opposition" posed a "significant risk to the project in the near term."[163]

While the greatest concerns exist over CSG developments in eastern Australia, a broad range of environmental concerns influence community views nationwide. Overall, Australia has developed

> strong industry support for the role of a "social licence to operate" as a complement to the regulatory licence issued by government. From an industry perspective a social licence to operate is about operating in a manner that is attuned to community expectations and which acknowledges that businesses have a shared responsibility with government and society, to help facilitate the development of strong and sustainable communities.[164]

Furthermore,

> [t]aking societal perspectives into account in planning, developing and implementing an operation is seen as necessary to reduce the risks associated with societal resistance. Such resistance could affect a company's profitability directly, through delays in production, or more indirectly, through lowering its reputation or through governments instituting higher levels of regulation.[165]

It would seem, therefore, that trust is a key element in securing a social licence to operate.[166] The social licence to operate, however, is not only limited to onshore gas fields. For instance, the onshore LNG processing precinct slated for development at James Price Point in Western Australia encountered strong resistance from environmentalists and some sections of both Traditional Owners and the wider Kimberley indigenous community. A case brought to the Western Australian Supreme Court by the Wilderness Society and a Goolaraboolo man resulted in the finding that the environmental approvals made by the State's Environmental Protection Agency were unlawful due to

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[162] T. Poise, "Coal Seam Gas Exploration and Production in New South Wales: The Case for Better Strategic Planning and More Stringent Regulation," *Environmental and Planning Law Journal* 29 (2012): 129–51.
[163] M. Stevens, "How Metgasco Lost its Bid to Drill in Bentley," *Australian Financial Review*, July 26–27, 2014: 1.
[164] J. Williams, A. Milligan, and T. Stubbs. "Coal Seam Gas Production: Challenges and Opportunities," *Gas Market Report 2013*. Canberra: Bureau of Resources and Energy Economics, 2013, 46–66.
[165] Gas Industry Social and Environmental Research Alliance, *The Social Licence to Operate and Coal Seam Gas Development: Literature Review Report*, March 31, 2013, p. 2. http://www.gisera.org.au/publications/tech_reports_papers/socioeco-proj-5-lit-review.pdf.
[166] Ibid.

conflicts of interest among the government's appointments to the Agency's board.[167] The finding was seen to undermine the credibility of the approval process and, therefore, questioned the certainty of decision-making in Western Australia.[168] It also raised the prospect that projects may be subject to longer and more costly approval processes.

Queensland is the state where considerable effort has been made to build trust with the community. The University of Queensland collaborated with industry and the state government to establish a Centre for Coal Seam Gas in the Sustainable Minerals Institute. An objective of the Centre is to "develop capabilities to deal with community concerns over the industry's environmental and social impacts."[169] The Queensland Government's Department of Natural Resources and Mines produces an annual Coal Seam Gas Engagement and Compliance Plan to inform the community on CSG activities. In response to community disaffection and issues between the agricultural and gas industries,[170] the Queensland Government also established the Gasfields Commission Queensland to act as an independent statutory body with legislated powers and functions related to:

- Reviewing legislation and regulation;
- Obtaining and publishing factual information;
- Identifying and advising on coexistence issues;
- Convening parties for the purpose of resolving issues;
- Promoting scientific research to address knowledge gaps; and
- Making recommendations to government and industry.[171]

While in some regions issues mostly concerning land access and environmental impacts remain,[172] these initiatives along with concerted efforts from CSG producers affiliated with LNG projects (Arrow Energy, Santos, Origin Energy and QGC) to consult and engage with communities have been largely beneficial in gaining community acceptance for the three LNG projects under construction. Queensland's experiences over the various stages of the three projects' development provide useful insights into the types of institutions and initiatives that may help build trust with the community.

In sum, the Australian experience provides a number of insights about community concerns and the need for those proposing and undertaking gas development to gain community trust. First, as shown by the resistance to the James Price Point development, if indigenous and environmental interests are opposed to projects, this can effectively delay, and may even stop projects. Thus, genuine engagement that generates sustainable benefits to vulnerable communities and protects sites of cultural and environmental significance is important to ensure projects proceed. Second, state governments, such as Queensland and South Australia, that have been pro-active in engaging with communities in the provision of information can overcome some community objections

[167] N. Perpitch and A. Burrell, "Approval for $40bn Gas Giant at James Price Point 'Unlawful'," *The Australian*, August 20, 2013. http://www.theaustralian.com.au/national-affairs/approval-for-40bn-gas-giant-at-james-price-point-unlawful/story-fn59niix-1226700212878.

[168] Clayton Utz, "James Price Point Environmental Approval Knocked Out – What Does This Mean for Other Proposals?" August 23, 2013. http://www.claytonutz.com/publications/news/201308/23/james_price_point_environmental_approval_knocked_out-what_does_this_mean_for_other_proposals.page.

[169] http://www.ccsg.uq.edu.au/AboutCCSG.aspx.

[170] http://www.michaelhartmp.com.au/blog/gasfields-commission-billd-2013.

[171] http://www.gasfieldscommissionqld.org.au/gasfields/about-us/.

