Deloitte Access Economics

Gas market transformations– Economic consequences for the manufacturing sector

A report to the Australian Industry Group, the Australian Aluminium Council, the Australian Food and Grocery Council, the Australian Steel Institute, the Energy Users Association of Australia and the Plastics and Chemicals Industries Association

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Acronyms

Ai Group	Australian Industry Group
CGE	Computable general equilibrium
CSG	Coal seam gas
DAE	Deloitte Access Economics
GDP	Gross Domestic Product
GJ	Gigajoules
GSP	Gross State Product
GSA	Gas supply agreements
JV	Joint Venture
LNG	Liquefied natural gas
M	Million
MJ	Mega joules
NWS	North West Shelf
PJ	Peta joules
IES	Intelligent Energy Systems
SKM	Sinclair Knight Merz
EADGMS	Eastern Australian Domestic Gas Market Study

Executive Summary

Australia's gas markets on the East and West Coasts are undergoing unprecedented change. On the East Coast transformations are being driven by the development of new LNG export facilities in Queensland, which will link the East Coast gas markets to international gas prices for the first time in history. While exporting Australia's previously untapped unconventional coal seam gas reserves is expected to provide a boost to Australia's GDP, realising these benefits will also entail painful consequences. Both costs and benefits are very unevenly spread across sectors and regions.

On the ***East Coast*** the gas market is changing in two ways:

- Gas prices are rising as the market links to international LNG markets.
- Gas supply is tight and domestic contracting very challenging, primarily because of uncertainty about the ability of coal seam gas developments to achieve the huge and rapid ramp up required to meet LNG export commitments.

On the ***West Coast***, domestic and LNG export markets have co-existed since Western Australia (WA) began exporting gas from the North West Shelf (NWS) in 1989. However, WA gas users now face similar issues to their East Coast counterparts:

- Gas prices are expected to rise strongly to oil-linked LNG netback parity as long-term legacy contracts under the NWS State Agreement expire.
- Gas supply is tight and gas users are finding it extremely difficult to secure new supply contracts, due to uncertainty about whether the NWS will recontract with the domestic market when current contracts expire.

Despite differences in the underlying drivers, gas users face similar challenges on both coasts. Where businesses can pass on increased costs or switch to alternative fuels or technologies, the projected impacts may represent a squeeze on profit margins. For other businesses, higher gas prices and greater supply risk could result in more significant losses, potentially threatening the viability of certain industries.

Our task and approach

Within this context, Deloitte Access Economics were engaged by a consortium of manufacturing industry associations to assess the impact of changes taking place in both the East and West Coast gas markets for gas-using manufacturing industries and the Australian economy more broadly. These associations (the project consortium) are:

- The Australian Industry Group
- The Australian Aluminium Council
- The Australian Food and Grocery Council
- The Australian Steel Institute
- The Energy Users Association of Australia
- The Plastics and Chemicals Industries Association

This project was funded by the Consumer Advocacy Panel (www.advocacypanel.com.au) as part of its grants process for consumer advocacy projects and research projects for the benefit of consumers of electricity and natural gas.

The views expressed in this document do not necessarily reflect the views of the Consumer Advocacy Panel or the Australian Energy Market Commission.

Our approach was to:

1. select a plausible range of scenarios for future gas prices in the East and the West;
2. model the impact on the Australian economy and gas-intensive manufacturing;
3. undertake five case studies to illustrate the consequences for individual businesses.

This report does not present new estimates of future gas prices. It draws on existing modelled prices from recent government reports. Nor does it consider scenarios for physically inadequate supply. While price projections and supply risks have already been the subject of considerable effort, the potential economic impact and implications of expected gas prices have not yet been thoroughly assessed. This report seeks to fill this gap.

Key findings

LNG developments on the East Coast will create a new export industry involving significant production, employment and capital investment. However, gas market transformations on both the East and West Coasts will also have adverse consequences. Table i shows the impact to industry output (equivalent to sales and services income) for all sectors in the economy in the years 2015, 2018 and 2021 and cumulatively over the period 2014-2021.

The scenarios considered are explained in greater detail in **Chapter 4** and **Appendix B**. Broadly, the 'IES Scenario' projects prices if the East enjoyed a perfect gas market, while the 'SKM Scenario' assumes some market power. Both are compared to baseline scenarios in which Eastern LNG does not develop and the NWS recontracts to domestic customers in the West.

Overall impacts are discussed in **Chapter 6**. In each of the snap-shot years (2015, 2018 and 2021), with the exception of gas, services and the construction sector (which receives a boost through its role in supporting LNG developments), gas price increases and other drivers translate into a reduction in industry output for all other sectors in the economy compared to a baseline scenario. Similarly, over the period 2014-2021, all industries except the gas, construction and services experience a cumulative reduction in industry output (as measured by the net present value of the total year on year output reductions during the period). Output equates to gross income for the sectors concerned, and is distinct from Gross Domestic Product.

The manufacturing sector is projected to experience the greatest reduction in industry output. This is primarily due to its significant gas usage and high trade exposure, which largely limits the sector's ability to pass on higher gas input costs. In 2021, the final year modelled, manufacturing output is projected to be 3.6% (IES) to 4.4% (SKM) lower than in the baseline scenario. The net present value of the cumulative reduction in manufacturing output from 2014 to 2022 is around $88 billion under the IES gas price projections, and $120 billion under SKM gas price projections.

Table i: Industry output impacts for Australia for the years 2015, 2018 and 2021 and cumulative Net Present Value (NPV) of output impacts over 2014 - 2021

	Value of difference from baseline			% difference			NPV
	2015	2018	2021	2015	2018	2021	Cumulative impact over 2014-2021
IES scenario							
Output ($ million)							
Manufacturing	-17,937	-15,810	-25,070	-3.07	-2.47	-3.61	-87,701
Gas	7,119	15,448	22,141	38.15	57.37	52.16	69,965
Mining	-6,789	-5,196	-8,773	-3.34	-2.32	-3.59	-30,245
Agriculture	-1,116	-713	-1,304	-1.99	-1.18	-2.01	-4,421
Electricity and Water	-1,277	-1,278	-1,730	-2.19	-1.99	-2.45	-6,812
Construction and Trade	20,077	2,701	12,106	3.11	0.38	1.55	42,644
Transport	-2,226	-1,690	-2,940	-1.61	-1.12	-1.79	-9,856
Commercial & Services	3,296	-558	734	0.28	-0.04	0.05	3,221
SKM scenario							
Output ($ million)							
Manufacturing	-23,199	-22,259	-30,386	-3.97	-3.48	-4.38	-118,069
Gas	8,922	17,672	24,225	47.81	65.63	57.07	80,746
Mining	-7,226	-6,031	-9,679	-3.55	-2.69	-3.96	-33,804
Agriculture	-1,110	-798	-1,430	-1.98	-1.32	-2.21	-4,705
Electricity and Water	-1,962	-1,989	-2,204	-3.36	-3.09	-3.12	-10,269
Construction and Trade	18,049	2,443	13,265	2.80	0.34	1.69	38,519
Transport	-2,328	-1,988	-3,288	-1.68	-1.31	-2.00	-11,044
Commercial & Services	3,015	-897	649	0.26	-0.07	0.05	1,695

Source: Deloitte Access Economics
Note: The discount rate of 7% was used to calculate the NPV figure.

Employment is also significantly impacted. By 2021, manufacturing employment for the manufacturing industries selected by the project consortium is projected to reduce by around 12,227 (IES) to 14,626 (SKM) full time equivalent jobs.

Overall, output losses are higher under the SKM gas price forecasts. This is due to the SKM gas price forecasts reflecting the ability of gas suppliers to raise prices in line with market power – particularly in Victoria and NSW. As discussed further below, we consider the SKM forecasts to be more realistic. Consequently, we would stress that more emphasis be placed on the impacts associated with the SKM gas price forecasts, particularly when considering policy responses.

State impacts vary widely, as depicted in Table ii. Expansion in the gas and construction sectors is heavily concentrated in Queensland. However, regardless of the gas price forecast used, Queensland also sees the most severe decline in output from manufacturing (around $60 billion cumulatively to 2021) and mining (around $22 billion). This is due both to gas prices and the impact of LNG construction on wage pressures and competitiveness. New South Wales and Victoria see serious declines in manufacturing (accumulating to around $24 billion and $23 billion respectively) under the more realistic SKM gas price forecasts. South Australian manufacturing output is hit by a cumulative $2.4 (IES) to 3.4 (SKM) billion decline, though gas and construction expand significantly. In WA, mining output declines by around $4 billion cumulatively, and manufacturing output by approximately $8.3 billion, if the NWS does not recontract to domestic gas users.

Table ii: Industry outcomes for States (cumulative impact over 2014-2021 NPV, $m)

	NSW	VIC	QLD	SA	WA
IES Scenario					
NPV ($m)					
Manufacturing	-12,633	-2,000	-61,848	-2,442	-8,738
Gas	1,084	283	61,624	720	6,156
Mining	-1,502	-764	-22,406	-201	-4,114
Agriculture	-611	-241	-3,407	-231	-43
Electricity and Water	-796	67	-7,861	730	714
Construction and Trade	4,672	-489	40,277	1,213	-1,840
Transport	-1,432	147	-9,174	-157	484
Services	7,035	1,127	-5,919	338	769
SKM Scenario					
NPV ($m)					
Manufacturing	-24,543	-23,426	-59,142	-3,375	-7,921
Gas	3,862	7,388	61,624	1,559	6,156
Mining	-2,467	-2,928	-22,378	-288	-4,057
Agriculture	-588	-396	-3,480	-343	-54
Electricity and Water	-2,816	-2,181	-6,808	579	640
Construction and Trade	-103	-1,622	42,200	2,123	-2,230
Transport	-1,825	-526	-9,328	-223	484
Services	6,790	703	-6,449	320	561

Manufacturing subsector impacts

Output declines in every subsector of manufacturing selected by the project consortium, as set out in Table iii and detailed in **Chapters 7 to 12**. Some face a lower percentage decline in output than others, though these impacts still translate to large absolute losses due to the size of the industries concerned.

In general, transformations occurring on the East and West Coast gas markets will have the most adverse consequences for manufacturing businesses that:

- Use gas most intensively, and therefore incur significant increases in input costs.
- Are substantially trade-exposed, or face other market imperfections, which limit their ability to pass on increased input costs.

It is important to note that the modelled results are based on projections for average gas prices, and do not account for the moderating effects of long-term legacy contracts (which will shield some businesses from gas price increases) or adaptive actions taken by firms.

For example, one of our case studies (detailed in **Chapter 5**) shows that Rio Tinto Alcan, which uses over 20 PJ of gas per year to produce alumina in its Yarwun refinery, has a long-term gas contract that largely mitigates the impact of the current gas market on the Yarwun refinery until 2031. However, the current gas market restricts growth opportunities and erodes the sustainability of operations. For example, Rio Tinto Alcan Yarwun has been unable to secure a competitive supply agreement for a relatively small supply requirement from 1 January 2015, and is planning to reduce electricity production at its 160 megawatt (MW) cogeneration power plant from next year.

Table iii: Industry output impacts for selected manufacturing subsectors

	IES scenario			SKM scenario		
	Output % difference in 2021	NPV cumulative over 2014-2021	Average FTE jobs difference over 2014-2021	Output % difference in 2021	NPV Cumulative over 2014-2021	Average FTE jobs difference over 2014-2021
Sector						
Food and Beverage products*	-2.3	-8,991	-2,978	-2.5	-9,739	-2986
Paper products	-1.0	-1,653	-688	-1.2	-2,270	-696
Chemical products**	-3.7	-8,875	-3,037	-4.9	-13,664	-4,034
Iron and steel	-3.8	-4,411	-1,267	-4.6	-6,071	-1,552
Basic Non-ferrous Metal products^	-9.8	-23,960	-3,397	-11.6	-29,697	-4,236
Fabricated metal products	-1.3	-1,483	-860	-1.5	-2,064	-1,122

Note: *Includes groceries and fresh foods, **includes basic, specialty and consumer chemicals, and ^includes bauxite, alumina and aluminium manufacturers
Source: Deloitte Access Economics

Orica, which uses around 14 PJ of gas per year in its ammonia plant in Kooragang Island, is currently exploring upstream gas development options to bring new, affordable sources of gas into New South Wales. If successful, this strategy would also shield Orica from higher gas prices, meaning the projected impacts to its operations would be considerably less adverse than predicted by the CGE model.

However, as the CGE model tends to show ‘average’ outcomes and is not setup to capture granular flow-on impacts across an individual businesses’ value chain, individual circumstances could also lead to worse outcomes than projected. If efforts to insulate businesses from higher prices do not succeed, those businesses could carry costs both of their protective investments and higher input costs, with potential consequences across their supply chains. Options to insulate against higher costs, whether by moving upstream or signing favourable long term contracts, are not available or practical for all businesses.

With lower gas intensity and more limited trade exposure, paper, fabricated metal and food, beverage and grocery industries are projected to experience lower percentage declines in output – though these are still large in absolute terms. Again, with our CGE results tending to reflect industry averages, projected industry impacts might not align with the realities faced by some individual businesses. Australian Paper is an important case in point. Using 7.5 PJ of gas per year to produce pulp and paper products in its Maryvale Mill, Australian Paper is one of the largest gas users in Victoria and also the largest private employer in the Latrobe Valley. If Australian Paper was to absorb increased gas input costs associated with the gas contracts it has been offered to date (which reflect prices much closer to SKM's Victorian price projections), it is unlikely that the Mill's operations would remain viable for more than a few years. With 900 regional jobs tied directly to the Maryvale Mill's operations, a potential closure could have significant direct and flow on impacts within the Latrobe Valley.

Conclusion

Changes taking place in the East and West Coast gas markets will bring forth both positive and negative impacts. While the gas and construction sectors are expected to benefit from the development of a new East Coast LNG industry, almost all other sectors within Australia's economy are likely to experience losses in income. Greater input costs associated with higher gas prices and greater risk arising from a more difficult gas contracting environment will have adverse consequences for many regions and states.

Unsurprisingly, our CGE modelling results indicate that the most severely impacted sectors of the economy are those engaged in manufacturing, given they are generally large gas users and are trade exposed. Overall, the manufacturing sectors included in the modelling suffer an $88 (IES) – 118 (SKM) billion loss of income in NPV terms from 2014-2021, as a consequence of gas market transformations. The case studies presented in this report provide further evidence of the negative consequences that are already beginning to be felt by various manufacturing businesses.

1 Introduction

Australia's gas markets on the East and West Coast are undergoing unprecedented change. Increasing global demand for gas, driven primarily by the development of emerging Asian economies and the transition towards lower carbon fuel sources, presents Australia with a significant opportunity to benefit from exporting natural gas. Although exporting liquefied natural gas (LNG) provides a boost to Australia's GDP, realising these benefits will also entail painful consequences. Transformations occurring within both the East and West Coast gas markets will have significant impacts, the burden of which will be felt most by large users of domestic gas and those unable to pass on gas price increases.

Having a reliable and affordable gas supply is important to many of Australia's manufacturing industries. For a number of companies, access to relatively affordable gas has been an important advantage, underpinning their competitiveness in global markets. While some industries use large amounts of gas to generate electricity or provide heat and steam for various production processes (such as food, beverage and grocery production and alumina refining), other industries use gas as a feedstock into the manufacture of particular products (such as plastics, explosives and fertilisers).

Changes taking place within both gas markets are placing significant upward pressure on domestic gas prices and creating uncertainty about domestic supply. Although underlying drivers of price increases and supply uncertainty are different across the East and West, the impact experienced by domestic gas users is likely to translate into similar outcomes across Australia. For some businesses, particularly those able to pass on increased costs or switch to alternative fuels or technologies, projected impacts may represent a squeeze on profit margins. For other businesses, higher gas prices and greater supply risk could result in more significant losses and potentially threaten the viability of certain industries.

1.1 Our task and approach

Within this context, Deloitte Access Economics was engaged by a consortium of associations to undertake a detailed analysis of the potential adverse implications of higher prices and supply uncertainty in the East and West Coast gas markets for gas-using manufacturing industries and the Australian economy more broadly. These associations (the project consortium) include:

- The Australian Industry Group
- The Australian Aluminium Council
- The Australian Food and Grocery Council
- The Australian Steel Institute
- The Energy Users Association of Australia
- The Plastics and Chemicals Industries Association

The project consortium received important financial support from the Consumer Advocacy Panel, which was established by Australian governments to support advocacy and research on behalf of energy users.

Our approach to this analysis comprised three key components:

1. Undertaking a critical examination of the current profile within the East and West Coast gas markets and selecting appropriate gas price scenarios for the period 2014-2023.
2. Conducting a quantitative assessment of gas price increase impacts under each of the different scenarios at an economy-wide and sectoral level, with a particular focus on the manufacturing sector.
3. Undertaking a series of case studies to better illustrate the consequences for individual manufacturers.

1.1.1 What is and what is not included in this report

As considerable effort has already been devoted to projecting future gas prices over the 2014-2022 period, the purpose of this report is not to replicate or further complicate price projections that already exist in the public domain. Further, this report does not seek to provide predictions on the most likely price scenario or to discuss future constraints to the gas supply. Instead, we have selected scenarios to cover the range of prices that could plausibly result from developments in the East and West Coast gas markets and have provided a quantitative assessment of the economic impact arising from these projected gas prices.

Additionally, this report is not intended to propose policy solutions to address issues highlighted in the findings. Rather, in quantifying potential impacts that could arise from transformations in the East and West Coast gas markets, this report seeks to provide an input that could be used by government, regulators and policy makers to shape Australia's future gas market policy.

Report structure

The remainder of this report is organised as follows:

Context

- Chapter 2 explores the context to the analysis, describing the background and key factors driving current challenges within the East and West Coast gas markets
- Chapter 3 gives an overview of gas use within Australia's manufacturing sector and describes its economic profile within the broader Australian economy

Methodology

- Chapter 4 briefly describes our methodology for constructing the gas price scenarios and forecasts used in this report

Results

- Chapter 5 comprises five case studies examining impacts to individual businesses that use gas within their operations
- Chapter 6 outlines aggregate National and State impacts for the Australian economy and gives a brief overview of the impacts for the manufacturing sector

- Chapters 7 – 12 details impacts for the manufacturing sub-sectors selected by the project consortium

2 Australia's East and West Coast Gas Markets

This section presents a brief background on the East and West coast gas markets and provides an overview of key factors driving current challenges within both market environments.

2.1 East Coast gas market

2.1.1 LNG expansion in response to increasing global gas demand

Historically, the East Coast gas market has operated purely to serve the needs of domestic customers. Plentiful conventional gas resources, such as South Australia's Cooper Basin and Victoria's Gippsland Basin, have provided domestic consumers with access to cheap, reliable gas supplies and have facilitated the development of many gas-intensive industries. However, with the growth in global gas demand presenting Australia with a unique opportunity to export our rich natural gas reserves and resources to high-paying Asian customers, the East Coast gas market is set to change.

2014 will see the completion of the Gladstone LNG facilities in Queensland and development of a number of unconventional coal seam gas reserves in the East Coast. While these developments will allow gas producers to export unprecedented amounts of LNG to meet increasing demand in the Asia-Pacific region, they will also expose the East Coast gas market to higher international gas prices for the first time in its history.

2.1.2 Higher prices set by international market forces

Without linkages to international LNG markets, domestic gas prices in the East coast were traditionally driven by local factors and have historically averaged around $3-4/ gigajoule.[1] However, prices paid by Asian customers have typically been considerably higher. This is because Asian countries such as Japan, China, South Korea and Taiwan have traditionally imported LNG under oil-linked contracts. With oil prices rising to upwards of $100/barrel, LNG prices have also risen and are currently around $14-16/GJ. However, international spot prices for LNG have been known to reach up to $18/GJ.[2] LNG netback prices, which represent the price paid by international LNG customers less the cost of liquefaction and transport, currently average around $10-12.[3]

This higher opportunity cost of gas, made possible by the development of the Gladstone LNG export facilities, has been impacting domestic gas users for some time now. In April

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1 BREE 2013, *Gas Market Report*, p 17

2 Bloomberg, January 10 2014, LNG Export Surge Boosting Prices for Australian Buyers: Energy http://www.businessweek.com/news/2014-01-09/lng-export-surge-boosting-prices-for-australian-buyers-energy

3 Deloitte Analysis

and May of 2013, Ai Group's survey of gas-using businesses on the East Coast found the average reported price offer for long term contracts was $8.72/GJ.[4] Adjusting to a new environment where gas prices are not only higher, but affected by international factors that are inherently more complex and volatile, will be challenging for a number of domestic gas users.

2.1.3 Domestic supply uncertainty

Beyond the price impact from linking to the international market, domestic supply uncertainty may also place upward pressure on gas prices over the short term. Domestic supply uncertainty is, to a large extent, driven by the immense expansion in East Coast gas requirements to meet contracted export demand. Table 2.1 outlines Queensland's three LNG projects, which involve the expansion and development of Coal Seam Gas (CSG) fields in the Surat and Bowen Basins, and the construction and development of six LNG trains on Curtis Island near Gladstone.

Table 2.1: Queensland LNG developments

LNG project	Estimated annual gas consumption (PJ)	Scheduled commencement	Number of committed LNG trains	LNG train capacity (Mtpa)
Gladstone LNG (GLNG)	468	2015	2	3.9
Queensland Curtis LNG (QCLNG)	510	2014	2	4.25
Australia-Pacific LNG (APLNG)	540	2015	2	4.5

Source: IES gas market study 2013, Eastern Australian Domestic Gas Market study

Collectively, these projects are estimated to consume a 1,518 PJ of gas per year.[5] This additional gas requirement is significantly larger than Queensland's current annual gas consumption of around 252 PJ and, indeed, the entire East Coast's annual 2012 gas consumption of 687 PJ.[6] We illustrate the sheer size of this demand increase in C 2.1, which shows AEMO's most recent forecast for domestic and LNG demand on the East Coast.[7]

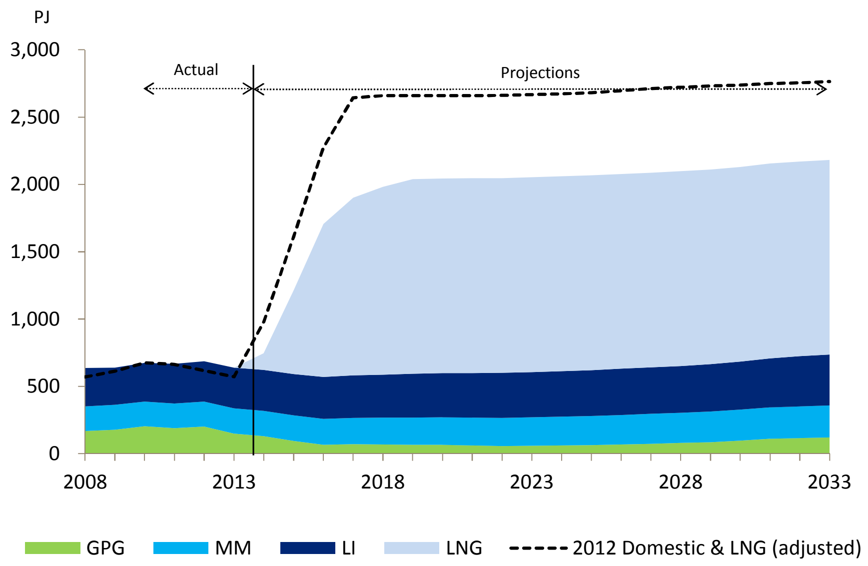
[4] Australian Industry Group, 2013, *Energy shock – The gas crunch is here*

[5] Department of Industry, BREE 2013, *Eastern Australian Domestic Gas Market Study*

[6] Department of Industry, BREE 2013, *Eastern Australian Domestic Gas Market Study*

[7] AEMO 2013, *Gas Statement of Opportunities*

Chart 2.1: Projected domestic and LNG demand for the East Coast



Source: AEMO 2013, Gas Statement of Opportunities

NB: AEMO's 2013 projections do include Arrow Energy

GPG refers to Gas Powered Generation, MM refers to Mass Market (residential and commercial)_LI refers to Large Industrial

With 53,229 PJ of proven and probable (2P) reserves,[8] Eastern Australia is likely to have sufficient resources to meet projected domestic and export demand for the next 30 years. However, there is currently considerable concern about the potential risks to the domestic market if adequate supply cannot come on line quickly enough to meet the rapid ramp up in LNG demand.

As noted in the Australian Government's recent Eastern Australian Domestic Gas Market Study (EADGMS), significant uncertainties presently impacting domestic supply stem from two critical elements:

- the rate at which CSG projects can be developed
- the performance of CSG wells

Project timelines for CSG developments to satisfy LNG export requirements are extremely tight. As such, even slight project delays or inadequate well performance could cause domestic gas supplies to be diverted to LNG projects. Further fuelling uncertainty is the fact that no other country has ever attempted to develop LNG export trains based on CSG resources. As such, these LNG projects represent a world first.[9]

These uncertainties are creating significant challenges within the gas contracting environment. While the East Coast gas market used to be largely characterised by long-term contracts that provided certainty for both the buyer and the seller, the current supply tightness is making gas producers and retailers extremely hesitant to offer long-term

[8] Core Energy Group AEMO GSOO Reserve and Resource Databook, Deloitte Analysis

Proven and probable (2P) reserves represent proved plus probable reserves. Proved reserves have at least a 90% probability of being recoverable and probable reserves have at least a 50% probability of being recoverable.

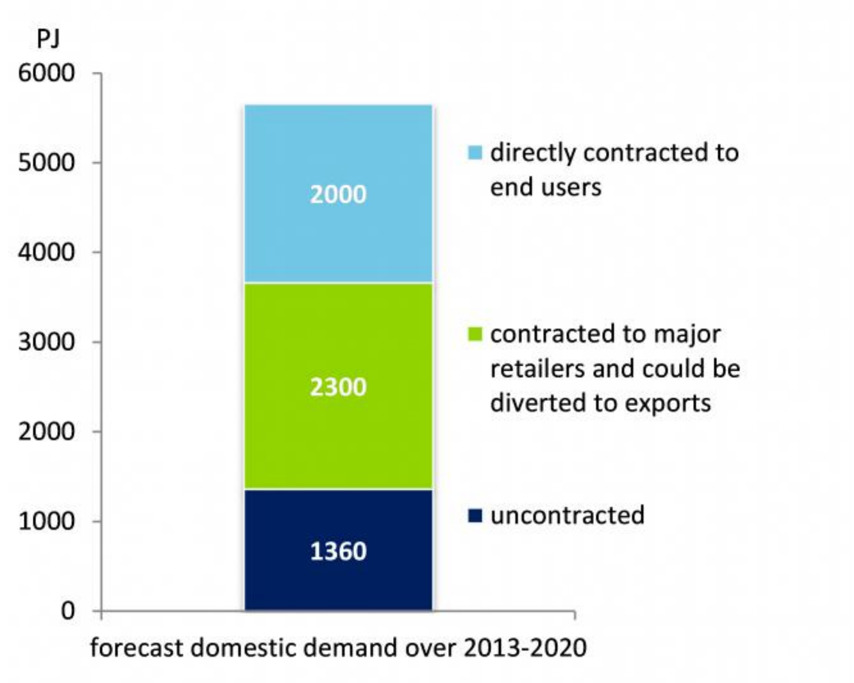
[9] Department of Industry, BREE 2013, *Eastern Australian Domestic Gas Market Study,* p1

contracts to domestic customers. Such reluctance was highlighted in Ai Group's recent survey of gas-using businesses on the East Coast. [10] Of the surveyed businesses that were looking for a new gas contract at the time:

- Nearly 10% could not get an offer at all
- One third could not get a serious offer
- One quarter could get an offer from only one supplier.

Modelling undertaken by SKM (further expanded upon in Chapter 4) shows the potential extent of the domestic contracting shortfall. As illustrated in Chart 2.2, SKM indicate that although approximately 76% (4,300 PJ) of forecast demand is contracted over the period 2013-2020, the majority of these contracts are not fully allocated to domestic end users. Instead, these contracts are held by gas retailers AGL, Origin Energy and Energy Australia, who could choose to divert around 2,300 PJ of 'domestic' contract gas to exports.

Chart 2.2: Contract status of forecast domestic demand for the East Coast over 2013-2020



Source: SKM 2013, Gas market modelling

With a significant number of gas supply agreements (GSAs) serving the domestic market expected to roll-off in the period associated with the greatest supply uncertainty, there is currently significant debate about the ability of the East Coast market to function effectively.

2.2 West Coast gas market

Unlike the East Coast, the West Coast domestic and LNG export markets have co-existed since Western Australia began exporting from the North West Shelf (NWS) in 1989.

[10] Australian Industry Group, 2013, Energy shock – The gas crunch is here

However, due to a number of government arrangements to reserve gas for the domestic market, domestic gas consumers in WA have largely been protected from international LNG market prices.

The first and most significant of these arrangements was the 1979 NWS State Agreement. The 1979 North West Shelf State Agreement largely underwrote the development of both WA's domestic and LNG export markets. Under the NWS State agreement, the WA State Government contracted to buy 3,023 PJ of gas and reserve a further 2041 PJ for domestic use.[11] The agreement also required the NWS JV partnership to build a domestic gas processing facility on the Burrup Peninsular (the Karratha Gas Plant), while the State Energy Commission of WA (SECWA) was responsible for building gas fired power stations and developing the Dampier to Bunbury Natural Gas Pipeline. This infrastructure allowed gas to be processed and transported to WA domestic customers.[12]

Although the low-risk returns associated with this long-term contract facilitated the development of the NWS project, contracted domestic volumes often exceed local demand.[13] This excess supply in the domestic market tended to keep domestic gas prices lower than international prices. Relatively low gas prices encouraged development of many gas-intensive industries. Presently, Western Australia is Australia's most gas intensive state, consuming almost one third of the country's gas supply.[14]

2.2.1 Higher prices as existing legacy contracts expire

Many of Western Australia's large domestic gas consumers have been supplied via long-term contracts with the NWS. These 'legacy contracts' were indexed to local inflation indicators and historically averaged around \$2-3/GJ.[15] However, a number of these contracts have expired and more are expected to expire in 2020.[16] New contracts are now being set at oil linked LNG netback prices, which, similar to the East Coast, are significantly higher than historical prices.

During the peak of the resource boom many of WA's gas-intensive mining companies, which were requiring unprecedented levels of gas, were thought to be able to absorb higher oil linked prices. Additionally, with diesel reaching energy equivalent prices of \$20/GJ during that period, gas was still seen as relatively competitive in comparison with the next best alternative.[17] However, as the resource boom begins to slow and many companies seek to find greater efficiencies in their production processes, a higher gas price environment may lead WA's domestic gas users to consider other options.

[11] North West Gas Development (Woodside) Agreement Act 1979 – Schedule 3

[12] Economics and Industry Standing Committee, 2011, *Inquiry into domestic gas prices. Report No. 6 in the 38th Parliament*

[13] Grattan Institute 2013, *Getting Gas right: Australia's energy challenge*

[14] BREE 2013, *Australia energy statistics*

[15] Economics and Industry Standing Committee, 2011, *Inquiry into domestic gas prices. Report No. 6 in the 38th Parliament*

[16] Western Australia Gas Statement of Opportunities, 2013

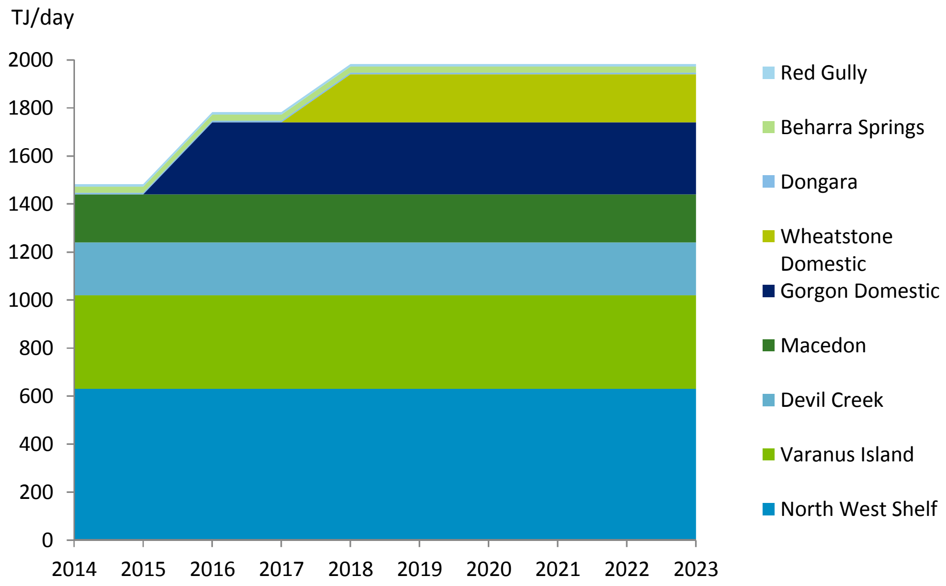
[17] Economics and Industry Standing Committee, 2011, *Inquiry into domestic gas prices. Report No. 6 in the 38th Parliament*

2.2.2 Domestic supply uncertainty

Although higher prices will have implications for WA's large domestic gas users, the Western Australian domestic gas market is currently facing a more serious potential risk. Despite having more than enough 2P conventional reserves to meet both domestic and LNG export demand, there is presently significant uncertainty around the supply-demand balance within WA's domestic market post 2020.

Chart 2.3 illustrates the supply sources available (in terms of nameplate processing capacity[18]) to meet WA's domestic gas demand over the period 2014 – 2023.

Chart 2.3: Domestic gas supply sources in Western Australia



Source: Western Australia Gas Statement of Opportunities, 2014

As can be seen, the NWS project represents a significant proportion of WA's domestic gas processing capacity and accounts for a large share of WA's domestic supply. However, the NWS joint venture's (JV) commitment to supply the domestic market with 5,064 PJ of gas under the State Agreement is expected to be fulfilled in the near future. Although new supply sources such as Gorgon and Wheatstone are coming online, it is presently unknown whether the NWS project will recontract with the domestic market. With such a large quantity of domestic supply currently reliant on the NWS, such uncertainty is creating significant tension and unease within the domestic market.

In response to a number of domestic market participants' concerns about the NWS JV's intentions and ability to supply the domestic market once existing contracts expire, the latest Western Australian Gas Statement of Opportunities released on January 2014 (2014 GSOO) undertook an investigation into the capability of the North West Shelf to continue to supply the domestic market. This analysis found that ongoing supply from the North West Shelf JV beyond the terms of its existing contracts depends on a range of factors including:

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[18] Nameplate capacity relates to the intended technical maximum sustained output of the gas processing plants

- the outcomes of ongoing discussions between the WA Government and the North West Shelf JVs that relate to the status of remaining North West Shelf reserves
- investment decisions required by the North West Shelf JVs to access remaining undeveloped reserves
- investment required to extend the life of the Karratha Gas Plant (KGP), which is the NWS's ageing domestic gas production facility.

The 2014 GSOO indicated that, if the North West Shelf continues to produce gas at the current estimated production rate (1,191 PJ/annum), it will have enough 2P reserves to supply both the domestic and LNG markets for at least another 12 years. However, the North West Shelf JV has currently not confirmed whether it intends to continue to invest in extracting these remaining reserves.[19] Further, several domestic gas users have highlighted that a large proportion of the remaining North West Shelf gas reserves have already been committed to LNG customers, leaving little (if any) reserves to serve the domestic market.

[19] Western Australia Gas Statement of Opportunities, January 2014, p23

3 Domestic Gas Use within the Manufacturing Sector

While many sectors within Australia's economy will be impacted by higher gas prices and a more difficult gas contracting environment, gas-using industries within the manufacturing sector are likely to bear the brunt of the adverse consequences. As manufacturing has played a vital role in Australia's economic advancement for over a century, it is important to understand how these changes in the East and West Coast gas markets are likely to affect key industries within Australia's manufacturing base. Further, as many manufacturing industries are closely intertwined with other economic sectors, impacts to the manufacturing sector could have flow-on effects, potentially impacting the resilience of Australia's economy more broadly.

3.1 Economic profile of Australia's manufacturing sector

Currently, the manufacturing sector currently accounts for 8.6% of GDP and employs approximately one million people, considerably exceeding the contribution of output and employment from other goods sectors. We provide a detailed snapshot of gas-using manufacturing industries in Table 3.1.

For the purposes of this analysis, the ANZSIC categories defined by the ABS have been modified and calibrated to align with the groups selected by the project consortium. The subsectors below (with the exception of other manufacturing) also accord with the modelling disaggregation.

It is important to note that while measures such as wages, income, industry value added and employment are revealing; they do not paint a complete picture of the total influence of manufacturing in the Australian economy. As noted above, manufacturing has strong linkages to other sectors of the economy, reflecting the goods refinement nature of its core operations.

The strongest connections are with the agriculture and mining industries, which are tightly coupled to many production processes within the manufacturing sector. For example, meat, dairy and fresh produce farmers provide goods that are processed into food, beverage and grocery products. Similarly, the chemical manufacturing sector's production of explosives, fertilisers, agrichemicals, building products, fresh food packaging and other industrial derivatives are used by wide range of supply chains within the Australian economy.

Table 3.1: Key sector statistics, 2011-12

Subsector	Wages and salary ($m)	Sales and service income ($m)	Industry value added ($m)	Employment (No.)	Australian Business Count (No.)
Food and beverage	12,278	90,909	23,963	244,399	12,992
Groceries	1,663	11,828	3,392	18,730	373
Fresh food	793	10,604	3,694	73,622	24,068
Paper products	1,121	7,342	1,883	14,822	767
Basic chemicals	1,472	15,403	3,684	15,620	986
Specialty chemicals	3,236	18,112	6,530	48,291	3,523
Consumer chemicals	552	4,011	1,048	8,644	999
Iron and steel	2,269	17,306	2,809	30,132	1,778
Alumina	1,156	6,970	2,626	9,094	21
Aluminium	682	8,821	1,049	7,492	61
Bauxite	269	1,682	568	2,288	12
Fabricated metal products	5,708	28,499	10,217	104,784	13,703
Other manufacturing	25,277	189,366	45,201	432,292	52,725
All manufacturing	56,477	410,853	106,664	1,010,210*	112,008

Source: ABS, Deloitte Access Economics

Note: The Australian Business Count data is based on the ABS *Counts of Australian Businesses, including Entries and Exits, Jun 2008 to Jun 2012*. The data provided is the total number of businesses operating at the end of financial year 2012.

*We note that the most recent employment numbers given for the manufacturing sector by the ABS 6291.0 are slightly lower (around 950,000)

3.2 Gas use and dependence within Australia's manufacturing sector

The extent to which gas-using industries are impacted by higher gas prices and a more difficult gas contracting environment depends on:

- the nature of their gas consumption
- their trade exposure
- their ability to pass on cost increases and
- their ability to switch fuel sources.

As shown in Figure 3.1, industry gas use can be segmented into three main categories, which also map to different degrees of gas dependence.[20]

[20] Department of Industry, BREE 2013, *Eastern Australian Domestic Gas Market Study,* p 40

Figure 3.1: Gas use and dependence within industry

High gas dependence	**Feedstock usage** • Chemical products, such as fertilisers, plastics, explosives and methanol
Moderate gas dependence	**Heat or steam requirements** • Production of cement, pulp and paper, glass, food and beverages, or the refining of alumina and non-ferrous metals
Low gas dependence	**On-site electricity generation** • Used at mining sites, factories and plants for various industrial processes

Source: Department of Industry, BREE 2013, Eastern Australian Domestic Gas Market Study

Industries that use gas for on-site electricity generation are typically the least gas dependent as they are able to substitute to electricity from the grid, or other fuel sources such as coal.

Industries with production processes that involve lower temperatures or lower-pressure steam generation may also be able to switch to alternative fuels or technologies. However, this substitution generally comes at the cost of large capital outlays and higher emissions. Industrial processes that require greater temperatures or steam pressure are often more reliant on gas, due to its higher energy content and efficiency.

Industries that use gas as a feedstock (or key ingredient) in the manufacture of chemical products are generally seen to be the most dependent on gas availability, as they simply do not have any alternatives to gas. In these instances, gas is generally non-substitutable and the chemical processes requiring gas operate in a narrow band of supply tolerance in terms of flow rates. By this, we mean that chemical plants usually either need to be completely off or completely on, with limited ability to moderate demand during supply side tightness. Further, as most chemical plants need to run continuously, the ability to secure a long-term GSA is often critical to the viability of the chemical production process.

One other key aspect of chemical feedstock production is the integration and tight interdependencies with other supply chains as noted in Section 3.1. With other industries, such as fresh food requiring a constant supply of select polymer grades for their packaging, supply interruptions will have logical flow-on implications for supply chains, consumers and the economy.

4 Gas Price Scenarios

Despite unique differences between the East and West Coast gas markets, changing circumstances in both markets are placing significant upward pressure on prices. To characterise the impacts of higher prices on domestic gas users we have sought to model scenarios reflecting projected higher gas prices, and compare these against baseline (or counterfactual) scenarios involving lower gas prices.

We present the scenarios constructed for the East and the West Coast gas markets in Table 4.1 below.

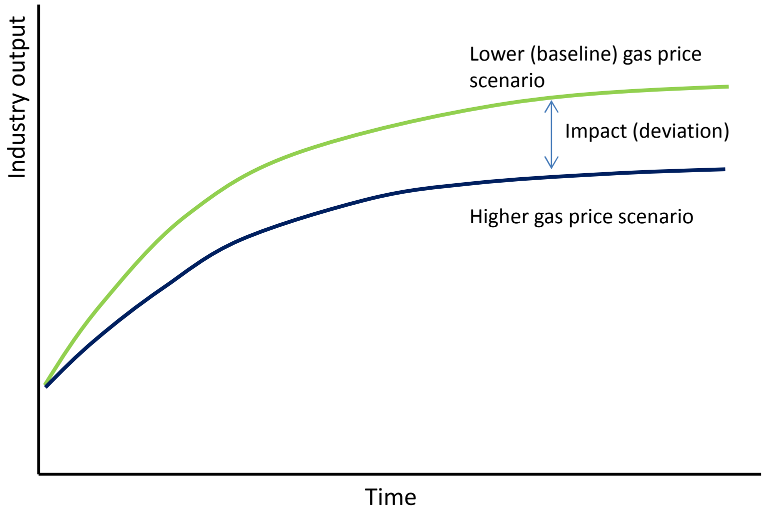
Table 4.1: Modelled gas price scenarios

Scenario	East Coast	West Coast
Higher gas price (LNG) scenario	Gas prices rise to reflect linkages to international LNG prices	Gas prices rise to reflect LNG netback prices, either as a result of the NWS not recontracting, or only recontracting at netback parity
Lower gas price (baseline) scenario	Gas prices reflect production and transportation costs as there is no international linkage	Gas prices reflect the North West Shelf recontracting with the domestic market, creating significant excess supply

Source: DAE analysis

As shown in Figure 4.1 below, this approach allows us to characterise the *economic impact* as the difference (as measured in terms of industry output (equivalent to sales and service income), gross domestic product (GDP) and employment) between the baseline and the higher gas price scenario.

Figure 4.1: Baseline and higher gas price scenario



Source: Deloitte Access Economics

This approach has important implications for the interpretation of results presented in this report.

- For the East Coast, the difference (or 'deviation') between the baseline and the higher gas price scenario gives a measure of impacts associated with new linkage to international LNG markets, in comparison to a world in which prices did not rise to reflect LNG parity, but instead reflected production and transportation costs.

- For the West Coast, the difference (or 'deviation') gives a measure of impacts arising as a result of the NWS not recontracting with the domestic market (or only recontracting at netback parity) in comparison to a world in which the NWS recontracted at prices reflecting significant excess supply within the domestic market.

4.2 Gas price forecasts for each scenario

In light of significant transformations taking place in both the East and West Coast gas markets, considerable effort has already been devoted to projecting future gas prices over the 2014-2021 period. Rather than duplicating and potentially complicating the price projections that already prevail in the public domain, we have sought to use existing gas price modelling undertaken for the East and West Coast gas markets.

4.2.1 Price forecasts for the East Coast gas market

Modelling of gas price projections for the East Coast gas market was undertaken in the context of the Eastern Australia Domestic Gas Market Study (EADGMS). This study was carried out by the Commonwealth Department of Industry and the Bureau of Resources and Energy Economics and presents forecast price paths under a number of different scenarios.

Intelligent Energy Systems (IES), in partnership with Resource and Land Management Services (RLMS) were the primary source of modelled price paths included in the report. However, in order to provide a counterpoint and additional context to IES's price forecasts, the report also presented modelling undertaken by Sinclair Knight Merz (SKM), Core Energy Group, and the Australian Energy Market Operator (AEMO).[21]

As there are a significant number of price paths presented in the EADGMS, it would not be feasible (nor particularly useful) to model the impact of all included price paths. As such, we have focused our analysis on the modelling undertaken by IES and SKM because they illustrate an important distinction:

- The IES modelling estimates price impacts associated with the link to international LNG markets under the assumption that the market is perfectly competitive and offers little opportunity to exert market power.
- In contrast, the SKM modelling estimates price impacts under the assumption that gas producers and shippers are able to exert market power.

Additionally, as IES and SKM modelling both present a number of price projections for various scenarios, we have selected gas price paths on the basis of what we consider would represent a reasonable baseline and plausible higher priced scenarios (due to international market linkages) for the East Coast domestic market. While we have presented our analysis of the EADGMS modelling and our rationale for the East Coast gas market price path selection in Appendix B, both sets of modelling provide price projections for:

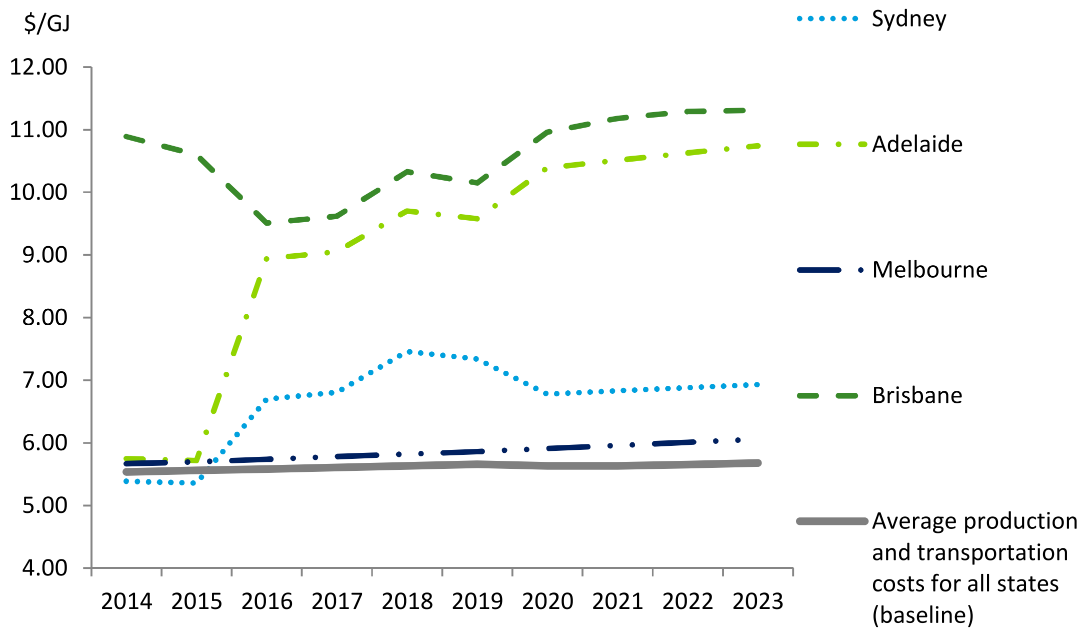
- Production and transportation costs (which we used to characterise the lower (baseline) gas price scenario)

- Domestic gas prices associated with 8 LNG trains becoming operational on the East Coast by 2023 (which we used to characterise the higher priced LNG scenario).

In determining the economic impact under both sets of modelling, we have compared the IES baseline (production and transportation costs) to the IES LNG scenario and the SKM baseline (production and transportation costs) to the SKM LNG scenario. This provides two separate measures of the impact of the linkage to international LNG markets on the East Coast. We present the IES and SKM baseline and LNG price forecasts in the charts below.

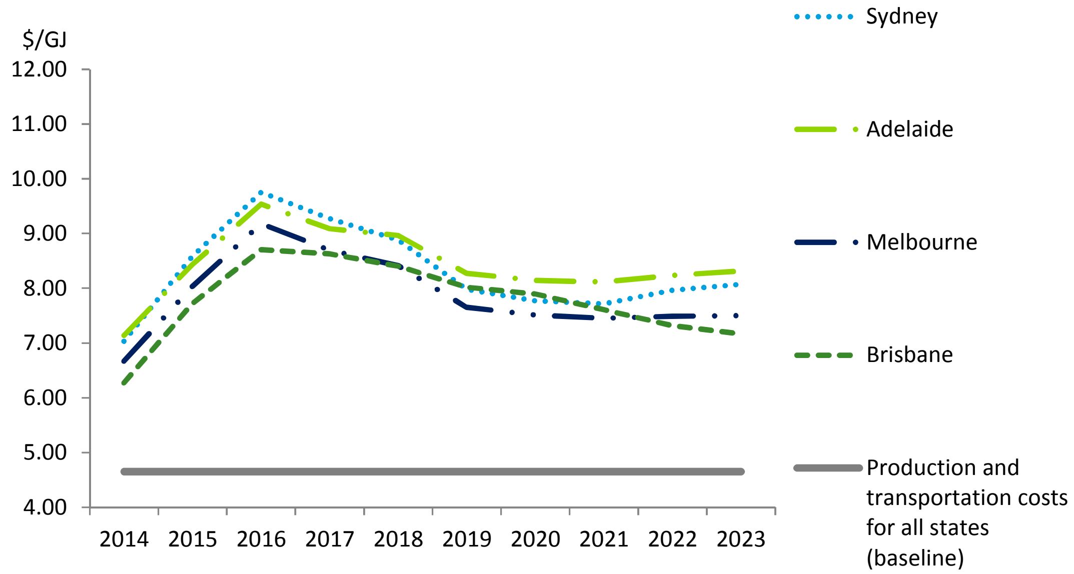
[21] Department of Industry, BREE 2013, *Eastern Australian Domestic Gas Market Study*, p 71

Chart 4.1: Baseline and LNG scenarios for East Australian jurisdictions based on IES modelling



Source: IES 2013, Study on the Australian Domestic Gas Market

Chart 4.2: Baseline and LNG scenarios for East Australian jurisdictions based on SKM modelling



Source: SKM 2013, *Gas market modelling*

As can be seen, both the SKM and IES higher gas price forecasts (reflecting international LNG market linkage) are significantly higher than the East Coast historical average of around $3-4/GJ. However, SKM's higher gas prices are relatively uniform across the East Coast jurisdictions, whereas the IES higher gas price forecasts show much greater divergence.

The differences between the two sets of modelling largely stem from the different modelling approaches. In assuming a perfect market environment, IES' model does not account for situations where it would be possible to set prices above least-cost levels.[22] As noted in the EADGMS, this includes circumstances where market tightness could allow suppliers to charge higher prices. In contrast, SKM's model can reflect suppliers' ability to exert market power due to limited supply. In fact, SKM's higher price paths for each jurisdiction (shown in Chart 4.2) were modelled on the assumption that a significant proportion of 'domestic' gas is diverted to meet LNG export requirements. While there is significant uncertainty around whether or not LNG projects *are* short on gas reserves (though we note that it appears the Gladstone LNG project does require additional supply[23]), SKM contend that profit maximising producers would seek to contract at prices reflecting market tightness, regardless of whether domestic gas supply is actually diverted to LNG export projects.

We note that IES was the primary source of advice for the EADGMS. However, it is important to emphasise that our initial analysis (detailed in Appendix B), the findings of Ai Group's 2013 survey of gas-using businesses in Eastern Australia, and our case study findings (detailed in Chapter 5) indicate that the SKM gas price forecasts appear to be a more accurate reflection of the current (and future) conditions within the East Coast gas market. In contrast to the SKM price paths, the IES price paths appear to underestimate the price rise in some jurisdictions compared with their market experience.

As the difference between the two sets of modelling are most pronounced in the Melbourne and (to a lesser extent) Sydney regions, it is important to bear this in mind when interpreting the results. In particular, to the extent that the Melbourne and Sydney gas price increases are understated under the IES forecasts, the impacts determined for these regions, and hence the national results, are also likely to be understated. For this reason, we consider that the impacts projected under the SKM gas price forecasts provides an important counterpoint and warrant greater attention.

4.2.2 Price forecasts for the West Coast gas market

Modelling of gas price projections for the West Coast gas market was developed as part of Western Australia's Gas Statement of Opportunities (GSOO). The latest GSOO for Western Australia was released in January 2014, and presents domestic price forecasts undertaken by the National Institute of Economic and Industry Research (NIEIR).

In light of the uncertainty associated with the NWS, the 2014 GSOO developed two supply scenarios for the 2014-2023 forecast period. These included:

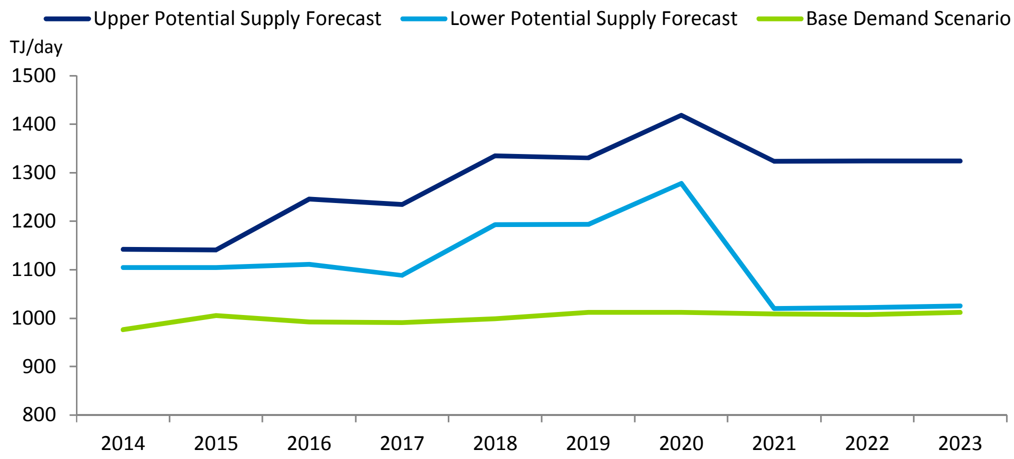
- The 'Upper potential supply forecast', which assumes the NWS will recontract to supply the domestic market. Under this scenario, the 2014 GSOO assumes the NWS will continue to supply the domestic market at a maximum of 470 TJ of gas per day till 2020 (inclusive) and thereafter up to 450 TJ per day to 2023.
- The 'Lower potential supply forecast', which assumes that NWS will only supply domestic gas under their remaining contracts (and not recontract with the domestic market)

[22] Department of Industry, BREE 2013, *Eastern Australian Domestic Gas Market Study*, p74

[23] Australian Financial Review, *WestSide reveals surging gas price,* 10 May 2014

These supply forecasts and the 2014 GSOO Base demand forecast are shown Chart 4.3 below.

Chart 4.3: 2014 GSOO Supply and demand forecasts



Source: Western Australia Gas Statement of Opportunities, 2014

According to the 2014 GSOO, if the NWS recontracts with domestic customers beyond 2020, domestic supply is projected to be approximately 30% greater than forecast domestic demand by 2023. This excess supply has the potential to place downward pressure on prices. However, the 2014 GSOO projects very tight market conditions and potential supply shortages if the NWS elects not to supply domestic gas beyond its remaining contracts.

Despite developing two supply scenarios for the West Coast domestic market, the 2014 GSOO only presented one price forecast. On the basis of our analysis (detailed in Appendix B), we consider that this price forecast could be a plausible price path associated with the Upper Potential Supply Forecast where NWS elects to the recontract with the domestic market (i.e. characterising the lower (baseline) gas price scenario for the West Coast, where there is surplus gas supply in the domestic market). However, we consider that this scenario is particularly unlikely. Even if the NWS chose to recontract with the domestic market, it is likely that they would only do so at LNG netback prices, which reflects their opportunity cost of supplying LNG to the international market.[24]

We have used the Deloitte Gas Market Model to develop an alternative price forecast to reflect the Lower Potential Supply Forecast, (which characterises the higher gas price scenario for the West Coast). This forecast reflects gas prices likely to be experienced by domestic gas users under a scenario where either the NWS:

- does not recontract with the domestic market, creating market tightness in accordance with the supply-demand balance associated with the 2014 GSOO's Lower Potential Supply Forecast and pushing prices up to LNG netback values, or
- recontracts with the domestic market at LNG netback prices

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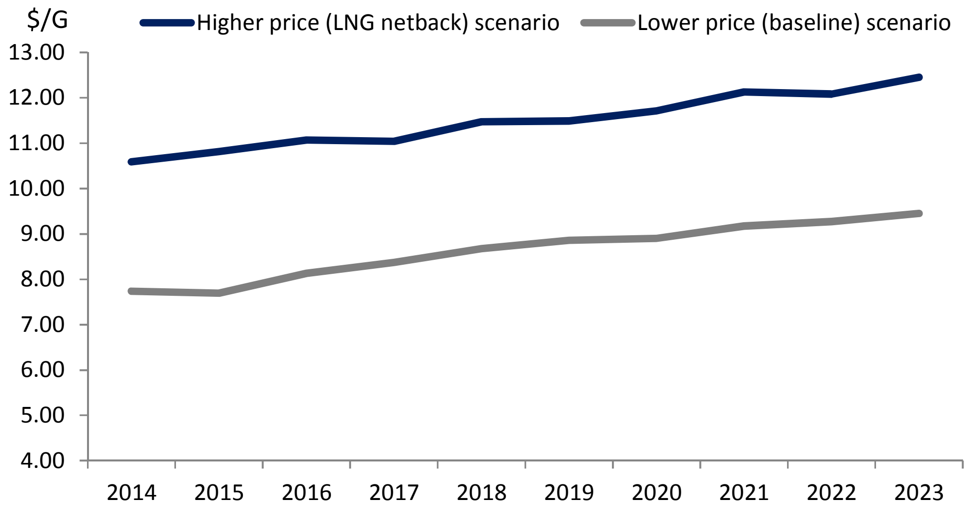
[24] Such sentiment was recently expressed by Peter Coleman, CEO of Woodside in a recent Investor Update briefing, where he stated "Our target in the [West Coast] market is to ensure that we get LNG netback prices or equivalent to that". *Woodside ASX Announcement*, Wednesday 11 December

We present the lower (baseline) and higher gas price scenarios for the West Coast gas market in Chart 4.4 below.

Chart 4.4: Lower price (baseline) scenario and Higher price scenario for the West Coast



Source: Western Australia Gas Statement of Opportunities, 2014, DAE Analysis

Importantly, both the lower and higher price scenarios are significantly higher than the West Coast historical average of around $2-3/GJ. Further detail on the construction of these price forecasts can be found in Appendix B.

5 Case studies

To complement the sectoral and economy-wide CGE modelling results (presented in Chapters 6-12) we have undertaken a series of case studies on contrasting businesses that use gas within their operations. Recognising that our CGE model's simplifying assumptions could potentially obscure some of the more granular and discrete impacts being felt by individual businesses, our case studies are intended to reflect some of the more detailed and specific realities currently being experienced by manufacturers operating within the East and West Coast gas markets.

In consultation with business representatives, we assessed the likely impact of projected gas prices on the businesses' profitability, risk profile and future investment decisions. In what follows, we present case studies on the following businesses:

- **Orica Australia** - uses gas as a chemical feedstock to produce ammonia (used in explosives and fertilisers) and sodium cyanide (used in gold extraction)
- **Rio Tinto Alcan** – uses gas for heat and steam to produce alumina, which is the key input into aluminium
- **Goodman Fielde**r – uses gas for heat and steam in its bakeries to produce bread and baked products
- **Australian Paper** – uses gas for heat and steam in its pulp and paper mill
- **GB Galvanizing** – uses gas for heating in its 'hot dip galvanizing' process, which is used to protect steel from corrosion

5.1 Orica

Orica Australia Pty Ltd (Orica) is an Australian-owned, publically listed global company and is the largest provider of commercial explosives and blasting systems within the mining and infrastructure markets. Orica is also a leading supplier of sodium cyanide, which is used for gold extraction.

5.1.1 Gas usage

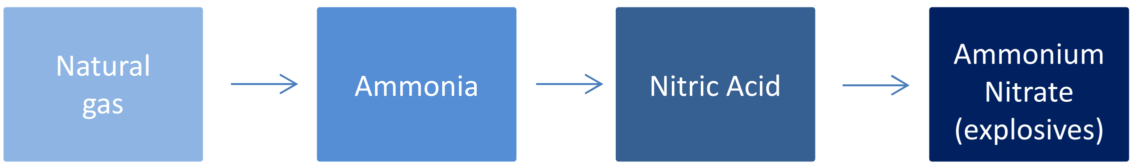
Orica uses gas as a feedstock for two key production processes:

- Production of ammonia, which is one of the main inputs used in the production of explosives.
- Production of sodium cyanide, which is used by precious metal mining sectors to extract gold from ore.

5.1.1.1 Production of ammonia

Orica produces ammonia at its facility on Kooragang Island, which is located in the Hunter Valley in NSW. Orica uses approximately 14 PJ of natural gas per year to produce around 360,000 tonnes of ammonia. Approximately 70% of this ammonia is then converted to nitric acid, which, as shown in the following figure, is then used to produce ammonium nitrate. Ammonium nitrate is used to manufacture blasting explosives for the coal mining industry in the Hunter Valley.