[172] J. McCarthy, "Queensland Government Refuses to Define "Social Licence" as Arrow Energy Faces Opposition from Landowners Near Dalby," *The Courier Mail*, February 24, 2014. http://www.couriermail.com.au/business/queensland-government-refuses-to-define-social-licence-as-arrow-energy-faces-opposition-from-landholders-near-dalby/story-fnihsps3-1226835293932.

and develop trust in processes. Third, rather than leaving the engagement to project proponents, pro-active state engagement demands adequate monitoring and enforcement to ensure that developers who fail to follow rules and community standards are not able to continue operating and are held responsible for problems they may have created. Fourth, after relationships between project proponents and communities have soured, as has occurred in some locations in New South Wales, it can be very difficult to negotiate any “win-win” as positions become fixed and there is little or no support for compromises or alternatives.

CONCLUSION

The challenges, risks and opportunities experienced by Australia, especially over the past decade, provide valuable insights for prospective investors in other countries interested in developing LNG export facilities. Australia has had 25 years of experience in LNG production and marketing, and is now the world's third largest LNG exporter after Qatar and Malaysia. Later this decade, Australia is positioned to overtake both countries and become the world's largest LNG exporter. Underlying the growth in LNG exports has been a range of initiatives between Commonwealth and state and territory governments and the oil and gas sector. These initiatives have enhanced the competitiveness of the industry and helped remove or mitigate impediments to its growth.

Despite the fact that about half of the current global LNG capacity under construction is in Australia, there are real concerns about the ability of the Australian LNG sector to grow further. The causes are varied and include greater supply-side competition with potentially large LNG supplies originating from the United States, Canada, East Africa, Qatar, Papua New Guinea, and Russia. Further, LNG markets globally are becoming more interconnected and more flexible contract arrangements are being adopted. These arrangements are jointly placing downward pressure on prices at a time when the cost of projects is increasing. While Australia has gained a deserved reputation over the last 25 years as a low-risk, reliable, and experienced supplier of LNG, it is now gaining an unfortunate reputation as a high-cost location for investment in LNG projects.

Australia's high cost base for LNG projects is attributed to their complexity, remote locations, and exposure to some of the highest construction costs in the world. While the industry acknowledges the threat from increased international competition, it regards spiralling development costs, with associated issues of 'red tape', labour productivity, and extreme weather events, as the main challenge for new investment in LNG projects.

The consequences for investment in Australian LNG plants arising from the escalation in project costs are multiple and include project cancellations and delays, and major concept revisions. LNG project developers in Australia have responded to the escalation in costs and focused on trying to lower cost drivers through engineering/technology solutions, actions to improve labour productivity, and changes to the regulatory regime.

Floating Liquefied Natural Gas (FLNG) is an option for reducing the cost of projects. All currently proposed projects in the west and northwest of Australia are FLNG. This technology allows proponents to de-risk potential labour productivity issues and to avoid costly infrastructure such as pipelines, harbour facilities, and roads. FLNG may also allow project proponents to lawfully avoid domestic gas reservation requirements, and also the eventual decommissioning costs associated with an onshore facility. A downside to the adoption of FLNG, from a national perspective, is the significant reduction in employment in its construction and operations compared to a land-based plant.

Project developers argue that to prevent costs escalating companies need to set wages and conditions that reflect the changing reality of the investment cycle, while also increasing the training and supply of oil and gas operating staff. While the Australian Government has undertaken not to change existing industrial relations arrangements, it is endeavouring to make amendments to the principal piece of legislation relating to them – the *Fair Work Act 2009*. The government has also launched a Productivity Commission inquiry into industrial relations that will entail a comprehensive and broad review of the laws relating to workplace relations. Despite the industry claims, there is a broad understanding that the industrial relations framework is not the sole competiveness problem. Planning, design, scheduling, and procurement problems are also recognized as key contributors to unsatisfactory productivity levels for Australian LNG projects.

The skills shortage in the oil and gas sector is expected to continue for future Australian projects, and also in the operation and construction of current projects, as a result of demand for skills and labour for gas projects globally. The seven Australian projects under construction have attempted to deal with the skills shortage by employing overseas skilled workers under a temporary work visa and utilizing fly-in, fly-out arrangements for workers living in other states and regions. The oil and gas industry is also tackling the skills shortage through a variety of firm and education provider training initiatives.

The other major area for reducing project costs is through more efficient and effective regulations. The industry argues that the “red tape” involved in the various stages of an LNG project is onerous, delays projects, and is a result of the federal system of government in Australia. This is particularly relevant to LNG projects sourcing their feed-in gas from onshore gas reserves, such as the CSG to LNG projects in Queensland. From an industry perspective, the development and assessment and approvals process for projects is considered overly complex, inefficient, unpredictable and duplicative, and contributing to project delays and compliance costs. In response to these concerns, the Australian Government is implementing a one-stop shop initiative that will create a single environmental assessment and approval process. This follows the government’s establishment of a single agency responsible for the regulation of petroleum activities in Commonwealth offshore waters.