Figure 5.1: Production of ammonium nitrate at Kooragang Island, NSW



Orica also produces ammonium nitrate at its Yarwun facility in Gladstone, Queensland. However, unlike the Kooragang Island production process, Orica does not currently produce ammonia at Yarwun. This is largely because natural gas prices in Queensland are higher than in NSW. In fact, although the Yarwun facility has a site that was specifically marked out for an ammonia plant, it is presently more cost effective for Orica to import ammonia from international markets or source surplus ammonia directly from the Kooragang Island facility.

Figure 5.2: Production of ammonium nitrate at Yarwun, Queensland

5.1.1.2 Production of sodium cyanide

Orica uses around 4 PJ of natural gas to produce around 95,000 tonnes of sodium cyanide per year at its Yarwun facility. Sodium cyanide is used within the gold leaching process, which is considered the most efficient method to extract gold from ore.[25] In Australia, 98% of our gold production is dependent on sodium cyanide, with each tonne of gold requiring around 300-500 tonnes of sodium cyanide.[26]

As ammonia production is Orica's most gas intensive production process, we have focused this case study on the impact of projected gas market transformations on Orica's business profitability, risk profile and future investment decisions relating specifically to their ammonia production operations.

5.1.1.3 Contracting for gas

In order to produce ammonia Orica's ammonia plant requires a constant supply of gas. With the exception of a four week shut down every four years to undertake major work and a one week shut down every two years to undertake minor maintenance, Orica's ammonia plant needs to run continuously. As such, Orica requires long term gas contracts and generally needs to contract for at least four years in advance.

Historically, Orica has been able to access long term, inflation indexed GSAs. However, Orica's current 10 year GSA with Santos expires in 2016. As Orica has been unable to secure a new long term GSA for the period post 2016 at acceptable terms, Orica has had to resort to a three year stop-gap contract with BHP/ESSO. Although this arrangement provides Orica with the required security of supply in the short term, the contracted gas is oil-linked and too expensive to represent a viable long term option for Orica.

5.1.2 Impact

In light of Orica's gas intensive production processes and heavy reliance on long term gas contracts, higher gas prices and supply uncertainty stemming from transformations in the East Coast gas market could have a significant impact on Orica's business profitability, risk profile and future investment decisions. In what follows, we explore each of these impacts in turn.

5.1.2.1 Impact on profitability

Assessing the potential impact of transformations in the East Coast gas market on the profitability of Orica's ammonia production operations requires an understanding of:

- The price of ammonia (which determines revenue)
- Costs of ammonia production

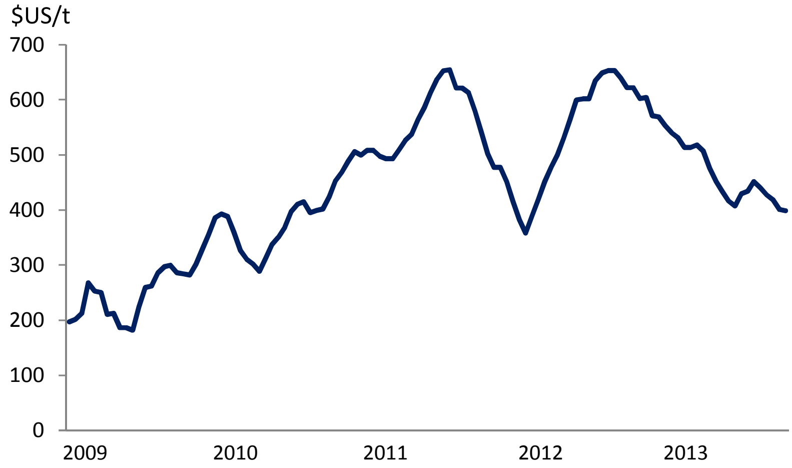
[25] Orica fact sheet 2014, Sodium Cyanide, http://www.orica.com/Products---Services/Mining-Chemicals/Products/Sodium-Cyanide/Sodium-Cyanide#.U0XtAfmSyBY

[26] Chemlink consultants, Sodium cyanide, http://www.chemlink.com.au/cyanide.htm

Price of ammonia

Ammonia is a globally traded commodity, with prices set by global supply and demand dynamics. Although Orica primarily uses ammonia to produce blasting explosives, ammonia is also an important feedstock in the production of fertilisers. Consequently, ammonia prices tend to be strongly influenced by dynamics within fertiliser markets. Chart 5.1 shows the FOB price per tonne (in $US) for ammonia over the period 2009 - 2013

Chart 5.1: FOB price ($US) per tonne of ammonia for 2009-2013



Source: Fertecon Ammonia Report, 21 November 2013

As can be seen, ammonia prices have been trending upwards on average, as tight global grain supplies, strong crop prices and increasing biofuels production drive growth in fertiliser demand. This has led to an average increase in the demand for ammonia by around 2.5% per year.[27]

As Orica's ammonia competes with imported ammonia, the effective price that Orica can charge is, on average, equivalent to the delivered price for ammonia (that is, the free on board (FOB) price set by the global ammonia market, plus shipping costs). Over the past year, the delivered price for ammonia has averaged around $AUD 608 per tonne.[28]

Cost of ammonia production

As ammonia production is very gas intensive, production costs are significantly influenced by gas prices. A benchmarking study undertaken by the International Fertilizer Association in 2006 found that of 66 ammonia production plants around the world, the production of one tonne of ammonia required an average of 37 GJ of gas.[29] This means that if gas prices rise by one dollar, ammonia production costs rise by around $37 per tonne. However, as ammonia prices largely depend on the global supply situation, increasing gas prices do not

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[27] IHS, 2014, *Biofuels Production, Improving diets and growing economies in 'BIC' countries driving global demand for Ammonia, New HIS Study Says,* March 2014

[28] Based on the last year of data from Fertecon Ammonia Report, 21 November 2013 and Fertecon Ammonia Report, 20 March 2014. NB: $US converted to $AUD using exchange rate of 0.9

[29] International Fertiliser Industry Association, 2006, *Energy Efficiency in Ammonia Production, Executive Summary for Policy Makers,* www.fertilizer.org

necessarily translate into higher ammonia prices.[30] Consequently, Orica has a limited ability to pass on increased costs associated with rising gas prices.

In order to obtain cost estimates for ammonia production, we relied on data provided by Orica. Due to the sensitive nature of this commercial information, we are only able to disclose our findings at an aggregate level.

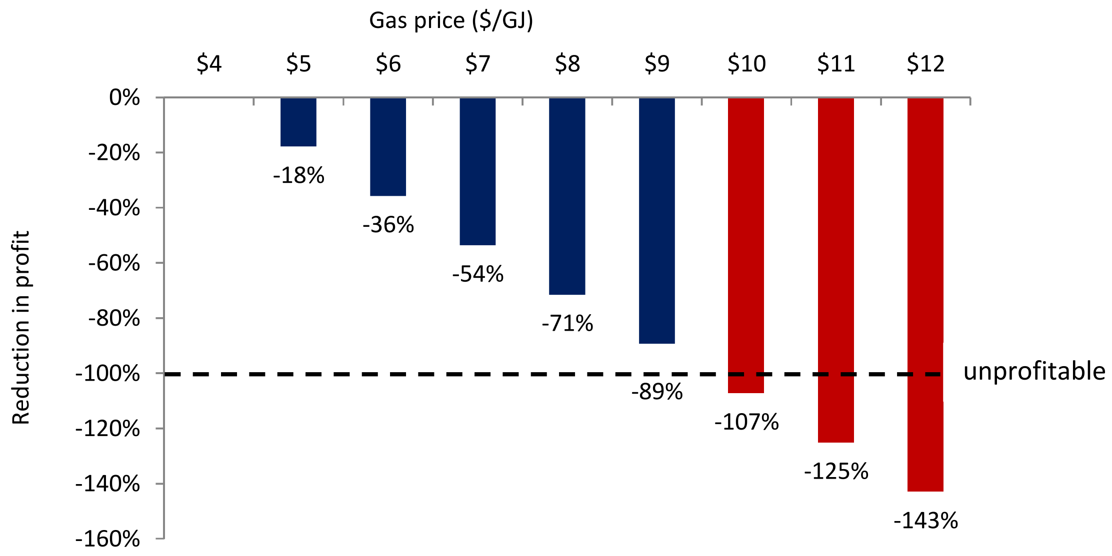
Impact on profit

Based on the available data for ammonia prices and production costs, we developed estimates for the reduction in Orica's profit associated with their ammonia production operations. In deriving these estimates, we have:

- Assumed an existing gas price of around $4/GJ
- Based the delivered price of ammonia on the current price of $AUD 607/t.[31]

Chart 5.2 shows the reduction in Orica's annual ammonia production profit estimates under different gas prices.

Chart 5.2: Estimated reduction in Orica's annual profit associated with ammonia production under different gas prices



Source: DAE Analysis

As shown, if gas prices were to reach beyond $9/GJ, Orica's ammonia production operations would no longer be viable. However, we note that these estimates are highly sensitive on the delivered price of ammonia. If the delivered price of ammonia was to drop by 10%, Orica could be looking to shut down its ammonia production facilities at a gas prices beyond $7.

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[30] IEA 2007, *Tracking Emissions Industry*, p 82

[31] Fertecon Ammonia Report, 20 March 2014. NB: $US converted to $AUD using exchange rate of 0.9

5.1.2.2 Impact on risk profile

Risk is one of the most important factors influencing Orica's ammonia production operations. Although Orica's risk profile will be influenced by a number of factors such as conditions within ammonia markets and future growth in the Hunter Valley coal mining sector, transformations taking place within the East Coast gas market have the potential to significantly increase the risk associated with Orica's operations.

As noted above, Orica requires reliable, long term gas supply contracts to continue operating its ammonia plant. However, in light of the uncertainty within the East Coast gas markets, affordable long term gas supply contracts are currently not available. Although Orica's three year contract with BHP/ESSO buys Orica some time, Orica is having to look upstream to find a viable long term solution.

In 2013, Orica signed a binding term sheet for up to 150 PJ of gas over 20 years with Strike Energy. Strike Energy is an upstream oil and gas exploration and production company with 15,000km^2 of exploration permits and applications in the Cooper Basin.[32] The binding term sheet arrangement is designed to facilitate the evaluation and commercialisation of Strike's prospective resources, with Orica being able to make up to $52.5 million of gas prepayments as Strike Energy achieves development milestones.[33] In 2014, Orica signed an additional agreement with Strike Energy to swap exploration funding for the future supply of an additional 100 PJ of gas over 10 years from 2020. [34]

If Strike Energy is successful in developing their prospective resources, these agreements would provide Orica with 250 PJ of gas over the period 2017-2036.[35] Orica has advised that this outcome would provide it with more gas than it requires, allowing Orica to sell surplus gas back to the market. However, as upstream gas exploration is inherently uncertain, Orica is having to take on much higher levels of risk to secure a reliable, affordable gas supply.

5.1.2.3 Impact on investment and the viability of other operations

Greater risk and the potential for higher gas prices to reduce profitability are likely to impact Orica's future investment decisions. As ammonia production processes require large capital outlays and are relatively inflexible in the short term, Orica is unlikely to undertake further investment in an environment characterised by high uncertainty. A key case in point is the ammonia plant site that was originally marked out in Orica's Yarwun site, but remains undeveloped due to higher gas prices in Queensland.

Changes within the East Coast gas market are increasing both the costs and risks associated with gas intensive operations within NSW. If Orica's undertaking with Strike Energy is unsuccessful, Orica's ammonia production operations in Kooragang Island are unlikely to remain viable. Consequently, Orica would shut down its ammonia plant and switch to using imported ammonia to produce explosives (in a similar manner to its Yarwun facility). This could have widespread impacts within and outside Orica. The chemicals and plastics

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[32] Strike Energy Company profile, http://www.strikeenergy.com.au/about-us/aboutprofile.html

[33] Strike Energy ASK Announcement, Orica and Strike Energy sign binding term sheet for up to 150 PJ of gas.

[34]https://www.mywealth.commbank.com.au/companies/orica-signs-supply-deal-with-strike-energy-news20140325

[35]https://www.mywealth.commbank.com.au/companies/orica-signs-supply-deal-with-strike-energy-news20140325

industry supplies inputs to 109 of the 111 industries in Australia, and approximately 80% of its outputs become inputs to other industry sectors.[36]

5.1.3 Conclusion

Transformations occurring in the East Coast gas market are presenting Orica with significant challenges. Despite potential impacts to Orica's business profitability, risk profile and investments, Orica has been explicit in their views against government handouts. Instead, Orica has been noticeably proactive in doing something about managing the higher prices and gas supply uncertainty it faces in NSW.

Admittedly, seeking to develop and commercialise prospective gas resources upstream requires Orica to take on much higher levels of risk. However, should the venture with Strike Energy be successful, Orica will not only have access to a reliable and affordable supply of gas for at least the next 20 years, it will also bring new, much needed sources of gas into NSW.

Such actions demonstrate that despite the concerns around the current changes occurring on the East Coast gas market, industry players like Orica are doing what they can to respond to short term market pressures, build resilience, and contribute towards bringing about long-term solutions for the East Coast gas market.

[36] CSIRO, *Elements in Everything* (2013) www.csiro.au.

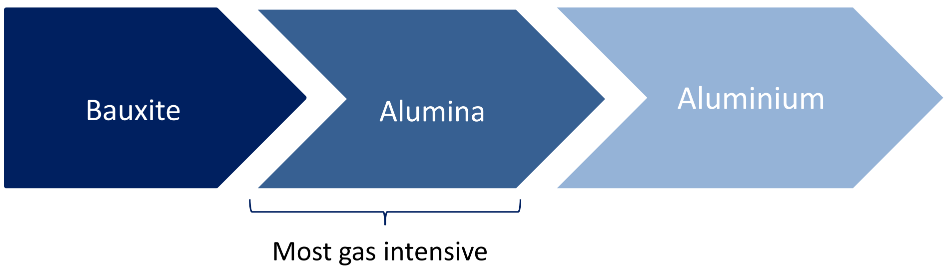
5.2 Rio Tinto Alcan

Rio Tinto Alcan is one of the world's largest producers of bauxite, alumina and aluminium. Rio Tinto Alcan operates as one of Rio Tinto's five product groups (which include Aluminium, Copper, Diamonds & Minerals, Energy and Iron Ore) and has a number of bauxite mines, alumina refineries and aluminium smelters in Australia.

5.2.1 Gas usage

Aluminium is a light, flexible and strong metal, which is infinitely recyclable and used in a broad range of applications within building and construction, aeronautical and automotive manufacturing, and in the production of many household appliances. As shown in the Figure below, the production of aluminium involves three key stages.

Figure 5.3: Aluminium Production



Firstly, bauxite, which is a clay-like raw material consisting of around 40-60% of alumina is mined from natural deposits. Secondly, alumina is extracted from bauxite through a refining process. Thirdly, alumina is transformed into aluminium through a smelting process.

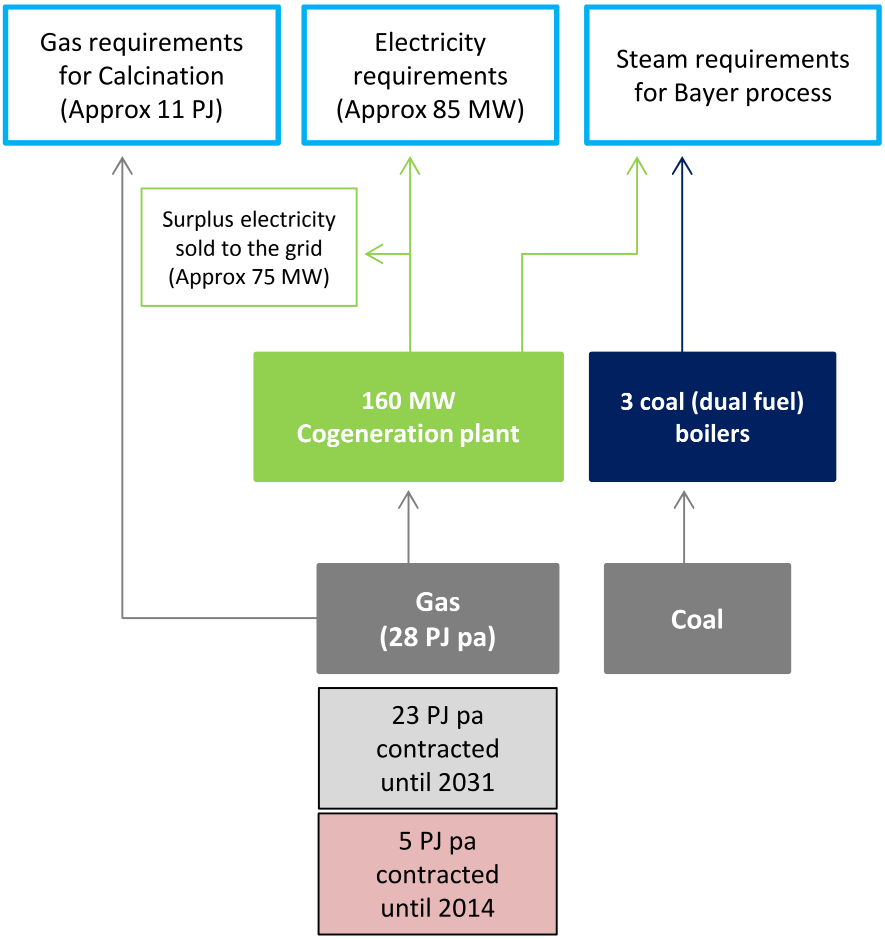
While Rio Tinto Alcan (RTA) is involved in all three stages of the aluminium production process, alumina refining represents the most gas intensive process. As such, we have focused this case study on RTA's Yarwun alumina refinery, which is located in Gladstone, Queensland.

RTA's Yarwun alumina refinery was opened in 2004 with an alumina production capacity of 1.4 million tonnes per annum. In 2012, an expansion project to increase the refinery's nameplate alumina production to 3.4 million tonnes per annum was completed. As part of this expansion, RTA incorporated a new 160 MW cogeneration facility. The facility now operates with:

- three coal fired (dual fuel) steam boilers
- a cogeneration facility that uses gas to generate both steam and electricity

Figure 5.4 shows a high level depiction of RTA's current plant and energy arrangements at the Yarwun refinery.

Figure 5.4: Rio Tinto Alcan's current plant and energy arrangements at the Yarwun refinery



Source: DAE Analysis

As shown, RTA's steam boilers and cogeneration facility provide steam required for heating in the 'Bayer process', which is the method in which RTA extracts alumina from bauxite. The Bayer process is further described in the box below.

Box 5-1: The Bayer Process

The Bayer process is the main industrial method for refining bauxite to produce alumina. The Bayer process involves four key steps:[1]

1. **Digestion** – Finely ground bauxite is mixed with a caustic soda solution at high temperatures and high pressure to dissolve and separate the aluminium contained in the bauxite
2. **Clarification** – Impurities are removed by passing the alumina and caustic soda solution into rows of thickener tanks
3. **Precipitation** – Alumina trihydrate is added to the alumina solution in order to produce alumina trihydrate crystals
4. **Calcination** – Alumina trihydrate crystals are cleaned, filtered and heated in gas- fired kilns at very high temperatures (greater than 1,100°C). This process removes the water molecules and creates a fine white powder, known as alumina.

As illustrated in Figure 5.4, RTA uses its 160 MW cogeneration plant to generate both steam and electricity needed for the refinery's operations. However, the Yarwun refinery only requires 80-85 MW of electricity per annum. Consequently, if RTA operates its cogeneration plant at full capacity, it will generate a surplus of around 75 MW of electricity. This electricity can be sold and exported to the Queensland electricity grid.[37] When pool prices in the electricity market are high, selling surplus electricity not only provides RTA with additional revenue, it also feeds in gas-powered electricity onto the electricity grid, which is associated with much lower emissions.

In addition to steam, the Bayer process also involves a calcination procedure (step 4 in Box 5-1), which requires around 11 PJ of gas per year. While RTA's steam requirements can be met using either coal or gas, the high temperatures involved in the calcination process can only be achieved using gas.

Contracting for gas

As shown in Figure 5.4 above, RTA currently has a foundation gas supply agreement (GSA) for 5 PJ of gas (per annum), which is due to expire in 2014. RTA also has another GSA for 23 PJ of gas (per annum) that expires in 2031.

RTA's current gas supply arrangements provide the Yarwun refinery with a total 28 PJ of gas. Of this, approximately 11 PJ is used for the calcination process and the remainder is used to generate steam and electricity. With RTA's 5 PJ GSA set to expire at the end of this year, RTA has been seeking to secure a new 5 PJ GSA. Despite attempting to obtain offers from the market for the past three years, RTA has only received a small number of conditional offers and is not seeing traditional liquidity in the gas supply market. Further, RTA considers that the offers it has received do not represent a competitive market price. As such, RTA has not, at the time of writing, recontracted for the additional 5 PJ of gas.

[37] http://bauxite.world-aluminium.org/refining/case-studies/yarwun.html

5.2.2 Impact

Having secured a 23 PJ contract through to 2031, RTA's Yarwun refinery is largely shielded from the impacts of transformations occurring on the East Coast gas market. However, as discussed above, RTA has been unable to secure the additional 5 PJ to supply the Yarwun refinery with its current total consumption of 28 PJ of gas per annum. Faced with this prospect, RTA has sought to optimise its facilities to operate without the additional gas.

In particular, although the Yarwun refinery's cogeneration plant has a 160 MW capacity, RTA can run the plant at around 120 MW to provide the necessary steam requirements for the Bayer process. The reduced plant output means that RTA could reduce its total gas requirement. However, it would also mean that less surplus electricity is fed back onto the grid.

RTA's legacy contract and the flexibility of the Yarwun refinery's facilities have largely protected the Yarwun refinery's alumina operations from the changes occurring in the East Coast gas market. However, if RTA had not previously secured large quantities of gas, prospects for the Yarwun refinery could look very different.

Impact if RTA did not have a long term GSA

If RTA's Yarwun refinery was not underpinned by a long-term legacy style GSA and was instead faced with gas prices increasing to the forecast netback prices, current dynamics within the East Coast gas market could have a significant impact on RTA's business profitability, risk profile and future investment decisions.

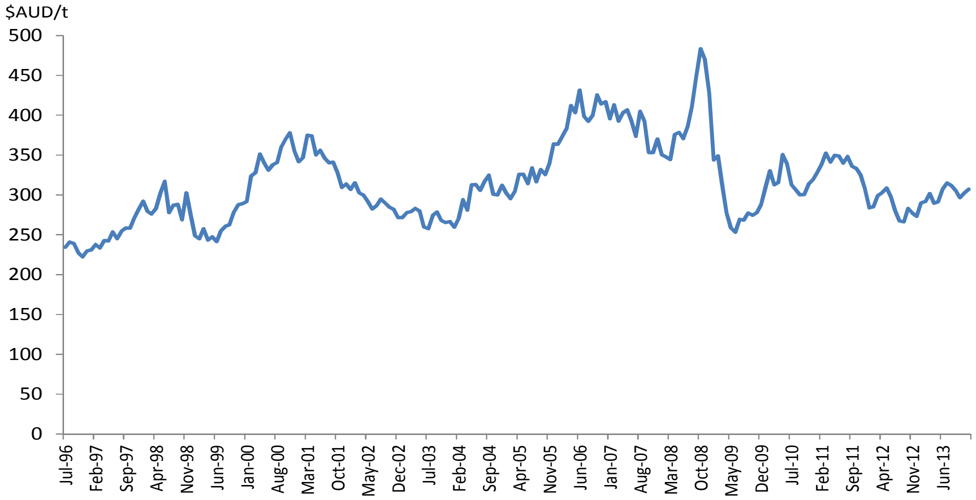
While around one quarter of the alumina produced in Australia is supplied to domestic aluminium smelters, the majority of Australian alumina production is sold to export markets. As RTA's Yarwun refinery is predominantly export focused, the profitability associated with its alumina operations largely depends on:

- the world price of alumina (which determines revenues)
- the cost of alumina production

Alumina is a tradable commodity and depends on the exchange rate and global supply and demand dynamics.[38] Chart 5.3 shows the historical monthly market price of alumina (in AUD/tonne of Alumina) over the period July 1996 – December 2013.

[38] Nappi 2013, *The Global Aluminium Industry, 50 years from* 1972, World Aluminium

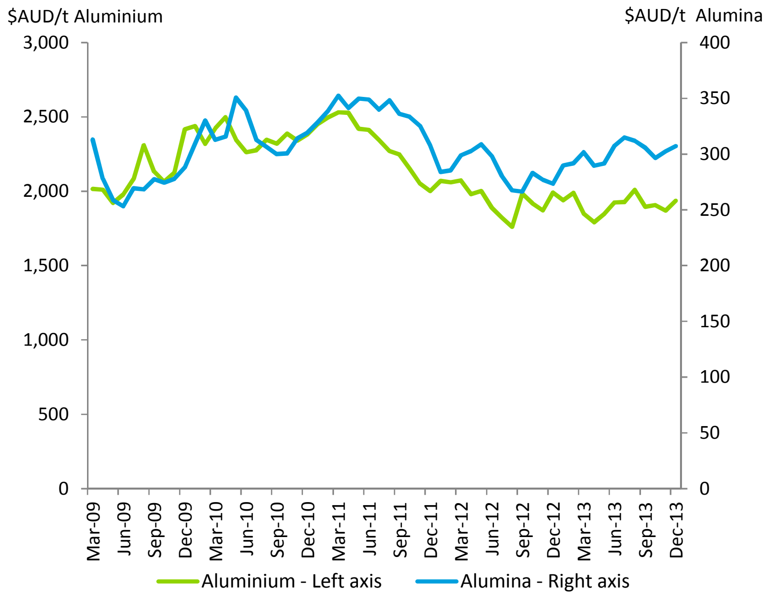
Chart 5.3: Monthly market price for alumina for the period July 1996 – December 2013



Source: Department of Mines and Petroleum, Government of Western Australia

Over the last 17 years the global price of alumina has averaged around $AUD 314/t and ranged from around $220/t to a peak of $483/t just prior to the global financial crisis. As alumina is the key input into aluminium production, the world price of alumina is closely coupled with the world price of alumina. We show the monthly market price of aluminium (on the left hand axis) and the monthly market price of alumina (on the right hand axis) in Chart 5.4

Chart 5.4: Monthly market price of aluminium and alumina for the period March 2009 – December 2013

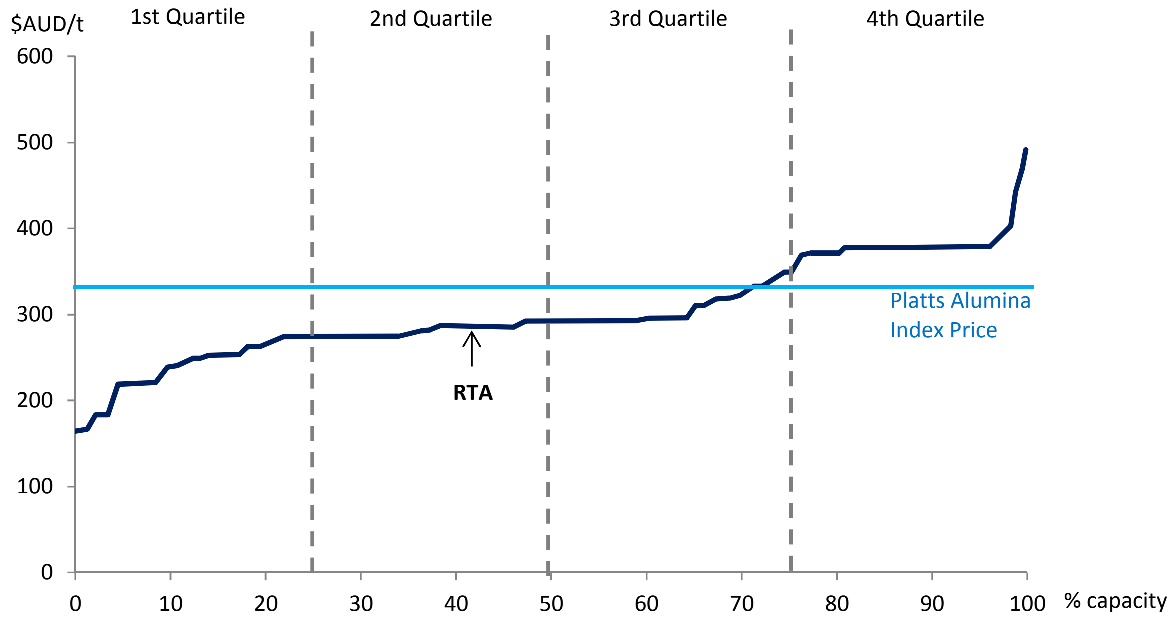


Source: Aluminium prices are based on the London Metal Exchange spot price for 99.5% minimum purity aluminium and Alumina prices are sourced from the Department of Mines and Petroleum, Government of Western Australia

The global aluminium price tends to be influenced by demand from rapidly developing countries such as China and India, which require large amounts of aluminium for industrial expansion and infrastructure development.[39] In light of the gas intensity of the alumina refining process and the electricity intensity of the aluminium smelting prices, aluminium and alumina prices are also influenced by global energy prices.

The competitiveness (and viability) of alumina refineries across the globe can be compared on the basis of their operating cash costs. A refinery's operating cash cost is a measure of its cost of production at site level per unit of output. However, it does not include non-cash costs, such as depreciation and amortisation, nor does it include non-site level costs, such as head office costs. Alumina refineries with low operating cash costs tend to be the most competitive (and often the most profitable), while refineries with high operating cash costs face higher risks of becoming unviable when supply or demand conditions change. Chart 5.5 shows the global alumina refinery cash cost curve as at the end of 2012.

Chart 5.5: Global Alumina refinery cash cost curve as at the end of 2012



Source: Alumina Limited 2013, Presentation prepared for the Bank of America Merrill Lynch Global Metals, Mining & Steel Conference, May 2013[40]

As can be seen, RTA was estimated to be operating in the second quartile of the global alumina cash cost curve, which means it can produce alumina at a lower cost than at least 50% of the rest of the world's alumina producers. However, with energy costs accounting for around 25-30% of alumina refining operating cash costs, even small increases in gas input costs could push RTA into the third quartile of the global alumina cash cost curve.

Using available data on RTA's annual production, gas usage and operating cash costs[41], we developed estimates for the reduction in operating cash flow associated with RTA's Yarwun refinery operations in the event that RTA was exposed to higher gas prices.

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[39] Nappi 2013, *The Global Aluminium Industry, 50 years from* 1972, World Aluminium

[40] Presentation available at http://www.sec.gov/Archives/edgar/data/857071/000119312513285422/d565756d6k.htm

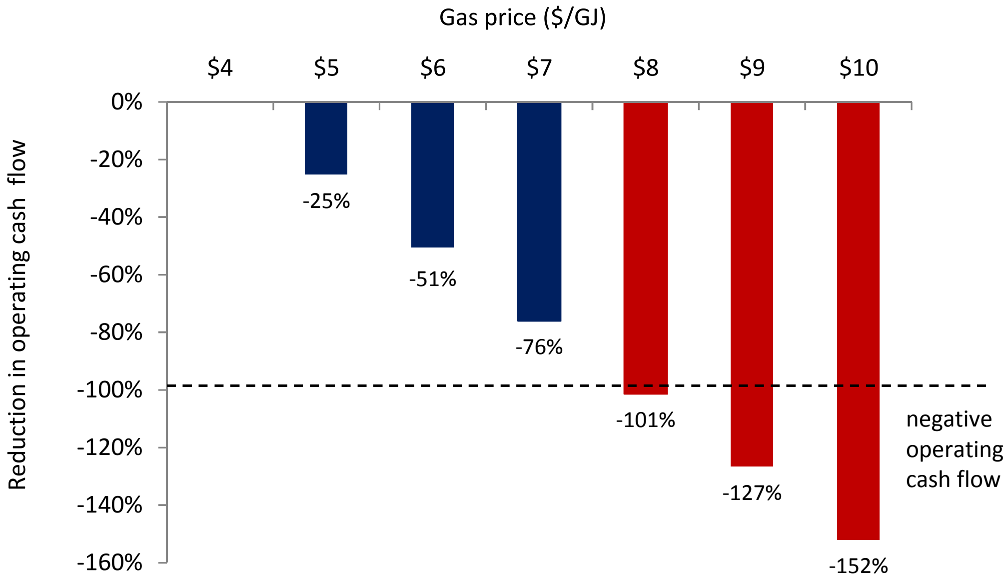
Platts Alumina index price is equivalent to approximately 17.5% of 3-month the London Metal Exchange based on 30 April 2013 prices

In deriving these estimates we have:

- assumed an existing gas prices of around $4/GJ
- based the price of alumina on the average historical price of $AUD 314/t[42]

We show the estimated reduction in operating cash flow under different gas prices in Chart 5.6.

Chart 5.6: Estimated reduction in RTA's operating cash flow associated with higher gas prices impacting the Yarwun refinery



Source: DAE analysis

Our analysis indicates that exposure to gas prices beyond around $8/GJ would not only significantly shift RTA's Yarwun facility much higher up the global alumina cash cost curve; it could also result in negative operating cash flow, causing the facility to potentially become commercially unviable.

A range of factors need to be considered including international alumina prices and exchange rates, however should such an outcome arise, we would expect that RTA would need to consider one of the following options:

- Curtail production, as has recently occurred with RTA's oil-fuelled Gove refinery in the Northern Territory
- Switch to coal where possible – While RTA will still require gas for some operations, such as the calcination process, RTA could switch their gas-fired technologies over to coal-fired technologies

[41] RTA's annual alumina production and gas usage data were provided by RTA. RTA's operating cash costs were sourced from Alumina Limited 2013 presentation, which was prepared for the Bank of America Merrill Lynch Global Metals, Mining & Steel Conference, May 2013

[42] Department of Mines and Petroleum, Government of Western Australia. We also note that this price is very close to the Platts Alumina Price Index shown in Chart 5.5 (which is equivalent to approximately 17.5% of 3-month the London Metal Exchange based on 30 April 2013 prices)

- Engage in upstream gas exploration and production activities – With such a large gas requirement, RTA could find itself in a similar position to Orica and have to look upstream for long-term competitively priced gas. While seeking to develop and commercialise prospective gas resources would be associated with higher risk.

We note that RTA operates as part of Rio Tinto, which comprises a much broader agglomerate of business units. With both the fuel switching and upstream options requiring further investment, RTA would need to compete with other business units for capital and the best rates of return within Rio Tinto's wider international footprint. As new non-core business areas (such as upstream gas development) involve significant new risks, RTA might find it particularly difficult to secure the additional capital required to sustain the Yarwun facility's future operations.

While assessing the potential impact if RTA was exposed to higher gas prices has largely been a hypothetical exercise, we note that other Australian alumina refineries might not enjoy the protection afforded by RTA's long-term contract. Alcoa's alumina refineries in Western Australia are a key case in point.

Box 5-2: Alcoa

Alcoa has three alumina refineries in Western Australia, which collectively produce just under 9 million tonnes of alumina each year (around 11% of world demand). Currently, all three of Alcoa's refineries are fuelled entirely by gas and consume around 95 PJ per year. This represents one quarter of Western Australia's domestic gas consumption.

Alcoa has traditionally sourced its gas from the North West Shelf under long term legacy contracts associated with the North West Shelf State Agreement. Such contracts are typically indexed to local inflation indicators and have historically averaged around $2-3/GJ.[1] However as Alcoa's legacy contract is set to expire in 2020, Alcoa could soon be exposed to much higher gas prices.

Potential higher future gas prices and the current lack of supply certainty have already impacted upon Alcoa's expansion plans. In 2008 Alcoa was provided approval to look at building an additional production train at one of their refineries (the Wagerup refinery). Alcoa indicate that the project would have:

- employed 1000 people during peak construction and added an additional 150 jobs when operating
- increased Alcoa's export value by around $650 million per year
- generated over $17 billion in exports over the project's life
- increased Western Australia's state revenue by around $11 million a year.

Unfortunately, Alcoa have been unable to negotiate any long term GSAs to provide the gas required for this project. As such, the project has been put on hold.

[1] Economics and Industry Standing Committee, 2011, *Inquiry into domestic gas prices. Report No. 6 in the 38th Parliament*

5.3 Goodman Fielder

Goodman Fielder is an Australian owned, publicly listed company, which supplies food products to the retail grocery market and commercial and food services market within Australia, New Zealand and the Asia Pacific. Goodman Fielder is Australia's largest locally listed food manufacturer, with business operations falling in the following four segments:

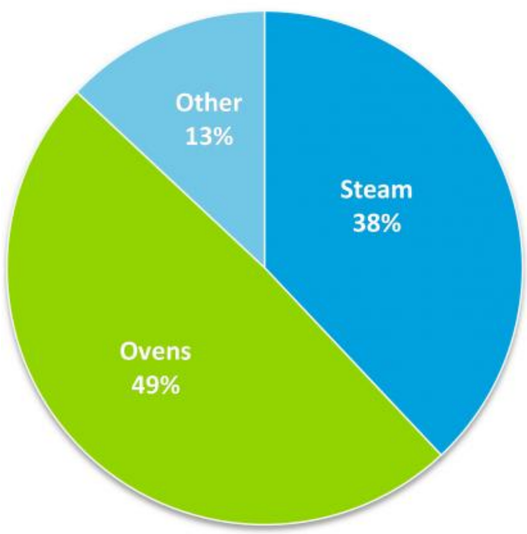
- Baking – production of bread and baked products (predominately in the Australian and New Zealand markets)
- Dairy – production of milk, yoghurt, cheese and cultured products in New Zealand
- Grocery – production of consumer food products such as margarine, spreads, flour, cake mixes, dressings, mayonnaise and pastry for the Australian and New Zealand market
- Asia Pacific – supply of bakery ingredients, dairy products and spreads to the region, and production of flour, ice cream, snack foods and chicken products in the Pacific Island region.

5.3.1 Gas usage

Goodman Fielder's most gas intensive production processes in Australia are associated with their bakery operations. Goodman Fielder currently operates bakeries in all States and mainland territories in Australia. While collectively, these bakeries require around 0.4 PJ of gas per year, Goodman Fielder's large metropolitan bakeries account for the majority of gas usage.

Within Goodman Fielder's bakeries, gas is mainly used to power the ovens and steam boilers. Ovens are associated with the greatest gas usage, providing the heat necessary to bake bread. Steam is generated in steam boilers primarily to deliver heat and/or humidity to various parts of the process. We show the typical gas use break down for a large metropolitan bakery in Chart 5.7

Chart 5.7: Typical gas use breakdown for a large metropolitan bakery



Source: Goodman Fielder

5.3.1.2 Contracting for gas

Goodman Fielder currently has a long term gas supply agreement (GSA) with a gas retailer. This GSA provides gas to all Goodman Fielder's facilities on the East Coast (with the exception of Tasmania). The GSA involves separate state based contracts that cover operations in each state. In discussing future contracting arrangements for the period beyond the existing GSA, Goodman Fielder has been provided initial indications that future contracts will be significantly more expensive than their existing GSA.

5.3.2 Impact

Although Goodman Fielder is not a considerably large gas user, higher gas prices and availability of supply still have the potential to impact Goodman Fielder's profitability, risk profile and future investment decisions. We explore these impacts below.

5.3.2.1 Impact on profitability

The impact of higher gas prices on Goodman Fielder's profitability largely depends on Goodman Fielder's ability to minimise these costs as the ability to pass on higher gas costs are generally limited by consumer price sensitivity and difficulty for suppliers in passing cost increases on.

Consequently, in the absence of cost mitigation, higher gas prices can translate into a direct impact on business profitability. Based on Goodman Fielder's present operations, an average $2 per GJ price increase has the potential to cost the business around $1 million.

The impact of the projected higher gas prices is compounded by the fact that Goodman Fielder, like other food manufacturers, has been exposed to above CPI price increases in energy prices over recent years. The average delivered cost for electricity across Goodman Fielder's Australian operations rose by approximately 40% from FY09 to FY13. The average delivered cost for natural gas has also risen significantly (up to 40% for some sites) over the last five years.

5.3.2.2 Impact on future investment

Higher future gas prices have already had an impact on Goodman Fielder's decisions to undertake future investment. In 2012, Goodman Fielder conducted a detailed feasibility study for investing in a cogeneration plant for one of its manufacturing facilities in NSW. The project represented an opportunity to reduce carbon emissions by about 2,000 tonnes CO2-e per annum but, in undertaking a thorough investment analysis, Goodman Fielder found that the upward risk on gas prices was too high to justify the investment.

In recent years there has been significant innovation in the baking industry focused on delivering energy and emission reductions. The International Baking Industry Exposition in 2013 awarded B.E.S.T. in Baking awards to suppliers whose products are able to enhance the environmental sustainability of the baking industry. All three awards related to oven technology were awarded to gas fired technologies. Gas fired technologies continue to be the focus of innovation for most industrial baking oven suppliers and significant increases in natural gas prices may discourage or delay the adoption of world leading innovation within Australia.

5.3.2.3 Managing the impact

Goodman Fielder is implementing a number of strategies to manage the impact of higher gas prices on its Australian operations. These include negotiating the best possible price and flexible trading arrangements, reducing gas use and finding alternative energy sources.

Some supply agreements place significant restrictions on the ability for companies such as Goodman Fielder to transfer gas volumes between facilities/customers leaving those companies potentially exposed to “take or pay” liabilities or excess extraction charges at individual sites while overall consumption lies within an acceptable band. Goodman Fielder’s negotiations for a new GSA will need to consider flexible trading arrangements as well as driving the most competitive price possible.

Within its bakeries, Goodman Fielder’s review of alternative technologies includes whether it would be cost effective to switch from gas to electricity. While direct fired gas powered bakeries are generally more energy efficient and generate lower emissions, when weighed against the prospect of commercially prohibitive gas prices and the potential removal of the carbon tax, many companies like Goodman Fielder could find that switching to coal-fired electricity is the economically favourable option.

With conditions in the East Coast gas market leading some companies to switch from gas to electricity on economic grounds, it is important to consider the associated impact on emissions. We estimate that if Goodman Fielder switched from gas as a fuel source to electricity, its emissions would be likely to increase by around 50%.43 While a more detailed assessment of the impact of fuel substitution on Australia’s emissions is beyond the scope of this study, we consider that industry movements from high efficiency, low emissions technologies to low efficiency, high emissions technologies would in general, represent a retrograde outcome.

As an alternative to fuel switching, Goodman Fielder is also considering options that would allow it to find greater efficiencies in its gas usage. Goodman Fielder is investing in energy sub-metering systems, linked to programmable logic controllers, within some of its bakeries. Sub-metering enables detailed monitoring of energy use and leakage across multiple sites and helps businesses find energy efficiency measures. For example, it can identify sources of recoverable heat arising from the exhausts of ovens and boilers, which can then be transferred to other locations within the bakery to heat water or generate steam. Such waste heat recovery measures can help companies like Goodman Fielder reduce overall energy consumption but often present a poor return on investment.

5.3.3 Conclusion

Despite not being a significant gas user (in comparison to Orica, Rio Tinto Alcan and Australian Paper), transformations occurring within the East Coast gas market are presenting Goodman Fielder with non-trivial impacts. Higher gas prices are likely to add additional pressure on what are already comparatively small margins.

We note Goodman Fielder’s progress in delivering their strategy to improve earnings in the baking category by transforming their manufacturing footprint, optimising the product portfolio and improving distribution efficiencies. Changes within the East Coast gas market could place further stress on the company’s cost minimisation initiatives within Australia.

[43] DAE Analysis (based on the relative efficiencies of gas versus coal technologies)

5.4 Australian Paper

Australian Paper manufactures paper, pulp, envelopes and stationary and is Australia's leading manufacturer of printing and writing products. Trading as an Australian registered company, Australian Paper is owned by Nippon Paper Industries and operates the largest integrated pulp and paper mill in Australia. With over 1,300 employees, Australian Paper produces over 450,000 tonnes of pulp and around 610,000 tonnes of paper products per year.[44]

Australia Paper operates three key facilities on Australia's East Coast:

- The Maryvale Mill is located in Gippsland, Victoria and accounts for around 95% of Australian Paper's operations. The Mill produces more than 580,000 tonnes of paper each year and is the largest private employer within the Latrobe Valley
- The Shoalhaven Mill is located in Bomaderry, NSW and is Australia's leading manufacturer of high-quality specialty papers
- The Preston Manufacturing facility is located in Melbourne, Victoria and is Australia's largest envelopes and stationary manufacturer.

As the Maryvale Mill represents the majority of Australian Paper's operations and accounts for the most gas consumption, we have focused this case study on the impact of the East Coast gas market transformations on Australian Paper's Maryvale Mill.

5.4.1 Gas usage

The Maryvale Mill accounts for 98% of Australian Paper's energy use, and comprises 3 pulp mills, 5 paper machines, a chemical recovery plant, pulp bleaching plant, wastepaper recycling plant, copy paper finishing facility, a 55 MW power station and effluent treatment facilities.[45]

In broad terms, the pulp and paper manufacturing process involves two key steps:

- Wood and waste paper is separated into two streams via a process that may include mechanical action (e.g. wood chipping), chemical reaction, temperature and pressure to produce:
  - pulp (a slurry of cellulose fibre and water) and
  - other organic (e.g. lignin) and inorganic (e.g. minerals, clay) materials.
- Pulp can then be sold or processed into paper products using specialised manufacturing equipment along with chemicals, heat and mechanical processes (e.g. pressing, calendaring). Other materials produced may be used for renewable energy generation, nursery products or other productive uses.

While the pulp and paper manufacturing process is extremely energy intensive, more than half of the Maryvale Mill's energy requirement is met through onsite renewable generation using black liquor. Black liquor is a dilute solution of wood lignin and organic materials, which is produced as a by-product of the pulping process.[46] The solution is concentrated

[44] http://www.australianpaper.com.au/about-us/

[45] Australian Paper 2012, Sustainability Report,

[46] ibid

and refined at the Mill and then burnt in the on-site power station to generate electricity and steam.

The use of black liquor significantly reduces the Maryvale Mill's reliance on purchased energy. However, the Maryvale Mill still requires large amounts of gas to supplement the steam and energy generated from burning black liquor. Currently, the Maryvale Mill requires around 6.5 PJ of gas to run three gas-fired boilers and 1 PJ of gas to power their lime kiln. This total consumption of 7.5 PJ of gas per year makes them one of the largest gas consumers in Victoria.

5.4.1.1 Contracting for gas

Australian Paper currently has a GSA with a gas retailer that expires in 2016. In light of their large and relatively steady gas usage profile, Australian Paper has historically been able to negotiate reasonably favourable GSA terms and conditions. However, despite seeking to recontract for the last 16 months, Australian Paper has only been given two offers with much higher gas prices and onerous take-or-pay conditions. These conditions include 100% CPI linkage, oil price linkage and a premium for any load profile that is not 100% flat (or constant).

It is worth noting that Australian Paper's experience significantly contradicts the Victorian gas prices projected by IES, which are forecasted to be around $5.75/GJ in 2016. Australian Paper indicates that current offers are actually much closer to the gas prices projected by SKM, which are forecast to be around $9.18/GJ.

5.4.2 Impact

With such a large gas usage profile, Australian Paper stands to be significantly impacted by transformations occurring in the East Coast gas market. In what follows, we examine potential impacts to the Maryvale Mill's profitability, risk profile and future investment decisions.

5.4.2.1 Impact on profitability

Projected gas price increases could have a considerable impact on the profitability of the Maryvale Mill's operations. With an annual consumption of 7.5 PJ of gas, the Maryvale Mill will face an additional $7.5 million in gas costs for each dollar of increased gas prices. It follows that the projected increase of between $4-6/GJ translates into a $30-45 million increase in input costs.

As Australian Paper's pulp and paper products compete with imports, the Maryvale Mill has no practical ability to pass on higher gas costs. In addition, the Maryvale Mill currently operates on relatively tight profit margins. Unlike the 'margin squeeze' impacts analysed in other case studies, higher gas prices could have a much more significant impact on the Maryvale Mill's operations. If the Maryvale Mill was forced to absorb cost increases of between $30-45 million per annum, it is unlikely that the Mill's operations would remain viable for more than a few years. With 900 regional jobs tied directly to the Maryvale Mill's operations, a potential closure could have significant direct and flow on impacts within the Latrobe Valley, a region with already high unemployment.

Managing the impact on profitability

Faced with the unfavourable GSA terms and conditions currently being offered on the East Coast gas market, Australian Paper is considering new avenues for bringing affordable gas into the market. Similar to Orica, Australian Paper is investigating upstream gas exploration and development options. In particular, Australian Paper is seeking to develop and commercialise potential sources of conventional onshore gas in the Gippsland region.

However, as outlined in the box below, Victoria presently has a moratorium on hydraulic fracturing and licences for all onshore natural gas exploration until at least July 2015.[47] This moratorium was put in place in mid-2012 in response to community and environmental concern around onshore gas development.

Box 5-3: Current status of onshore natural gas in Victoria[1]

In response to community concerns around onshore natural gas, the Victorian Government has undertaken the following actions:

- A moratorium on granting new exploration licences for all types of onshore natural gas
- A moratorium on approvals for hydraulic fracturing
- A ban on the use of BTEX (benzene, toluene, ethylbenzene, xylene) chemicals, which will be enshrined in legislation in mid-2014
- Commencement on the use of a Victoria-wide community engagement program in April 2014
- Commencement of a science program to understand the possible impacts of a potential onshore natural gas industry on Victoria's surface water and groundwater in mid-2014

The moratorium on new exploration licences and tenements for onshore natural gas and hydraulic fracturing will remain in place until at least July 2015.

In Victoria, as at April 2014, there are:

- 15 current mineral exploration licences that cover coal seam gas
- No mineral mining licences with approved work plans for coal seam gas production
- 11 current petroleum exploration permits that cover tight and shale gas
- Three current retention leases that cover tight and shale gas; none of these have approved operations plans for tight and shale gas production

[1] State Government of Victoria, Natural gas community information, *Current status of onshore natural gas in Victoria fact sheet*

Even though Australian Paper's upstream conventional gas development option does not involve hydraulic fracturing and is consistent with conventional gas operations that have been undertaken in Victoria for 35 years, the Victorian Government's moratorium does not distinguish between conventional and non-conventional gas operations. Consequently,

[47] Victorian Government, 2014, *Natural gas community information: Current status of onshore natural gas in Victoria fact sheet*

Australian Paper's ability to enter into conventional business arrangements to secure the continued operation of the Maryvale Mill is currently significantly compromised.

While the Victorian Government is currently undertaking a community engagement program and a science program relating to the development of onshore natural gas in Victoria, the earliest the moratorium could be lifted would be July 2015. However, Australian Paper's conventional gas option requires around 18 months of development time to bring gas online. Consequently, if Australian Paper is to avoid exposure to higher gas prices when its GSA expires in December 2016, it either needs find a stop-gap solution (similar to Orica's short term arrangement with ESSO/BHP) or find a way to commence upstream gas developments as soon as possible.

If Australian Paper is unable to access a competitive source of gas supply by engaging in upstream activities, it may need to consider switching to an alternative fuel source. While the Maryvale Mill will always require around 1 PJ of gas to power its lime kiln (as a different fuel could impact upon the quality of Australian Paper's products), the Maryvale Mill's three gas fired boilers could potentially be changed over to coal (currently priced at around $3-3.5/GJ). However, Australian Paper indicated that fuel switching would be a particularly unfavourable option for two reasons:

- Firstly, a switchover would involve significant capital expenditure – in particular, the requirement to develop a new steam raising plant
- Secondly, a switchover would be associated with a large increase in emissions. Australian Paper estimate that switching to coal would result in a 6.5 fold increase in their greenhouse gas emissions.[48]

5.4.2.2 Impact on risk profile

In addition to impacting Maryvale Mill's profitability, the changes taking place in the East Coast gas market could affect Australian Paper's risk profile in two key ways:

Firstly, if Australian Paper accepts one of the current GSA offerings available in the market, it will face exposure to oil price linkages. Oil-linked contracts are generally associated with greater price variability, with oil prices being driven by a range of factors such as geopolitics, international supply and demand dynamics, financial instability and major economic events (like the global financial crisis).[49] As these factors are complex and often unpredictable, contracting at oil-linked gas prices usually involves higher risk. Although Australian Paper could hedge against adverse oil price outcomes, this hedge would still impose additional costs, further reducing the profitability and potential viability of the Maryvale Mill's operations.

Secondly, if Australian Paper is able to pursue upstream gas supplies, it will face the following additional risks:

- Exploration risk – there is no guarantee that commercial quantities of gas can be brought to market
- Supply risk – a single source supply (new gas field) would place Australian Paper at risk of non-supply in the event of any plant failures at that gas field

[48] Brian Green has cited 'Factors taken from Australian National Greenhouse Accounts*, National Greenhouse Accounts Factors*, July 2013'

[49] U.S. Energy Information Administration, 2014, *What drives crude oil prices?*

- Potentially more complicated supply contract arrangements involving gas producer(s), gas pipeline owner/operators and separate contracts for gas supply and transport.

5.4.2.3 Impact on future investment

Nippon Paper Industries acquired Australian Paper in 2009 with the intention to expand Australian Paper's operations. However, Australian Paper indicated that the envisaged future investment is contingent upon being able to maintain a competitive ability to produce quality products. Australian Paper's competitive advantage traditionally stemmed from its ability to harness Australia's relatively cheap energy.

With East Coast gas market developments eroding Australia's energy cost advantage, Australian Paper noted that it would be extremely difficult to mount a compelling argument for future expansion in Australia. Australian Paper also indicated that it would be very difficult to make a compelling case for undertaking the additional capital expenditure required to maintain the Maryvale Mill's existing facilities in a competitive condition. This is concerning as capital expenditure by Australian Paper exceeded $1 billion over the last decade.

5.4.3 Conclusion

Transformations on the East Coast gas market are presenting Australian Paper's Maryvale Mill with significant challenges. With such a large gas requirement, recontracting at higher oil-linked gas prices could undermine the viability of the Maryvale Mill's operations. Although Australian Paper is seeking to bring new sources of conventional gas into the market, the current Victorian moratorium on onshore gas development is acting as a key impediment.

We note that the Maryvale Mill currently supports around 900 direct regional jobs and is the largest private employer in Victoria's Latrobe Valley.[50] Without access to an affordable, reliable gas supply, it is highly likely that the Mill's operations would be significantly curtailed, leaving little or no scope to undertake future or even continued investment in the Maryvale Mill's operations.

[50] Australian Paper 2014, Australian Paper supplementary submission to the Finance and Public Administration References Committee, *Inquiry into Commonwealth Procurement Procedures,* March 19, 2014

5.5 GB Galvanizing

GB Galvanizing is the largest galvanizer in Victoria and is also an Australian-owned family business. GB Galvanizing has been operating in Victoria for over 30 years and currently employs 200 people to operate two galvanising facilities in Bayswater and Dandenong South. These facilities are two of Australia's most modern galvanizing plants and supply corrosion protection for many projects in Australia and overseas. The business also owns a large transport fleet, which allows GB Galvanizing to service customers in local and country areas throughout Victoria and within other states, such as South Australia and New South Wales.

GB Galvanizing is one of Australia's 29 galvanisers that collectively have the capability to galvanize around 67,000 metric tonnes of steel per month.[51] As galvanising steel is an efficient and effective way to prevent corrosion within steel assets, the galvanising industry plays an important role in the Australian 'steel value chain'.[52] Australia's fabrication industry in particular benefits from the presence of a local galvanising industry, with many fabricators working closely with galvanizers to augment their capacity and market offerings.[53]

5.5.1 Gas usage

GB Galvanizing specialise in a process known as 'hot dip galvanizing', whereby steel items are completely immersed ('dipped') into a bath of hot molten zinc to form a uniform coating that protects steel from corrosion. The hot dip galvanizing process is explained in more detail in Box 5-4.

[51] Australian Steel Institute, 2010, *Capabilities of the Australian steel industry to supply major projects in Australia*

[52] ibid

[53] ibid

Box 5-4: The Hot Dip Galvanising process

The hot dip galvanizing process involves 4 key stages:[1 2]

- Impurities, such as scale, rust, paint or other surface contaminants are removed from the steel items by methods such as abrasive blast cleaning, acid cleaning or pickling in hydrochloric acids.
- In order to remove the oxide film that forms on the steel surface after acid cleaning, acid cleaned items are immersed in a 'flux' zinc ammonium chloride solution, which is maintained around 65°C.
- Prepared steel items are then immersed into a bath of molten zinc, which is maintained at temperatures of 445-465°C. Items need to remain in the bath until their temperature reaches the temperature of the molten zinc. During this process, the molten zinc reacts with the steel surface to form a protective coating of zinc-iron alloy layers.
- After immersion, items are quenched in a sodium dichromate solution, which prevents the formation of wet storage staining or 'white rust'.

[1] Galvanizers Association of Australia, 2011, Galvanizing process

[2] GB Galvanizing, *The Process of galvanizing*

Gas is primarily used for keeping the bath of molten zinc heated to around 445-465°C. These temperatures need to be maintained continuously (24 hours, 7 days a week). Gas is also used in the steel cleaning and preparation process, where chemical solutions need to be heated to temperatures of around 65°C. In order to operate both their facilities in Bayswater and Dandenong South, GB Galvanizing use a total of around 50,000 GJ of gas per year.

5.5.1.1 Contracting for gas

GB Galvanizing's current GSA is set to expire at the end of this year. As GB Galvanizing's gas consumption profile is relatively stable and continuous, GB Galvanizing has historically been able to negotiate reasonable GSA terms and conditions. However, in seeking to renew their contract with gas retailers, GB Galvanizing is facing price increases of around 30%.

While GB Galvanizing acknowledge that in general, gas does not represent a large cost to their business in the context of other input costs (such as wages and zinc), projected prices in the East Coast gas market still have the potential to impact on GB Galvanizing's profitability.

5.5.2 Impact on profitability

Recontracting at higher gas prices will impose significant additional costs on GB Galvanizing's operations. While all galvanisers on the East Coast are likely to face similar gas price increases, the competitive dynamics within the Australian steel value chain largely limit the industry's ability to pass on higher gas input costs. Australia's galvanisers tend to compete directly with imported products (primarily steel products that enter the country already galvanized). With countries like China being able to compete on the basis of lower labour costs and larger facilities with greater economies of scale, Australia's galvanisers, and indeed many other entities across the Australian steel value chain need to cut prices and reduce margins to remain competitive. As such, any increase in gas input costs are likely to further reduce what are already increasingly squeezed margins.

Based on the data provided to us by GB Galvanizing, we estimate that the additional gas cost impost would represent around a 4-5% reduction in GB Galvanizing's net profit after tax. This reduction alone would be unlikely to threaten the viability of GB Galvanizing's operations. However, when considered in light of other factors that are already placing pressure on Australian businesses, such as high wages, burdensome regulatory requirements, and in the case of GB Galvanizing, significant costs involved in complying with occupational health and safety standards, higher gas prices are yet another factor eroding the ability of Australian businesses to remain internationally competitive.

6 Aggregate results

6.1 Impacts for the Australian economy

LNG developments on the East Coast will create a new export industry involving significant LNG production, employment and new capital investment. However, gas market transformations on both the East and West Coasts also have adverse consequences.

The development of LNG export facilities on the East coast and the change in contracting arrangements on the West coast represents a significant change in the cost structure of major gas users in Australia. In particular, the linkage of the east coast to world markets is a process involving a number of stages, with a consequent staging of impacts on the domestic manufacturing sector that forms a recurring theme in the results of this report.

Chart 6.1 presents a stylised representation of the nature of many of the results we find for manufacturing industries over time. While the exact magnitude and relative impact of each of the phases will differ between industries depending on their sales structures, their exposure to international trade and their cost structures, the underlying drivers are common.

The results show that the manufacturing sector, broadly, is adversely affected by three main factors:

i. an increase in gas prices resulting from the international price linkage for LNG and, for the SKM results, the exercise of market power by gas retailers. The latter has an ongoing impact in Victoria, a State that does not have direct gas pipeline connections with Queensland, but also has a short term impact across the East Coast as retailers exercise market power in response to tight gas supply

ii. an exchange rate effect resulting from a significant increase in Australia's exports which increases the value of the Australian dollar

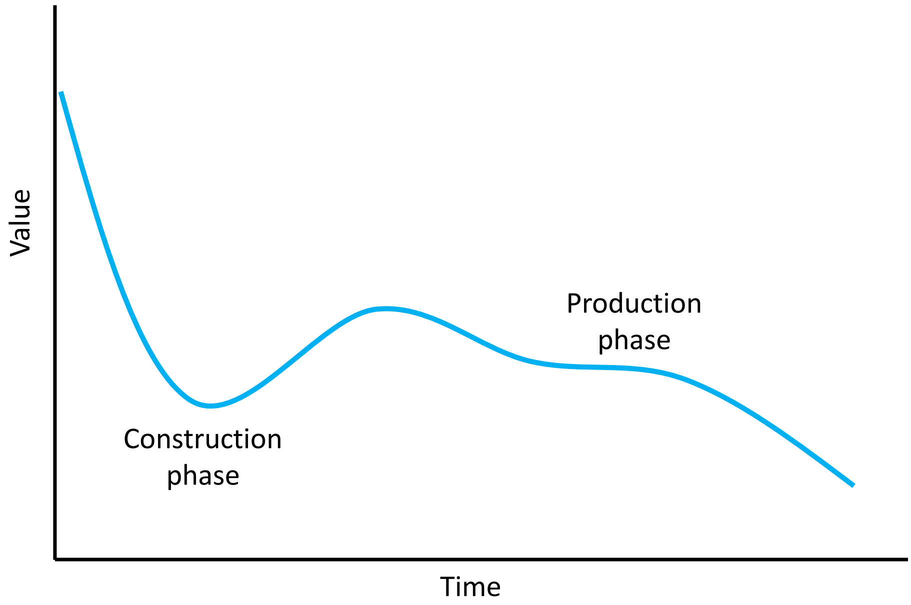
iii. competition in factor markets (primarily labour and capital) as the gas sector draws resources away from other parts of the economy which increases the cost of these factors.