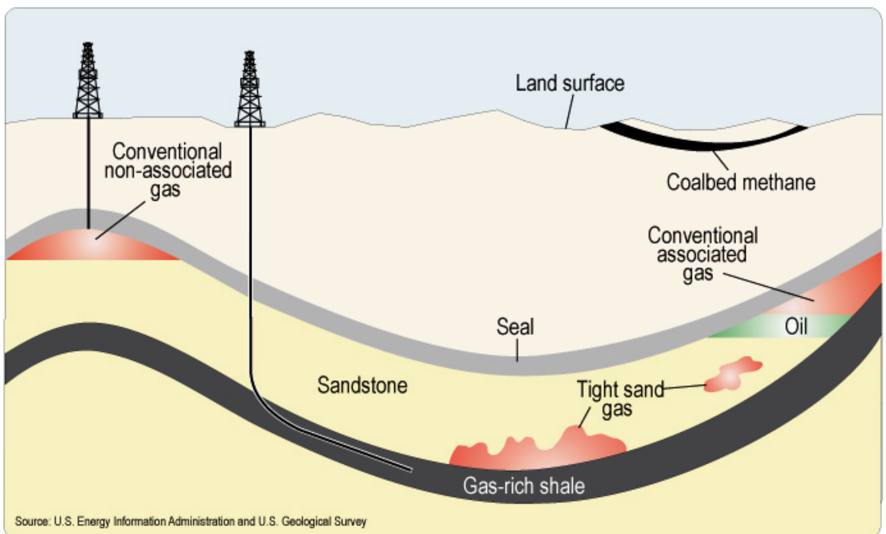
A key factor for future success of investments in Australian LNG projects is to acquire and to maintain a social licence to operate that depends on communities trusting the approval, development, and monitoring processes of government regulators as well as the actions of development proponents. Community trust has become especially important as the footprint of projects, such as the CSG to LNG projects on the east coast in Queensland, and their related effects extend further into local and regional communities, and into environmentally sensitive areas. Queensland’s experiences provide guidance on the types of institutions and initiatives needed to develop genuine trust in government processes and to ensure communities, as well as proponents, benefit from gas developments and the risks and rewards are clearly understood.

If there is a general lesson to be gained from Australia’s experience in developing an LNG export industry, it is the need for ongoing collaboration between governments/regulators and industry. Necessary (but not sufficient) conditions for sustainable and profitable LNG gas developments include: an effective and fair fiscal regime and regulatory process that encourages investment without unnecessary duplication or delays; a trustworthy and transparent process of approvals and monitoring that effectively manages risks and provides a social licence to operate that allows gas developments to proceed with community support; and public-private partnerships in terms of worker training and the distribution of benefits across communities in order to maximize the domestic benefits of gas projects.

APPENDIX A: OVERVIEW OF AUSTRALIA'S NATURAL GAS RESOURCES

Australia has substantial resources of both conventional and unconventional natural gas, which combined make natural gas Australia's third largest energy resource after coal and uranium.[173] We define conventional gas as the gas extracted from porous rock formations such as sandstones. There are three categories of unconventional gas: a) coal-bed methane or coal seam gas, which is extracted from coal seams around 300–1000 metres underground; b) tight gas, which is extracted from rock formations with very low permeability at depths greater than 1000 metres; and c) shale gas, which is extracted from low permeability sedimentary rock at 1000 to over 2000 metres underground.[174] This is visualized in Figure 18.

Figure 18. Conventional and unconventional gas schema



Source: US EIA, "The Geology of Natural Gas Resources." Today in Energy, February 14, 2011

Table 4 is from Australia's most recent energy resource assessment and provides a breakdown of the in-ground potential of different gas resources.[175] Australia's total gas resources, consisting of identified, potential, and undiscovered gas, is estimated to be about 919 trillion cubic feet (tcf) or 1,011,340 petajoules (PJ). In terms of identified resources (Economic Demonstrated Resources, Subeconomic Demonstrated Resources, and Inferred Resources), there are an estimated 166 tcf (183,097 PJ) of conventional gas and 225 tcf (247,706 PJ) of unconventional gas. To give some sense of the scale of Australia's gas resource, *global* gas consumption in 2011 was 127,109 PJ.[176]

Australia's total unconventional gas resource consists of an estimated 235 tcf of coal seam gas and an estimated 437 tcf of shale gas. Although large volumes, these estimates do not account for many basins that remain unassessed and, therefore, could underestimate the size of Australia's unconventional gas resource.

[173] Geoscience Australia and BREE, *Australian Energy Resource Assessment* (Canberra: Geoscience Australia, 2012), p. 81. http://www.ga.gov.au/energy/australian-energy-resource-assessment.html.
[174] CSIRO, *What is Coal Seam Gas? Factsheet*, p. 40. http://www.csiro.au/news/coal-seam-gas#FactSheets.
[175] Geoscience Australia and BREE, op. cit., p. 97.
[176] Ibid, p. 81.

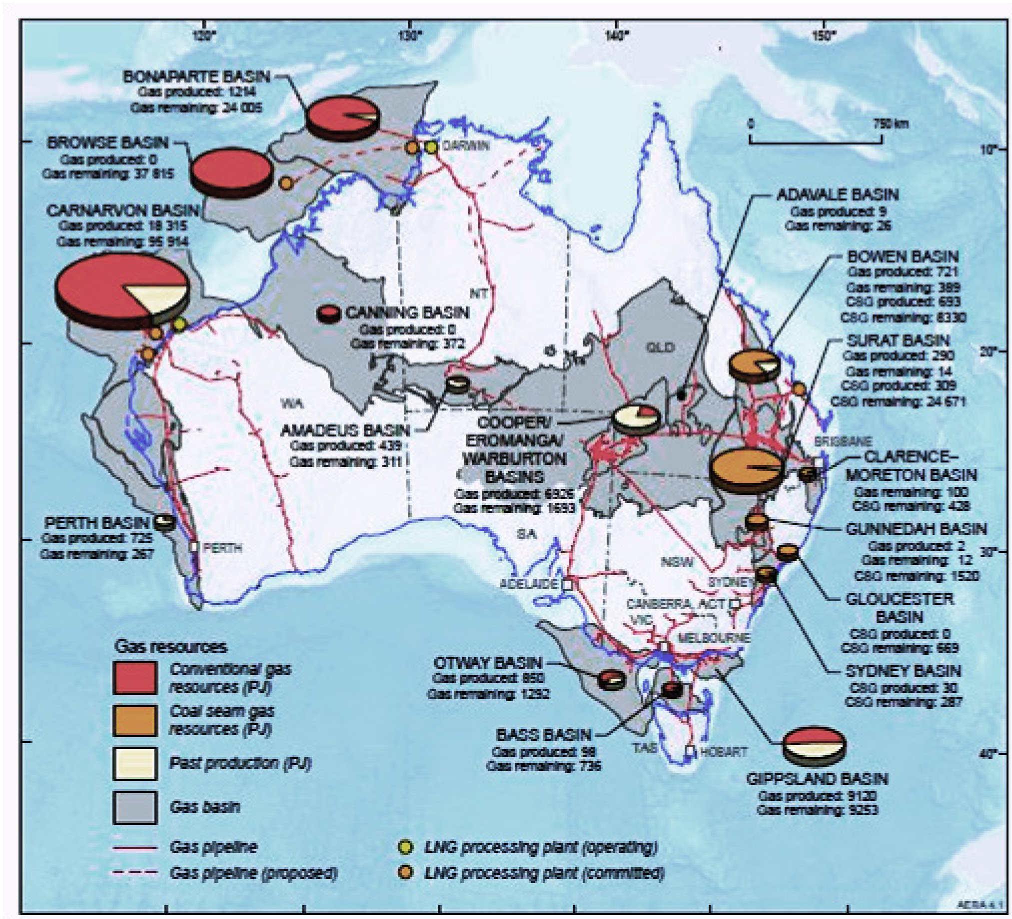
Table 4. Australia's conventional and unconventional gas resources

Resource Category	Conventional gas		Coal seam gas		Tight gas		Shale gas		Total gas	
	PJ	tcf	PJ	tcf	PJ	tcf	PJ	tcf	PJ	tcf
EDR	109,433	99	35,905	33	-	-	~3	-	145,341	132
SDR	62,664	57	65,529	60	-	-	2,200	2	130,393	119
Inferred	~11,000	~10	122,020	111	22,052	20			155,072	141
All identified resources	183,097	166	223,454	203	22,052	20	2,200	2	430,806	392
Estimates of total resources – identified, potential and undiscovered	249,700	227	258,888	235	unknown	unknown	480,700	437		

EDR stands for Economic Demonstrated Resources and includes Proved Reserves, Probable Reserves plus Measured Resources, and Indicated Resources. It is generally considered to provide an estimate of the availability of a resource over the long term. SDR is Subeconomic Demonstrated Resources, which are resources that cannot be extracted economically at the present time. The category includes both paramarginal and submarginal resources.

Source: Geoscience Australia and BREE, Australian Energy Resource Assessment, 2nd ed (2014), p. 97

Figure 19. Australia's gas resources and infrastructure



Source: Geoscience Australia and BREE, Australian Energy Resource Assessment, 2nd ed (2014), p. 82

Just over half of Australia's natural gas is located in the Carnarvon, Browse, and Bonaparte basins offshore along Australia's northwest coast (see Figure 19). These basins account for about 92 percent of Australia's conventional gas resource.[177] Some of the youngest conventional petroleum reservoirs are situated in the offshore Gippsland, Bass, and Otway basins in the southeast. The Cooper Basin, which is in central Australia and spans South Australia and Queensland, and the Amadeus Basin, which spans Western Australia and the Northern Territory, have some of the oldest conventional reservoirs. Large coal seam resources extend along eastern Australia, particularly the coal basins of Queensland and New South Wales.[178]

The most prospective gas basins are those close to existing pipeline and processing infrastructure servicing both domestic and LNG export markets. The geographical distance between Australia and major export customers precludes transporting gas by pipeline and, hence, all exported gas is in the form of LNG. During most of Australia's history of gas exploration the focus has been on conventional gas, but more recently in the eastern gas market this focus has shifted to coal seam gas. Both the scale and the speed of the development of coal seam gas in response to commercial opportunities, most significantly LNG export, have been dramatic.