The degree to which these impacts affect the manufacturing sector differs between the construction and production phases of the gas expansion.

During the construction phase, manufacturing experiences a significant reduction in output. This reduction is driven by two main factors. First, there is an immediate increase in domestic gas prices (assumed) which adversely affects industry cost structures and output levels. Second, the additional construction activity associated with the unprecedented expansion of gas fields and associated export infrastructure in Queensland competes for resources in the manufacturing sector, particularly labour, as well as putting upward pressure on the exchange rate. This effect exacerbates the impact of the gas price increase.

During the production phase, the manufacturing sector continues to be adversely impacted by increased gas prices and continued pressure on exchange rates as exports of gas come on line. Gas production and liquefaction is not labour intensive, so the effect of competition for labour drops away once the construction activity ends. Expansion of the gas industry has an increased rate of impact on manufacturing output from 2020 as it drives up the price of gas in both the IES and SKM scenarios.

Chart 6.1: Stylised modelling result



Source: Deloitte Access Economics

Context for the relative size of the different sectors of the Australian economy is set out in Table 6.1 below, drawn from ABS data for 2013.

Table 6.1: Major Australian Industries, output, turnover and profits (2013)

	Value added output		Business sales	Business profits	Profit margin
	Real $m per annum	*% of GDP*	*Nominal $m per annum*	*Nominal $m per annum*	*Ratio of profits to sales*
Manufacturing	101,791	6.5	363,618	28,939	0.07
Mining (inc gas)	160,139	10.3	222,680	90,265	0.41
Agriculture	34,516	2.2	na	na	na
Electricity and Water	36,721	2.4	58,976	11,948	0.20
Construction and Trade	251,134	16.1	1,072,489	67,138	0.06
Transport	72,804	4.7	127,562	21,173	0.17
Commercial and Services	678,927	43.5	583,269	91,391	0.16

Source: ABS 2013, Ai Group

Table 6.2 shows the impact to industry output (equivalent to sales and services income) for all sectors in the economy in the years 2015, 2018 and 2021 (the final year over which data were modelled) and the cumulative impact to industry output over the period 2014-2021.

In each of the snap-shot years (2015, 2018 and 2021), with the exception of gas, services and the construction sector (which receives a boost through its role in supporting LNG developments), gas price increases translate into a reduction in industry output for all other sectors in the economy. Similarly, over the period 2014-2021, all industries except the gas, construction and services industries experience a cumulative reduction in industry output (as measured by the net present value of the total year on year output reductions during the period).

Table 6.2 Industry output deviations for Australia for the year 2015, 2018 and 2021 and cumulative NPV output deviations over 2014 - 2021

	Value deviation			% deviation			NPV
	2015	2018	2021	2015	2018	2021	Cumulative impact over 2014-2021
IES scenario							
Output ($ million)							
Manufacturing	-17,937	-15,810	-25,070	-3.07	-2.47	-3.61	-87,701
Gas	7,119	15,448	22,141	38.15	57.37	52.16	69,965
Mining*	-6,789	-5,196	-8,773	-3.34	-2.32	-3.59	-30,245
Agriculture	-1,116	-713	-1,304	-1.99	-1.18	-2.01	-4,421
Electricity and Water	-1,277	-1,278	-1,730	-2.19	-1.99	-2.45	-6,812
Construction and Trade	20,077	2,701	12,106	3.11	0.38	1.55	42,644
Transport	-2,226	-1,690	-2,940	-1.61	-1.12	-1.79	-9,856
Commercial and Services	3,296	-558	734	0.28	-0.04	0.05	3,221
SKM scenario							
Output ($ million)							
Manufacturing	-23,199	-22,259	-30,386	-3.97	-3.48	-4.38	-118,069
Gas	8,922	17,672	24,225	47.81	65.63	57.07	80,746
Mining	-7,226	-6,031	-9,679	-3.55	-2.69	-3.96	-33,804
Agriculture	-1,110	-798	-1,430	-1.98	-1.32	-2.21	-4,705
Electricity and Water	-1,962	-1,989	-2,204	-3.36	-3.09	-3.12	-10,269
Construction and Trade	18,049	2,443	13,265	2.80	0.34	1.69	38,519
Transport	-2,328	-1,988	-3,288	-1.68	-1.31	-2.00	-11,044
Commercial and Services	3,015	-897	649	0.26	-0.07	0.05	1,695

Source: Deloitte Access Economics

Note: The discount rate of 7% was used to calculate the Net Present Value (NPV) figure.

* Mining relates to non-gas mining

While the magnitude of impacts for each industry is driven by a number of factors, we have focused our analysis on two key industry characteristics:

- Intensity of gas usage - relates to the degree to which industries are likely to face increases in input costs
- Level of trade exposure – relates to the degree to which industries are able to pass on increased input costs.

We expand on these characteristics in Box 6-1.

Box 6-1: Industry characteristics

Intensity of gas usage

Industries that use gas intensively in their production processes are likely to have higher increases in production costs compared to industries that use little gas in their production process. We have provided average estimates for the gas intensity (gas usage per dollar of industry value added) of different industries at a national level in Table 6.3. We note that there will be considerable variation above and below these average values within each sector. However, on the basis of this average measure, the industries with the highest levels of gas intensity include Mining, Manufacturing and the Electricity, Gas, Water and Waste Services sector.

Level of trade exposure

Heavily trade exposed industries will be constrained in their ability to pass through increased production costs if they are price takers on world markets or face competition in the domestic market from imports. Additionally, trade exposed industries are also affected by changes in the exchange rate. Deterioration in the exchange rate is likely to have a negative impact on the output from trade intensive industries. The trade intensity reflects both the ability to pass on prices in the export market, and the increase in production costs due to changes in import prices

The *Carbon Pollution Reduction Scheme: Australia's Low Pollution Future* white paper (2008) defines industry activity as trade exposed if it has a trade share greater than 10% in any one year. Table 6.3 outlines estimates for the trade intensity of different industries at a national level. Using the definition in the white paper, Agriculture, Mining, Manufacturing and, Transport are considered trade exposed sectors. Out of these sectors, Mining and Manufacturing are the most heavily trade exposed sectors with trade shares of 69% and 71%, respectively.

Table 6.3: Gas and trade intensive industries

ANZIC Industry	Natural gas consumption (PJ)	Production ($M)	Value added ($M)	Imports ($M)	Exports ($M)	Gas usage intensity (MJ/$)	Trade intensity (%)
Agriculture, forestry and fishing	0.1	65,878	28,416	1,381	8,870	0.004	16
Mining	257.6	162,515	95,185	21,074	91,250	2.71	69
Manufacturing	450.3	373,666	107,782	188,676	78,009	4.18	71
Electricity, Gas, Water & Waste Services	408.9	67,957	29,751	32	65	13.74	0
Construction	3.3	313,634	96,694	27	136	0.03	0
Transport, postal & warehousing	20.5	141,894	63,513	12,537	19,213	0.32	22
Commercial and Services	47.8	1,344,157	780,639	27,637	40,151	0.06	5

Source: BREE 2013, 2013 Australian energy statistics, BREE, Canberra, July; ABS 2013, 2009-10 National Input Output Tables, ABS, Canberra, September

Note: the trade intensity ratio was sourced from the *Carbon Pollution Reduction Scheme: Australia's Low Pollution Future* white paper (2008). It is defined as the ratio of the value of imports and exports to the value of domestic production); The Gas Intensity ratio is defined at Natural Gas Consumption to Value Added.

6.1.2 Industries with high gas intensity and high trade exposure: manufacturing and mining

Industries that both use gas intensively and are significantly trade exposed are likely to face the most adverse consequences from changes taking place in the East and West Coast markets.

Owing primarily to these two factors, the manufacturing sector is projected to experience the greatest reduction in industry output under both IES and SKM gas price forecasts. The manufacturing sector has an average gas usage intensity of 4.2 MJ of gas per dollar industry value added and a 71 per cent trade share.

The high trade intensity demonstrates that, compared to other sectors, the manufacturing sector would be relatively more constrained in passing through increased production costs resulting from a rise in gas prices, since a large proportion of trade is in international markets. In addition, the relatively high trade share also illustrates that the manufacturing sector is more susceptible to deterioration in the exchange rate.

The relatively high gas usage intensity shows that compared to other sectors, the manufacturing sector would face a relatively higher increase in production costs if gas prices increased above the baseline case. As a result, over the period 2014-2021, the net present value of the cumulative output reduction from the baseline for the manufacturing sector is estimated to be around $88 billion under the IES gas prices projections, and $118 billion under SKM gas price projections.

The mining sector also shares characteristics of having high gas usage and trade intensity. As a result, the mining sector is also projected to face relatively high reductions in output compared to the baseline case. Over the period 2014-2021, the mining sector would be expected to incur a cumulative output reduction (in net present value terms) of around $30 billion under the IES gas price forecasts and $34 billion under SKM gas price projections.

For these sectors, overall output losses are higher under the SKM scenario due to the assumption that gas producers are able to raise gas prices in line with market power.

6.1.3 Industries with low gas intensity and low trade exposure: commercial and services, and construction

Industries that have relatively low gas usage and low trade intensity are likely to face limited impacts as a result of changes taking place in the East and West Coast gas markets.

As an example, the commercial and service sector, on average, is estimated to have both low gas intensity usage (0.06 MJ) of gas per dollar sector value added) and trade exposure (5% trade share). As a consequence, when compared to other industries, the commercial and services sector would not be greatly impacted by a rise in gas costs, with projections for deviations in output in 2021 that are 0.2 and 0.3 per cent below the IES and SKM gas price forecasts, respectively. Such low deviations are primarily because the sector does not use much gas, but also because it faces limited constraints to passing through increased production costs caused by a rise in gas prices.

The construction sector also has relatively low gas intensity (0.3 MJ) and trade exposure (0% trade share) and, on this basis, is unlikely to face particularly adverse consequences from rising gas prices. Additionally, in light of its role in the construction phase of the LNG industry expansion, the construction sector stands to achieve significant gains under both the IES and SKM price projections.

6.2 Aggregate Industry level value added impacts and overall GDP

While the industry output measures give an indication of the impacts in terms of industry sales and service income, in the following charts we show how higher gas prices translate into industry level value added contributions for the year 2021. Industry level value added contributions are defined as the value of the industry's output less the value of inputs used in production.

Chart 6.2: Industry value added and output deviations in the year 2021 under the IES gas price projections

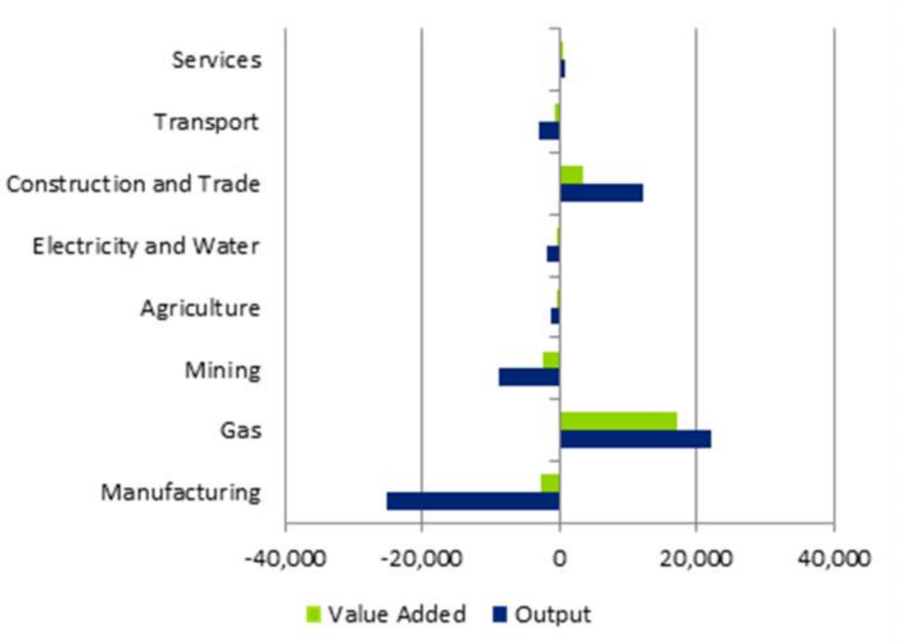
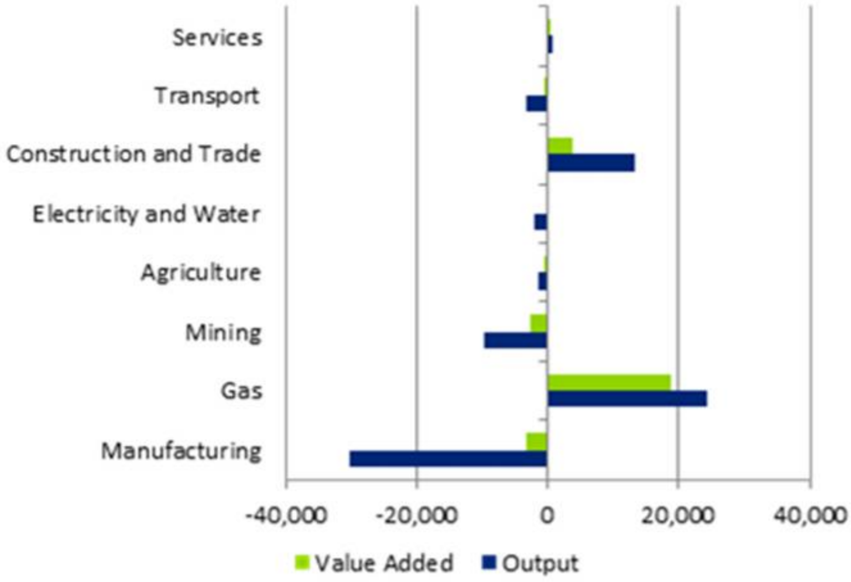


Chart 6.3: Industry value added and output deviations in the year 2021 under the SKM gas price projections



Source: Deloitte Access Economics

As illustrated, although the manufacturing sector experiences large reductions in output, the corresponding decrease in industry value added is significantly smaller. This result derives from the fact that manufacturing is generally associated with quite low value added contributions, particularly in comparison to the gas sector.

The low value added ratio of the manufacturing sector is representative of the comparatively high goods and services cost within the sector and comparatively low labour and capital cost, with the 2009/10 Australian Input/Output tables (ABS 5220.0.55.001) indicating that for every $1 of output in the manufacturing sector there are 71 cents of other goods and services in the economy consumed, compared to only 30 cents for the Oil and Gas Extraction sector. Thus while manufacturing accounts for a large absolute quantum of value added in the Australian economy, as set out in Table 6.1 above, its value added ratio is relatively low because it consumes so much of the output of other sectors.

As would be expected, significant gains in terms of both industry output and value added accrue to the gas sector. The construction sector is also projected to benefit, largely due to its involvement in building the capital expansion associated with new LNG projects. However, in comparison to the gas sector, the construction sector’s increase in value added contribution is relatively muted.

As a rule, industry level value added contributions sum to total GDP impacts. Given the high value-added contributions associated with the gas sector, summing the industry value added impacts for all sectors gives an overall net increase in GDP over the forecast period. We show the projected increase in National Gross Domestic Product for both IES and SKM price forecasts in Chart 6.4

Chart 6.4: National Gross Domestic Product

Source: Deloitte Access Economics estimates

6.3 State-level aggregate impacts

The impacts to aggregate economic sectors vary across state, and also across the IES and SKM gas price forecasts. We show the cumulative aggregate outcomes by state in Table 6.4.

Table 6.4: Industry outcomes for States (cumulative output impact 2014-2021 NPV, $m)

	NSW	VIC	QLD	SA	WA
IES Scenario					
NPV ($m)					
Manufacturing	-12,633	-2,000	-61,848	-2,442	-8,738
Gas	1,084	283	61,624	720	6,156
Mining	-1,502	-764	-22,406	-201	-4,114
Agriculture	-611	-241	-3,407	-231	-43
Electricity and Water	-796	67	-7,861	730	714
Construction and Trade	4,672	-489	40,277	1,213	-1,840
Transport	-1,432	147	-9,174	-157	484
Services	7,035	1,127	-5,919	338	769
SKM Scenario					
NPV ($m)					
Manufacturing	-24,543	-23,426	-59,142	-3,375	-7,921
Gas	3,862	7,388	61,624	1,559	6,156
Mining	-2,467	-2,928	-22,378	-288	-4,057
Agriculture	-588	-396	-3,480	-343	-54
Electricity and Water	-2,816	-2,181	-6,808	579	640
Construction and Trade	-103	-1,622	42,200	2,123	-2,230
Transport	-1,825	-526	-9,328	-223	484
Services	6,790	703	-6,449	320	561

Differences in state impacts under the IES and SKM gas price forecasts relate to the different assumptions employed in the modelling. As noted in Section 4.1.1 IES' model does not account for situations where market tightness would allow suppliers to charge prices that are higher than least-cost levels. In contrast, SKM's model is able to capture outcomes reflecting suppliers' ability to exert market power due to limited supply.

Differences between the two sets of modelling are most pronounced in the Melbourne and Sydney regions, where IES forecasts relatively limited gas price increases in comparison to SKM. We now see this translated into the state-level results, with impacts in Victoria and NSW under the IES gas price forecasts being significantly less adverse (in some cases even positive) than impacts derived under the SKM forecasts. As we outlined in Chapter 4, we consider the SKM gas price forecasts to be more realistic. Consequently, we would stress that more emphasis be placed on the impacts associated with the SKM gas price forecasts, particularly when considering policy responses.

When examining state-level impacts for the manufacturing sector, Queensland is shown to have the greatest reductions in overall industry output. In fact, with the exception of the gas and construction sectors, this result holds for all sectors. This is primarily because, in addition to incurring higher gas prices, Queensland also experiences a large capital expansion due to the LNG developments. This capital expansion will have a significant impact on the Queensland economy and is expected to drive up real wages and prices for a number of intermediate inputs. With real wage rates and input costs higher than the national average, Queensland industries become less competitive relative to their inter-state counterparts, and import competitors. This reduction in competitiveness causes many industries to reduce output, either as they reduce production in line with increased costs, or as they redistribute resources and economic activities to other states.

6.4 Impacts for manufacturing subsectors selected by the project consortium

We show the industry output impacts for the manufacturing subsectors selected by the project consortium in Table 6.5

Table 6.5: Industry output impacts for manufacturing subsectors selected by the project consortium

	IES scenario			SKM scenario		
	Output % difference in 2021	**NPV cumulative over 2014-2021**	**Average FTE jobs difference over 2014-2021**	**Output % difference in 2021**	**NPV Cumulative over 2014-2021**	**Average FTE jobs difference over 2014-2021**
Sector						
Food and Beverage products*	-2.3	-8,991	-2,978	-2.5	-9,739	-2986
Paper products	-1.0	-1,653	-688	-1.2	-2,270	-696
Chemical products**	-3.7	-8,875	-3,037	-4.9	-13,664	-4,034
Iron and steel	-3.8	-4,411	-1,267	-4.6	-6,071	-1,552
Basic Non-ferrous Metal products^	-9.8	-23,960	-3,397	-11.6	-29,697	-4,236
Fabricated metal products	-1.3	-1,483	-860	-1.5	-2,064	-1,122

Note: *Includes groceries and fresh foods, **includes basic, specialty and consumer chemicals, and ^includes bauxite, alumina and aluminium manufacturers
Source: Deloitte Access Economics

As can be seen, all manufacturing subsectors selected by the project consortium are expected to incur greater losses under the SKM gas price forecasts. As noted in Section 6.3, this is due to the SKM gas price forecasts reflecting the ability of gas suppliers to raise prices in line with market power – particularly in Victoria and NSW. Further, some manufacturing subsectors are predicted to be impacted more severely than others.

We have applied the same industry characteristics framework outlined in section 6.1 to analyse impacts for industries within the manufacturing sector. Consistent with our earlier explanation, we would expect transformations occurring in the East and West Coast gas markets to have the most adverse consequences for manufacturing sectors that:

- use gas most intensively, and therefore incur significant increases in input costs
- are substantially trade-exposed, with limited ability to pass on increased input costs

In the following chapters, we expand on the impacts shown in Table 6.4 for each manufacturing subsector and draw on additional insights from our case studies to complement the CGE modelling results.

7 Impacts on the Food, Beverage and Grocery Manufacturing Industry

The Food, Beverage and Grocery manufacturing industry[54] contributed approximately 28% of total manufacturing production in Australia. Within this manufacturing group, Grocery and Fresh Food products both account for 3% each, while Food and Beverage products manufacturing comprises approximately 22% of output. Businesses in the Food, Beverage and Grocery manufacturing industry are generally trade exposed with an average trade share of 36% and moderately gas intensive, using 1.3 MJ per dollar of output.

7.1 National impacts for the Food, Beverage and Grocery Manufacturing Industry

On the basis of these two characteristics alone, it would appear that, in comparison to other sectors, the Food, Beverage and Grocery industry would face lower adverse impacts from gas developments. However, as shown in Table 7.1, the industry is collectively estimated to incur a cumulative output reduction (in NPV terms) of $8.9 billion under the IES gas price forecasts and $9.7 billion under the SKM gas price forecasts.

[54] The food, beverage and grocery manufacturing industry includes the food and beverages manufacturing, grocery product manufacturing and fresh food manufacturing sub-sectors defined in Table 13.1. To avoid duplication, the chemical related sub-sectors of basic polymer manufacturing, cleaning compound and toiletry preparation manufacturing have been included in the modelling for the chemical products manufacturing industry even though they could also be considered part of the grocery manufacturing industry.

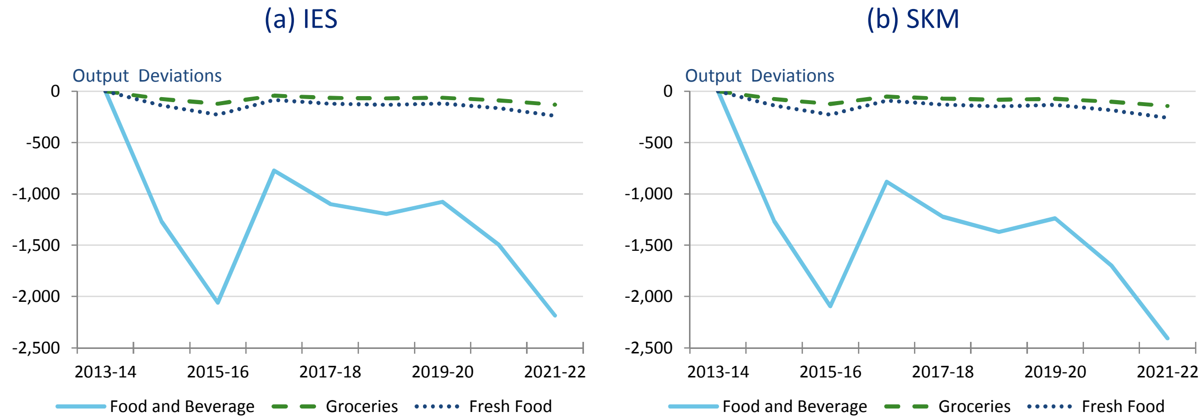
Table 7.1: Industry national output impacts: Food, Beverage and Grocery manufacturing

	$M deviation			% deviation			Cumulative NPV
	2015	2018	2021	2015	2018	2021	2014 -2021
IES scenario							
Food and Beverages	-2,060	-1,196	-2,185	-2.82	-1.53	-2.62	-7,691
Groceries	-122	-70	-129	-1.21	-0.65	-1.11	-452
Fresh food	-227	-133	-239	-1.63	-0.88	-1.47	-848
SKM scenario							
Food and Beverages	-2,095	-1,371	-2,408	-2.87	-1.75	-2.89	-8,344
Groceries	-124	-82	-144	-1.24	-0.75	-1.24	-496
Fresh food	-228	-147	-259	-1.63	-0.97	-1.59	-899

Source: Deloitte Access Economics

We also show how these industry output impacts occur over time in Chart 7.1

Chart 7.1: National Food, Beverage and Grocery manufacturing industry ($m deviations)



Source: Deloitte Access Economics estimates

The large impact accruing to the Food, Beverage, and Grocery manufacturing industry is mainly driven by the sheer size of its production. However, we also note that despite not having a high degree of trade exposure, many businesses within the Food, Beverage and Grocery manufacturing industry face a very limited ability to pass on costs to customers.

The limited ability for food, beverage and grocery manufacturers to pass on higher energy costs was highlighted in the AFGC *Impact of Carbon Price Survey*, which showed that 66 per cent of respondents were unable to pass on costs associated with the carbon price. The combination of these factors makes it very difficult for Food, Beverage and Grocery manufacturing companies to pass on higher gas costs. Consequently, higher gas prices are likely to translate into a direct reduction in business profitability, which, in the absence of any mediating factors (like fuel switching or finding energy efficiencies), has the potential to reduce industry output.

Given that the food, beverage and grocery manufacturing sector uses a significant proportion of output from the agriculture sector, its contraction will have a flow on negative impact on the agriculture sector. This impact may appear underestimated in the modelling results because of the model's assumption that agricultural output could easily be diverted to export, which may not be the case for small agricultural producers.

7.1 Impacts for the Food, Beverage and Grocery Manufacturing Industry by State

We present the industry output and employment impacts for the Food, Beverage and Grocery manufacturing industry by state in the following Table.

Table 7.2: State industry output impacts (NPV, $m)

	NSW	VIC	QLD	SA	WA
IES scenario					
Output (NPV)					
Food and Beverage	-846	-455	-6,215	-204	-77
Groceries	-67	-44	-325	-13	-9
Fresh food	-72	-52	-697	-30	-12
Employment (average)					
Food and Beverage	-279	-159	-2,026	-80	-5
Groceries	-24	-16	-93	-5	-1
Fresh food	-24	-18	-234	-13	-1.3
SKM scenario					
Output (NPV)					
Food and Beverage	-956	-780	-6,323	-367	-51
Groceries	-77	-63	-332	-23	-8
Fresh food	-74	-68	-714	-52	-9
Employment (average)					
Food and Beverage	-209	-114	-2,100	-143	3
Groceries	-17	-8	-97	-8	-1
Fresh food	-16	-10	-244	-22	-0.2

Source: Deloitte Access Economics

Note: The discount rate of 7% was used to calculate the Net Present Value (NPV) figure.

As can be seen, Queensland experiences the greatest reductions in both industry output and employment. As explained previously, this is primarily because, in addition to incurring higher gas prices, Queensland also experiences a large capital expansion due to the LNG developments. This capital expansion will have a significant impact on the Queensland economy and is expected to drive up real wages and prices for a number of intermediate inputs. With real wage rates and input costs higher than the national average, Queensland industries become less competitive relative to other states, and also relative to import competitors. This reduction in competitiveness causes many industries to reduce output, either as they reduce production in line with increased costs, or as they redistribute resources and economic activities to other states.

8 Impacts for Paper Products Manufacturing

The Paper products manufacturing sector comprises approximately 2% of total manufacturing production in Australia. It is moderately trade exposed, with an average trade share of 24%, and a gas use intensity of 3 MJ per dollar of output.

8.1 National Impacts for the Paper Products Manufacturing Industry

As the Paper Product manufacturing sector is not overly trade exposed and does not have high gas usage intensity, it could be expected that the sector would not be severely impacted by a rise in gas prices. We present the modelled impacts in Table 8.1 and Chart 8.1.

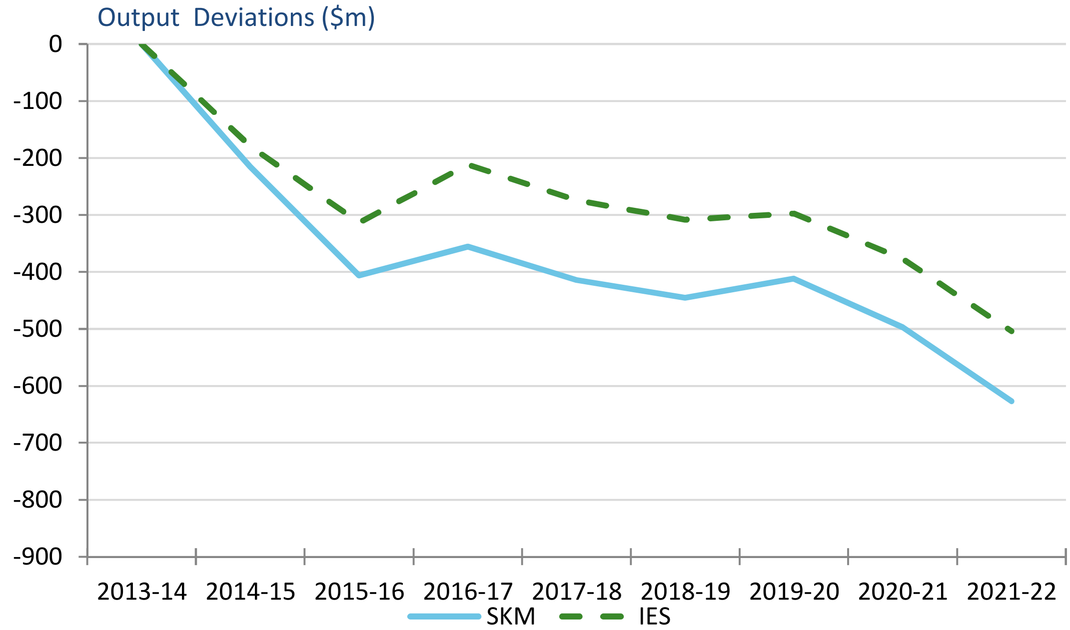
Table 8.1: Industry national output impacts: Paper products manufacturing

	$M deviation			% deviation			Cumulative NPV
	2015	2018	2021	2015	2018	2021	2014-2021
IES scenario							
Paper products	-314	-308	-504	-0.72	-0.65	-0.97	-1,653
SKM scenario							
Paper products	-406	-445	-627	-0.93	-0.94	-1.21	-2,270

Source: Deloitte Access Economics

The CGE modelling indicates that over the forecast period, the sector will incur a cumulative reduction of $1.7 billion under the IES gas price projections and $2.3 billion under the SKM gas price projections. In relative terms, in the year 2021, the increase in gas prices are expected to result in a decrease of -0.97% and -1.21% from the baseline under the IES and SKM price forecasts respectively.

Chart 8.1: National Paper products manufacturing output ($m deviations)



Source: Deloitte Access Economics estimates

8.2 State-level impacts for the Paper Products Manufacturing Industry

We present the industry output and employment impacts for the Paper products manufacturing sector by state in Table 8.2.