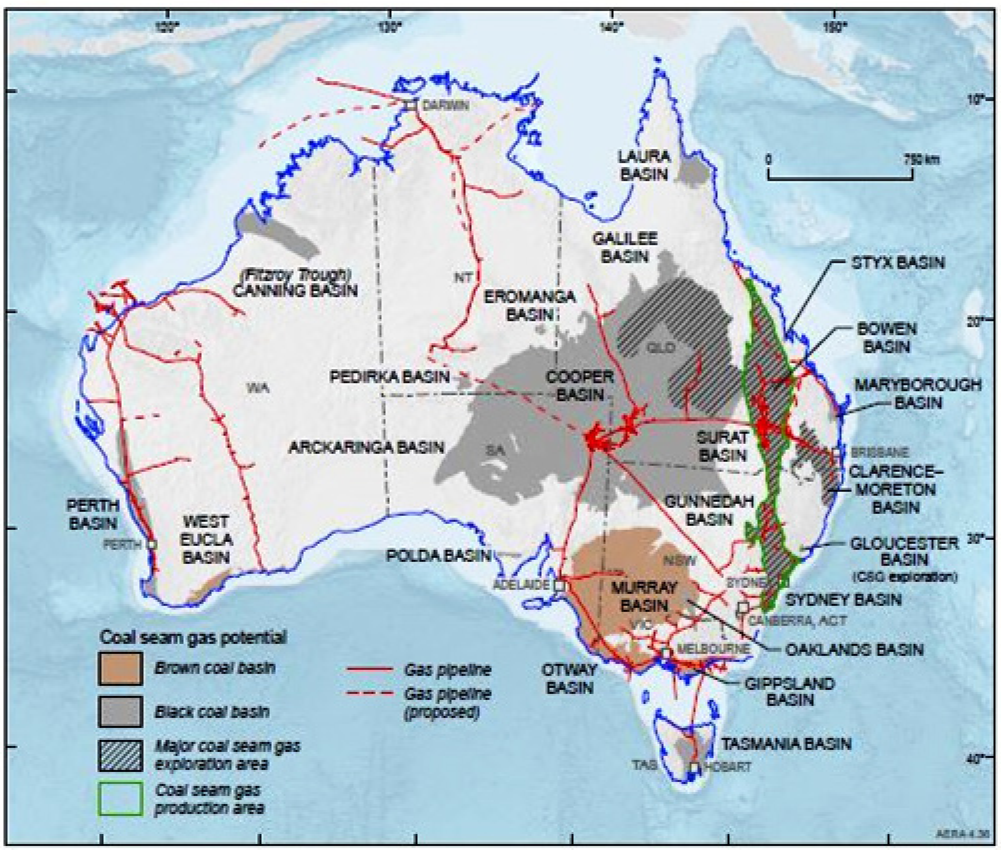
[177] Ibid. p. 81. Refer to C.J. Boreham, J.M. Hope, and B. Hartung-Kagi, "Understanding Source, Distribution and Preservation of Australian Natural Gas: A Geochemical Perspective," *The APPEA Journal* 41, no. 1 (2001): 523-47 for a detailed discussion on the geology and geography of Australia's conventional gas resources.

[178] Department of Industry and BREE, *Eastern Australian Domestic Gas Market Study* (Commonwealth of Australia, Canberra), p. 20. http://www.innovation.gov.au/Energy/EnergyMarkets/Documents/EasternAustralianDomesticGasMarketStudy.pdf.

COAL SEAM GAS

The production of coal seam gas (CSG) is not a recent activity to Australia. Coal seam gas was first produced as a by-product of coal mining in New South Wales in the early 1990s.[179] The first estimates of CSG reserves date back almost 20 years ago to 1996, when the first exploration and commercial production of CSG began in Queensland. Since this time, there has been significant and extensive characterization of CSG resources in Queensland's Bowen and Surat Basins. As shown in Figure 20, CSG production occurs along the east coast of Australia and major exploration is being undertaken in Queensland and New South Wales in the Bowen, Surat, Clarence Morton, Gunnedah, Gloucester, and Sydney basins.

Figure 20. Australia's coal seam gas resources



Source: Geoscience Australia and BREE, Australian Energy Resource Assessment, 2nd ed (2014), p. 118

The potential for significant CSG production from basins in New South Wales and Victoria is currently being constrained by restrictions imposed by both state governments on new CSG developments due to public concerns over health and environmental issues. New South Wales has banned all new CSG exploration and production activity within two kilometres of existing and potential residential areas, as well as regional areas with recognized equine and viticulture values.[180] In Victoria, the government imposed a moratorium on hydraulic fracturing in late 2012, which will stay in place until at least 2015.

[179] NSW Department of Trade and Investment, *Coal Seam Gas Fact Sheet 2: Exploration & Production* (Division of Resources and Energy, 2013). http://www.csg.nsw.gov.au/__data/assets/pdf_file/0010/29575/Exploration-and-Production-CSG-Fact-Sheet-2.pdf.

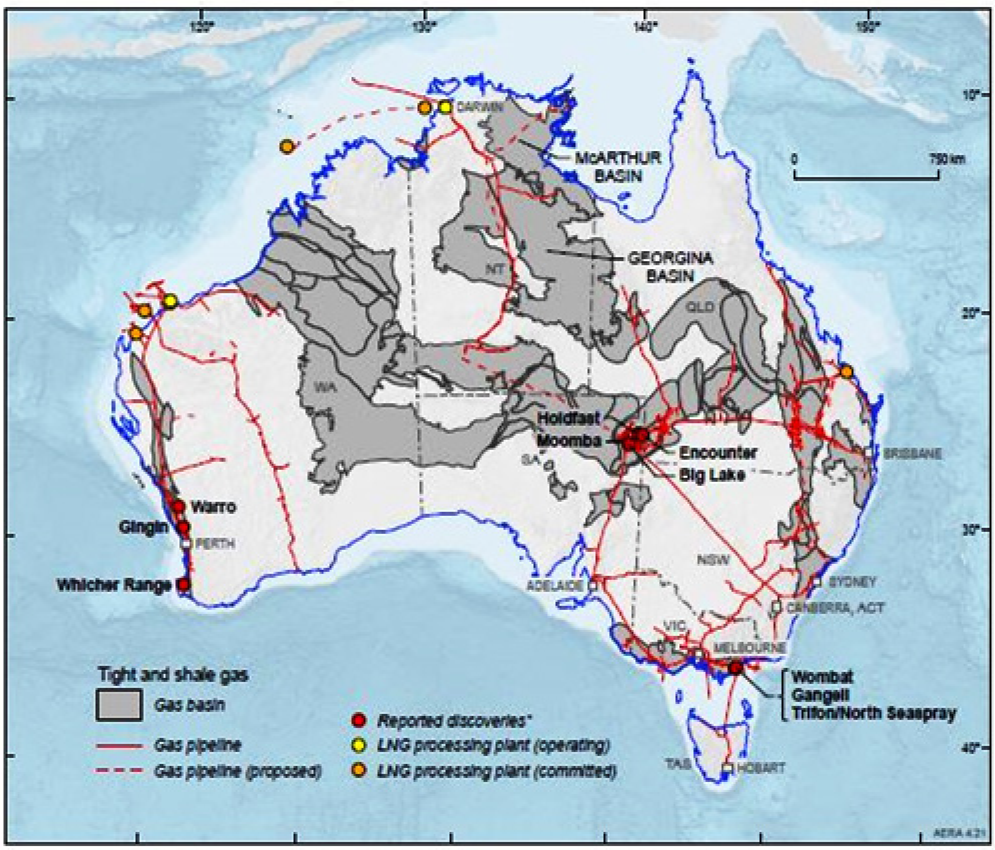
[180] NSW Department of Trade and Investment, Coal Seam Gas Fact Sheet 5: Environment, Health & Safety (Division of Resources and Energy, 2013). http://www.csg.nsw.gov.au/__data/assets/pdf_file/0004/29578/Environment,-Health-and-Safety-CSG-Fact-Sheet-5.pdf.

Nevertheless, in Queensland, the past decade has seen a rapid growth in the exploitation of the CSG resource. This growth has been assisted by greater knowledge about the scale of the resource, and opportunities to increase its economic value as an energy source for electricity generation and feed-stock for LNG production. At present, CSG accounts for just over 10 percent of Australia's total gas production but is 88 percent of Queensland's gas production.

TIGHT AND SHALE GAS

Tight gas is not commercially produced in Australia. The largest known resources are located in existing conventional reservoirs of the Perth Basin of Western Australia, Cooper Basin in South Australia, and the Gippsland Basin in Victoria. All of these locations are relatively close to existing infrastructure and, hence, are targets for commercialization (refer to Figures 18 and 21). There are potentially large resources of tight gas in basins elsewhere, but these are located far away from existing transportation and processing infrastructure and the main demand centres. The development and commercialization of tight gas will be confronted with similar challenges to those for shale gas: commercial viability, environmental management, and social acceptance where wells are drilled on private land.

Figure 21. Australia's tight and shale gas resources



Source: Geoscience Australia and BREE, Australian Energy Resource Assessment, 2nd ed (2014), p. 99

The Australian continent has significant potential for shale gas production. At an estimated 437 tcf, the shale gas resource is almost twice the size of conventional gas resources and almost equivalent to the resource estimate for all other sources of gas combined. Shale gas resources are located in remote basins in Western Australia, Queensland, the Northern Territory, and South Australia, but also in the not-so-remote locations of the Sydney and Bowen Basins in New South Wales and Queensland, respectively.

Most activity on shale gas exploration and development is occurring in the Cooper Basin in South Australia and Queensland, and the Canning Basin in Western Australia. In addition, exploration interest is underway in the Georgina and McArthur basins in the Northern Territory. The Cooper Basin benefits from being close to existing infrastructure historically used for conventional gas and oil production and is likely to be the basin that undergoes the fastest development of its shale gas resource. While substantial exploration and drilling are underway in the Cooper Basin and a well has been in commercial production there since 2012, no large-scale ramp-up of production is expected before 2020.

POTENTIAL FOR MONETIZING GAS RESOURCES

The cost of producing gas from unconventional gas reserves is a challenge confronting the Australian LNG industry. Recent experience indicates that coal seam gas production on the east coast in Queensland is more costly and uncertain than originally estimated by LNG proponents. A major issue for the CSG to LNG projects in Queensland is the uncertainty of supply. Doubts persist about CSG well performance and, hence, the number of wells required and the capacity of the eastern gas market to supply sufficient volumes from existing sources.[181]

If there is an improvement in the economics of production and transportation of unconventional gas over the medium term, there is the potential for an increased interest in shale and tight gas as sources of supply for future LNG projects. Whether or not this gas would underpin further investment in LNG projects in Australia will depend on its cost, which is likely to remain subject to considerable uncertainty. The economics of shale gas in Australia looks to be different to that of the United States due to differences in the amount of organic matter, hydrocarbon content, and mineralogy. Results to date show that compared to the United States, the Australian gas basins have varying amounts of organic matter, lower hydrocarbon content, and higher levels of clay.[182] The relative differences in these geological factors and higher costs of production, especially drilling, are likely to result in the economics of producing unconventional gas to be less favourable than in the United States.

[181] IEA, *Medium-Term Gas Market Report 2014* (Paris: OECD, 2014), p. 152.
[182] Santos, *2013 Investor Seminar*. December 4, 2013, p.55. http://member.afraccess.com/media?id=CMN://2A771853&file-name=20131204/STO_01473491.pdf.