Table 8.2: State industry output impacts (NPV, $m)

	NSW	VIC	QLD	SA	WA
IES scenario					
Output (NPV)					
Paper products	-391	660	-1,845	-73	-22
Employment (average)					
Paper products	-181	369	-837	-43	4
SKM scenario					
Output (NPV)					
Paper products	-619	239	-1,823	-96	-2
Employment (average)					
Paper products	-158	353	-850	-55	14

Source: Deloitte Access Economics

Note: The discount rate of 7% was used to calculate the Net Present Value (NPV) figure.

As can be seen, the CGE modelling results show that the Victorian paper product manufacturing sector is projected to experience a small positive change in industry output and employment compared to the baseline. From a modelling perspective, the reasons for this result include:

- Gas intensity: While the p=Paper products sector uses a significant quantity of gas, its gas usage intensity is lower than much of the manufacturing sector, reducing the comparative disadvantage faced by the sector compared to other manufacturing sectors
- Gas intensity of intermediate inputs: Unlike some sectors such as Aluminium the paper products sector does not rely heavily on any intermediate inputs that are highly gas intensive, reducing their indirect exposure to gas prices.

We note that our case study on Australian Paper paints quite a different picture to the results depicted by the CGE model. Despite being considered to have 'low' average gas intensity, the large scale of Australian Paper's operations means that the company uses large amounts of gas. In fact, using 7.5 PJ of gas per year to produce pulp and paper products in its Maryvale Mill, Australian Paper is one of the largest gas users in Victoria. Further, as Australian Paper's pulp and paper products compete with imports, it faces a very limited ability to pass on higher gas costs.

Australian Paper's experience also significantly contradicts the Victorian gas prices projected by IES. While IES forecasted gas prices to be around $5.75/GJ in 2016, Australian Paper indicates that current offers are actually much closer to the gas prices projected by SKM (forecast to be around $9.18/GJ). If Australian Paper was to absorb increased gas input costs associated with the gas contracts it has been offered to date, it is unlikely that the Mill's operations would remain viable for more than a few years. With 900 regional jobs tied directly to the Maryvale Mill's operations, a potential closure could have significant direct and flow on impacts within the Latrobe Valley. Moreover, it could potentially have a disruptive impact on supply chains outside of the Paper Products manufacturing sector; for example, by disrupting the supply of paper to the Food, Beverage and Grocery industry, which is a major consumer of paper products for food packaging.

9 Impacts for the Chemical Products Manufacturing Industry

Chemical products manufacturing contributed approximately 10% of total manufacturing production in Australia. Of that total, Basic Chemical products contributed 4%, while Specialty Chemical products and Consumer Chemical products contributed approximately 5% and 1%, respectively.

The Chemical products manufacturing industry is highly trade exposed, with a trade share of approximately 80%. With a high level of trade exposure, the Chemical products manufacturing group will be restricted in its ability to pass through increases in production costs. In addition, the Chemical products manufacturing industry is a moderate to high intensity user of gas in its production process, using 8.4 MJ per dollar of output.

9.1 National impacts for the Chemical Products Manufacturing Industry

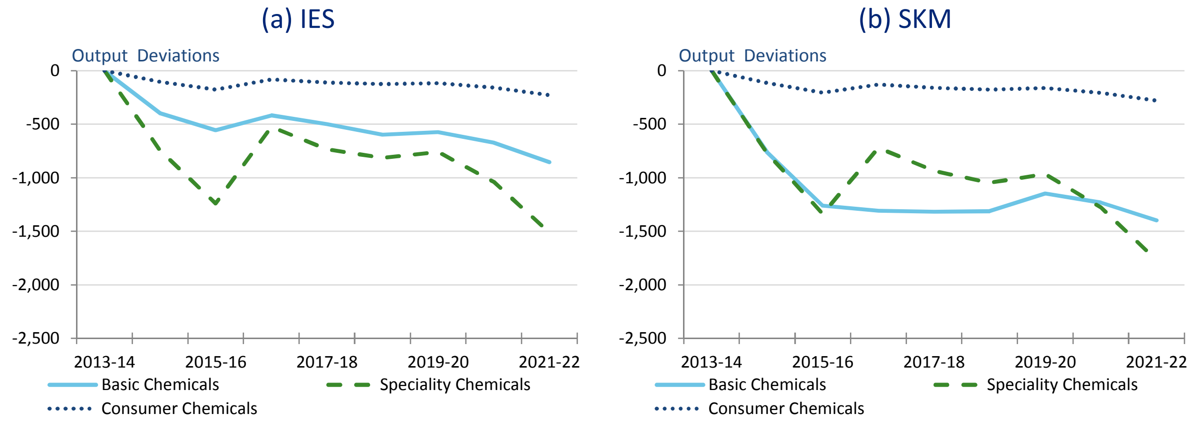
Given these characteristics, we would expect chemical products manufacturing to be highly impacted by rising gas prices and more difficult contracting environments in the East and West Coast gas markets. We show the modelled impacts in Table 9.1 and Chart 9.1.

Table 9.1: Industry national output impacts: Chemical products manufacturing group

	$M deviation			% deviation			NPV
	2015	2018	2021	2015	2018	2021	Cumulative 2014-2021
IES scenario							
Basic Chemicals	-556	-598	-854	-3.71	-3.65	-4.81	-3,901
Speciality Chemicals	-1,240	-815	-1,512	-3.31	-2.00	-3.44	-5,031
Consumer Chemicals	-177	-126	-229	-2.28	-1.49	-2.52	-753
SKM scenario							
Basic Chemicals	-1,261	-1,314	-1,397	-8.43	-8.02	-7.87	-6,703
Speciality Chemicals	-1,337	-1,047	-1,769	-3.57	-2.56	-4.03	-5,986
Consumer Chemicals	-206	-176	-280	-2.66	-2.09	-3.08	-975

Source: Deloitte Access Economics

Chart 9.1



Source: Deloitte Access Economics estimates

As shown, the cumulative reductions in output for the forecast period are reasonably significant for the Basic, Specialty and Consumer Chemicals manufacturing industries under both IES and SKM gas price forecasts. However, the Basic Chemicals manufacturing industry incurs much greater losses under the gas price projections modelled by SKM. This result stems from the fact that there is a large basic chemicals industry located in Victoria, which would be significantly more adversely affected by the higher SKM gas price projections. Again, as we consider that the SKM gas price forecasts are likely to be a closer depiction of reality, we believe that these results should be given greater attention.

Under the SKM gas price forecasts, the collective chemical products manufacturing industry is expected to incur a cumulative reduction of $13.6 billion over the forecast period. As a proportion of the total industry, the Basic Chemicals industry is expected to be the most severely affected, with year-on-year reductions in output averaging around 8% from the baseline.

9.2 State-level impacts for the Chemical Products Manufacturing Industry

We present the industry output and employment impacts for the Chemical products manufacturing sector by state in Table 9.2.

Table 9.2: State industry output impacts (NPV, $m)

	NSW	VIC	QLD	SA	WA
IES scenario					
Output (NPV)					
Basic Chemicals	-824	-106	-1,895	-72	-190
Speciality Chemicals	-1,170	-283	-3,267	-212	-92
Consumer Chemicals	-215	-30	-463	-28	-17
Employment (average)					
Basic Chemicals	-223	-12	-529	-28	-44
Speciality Chemicals	-445	-117	-1,244	-94	-25
Consumer Chemicals	-91	-12	-158	-11	-4
SKM scenario					
Output (NPV)					
Basic Chemicals	-2,230	-2,644	-1,624	-100	-124
Speciality Chemicals	-1,374	-930	-3,303	-291	-92
Consumer Chemicals	-278	-180	-463	-37	-17
Employment (average)					
Basic Chemicals	-465	-513	-475	-37	-18
Speciality Chemicals	-485	-282	-1,269	-129	-25
Consumer Chemicals	-105	-52	-160	-15	-4

Source: Deloitte Access Economics
Note: The discount rate of 7% was used to calculate the Net Present Value (NPV) figure.

As explained in section 9.2, the Chemical products manufacturing industries operating in Victoria are expected to incur significantly greater output losses under the SKM price forecasts.

Chemical product manufacturing groups, particularly Specialty Chemicals, are also projected to experience severe impacts in Queensland. As outlined in Chapter 6, this is primarily because, in addition to incurring higher gas prices, Queensland also experiences a large capital expansion due to the LNG developments. This capital expansion will have a significant impact on the Queensland economy and is expected to drive up real wages and prices for a number of intermediate inputs. With real wages and input costs higher than the national average, Queensland industries become less competitive relative to other states, and also relative to import competitors. This reduction in competitiveness causes many industries to reduce output, either as they reduce production in line with increased costs, or as they redistribute resources and economic activities to other states.

Under the SKM gas price forecasts, the Basic Chemicals industry takes a significant hit in NSW, with the CGE modelling indicating a cumulative reduction in output of 2.2 billion over the forecast period. However, it is important to emphasise that the CGE results will not capture certain adaptive actions taken by industry players. For example, Orica, which uses large amounts of gas in its Kooragang Island ammonia plant located in NSW, would stand to be significantly impacted by higher gas prices forecast for this region. However, Orica is currently exploring upstream gas development options to bring new, affordable sources of gas online for its operations. If Orica’s upstream strategy is successful, the impact to its operations will be considerably less than that predicted by the CGE model.

Importantly, as the CGE model tends to show ‘average’ outcomes and is not setup to capture granular flow-on impacts across an individual businesses’ value chain, individual circumstances could also lead to worse outcomes than projected. If efforts to insulate businesses from higher prices do not succeed, those businesses could carry costs both of their protective investments and higher input costs, with potential consequences across their supply chains.

10 Impacts for the Basic Non-ferrous Metal Products Manufacturing Industry

The Basic Non-ferrous Metal products manufacturing group (which includes the Bauxite, Alumina and Aluminium sectors) contributed approximately 4% of total manufacturing production in Australia. Within this manufacturing group, Bauxite contributes 0.5% to the total national manufacturing output, while Alumina and Aluminium products sectors contribute close to 2% each.

The Basic Non-ferrous Metals products manufacturing industry is a highly trade exposed industry with a trade share of approximately 70%. This manufacturing group is also a relatively intensive user of gas in its production process, with a gas use intensity of 15.7 MJ per dollar of output. As a result, manufacturing sectors in this group will face large increases in production costs and, given their high trade share, will also experience a high level of constraints in passing through these cost increase.

10.1 National impacts for the Basic Non-ferrous Metal Products Manufacturing Industry

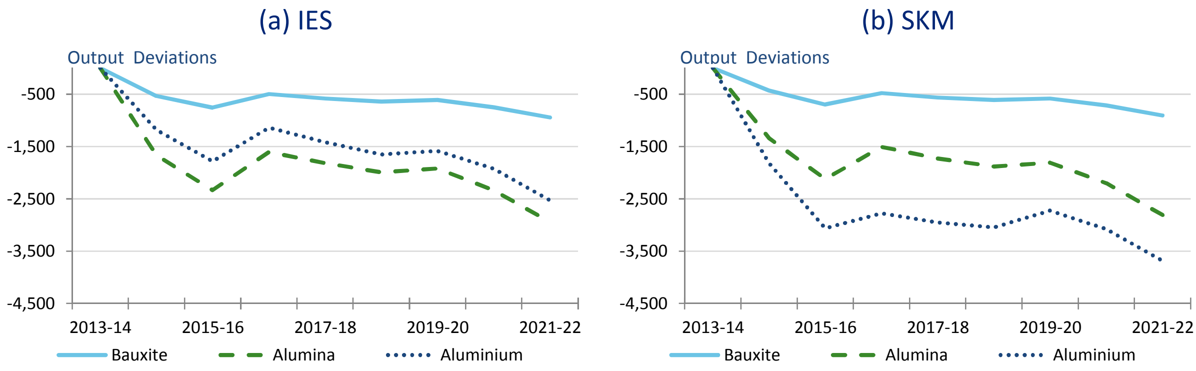
Due to the combination of high trade exposure and high gas intensity, the Basic Non-ferrous Metal products manufacturing group is expected to experience the largest reductions in industry output below the baseline of all the manufacturing sectors. We present the output impacts for the Bauxite, Alumina and Aluminium sectors in Table 10.1 and Chart 10.1 below.

Table 10.1: Industry national output impacts: Basic Non-ferrous Metal products manufacturing

	$M deviation			% deviation			NPV
	2015	2018	2021	2015	2018	2021	Cumulative 2014-2021
IES scenario							
Bauxite	-758	-640	-944	-14.88	-11.16	-14.81	-3,643
Alumina	-2,333	-1,992	-2,942	-11.16	-8.42	-11.06	-11,363
Aluminium	-1,785	-1,653	-2,530	-7.08	-5.95	-8.44	-8,954
SKM scenario							
Bauxite	-696	-613	-904	-13.68	-10.68	-14.18	-3,391
Alumina	-2,121	-1,880	-2,806	-10.15	-7.95	-10.54	-10,472
Aluminium	-3,063	-3,043	-3,684	-12.15	-10.95	-12.29	-15,834

Source: Deloitte Access Economics

Chart 10.1: National Basic Non-ferrous Metal products manufacturing output ($m deviations)



Source: Deloitte Access Economics estimates

The CGE modelling shows quite different impacts under the IES and SKM gas price forecasts. In particular, the Aluminium sector is projected to incur much larger output losses under SKM gas price forecasts. This is because a significant amount of aluminium production activity takes place in Victoria, and with SKM projecting higher gas price increases than IES, the resulting output losses are greater.

We note that aluminium production is electricity intensive, not gas intensive. However, aluminium relies on a number of gas intensive intermediate inputs. In particular, alumina (which is very gas intensive in production), is the key input into aluminium. Under both the IES and SKM gas price forecasts, alumina production is significantly impacted by gas price increases in a Queensland and Western Australia and this flows through to the Aluminium sector. However, under the SKM gas price forecasts, Victorian aluminium production incurs additional costs in terms of the higher price of intermediate inputs in that state, resulting in greater losses.

10.2 State level impacts for the Basic Non-ferrous Metal Products Manufacturing Industry

We present the industry output and employment impacts for the Basic Non-ferrous Metal products manufacturing group by state in Table 10.2.

Table 10.2: State industry output impacts (NPV, $m)

	NSW	VIC	QLD	SA	WA
IES scenario					
Output (NPV)					
Bauxite	0	0	-2,865	0	-789
Alumina	0	0	-7,236	0	-4,203
Aluminium	-1,716	-223	-6,265	-73	-640
Employment (average)					
Bauxite	0	0	-449	0	-87
Alumina	0	0	-1,077	0	-482
Aluminium	-295	-27	-933	-12	-35
SKM scenario					
Output (NPV)					
Bauxite	0	0	-2,670	0	-748
Alumina	0	0	-6,744	0	-3,867
Aluminium	-4,695	-4,706	-5,809	-64	-611
Employment (average)					
Bauxite	0	0	-425	0	-82
Alumina	0	0	-1,017	0	-436
Aluminium	-697	-659	-877	-10	-33

Source: Deloitte Access Economics
Note: The discount rate of 7% was used to calculate the Net Present Value (NPV) figure.

In addition to the large output reductions expected to be experienced by the Aluminium sector under the SKM gas price forecasts, the CGE modelling also projects significant impacts to the Basic Non-ferrous Metal product manufacturing group in Queensland and Western Australia. However, it is important to note that the CGE model will not account for the moderating effects of long-term contracts (which will shield some businesses from gas price increases) or adaptive actions taken by firms.

For example, one of our case studies shows that Rio Tinto Alcan, which uses over 20 PJ of gas per year to produce alumina in its Queensland-based Yarwun refinery, has signed a long-term gas contract in 2007 that largely mitigates the impact of the current gas market on the Yarwun refinery until 2031. However, RTA note that current gas market challenges restrict growth opportunities and erodes the sustainability of operations.

We note that other alumina refiners in Australia might feel the impact of higher gas prices sooner. In particular, Alcoa, which operates three gas-powered alumina refineries in Western Australia, could face significantly higher gas prices after its contracts with the

North West Shelf expire in 2020. The potential of higher gas prices and the current lack of supply certainty have already impacted upon Alcoa's expansion plans. In 2008 Alcoa was provided approval to look at building an additional production train at one of their refineries (the Wagerup refinery). Alcoa indicate that the project would have:

- employed 1000 people during peak construction and added an additional 150 jobs when operating
- increased Alcoa's export value by around $650 million per year
- generated over $17 billion in exports over the life of the project
- increased Western Australia's state revenue by around $11 million a year

Unfortunately, Alcoa were unable to negotiate any long term gas supply agreements to provide the gas required for this project. As such, the project has been put on hold.

11 Impacts for the Iron and Steel Manufacturing Industry

The Iron and Steel products manufacturing sector comprises approximately 4% of total manufacturing production in Australia.

The Iron and Steel products manufacturing sector has a medium level of trade exposure compared to other manufacturing industries, at 42%. Similarly, relative to other sectors the Iron and Steel products manufacturing sector has medium average gas usage intensity in its production process, at 6.3 MJ per dollar of output.

11.1 National impacts for the Iron and Steel Manufacturing Industry

With an increase in production costs and a constrained ability to pass these costs on, the Iron and Steel manufacturing sector is expected to experience a considerable reduction in industry output. As shown in Table 11.1, over the forecast period, the Iron and Steel manufacturing sector is projected to incur a cumulative reduction in industry output of $4.4 billion under the IES gas price forecasts and $6 billion under the SKM gas price forecasts.

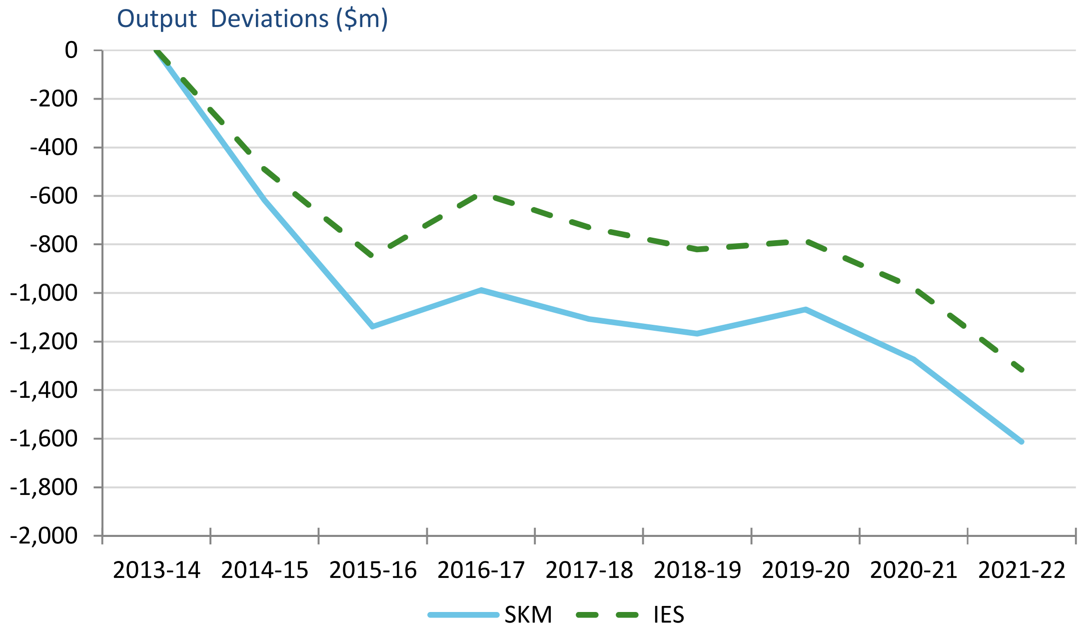
The differences between the two estimates are largely the result of interstate variation between the IES and SKM gas price forecasts. These are discussed in the following section.

Table 11.1: Industry national output impacts: Iron and Steel products manufacturing

	$M deviation			% deviation			NPV
	2015	2018	2021	2015	2018	2021	Cumulative 2014-2021
IES scenario							
Iron and Steel products	-849	-821	-1,316	-2.89	-2.55	-3.78	-4,411
SKM scenario							
Iron and Steel products	-1,138	-1,167	-1,613	-3.88	-3.63	-4.63	-6,071

Source: Deloitte Access Economics

Chart 11.1: National Iron and Steel products manufacturing output ($m deviations)



Source: Deloitte Access Economics estimates

11.2 State impacts for the Iron and Steel Manufacturing Industry

We present the industry output and employment impacts for the Iron and Steel manufacturing sector by state in Table 11.2.

Table 11.2: State industry output impacts (NPV, $m)

	NSW	VIC	QLD	SA	WA
IES scenario					
Output (NPV)					
Iron and Steel	-1,049	-147	-2,803	-191	-217
Employment (average)					
Iron and Steel	-311	-42	-804	-67	-43
SKM scenario					
Output (NPV)					
Iron and Steel	-1,952	-1,003	-2,683	-262	-181
Employment (average)					
Iron and Steel	-444	-190	-795	-91	-32

Source: Deloitte Access Economics

Note: The discount rate of 7% was used to calculate the Net Present Value (NPV) figure

As shown, the IES and SKM gas price forecasts give significantly different impacts for Victoria and NSW, with output losses considerably higher under the SKM gas price estimates. This is due to the higher (and more realistic) projected gas price increases for Victoria and NSW under the SKM modelling.

Our case study on GB Galvanizing is also consistent with the SKM gas price forecasts for Victoria. GB Galvanizing is the largest galvanizer in Victoria and uses around 50,000 GJ of gas per year to supply steel corrosion protection for many steel projects in Australia and overseas. As GB Galvanizing’s gas consumption profile is relatively stable and continuous, GB Galvanizing has historically been able to negotiate reasonable GSA terms and conditions. However, in seeking to renew their contract with gas retailers, GB Galvanizing is facing price increases of around 30%.

While all Australian galvanisers are likely to face similar gas price increases, the competitive dynamics within the Australian steel value chain largely limit the industry’s ability to pass on higher gas input costs. Like most of the Iron and Steel manufacturing sector, Australia’s galvanisers tend to compete directly with imported products (primarily steel products that enter the country already galvanized). With countries like China being able to compete on the basis of lower labour costs and larger facilities with greater economies of scale, Australia’s galvanisers, and indeed many other entities across the Australian steel value chain need to cut prices and reduce margins to remain competitive. As such, any increase in gas input costs are likely to further reduce what are already increasingly squeezed margins.

We estimated that recontracting at these higher gas prices would reduce GB Galvanizing’s net profit after tax by around 4-5%. This reduction alone would be unlikely to threaten the viability of GB Galvanizing’s operations. However, when considered in light of other factors that are already placing pressure on the Iron and Steel manufacturing sector, such as high wages, and burdensome regulatory requirements, higher gas prices are yet another factor eroding the ability of Australian industries to remain internationally competitive.

12 Fabricated Metal Products Manufacturing Industry

The Fabricated Metal products manufacturing sector comprises approximately 6% of total manufacturing production in Australia.

The Fabricated Metal products manufacturing sector is trade exposed, with a trade share of 22%. However, compared to other manufacturing industries, its trade exposure is relatively low. Similarly, compared to other sectors the Fabricated Metal products manufacturing sector has a relatively low gas usage intensity in its production processes, of 0.2 MJ per dollar of output.

12.1 National impacts for Fabricated Metal Products Manufacturing Industry

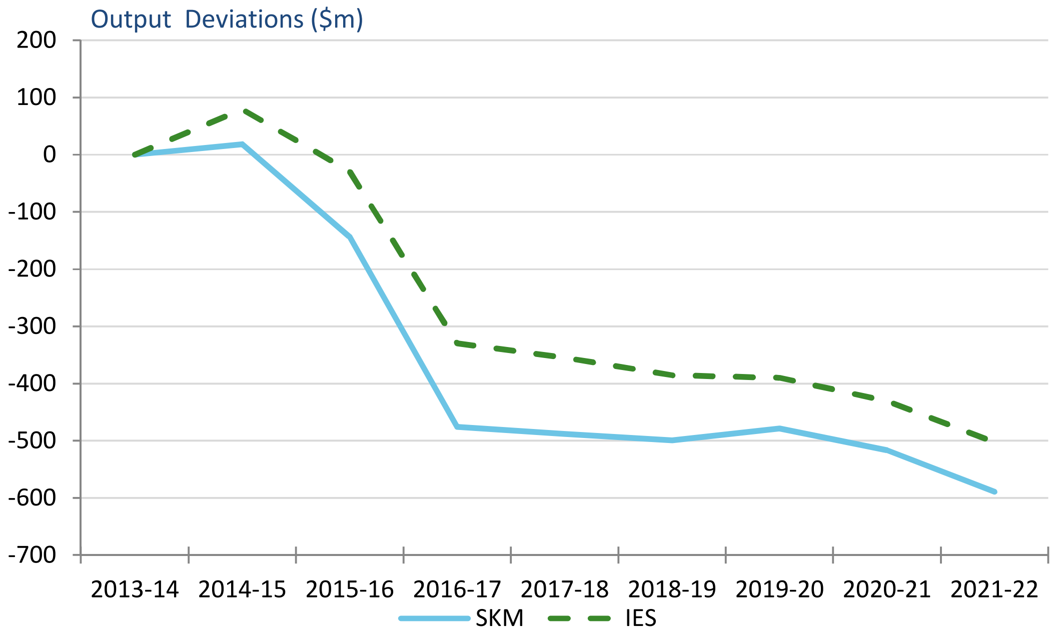
Given these characteristics, the impacts to the Fabricated Metal products manufacturing sector as a result of higher gas prices and a more difficult contracting environment are expected to be relatively small. We show the modelled impacts in Table 12.1 and Chart 12.1.

Table 12.1: Industry national output impacts: Fabricated metal products manufacturing

	$M deviation			% deviation			NPV
	2015	2018	2021	2015	2018	2021	Cumulative 2014-2021
IES assumptions							
Fabricated metal products	-29	-386	-503	-0.09	-1.05	-1.25	-1,483
SKM assumptions							
Fabricated metal products	-143	-499	-589	-0.43	-1.36	-1.47	-2,064

Source: Deloitte Access Economics

Chart 12.1: National Fabricated Metal products manufacturing output ($m deviations)



Source: Deloitte Access Economics estimates

As illustrated in Chart 12.1, the Fabricated Metal products industry actually experiences an increase in industry output early in the forecast period. We explain why this occurs with reference to impacts occurring across states in the following section.

12.2 State impacts for the Fabricated Metal Products Manufacturing Industry

We present the industry output and employment impacts for the Fabricated Metal products manufacturing sector by state in Table 12.2 and Chart 12.2.

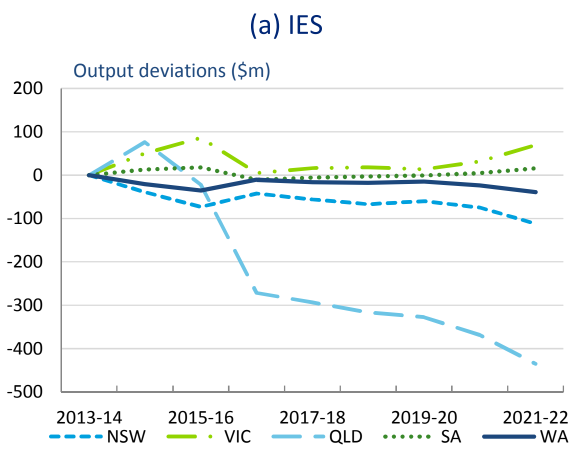
Table 12.2: State industry output impacts (NPV, $m)

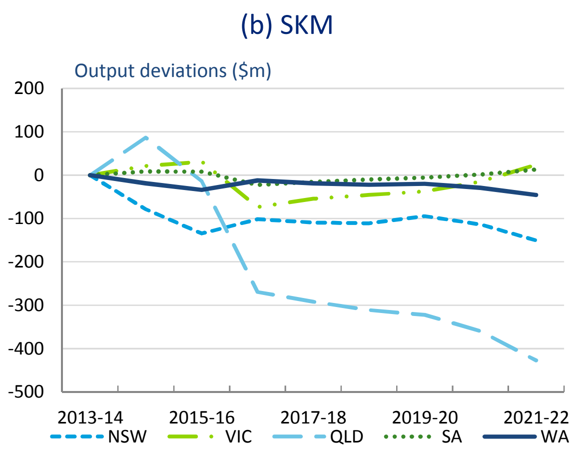
	NSW	VIC	QLD	SA	WA
IES scenario					
Output (NPV)					
Fabricated Metal Products	-352	206	-1,235	23	-123
Employment (average)					
Fabricated Metal Products	-211	116	-716	10	-59
SKM scenario					
Output (NPV)					
Fabricated Metal Products	-615	-101	-1,199	-17	-137
Employment (average)					
Fabricated Metal Products	-321	-14	-706	-15	-66

Source: Deloitte Access Economics

Note: The discount rate of 7% was used to calculate the Net Present Value (NPV) figure.

Chart 12.2: State Fabricated Metal products manufacturing output ($m deviations)





Source: Deloitte Access Economics estimates

As can be seen in Chart 12.2, the industry output impacts to the Queensland and Victorian Fabricated Metal products manufacturing sector are actually positive under both IES and SKM gas price forecasts until around 2016.

The increase in industry output for the Queensland Fabricated metal manufacturing industry in 2014/15 is driven by the capital expansion associated with Queensland's new LNG projects. As the construction sector draws heavily on fabricated metal products, Queensland's fabricators are expected to experience an increase in demand during the LNG construction phase. After this short term boost in output, the Queensland Fabricated metal manufacturing sector is likely to incur a decline in industry output due to the increase in gas prices and real wages.

We note that the positive Victorian impacts under the (more realistic) SKM gas price forecasts are very small and, when considered in the context of the entire forecast period, are outweighed by the cumulative negative impact

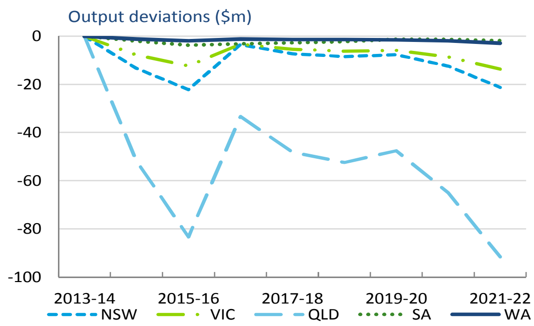
Appendix A: Additional industry results

The following are the modelled impacts for each industry broken down by state over time.