APPENDIX B: AUSTRALIA'S GAS MARKETS

Australia has three distinct and physically separated domestic gas markets: the western market in West Australia, the northern market in the Northern Territory, and the eastern market that links the states of South Australia, Victoria, New South Wales, Queensland, and Tasmania. In its most recent five-year projections, the Bureau of Resources and Energy Economics predicts that all three markets will grow significantly in terms of domestic supply production as the current LNG projects under development commence production.[183]

The western market is the largest of the three and is supplied by gas from conventional basins in the State's northwest. The majority of gas consumed for domestic purposes (principally mining and electricity generation) in 2012–13 was sourced from the Carnarvon Basin.[184] Total gas demand in 2012–13 was 39 billion cubic metres (bcm) (1,530 PJ) and projected to increase to 73 bcm (2,860 PJ) in 2018–19, primarily due to increases in LNG requirements.[185] The western market is the only market that has a gas reservation policy for gas export projects. In particular, the Western Australian government's *Policy on Securing Domestic Gas Supplies* requires gas export project proponents to make available to the domestic market up to 15 percent of their LNG production at commercial rates.[186]

The northern market is the smallest at less than 1 bcm (about 39 PJ) in 2012–13 but is projected to increase to 17 bcm (667 PJ) in 2018–19.[187] In 2012–13, most gas was sourced from the Bonaparte Basin. Domestic gas consumption is underpinned by electricity generation, which consumes the major share, and large industrial mining. Feasibility studies on pipeline options for linking the northern gas market to the eastern gas market are currently being undertaken.[188]

The eastern market is the largest "domestic" market and is currently undergoing a major transition in the lead-up to the first of the LNG projects in Queensland beginning production later in 2014. Demand is shifting from domestic consumption (large industrial, commercial, electricity generation, and residential) to a market that will become increasingly dominated by LNG exports. The Australian Government is responding to the significant changes in the eastern market through a number of policy studies.[189] The eastern market is currently almost entirely supplied by conventional gas from basins in Victoria's Gippsland and Otway basins and the Cooper-Eromanga basin in inland South Australia and Queensland.[190] Coal seam gas from Queensland's Surat and Bowen Basins has become an increasingly important source in recent years. Over the next five years, the eastern market is projected to increase from 22 bcm (863 PJ) to 61 bcm (2,392 PJ)[191] with almost all of this increase in production destined for export as LNG.

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[183] BREE, *Resources and Energy Quarterly* (March Quarter 2014), op. cit.

[184] Independent Market Operator, *Gas Statement of Opportunities – January 2014*, p. 9. http://www.imowa.com.au/docs/default-source/publications-and-reporting/general-documents/gsoo_2_report_final95222D27BB75.pdf?sfvrsn=2.

[185] BREE, op. cit. p. 31.

[186] Parliament of Western Australia, *The Economic Impact of Floating LNG on Western Australia Volume 1*, op. cit., p. 42. The reservation policy is not legislated but rather dealt with on a case-by-case basis. LNG proponents have an incentive to negotiate with the government to supply the required gas in return for access to land for the project facilities. A review of the policy is scheduled for 2014–15.

[187] BREE, op. cit.

[188] R. Wheals, "New Pipeline Developments: Linking Australia's Gas Markets for Improved Energy Security," APA Group presentation to the South East Asia Australia Offshore & Onshore Conference (SEAAOC), August 20, 2014. http://www.apa.com.au/media/227294/2014%2008%2020%20apa%20presentation%20-%20seaaoc%20darwin.pdf.

[189] These include the Department of Industry and BREE, *Eastern Australia Domestic Gas Market Study*, released in January 2014, and an *Energy White Paper* expected in September 2014.

[190] Department of Industry and BREE, op. cit., p. 22.

[191] BREE, op. cit., p. 31.

The development of Australia's domestic gas markets has been strongly influenced by three characteristics:

- The remoteness of most of the gas supply basins from major population centres;
- Energy demand concentrated in and around spread-out population centres; and
- Relatively low gas demand due to a small population, small manufacturing sector, and electricity generation based largely on coal and a temperate climate.[192]

With the commencement of LNG production on the east coast, all three of Australia's natural gas markets will be linked to the LNG export market. This has implications for the opportunity cost of gas in each market and, therefore, domestic prices. The eastern gas market is in the transition to linking to the LNG export market and is experiencing substantial increases in gas prices across all domestic demand sectors due to the relatively large demand for gas to feed exports.[193]

The large size of export demand is also increasing the cost of extracting and transporting gas due to the need to develop and produce from higher cost resources (including unconventional gas) in more remote locations. Figure 22, reproduced from a recent study on the impact of the eastern gas market transitioning to LNG exports, shows significant increases in the projected average contract or wholesale price of gas, sold to domestic buyers and LNG projects. The modelling results highlight the combined effects of the export netback price[194] and higher production costs on the average gas wholesale contract price in the eastern market under three scenarios based on the amount of LNG capacity developed in Queensland.