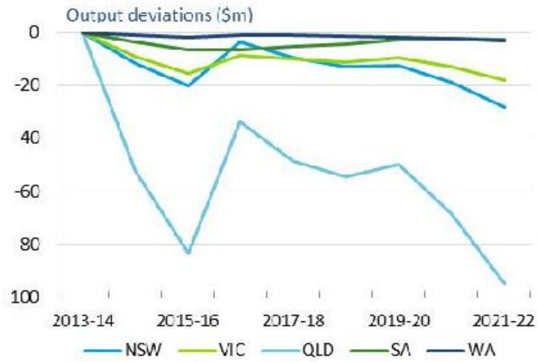
Food, Beverage and Grocery Manufacturing

Chart A.1: State Food and Beverage manufacturing output ($m deviations) under IES gas price forecasts

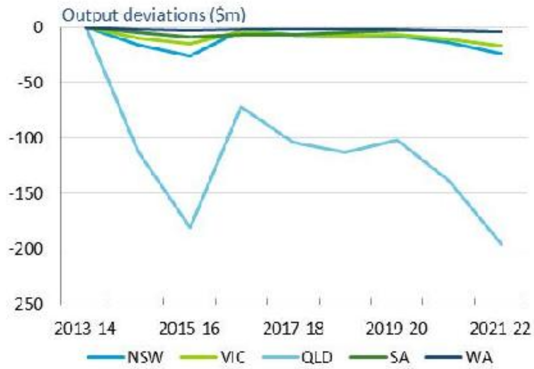
a) IES – Groceries



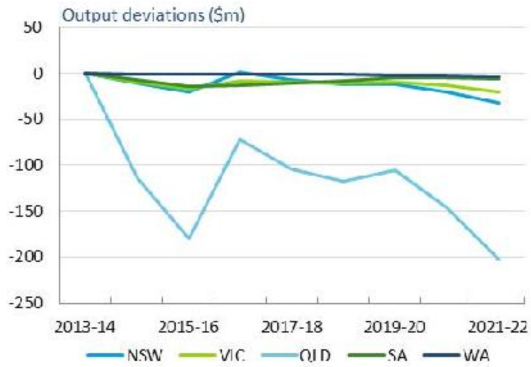
(b) SKM – Groceries



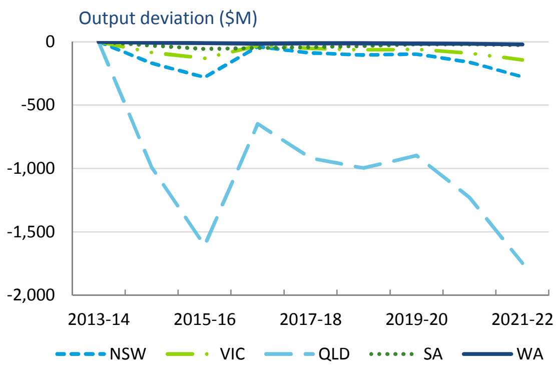
c) IES – Fresh Food



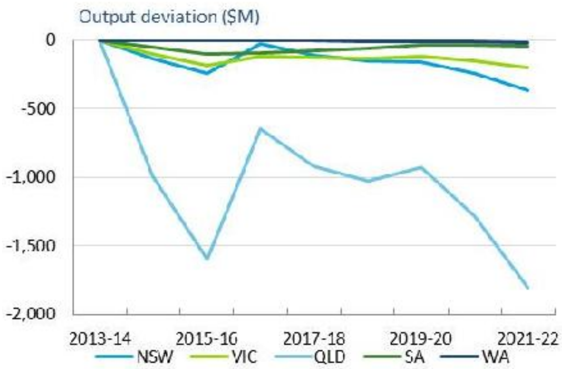
(d) SKM – Fresh Food



(e) IES – Food and Beverages



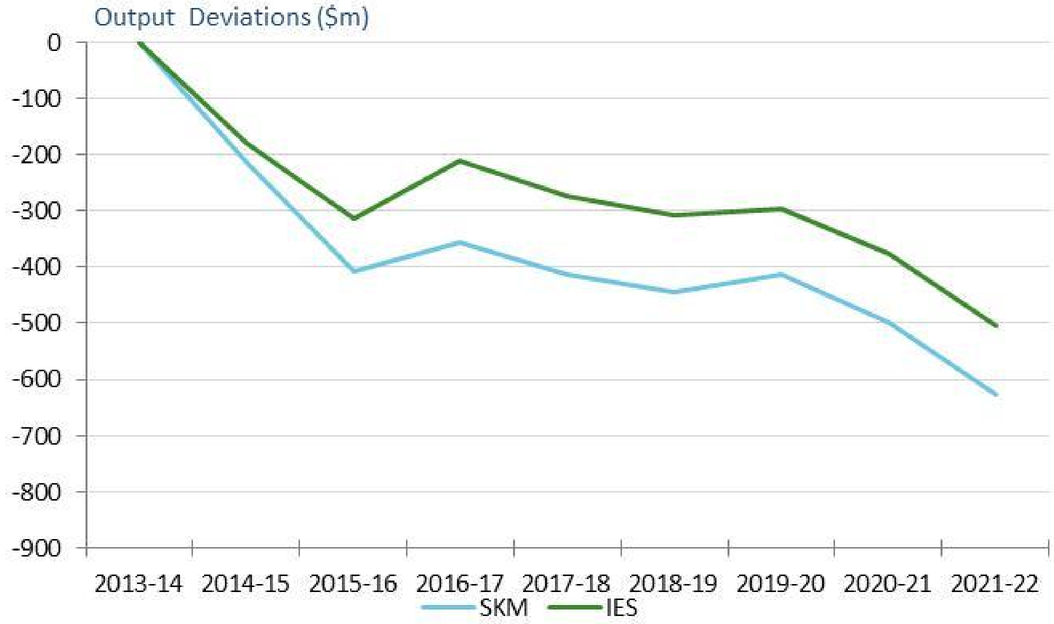
(f) SKM – Food and Beverages



Source: Deloitte Access Economics estimates

Paper Products Manufacturing

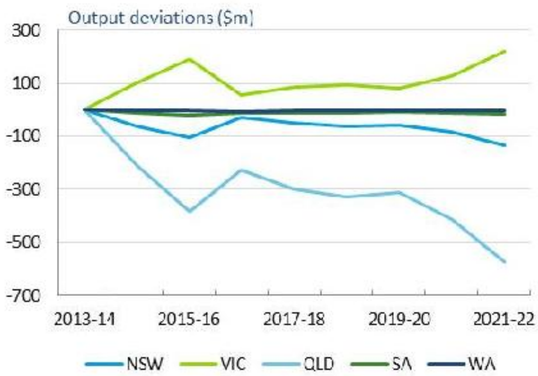
Chart A.2National Paper products manufacturing output ($m deviations)



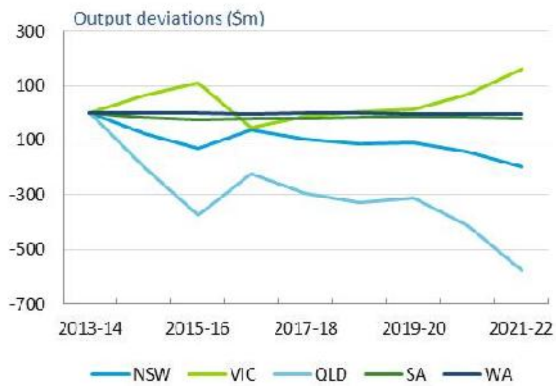
Source: Deloitte Access Economics estimates

Chart A.3: State Paper products manufacturing output ($m deviations)

(a) IES



(b) SKM



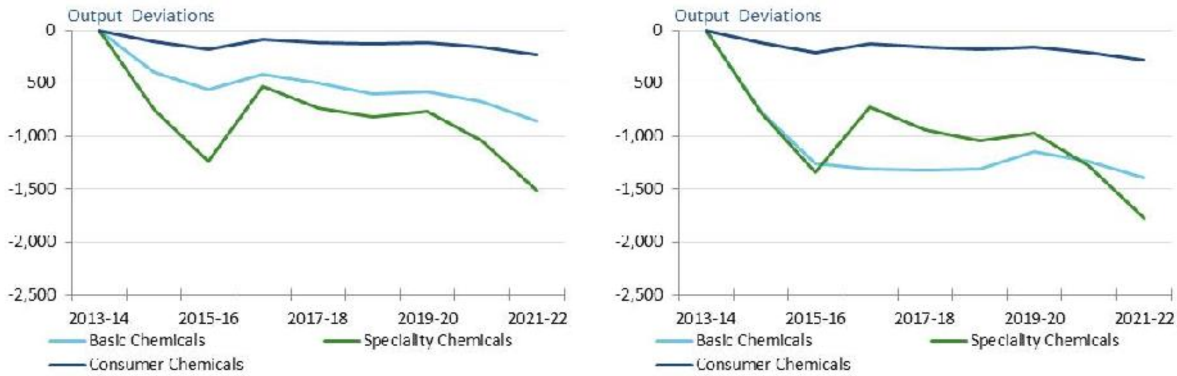
Source: Deloitte Access Economics estimates

Chemical Products Manufacturing

Chart A.4: National Chemical products manufacturing output ($m deviations)

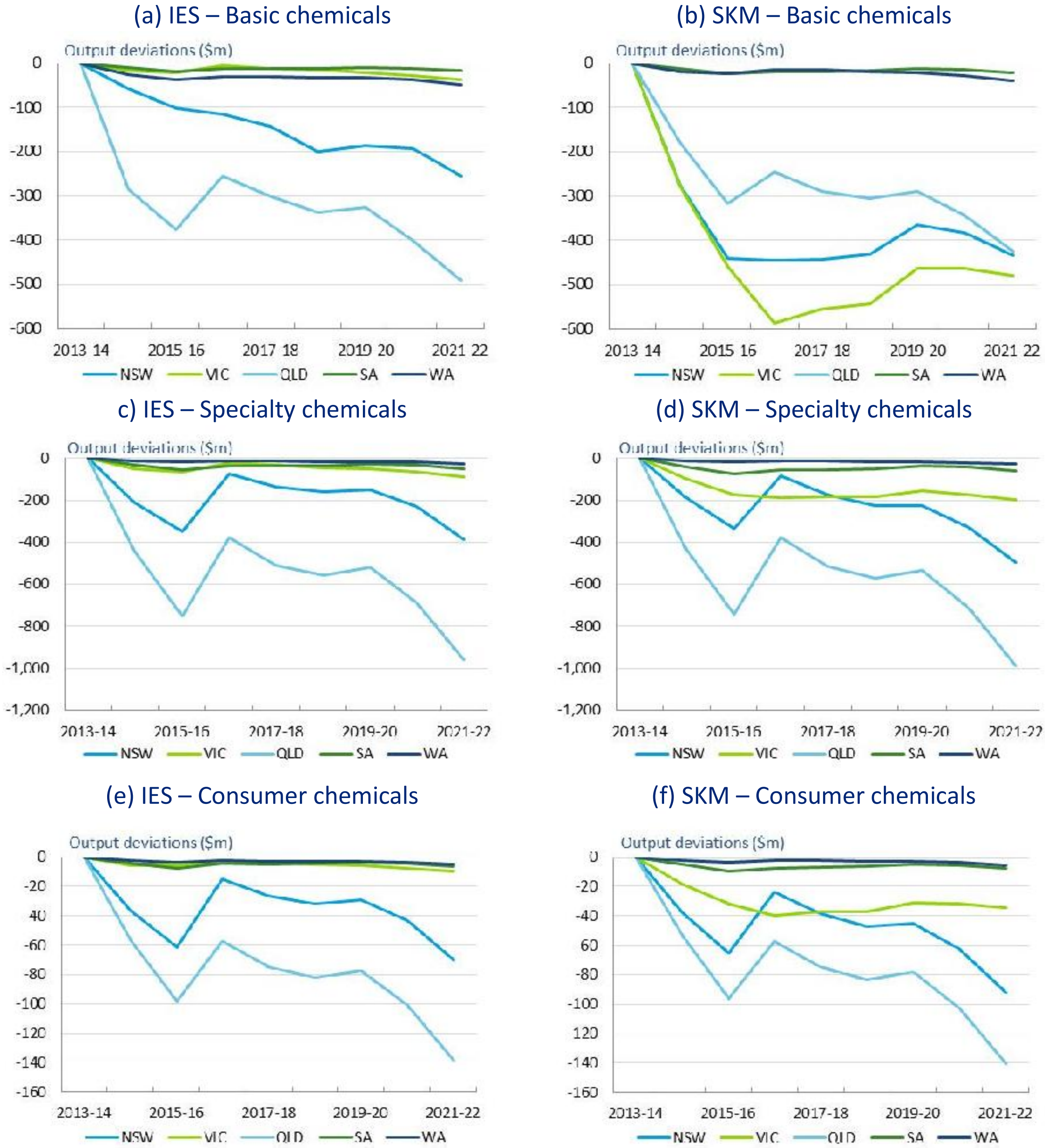
(a) IES

(b) SKM



Source: Deloitte Access Economics estimates

Chart A.5: State Chemical products manufacturing output ($m deviations)

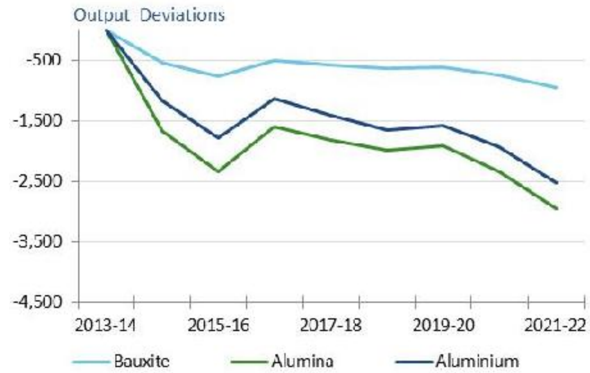


Source: Deloitte Access Economics estimates

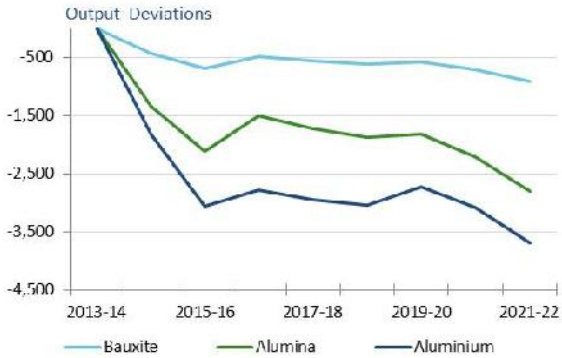
Basic Non-ferrous Metal Products (Bauxite, Alumina and Aluminium)

Chart A.6: National Basic Non-ferrous Metal products manufacturing output ($m deviations)

(a) IES



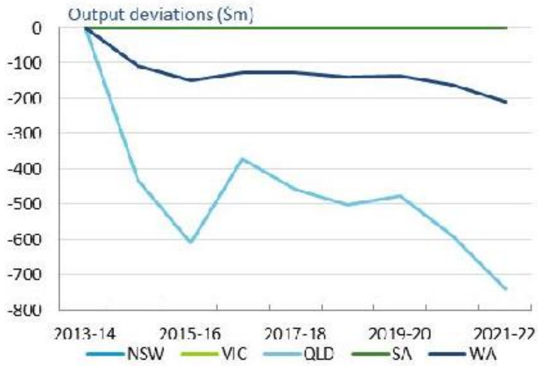
(b) SKM



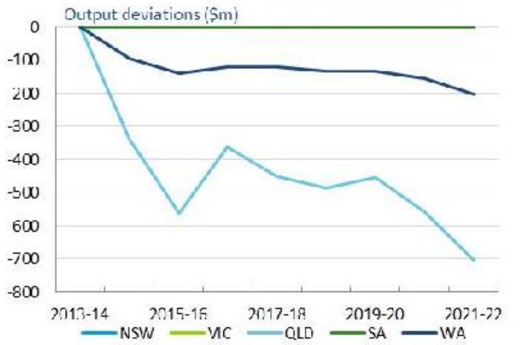
Source: Deloitte Access Economics estimates

Chart A.7: State Basic Non-ferrous Metal products manufacturing output ($m deviations)

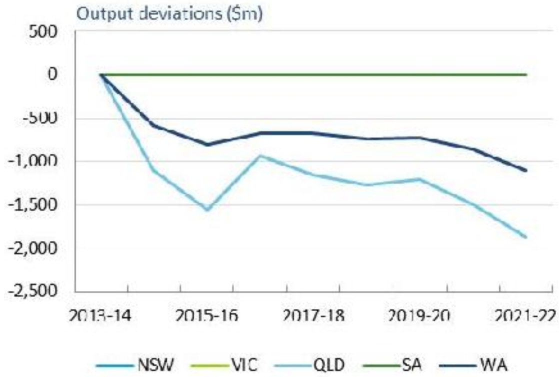
(a) IES – Bauxite



(b) SKM – Bauxite

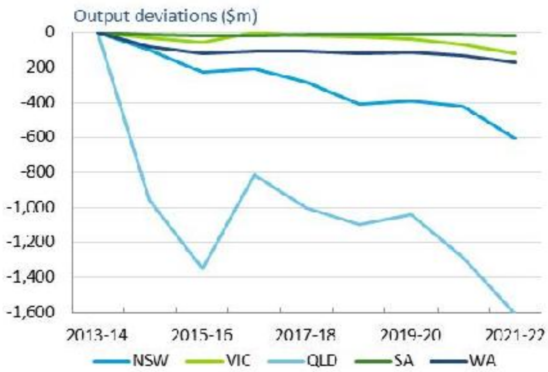


c) IES – Alumina

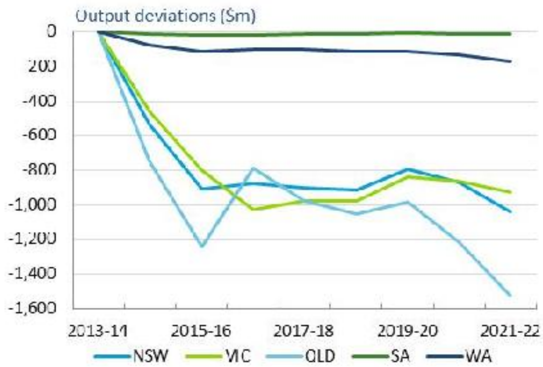


(d) SKM – Alumina

(e) IES – Aluminium



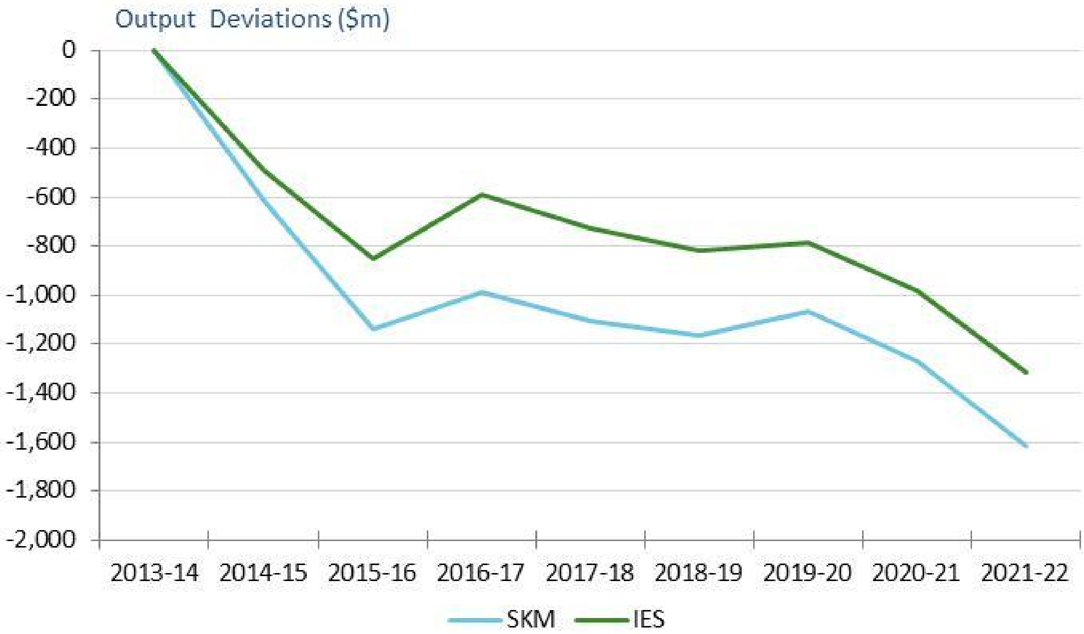
(f) SKM – Aluminium



Source: Deloitte Access Economics estimates

Iron and Steel Products

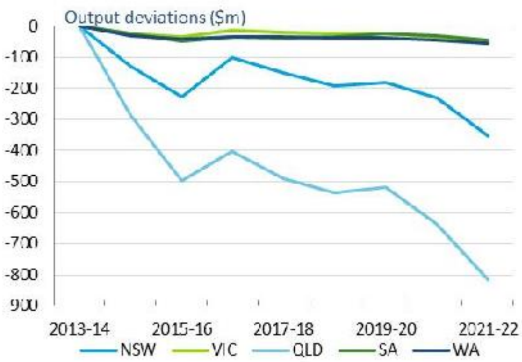
Chart A.8: National Iron and Steel products manufacturing output ($m deviations)



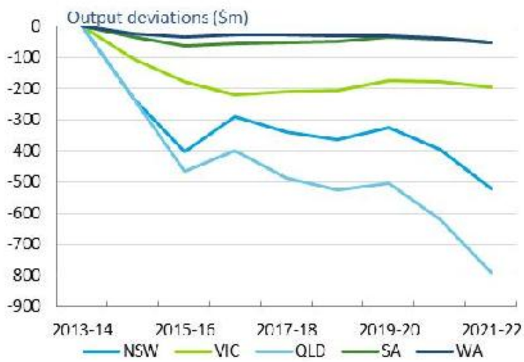
Source: Deloitte Access Economics estimates

Chart A.9: State Iron and Steel products manufacturing output ($m deviations)

(a) IES



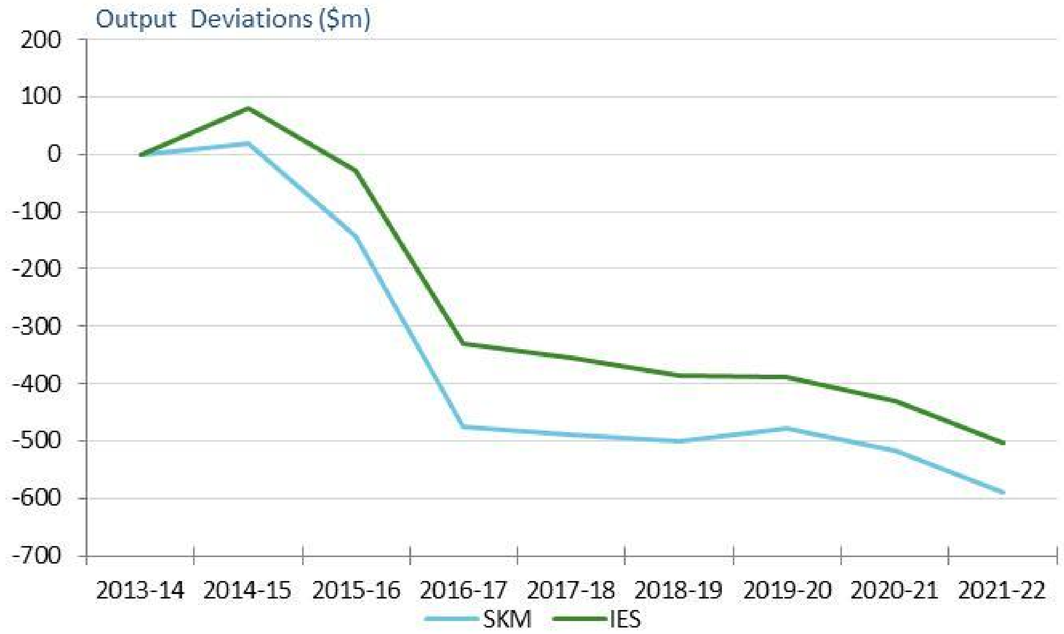
(b) SKM



Source: Deloitte Access Economics estimates

Fabricated Metal Products Manufacturing

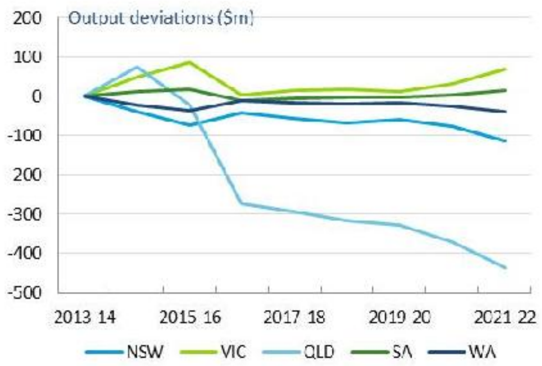
Chart A.10: National Fabricated Metal products manufacturing output ($m deviations)



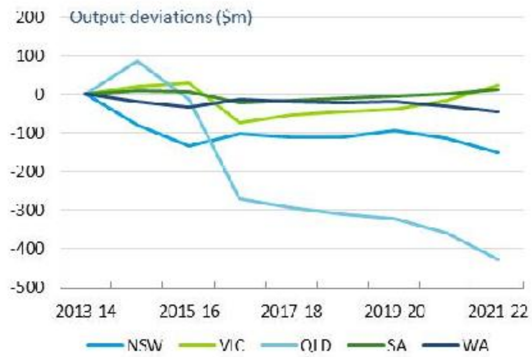
Source: Deloitte Access Economics estimates

Chart A.11: State Fabricated Metal products manufacturing output ($m deviations)

(a) IES



(b) SKM



Source: Deloitte Access Economics estimates

Appendix B: Gas price forecasts

Price forecasts for the East Coast gas market

This section provides an overview and critique of the modelling undertaken for the EADG study. In addition, it provides our rationale for the selection of the price paths for the East Coast gas market.

Eastern Australia Domestic Gas Study

The EADG Study was initiated by government in response to the significant changes occurring in the East Coast gas market. In recognising that Coal Seam Gas developments and the associated establishment of LNG export industry were creating significant uncertainty about the outlook for supply and demand, the EADG Study aimed to address information deficiencies and inform debate on gas policy strategy. The work also is intended to inform the Eastern Australian Gas Supply Strategy to 2020 and the Energy White Paper.

Intelligent Energy Systems (IES), in partnership with Resource and Land Management Services (RLMS) were the primary source of modelled price paths included in the report. However, in order to provide a counterpoint and additional context to IES's price forecasts, the report also presented modelling undertaken by Sinclair Knight Merz (SKM), Core Energy Group, and the Australian Energy Market Operator (AEMO).[55]

We focused our analysis on the modelling undertaken by IES and SKM as they differ in their modelling approach and provide important points of comparison. In particular:

- The IES modelling estimates the price impacts associated with the link to international LNG markets under the assumption that the market is perfectly competitive and offers little opportunity to exert market power.
- In contrast, the SKM modelling estimates price impacts under the assumption that gas producers and shippers are able to exert market power.

In what follows, we present an overview and critique of both sets of modelling.

Intelligent Energy Systems Modelling

The IES Integrated Gas and Electricity Model (IGEM) is based on a least-cost modelling approach that assumes a perfectly competitive market and does not take into account gas market participants' market power or bilateral contracts. The model optimises outcomes by annually solving the gas market for supply and demand, production costs, LNG netback price and a maximum daily quantity run.

[55] Department of Industry, BREE 2013, *Eastern Australian Domestic Gas Market Study*, p 71

IES Scenarios

IES has modelled the following six scenarios:

- **Reference case**: Most likely scenario, which assumes 8 LNG trains are operational by 2023.
- **LNG Low:** International LNG demand slows, leading to a decline in global LNG prices. As such, the development of uncommitted LGN trains (including Arrow Energy's proposal) is delayed and only 6 LNG trains come online.
- **LNG High:** High LNG netback prices result in 12 LNG trains, with additional investment in CSG reserve development increasing reserve efficiency and conversion time. Domestic gas supply and infrastructure development is also delayed.
- **Low Supply:** CSG reserve development and domestic gas demand slow, and investment to bring additional gas fields and associated pipeline infrastructure online is delayed
- **High Growth:** High growth in domestic gas demand, which is facilitated by additional gas supply and associated infrastructure being brought online in a timely manner. CSG reserves are developed more rapidly than the Reference case
- **High Infrastructure**: All variables are identical to the Reference Case, except additional gas fields, associated infrastructure and CSG reserve development occur earlier.

Across all modelled scenarios, the LNG High scenario represents the highest pricing outcome, while the LNG Low scenario represents the lowest. We have considered each of these scenarios and, consistent with IES, we believe the Reference case (where 8 LNG trains are developed) is the scenario most likely to eventuate. Although we note cost pressures currently impacting Arrow Energy's proposed developments, we expect that at the very least, Arrow Energy will adopt a development option that will allow it to monetise their gas reserves and bring two more LNG trains online.

For this reason, we consider the LNG Low scenario (where only the 6 committed trains are developed) to be less likely. As Arrow Energy has invested heavily in proving up their reserves, we believe that Arrow would be sufficiently motivated to develop the proposed trains, potentially by partnering with existing LNG projects to lower overall infrastructure costs. We also consider the LNG High scenario to be improbable for two key reasons. Firstly, a doubling of the current LNG commitments to 12 trains by 2023 (which is the period that this study considers) seems extremely unlikely, particularly given the present uncertainty around the production viability of CSG reserve development. Secondly, although we acknowledge that a high oil price scenario is plausible, we cannot isolate this oil price impact from the effects of the assumed increased LNG production. Specifically, as the increased LNG production is assumed to draw supplies away from the domestic market, higher prices experienced by domestic gas consumers result from both the high oil price and the high LNG production assumptions. As such, we consider that the IES reference case is the most reasonable and defensible of the modelled scenarios.