Figure 22. Eastern gas market weighted average of ongoing and new contract prices ($/GJ, $2013 real)

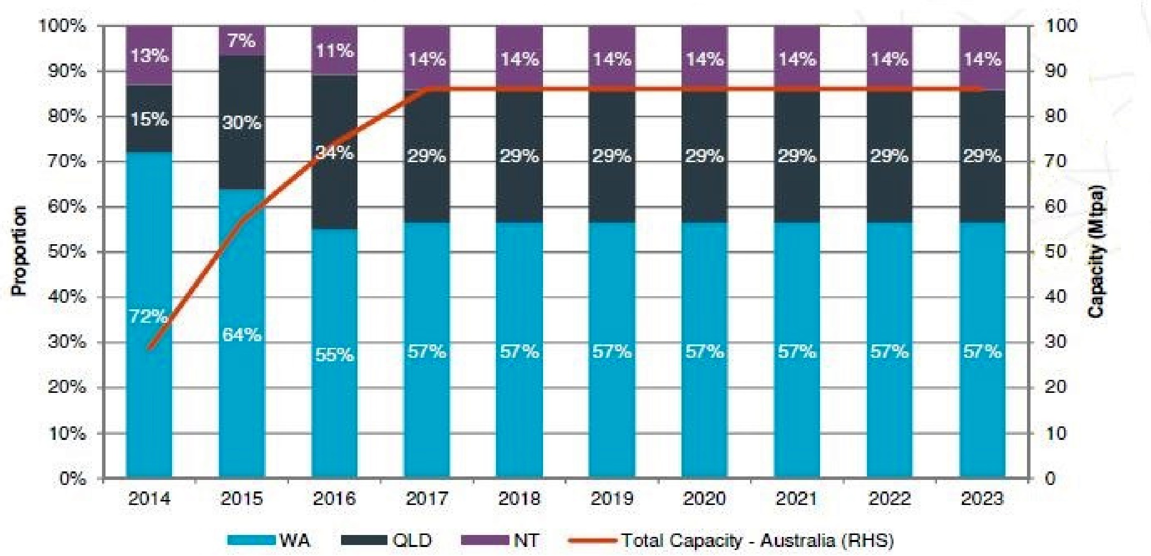
Source: SKM (2013) cited in Department of Industry and BREE, Eastern Australian Domestic Gas Market Study (2014), p. 78

Figure 23 shows both the share of LNG export capacity and the amount of "nameplate capacity"[195] across the two exporting states (Western Australia and Queensland) and the Northern Territory and for each gas market over the next ten years. In 2017, if there are no other LNG projects in addition to those that have currently attained

[192] Australian Pipeline Industry Association [APIA]. *Securing Australia's Gas Future: Lower Emissions, Higher Efficiency*, July 2013, p. 29. http://www.euaa.com.au/wp-content/uploads/2013/07/APIA-Releases-Australias-gas-future-policy.pdf.
[193] Department of Industry and BREE, op. cit.
[194] The netback price is mainly used to compare costs against those of competitors. It is the value of a unit of gas used in the production of LNG by an exporter after subtracting liquefaction and shipping costs from the delivered price of LNG to the customer.
[195] "Nameplate capacity" refers to the maximum rated output of the gas plant generator.

final investment decision (FID), then the share of the overall national LNG liquefaction capacity from the western market will be 57 percent in the western market, 29 percent in the eastern market, and 14 percent in the northern market.

Figure 23. Share of LNG export capacity by exporting state and territory, 2014–2023*



*Includes Prelude FLNG and only projects that have attained FID approval.

Source: Independent Market Operator, Gas Statement of Opportunities – January 2014 (2014), p. 83

APPENDIX C: AUSTRALIA'S CURRENT MAJOR LNG PROJECTS

Project	Company	State	Location	Type	Estimated Start Up	Publicly Announced	Feasibility Stage	Committed	Estimated New Capacity mtpa	Indicative Cost Estimate $m	Construction Employment Estimate	Operating Employment Estimate
Arrow LNG Plant	Shell / Petro China	Qld	Gladstone	new project	2019	y			4+	5000+		
Australia Pacific LNG (trains 1 and 2)	Origin / ConocoPhillips / Sinopec	Qld	Gladstone	new project	2015			y	9	24700	6000	1000
Browse LNG	Woodside/ BP / PetroChina / Shell / Japan Australia LNG	WA	Browse Basin	new project	2019+	y			n/a	5000+		1000
Cash Maple Development	PTTEP Australasia		Timor Sea	new project	2019+	y			2	5000+		
Crux LNG	Shell / Nexus Energy / Osaka Gas		700 km W of Darwin	new project	2019+	y			3	5000+		
Equus	Hess	WA	300 km W of Dampier	new project	2019+	y			n/a	1500 - 2500		
Gladstone LNG	Santos / Petronas / Total / Kogas	Qld	Gladstone	new project	2015			y	7.8	18000	5000	1000
Gorgon (train 4)	Chevron / Shell / ExxonMobil	WA	Barrow Island	expansion	2018+		y		5.2	12000		
Gorgon LNG	Chevron / Shell / ExxonMobil	WA	Barrow Island	new project	2015			y	15.6	54000	10000	3500
Ichthys LNG	Inpex Holdings / Total	NT	Darwin	new project	2017			y	8.4	33000	4000	700
Prelude Floating LNG	Shell	WA	Browse Basin	new project	2017			y	3.6	12600	n/a	n/a
Queensland Curtis LNG project	BG Group, CNOOC	Qld	Gladstone	new project	2014			y	8.5	19800	5000	1000
Scarborough FLNG	Exxon Mobil / BHP Billiton	WA	220 km NW of Exmouth	new project	2019+		y		6	14000		
Sunrise Gas project	Woodside/ Conoco Phillips / Shell / Osaka Gas	JPDA	450 km NW of Darwin	new project	2019+	y			4+	5000+		
Wheatstone LNG	Chevron / Apache / KUFPEK / Shell	WA	145 km NW of Dampier	new project	2016			y	8.9	29000	5000	400

Source: Adapted from BREE Resources and Energy Major Projects April 2014, http://www.bree.gov.au/publications/resources-and-energy-major-projects

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