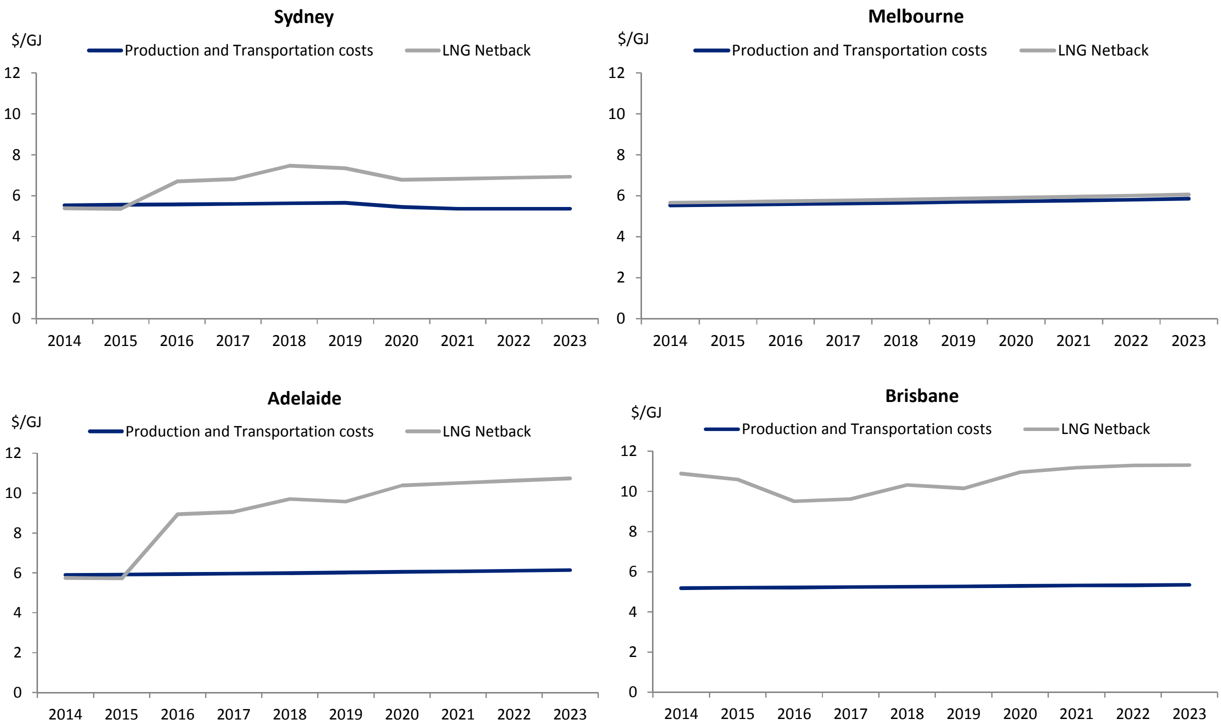
IES price paths for Eastern Australia's jurisdictions under the Reference Case

For each of the six modelled scenarios, IES present two possible price paths that could reflect the prices likely to be experienced by domestic gas consumers with and without the linkage to international LNG markets:

- Production and transportation costs reflect the lowest possible price domestic gas consumers would be likely to face if the East Coast market was not linked to international LNG markets. IES have used costs of production sourced from Resource and Land Management Services, which are specified at each basin for 2P, 3P, contingent and prospective reserves and resources.[56]
- LNG netback prices reflect the price domestic gas consumers are likely to face if the East Coast market was linked to international LNG markets, as it represents gas producers' opportunity cost of exporting gas to international customers. In modelling the LNG netback price, IES present Base, Low and High oil price projections for the period 2014 - 2023.

We present IES' price paths for Queensland (Brisbane), New South Wales (Sydney), South Australia (Adelaide) and Victoria (Melbourne) under the Reference Scenario in Chart B.1

Chart B.1: Baseline and LNG scenarios for East Australian jurisdictions based on IES modelling



Source: IES 2013, Study on the Australian Domestic Gas Market

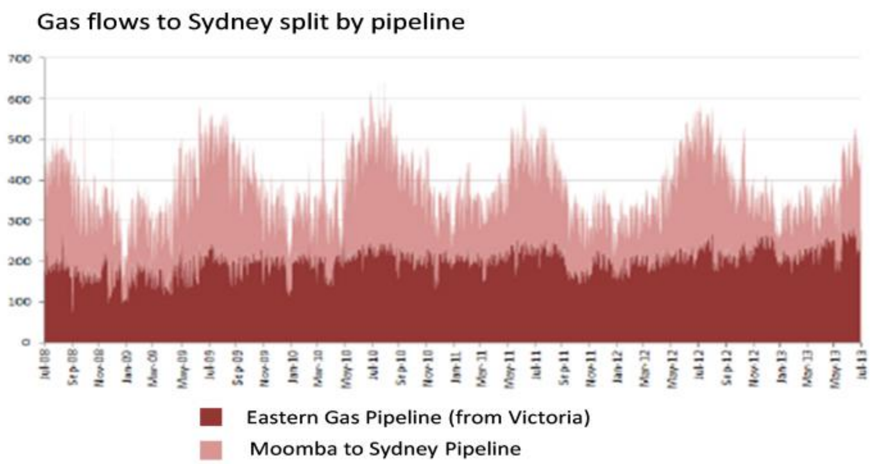
While we accept the production and transportation costs, we have some reservations about the LNG netback prices modelled for each jurisdiction. In particular:

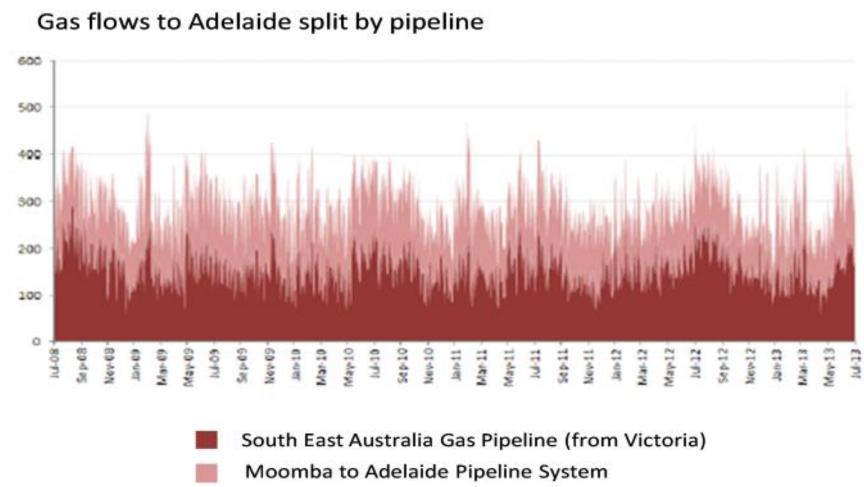
- We consider LNG netback price path for the Melbourne region to be unrealistically low. We note that IES have been explicit about IGEM's inability to capture market power and their decision not to replace the cost of production at the Gippsland basin with an LNG netback price. However, as we would expect profit maximising gas producers in Victoria to use their market power to increase prices, we believe the modelled

Melbourne price path would significantly understate gas prices (and the pain) facing Victorian domestic gas users.

- We would not expect there to be such a large divergence between gas prices in the Sydney and Adelaide regions. As shown in Chart B.2, the Sydney and Adelaide regions source gas from Victoria and Moomba. Moomba is directly connected to the LNG supply chain via the South West Queensland pipeline. Consequently, as gas producers either divert gas to LNG projects or engage in profit maximising behaviour, prices in both South Australia and New South Wales should be set with reference to LNG netback prices. While this increase is evident in the price path modelled for the Adelaide region, gas prices projected for the Sydney region appear to be unreasonably low. As both regions are connected to Moomba, we would expect wholesale gas prices in SA and NSW to be fairly comparable.

Chart B.2: Gas flows to Sydney and Adelaide regions by pipeline





Source: IES 2013, *Study on the Australian Domestic Gas Market*

We performed additional analysis using the Deloitte Gas Market Model to test our expectations about price paths facing the Melbourne, Sydney and Adelaide regions. Consistent with our presumptions, the Deloitte Gas Market Model shows gas price projections for the Sydney and Adelaide regions to be reasonably similar, while the prices for the Melbourne region are around a dollar less.

Despite these reservations, we accept that the price paths developed by IES are potentially plausible, and represent a reasonable representation of future domestic gas prices in a perfectly competitive market. However, it is important to note that, for the reasons outlined above, we consider the prices modelled for Melbourne and Sydney regions in an internationally linked market to be significantly understated. Consequently, in using these prices to model the economic consequences of international linkage on the East Coast, the impacts determined for the Melbourne and Sydney regions are also likely to be understated. For this reason, we consider that the modelling undertaken by SKM provides an important counterpoint.

Sinclair Knight Merz (SKM) Gas Market Modelling

SKM's Market Model Australia – Gas (MMAGas) represents the market for new long-term gas contracts as a competitive game between producers with uncommitted 2P gas reserves. Unlike the IES IGEM model, the MMAGas model is able to capture outcomes reflecting market power due to limited supply. In addition, while the IES IGEM model does not attempt to incorporate bilateral contracts, the MMAGas model combines information on gas demand and committed contracts to estimate the demand for new contracts.

SKM Scenarios

SKM model the following three gas market scenarios:

- **Base case:** Most likely scenario and, consistent with IES, assumes that 2 further LNG trains are commissioned in addition to the 6 trains currently committed
- **High LNG:** LNG expansion leads to one new train completed every two years after the second Arrow train is developed
- **Low LNG:** Only 6 trains are developed.

As these scenarios are reasonably consistent with IES' Reference case, LNG Low and LNG High scenarios, for the same reasons outlined above, we consider the Base case to be the most reasonable and defensible of the modelled scenarios.

SKM Price Paths and Diversion assumptions

SKM show two price paths relating to new and average contract prices:

- New upstream contract prices represent the estimated price of new 15 year gas contracts starting in a particular year
- Average upstream contract prices represent the estimated average price over all gas contracts delivering gas in any year

This is a slightly different approach to the IES modelling, which presented price paths relating to production cost and LNG netback prices. For all modelling, SKM assume a constant production and transportation cost of $4.65/GJ, which is lower than the production and transportation price paths modelled by IES. Under the IES Reference case, IES' production costs trend on average around $5.60. The SKM Base Scenario is also associated with a slightly lower LNG netback price than that presented in the IES Reference case. However, overall we consider the assumptions underpinning the IES Reference case and the SKM Base case to be broadly comparable.

SKM have modelled the price paths for each scenario under two alternative assumptions:

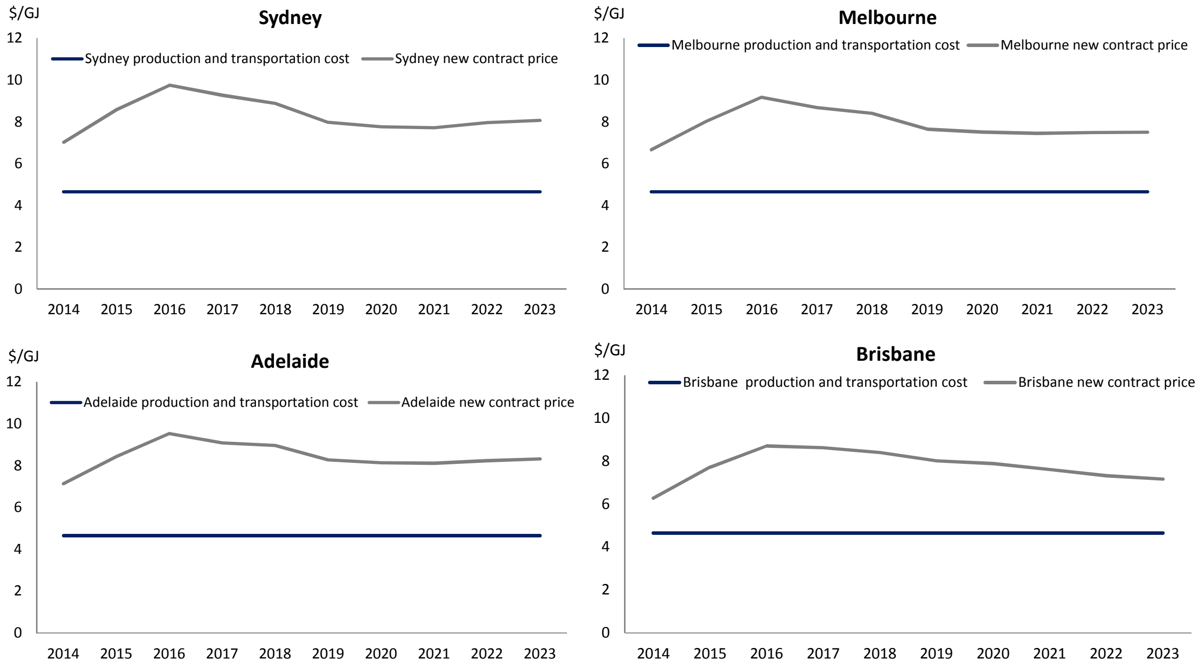
- No contract diversion, where all existing contracts (4,300 PJ) remain dedicated to the domestic market
- High contract diversion, where all gas that is not contracted directly or indirectly to end users is available for diversion to exports (i.e. 2,300 PJ is diverted from the domestic market to LNG producers).

SKM note that the actual outcome is likely to fall somewhere between these two extremes. This is because if LNG projects are short, they would rely on domestic gas reserves to ensure adequate supply. As such, some domestic contract diversion is highly likely. However, LNG projects are unlikely to require the full 2,300 PJ modelled under the High Contracted Diversion. Irrespective of whether existing contracts are actually diverted to LNG exports, SKM suggest that gas retailers would be more likely to set prices consistent with the High Contract Diversion assumption, rather than giving retail customers the benefit of continuing lower average contract prices.

In light of supply tightness on the East Coast, we broadly agree that profit maximising retailers would be likely to increase gas prices, regardless of whether 'domestic' supplies are actually diverted to LNG projects. Additionally, consistent with SKM, we consider that the High Contract Diversion assumption provides an appropriate proxy for modelling the future price movements suggested in Ai Group's recent survey of businesses in Eastern Australia, which indicated that retail prices would increase significantly from 2014 as if there were no price protection from ongoing contracts. Further, given the limited ability of the IES modelling to address market power dynamics, we consider that the price paths modelled under the SKM High Contract Diversion assumption provide a useful indication of the potential prices gas consumers on the East Coast are likely to face in the presence of market power.

We present SKM's baseline (based on production costs) and high contract diversion price paths in Chart B.3 below.

Chart B.3: Baseline and LNG scenarios for East Australian jurisdictions based on SKM modelling



Source: SKM 2013, *Gas market modelling*

East Coast gas market scenarios

The modelling undertaken by IES and SKM both provide reasonable, but different estimates of gas prices under the following scenarios:

- **Baseline (No LNG) scenario** (where prices reflect production and transportation costs)
- **LNG scenario**, where prices rise to reflect international LNG market prices.

Although modelling outputs will typically vary in accordance with different assumptions, data and modelling approaches, as noted above, we consider that the IES and SKM modelling highlight an important distinction. In particular, the IES baseline and LNG scenario price paths outlined above provide an estimate of the impacts associated with the link to international LNG markets under the assumption that the market is perfectly competitive. In contrast, the SKM baseline and High Contract Diversion scenarios provide an estimate of the impacts associated with the link to international LNG markets under the assumption that retailers are able to exert market power (a more realistic scenario).

As this distinction could be potentially useful for policy makers, we considered that it would be appropriate to analyse the impact of the price paths developed under both sets of modelling. We discuss our approach further in Section 4.

Price forecasts for the West Coast gas market

This section presents an overview and critique of the modelling undertaken in the GSOO. It also provides our rationale for the development of an additional price path for the West Coast gas market.

Western Australia Gas Statement of Opportunities

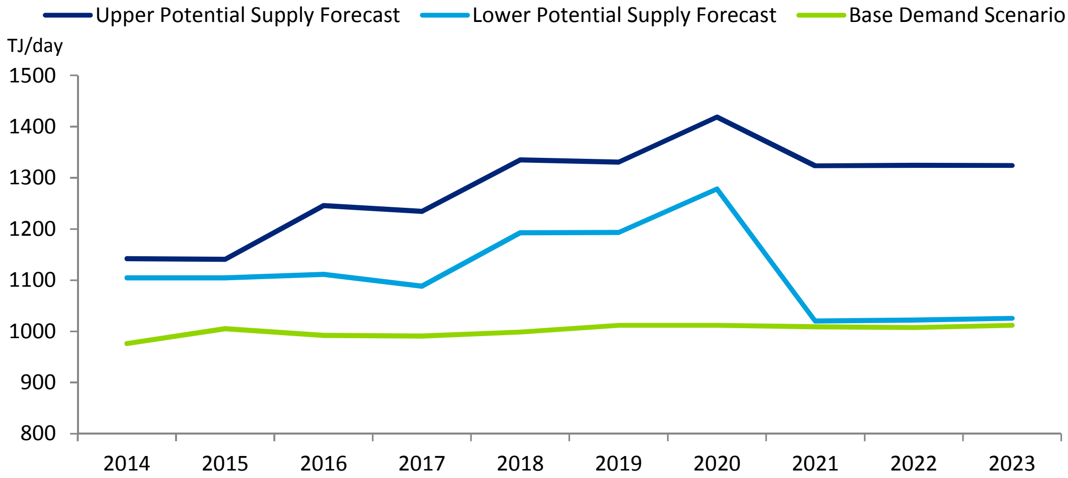
In July 2013, the Western Australian Independent Market Operator (IMO) released the 2013 Gas Statement of Opportunities (2013 GSOO), which presented supply, demand and price forecasts under the assumption that the NWS would recontract to supply the domestic market. In January 2014, the IMO released a second Gas Statement of Opportunities (2014 GSOO) that aimed to address a number of WA market participants' concerns about the NWS JV's intentions and ability to supply the domestic market once existing contracts expire. In particular, in response to feedback from stakeholders, the 2014 GSOO implemented a number of adjustments to supply and demand forecasts and also undertook an investigation into the capability of the NWS to continue to supply the domestic market.

In light of the uncertainty associated with the NWS, the 2014 GSOO developed two supply scenarios for the 2014-2023 forecast period. These included:

- The 'Upper potential supply forecast', which assumes the NWS will recontract to supply the domestic market. Under this scenario, the 2014 GSOO assumes the NWS will continue to supply the domestic market at a maximum of 470 TJ of gas per day till 2020 (inclusive) and thereafter up to 450 TJ per day to 2023.
- The 'Lower potential supply forecast', which assumes that NWS will only supply domestic gas under their remaining contracts (and not recontract with the domestic market)

These supply forecasts and the 2014 GSOO Base demand forecast are shown in the chart below.

Chart B.4: 2014 GSOO Supply and demand forecasts



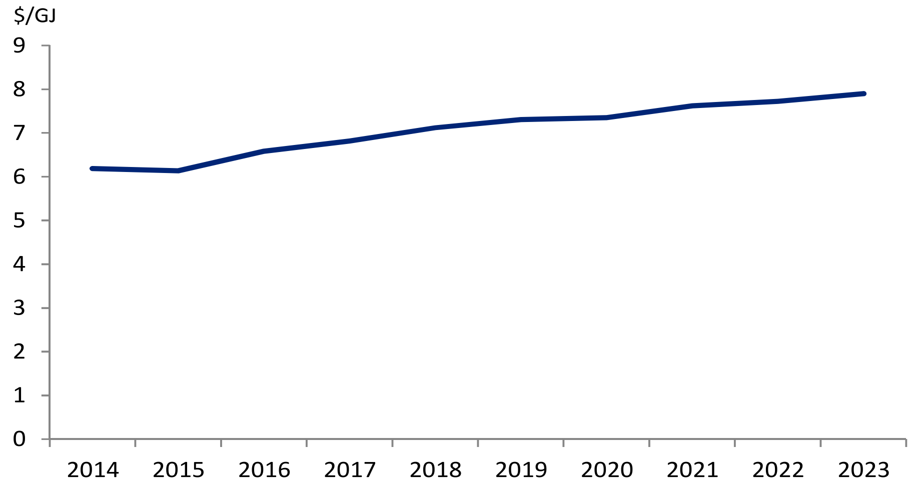
Source: Western Australia Gas Statement of Opportunities, 2014

According to the 2014 GSOO, if the NWS recontracts with domestic customers beyond 2020, domestic supply is projected to be approximately 30% greater than forecast domestic demand by 2023. This excess supply has the potential to place downward pressure on prices. However, if the NWS elects not to supply domestic gas beyond its remaining contracts, the 2014 GSOO projects very tight market conditions and potential supply shortages.

In comparison to the IES and SKM modelling of the East Coast gas prices, the 2014 GSOO takes a different approach to forecasting gas prices for the WA domestic market. While the IES and SKM modelling determine unique price projections resulting from different supply and demand assumptions, the 2014 GSOO have used the same assumed base gas price forecast as an input into the determination of both the Upper and Lower Supply Forecasts.[57] This Base gas price forecast represents the prices of new medium to long-term gas contracts (ex-plant) in the WA domestic market and is shown in Chart B.5 below.

[57] We note that the 2014 GSOO presents a Low, Base and High price scenario using different assumptions about oil prices, Asia Pacific LNG prices and recoverable reserves. However, as only the Base price projections were used as an input into the supply scenarios, we have limited our analysis to the 2014 GSOO Base price.

Chart B.5: 2014 GSOO projected new medium to long-term gas contract prices (ex-plant)



Source: Western Australia Gas Statement of Opportunities, 2014

In light of the uncertainty and lack of transparency associated with gas contract prices for the WA gas market, we acknowledge the difficulty and complexity associated with modelling gas price forecasts. However, we have a number of reservations about the gas price forecast presented in the 2014 GSOO, particularly in relation to its adoption in this study. In particular, we consider the application of only one price forecast in both supply scenarios to be inappropriate. As the supply scenario in which the NWS does not recontract is likely to be associated with significant market tightness and potential supply shortages, we would expect prices under this scenario to be higher and linked closely to LNG netback values. Indeed, the 2014 GSOO have explicitly stated that a decision by the NWS not to recontract with the domestic market may result in gas prices rising above the forecasts used in the GSOO.

We accept that the price forecast presented in the 2014 GSOO could be a plausible price path associated with the Upper Potential Supply Forecast where NWS elects to the recontract with the domestic market and effectively floods the domestic market. However, we consider that this scenario is particularly unlikely. Even if the NWS chose to recontract with the domestic market, it is likely that they would only do so at LNG netback prices, which reflects their opportunity cost of supplying LNG to the international market.[58]

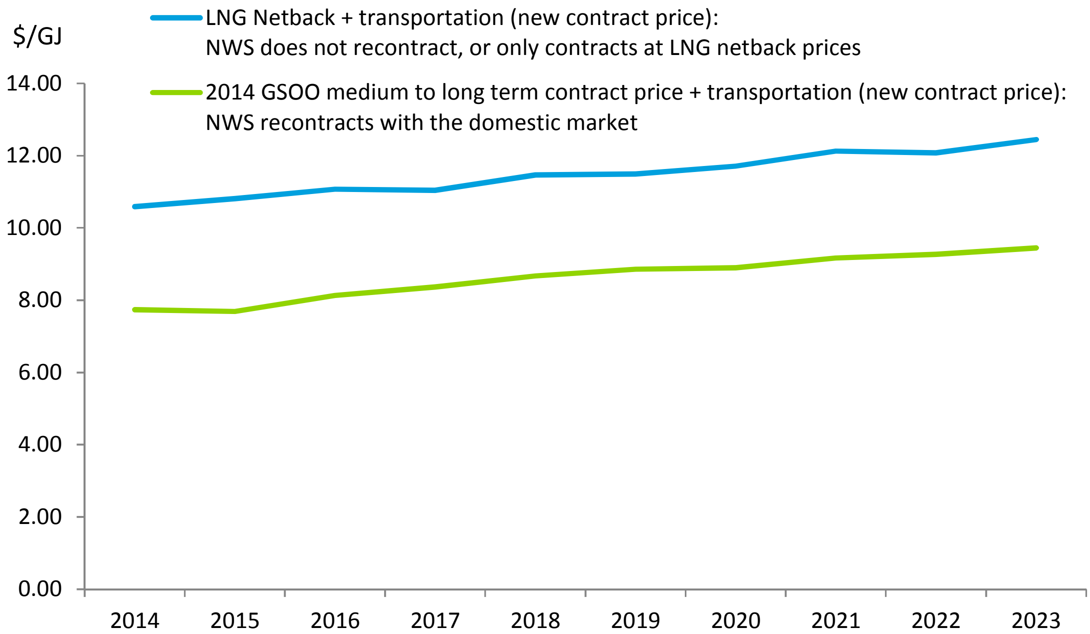
As such, we have developed an alternative price path (linked more closely to LNG netback values). This price path reflects prices likely to be experienced by domestic gas users under a scenario where either:

- the NWS does not recontract with the domestic market, creating market tightness in accordance with the supply-demand balance associated with the 2014 GSOO's Lower Potential Supply Forecast and pushing prices up to LNG netback values, or
- the NWS recontracts with the domestic market at LNG netback prices

[58] Such sentiment was recently expressed by Peter Coleman, CEO of Woodside in a recent Investor Update briefing, where he stated "Our target in the [West Coast] market is to ensure that we get LNG netback prices or equivalent to that". *Woodside ASX Announcement*, Wednesday 11 December

We have used the Deloitte Gas Market Model to develop an alternative price path for the supply scenario in which the NWS does not recontract with the domestic market beyond its existing contracts. As the 2014 GSOO presents ex-plant price projections, we have adjusted both the 2014 GSOO price forecast and our alternative price path to include an estimated transportation costs of $1.55/GJ. These adjusted price paths, which represent *new* medium to long-term contract prices for the forecast period, are shown in Chart B.6.

Chart B.6: 2014 GSOO and DAE medium to long-term projections for new contract prices for different supply scenarios



Source: Western Australia Gas Statement of Opportunities, 2014, DAE Analysis

The DAE price projection for the scenario where NWS does not recontract shows new contract prices to be, on average, around $2.86 more per gigajoule. However, over the period leading up to 2020, it is unlikely that all domestic gas consumers will have negotiated new contracts. Instead, a proportion of the domestic gas customers will be paying prices associated with existing (legacy) contracts that will roll off over time. The table below shows the assumptions relating to NWS existing contracts that we have used in determining the average price for WA domestic market contracts.

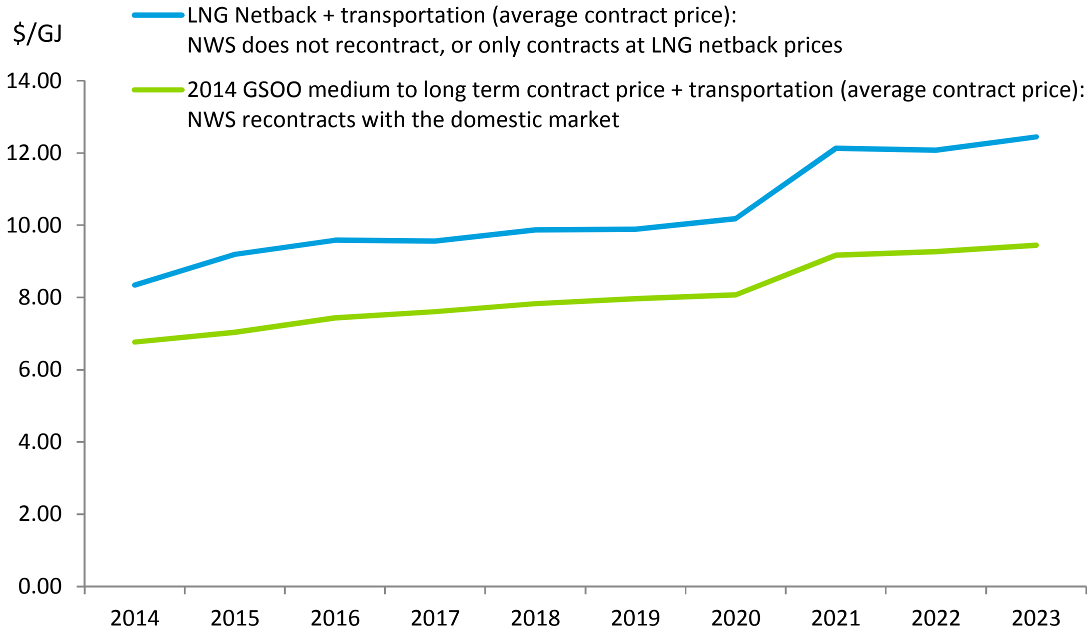
Table B.1: Assumptions relating to the roll-off of NWS existing contracts

NWS existing contracts	Estimated contract expiry as shown in the 2014 GSOO	DAE assumed expiry date	Estimated quantity (TJ/day)
Alcoa Australia	2020	2020	175
Alinta Energy	2012 or 2020	2012	62
Alinta Energy	2012 or 2020	2020	90
BHP Billiton	2013	2013	110
Synergy	2015	2015	135
Other undisclosed parties	Before 2020	2020	Undisclosed

Source: Western Australia Gas Statement of Opportunities, 2014, DAE Analysis

We have assumed that existing contracts are priced at around $4/GJ. Further, as existing contracts roll off, contracted quantities are assumed to be recontracted at the new contract prices, shown in Table B.1. We present the average price for medium to long term contracts for both supply scenarios in Chart B.7

Chart B.7: Average price for medium to long term contracts under different supply scenarios



Source: Western Australia Gas Statement of Opportunities, 2014, DAE Analysis

As illustrated, the average contract price for the scenario where NWS does not recontract, or only contracts at LNG netback prices is consistently higher than the average contract price associated with the scenario where NWS elects to recontract with the domestic market. In both scenarios, average contract prices approach new contract prices in 2021, following the expiry of all the existing NWS contracts.

West Coast gas market scenarios

As the outcome of the NWS's decision to recontract with the domestic market is likely to have significant consequences for domestic gas users in Western Australia, We have sought to model the following scenarios to assess the impact to industry and the broader economy:

- **Baseline scenario (NWS JV recontracts with the domestic market):** price path based on the price forecast presented in the 2014 GSOO, but adjusted to reflect transportation costs and the average price of gas contracts in the WA domestic market
- **Alternative scenario (NWS JV does not recontract with the domestic market, or only recontracts at LNG netback prices):** price path based on the LNG netback price forecast developed using the Deloitte Gas Market Model, which is also adjusted to reflect transportation costs and the average price of gas contracts in the WA domestic market.

Appendix C: Framework for quantitative modelling

Deloitte Access Economics has undertaken quantitative modelling of the economic impacts of changes in gas prices. This modelling is based on the application of a computable general equilibrium (CGE) model to examine the broader economy-wide impacts of abatement policies, as well as specific analysis of likely sectoral outcomes. CGE modelling is a widely accepted framework for macroeconomic analysis in the academic and public sector.

The CGE model used is Deloitte Access Economics' in house CGE model called DAE-RGEM.

DAE-GEM is a large scale, dynamic, multi-region, multi-commodity computable general equilibrium model of the world economy. The model allows policy analysis in a single, robust, integrated economic framework. This model projects changes in macroeconomic aggregates such as Gross Domestic Product, Gross State Product, employment, export and import volumes, investment and private consumption. At the sectoral level, detailed results such as output and employment are also produced.

The base data of the model is derived from the Global Trade Analysis Project (GTAP) which produces a global database for general equilibrium modelling used across a large research community. The Australian component of the database is provided by the Productivity Commission, and is based on Australian input-output tables produced by the Australian Bureau of Statistics.

The model is primarily based on input-output or social accounting matrices, as a means of describing how economies are linked through production, consumption, trade and investment flows. For example, the model considers:

- direct linkages between industries and countries through purchases and sales of each other's goods and services; and
- indirect linkages (see Box 13-1) through mechanisms such as the collective competition for available resources, such as labour, that operates in an economy-wide or global context.

Box 12-1: Industry linkages in CGE modelling

CGE models are a particularly powerful tool for measuring the likely broader impacts at the micro and macroeconomic levels of changes in policy settings and industry specific outcomes, in particular due to the "bottom-up" representation of the various production sectors and sources of final demand (for example – householders and export markets) within the economy.

Within the DAE-RGEM model, individual industries interact with foreign export and import product markets, "factor markets" including the labour and capital markets, government and other domestic and interstate industries and householders to model the suite of transactions that take place in a market economy in a framework consistent with established national accounting standards – including in the calculation of familiar macroeconomic aggregates such as GDP.

For example, the impacts of international gas market linkage will manifest itself in a number of ways in the manufacturing sector, including:

- Through an increase in the immediate energy costs of each industry
- Through increased pressure on trade exposed industries as increased gas exports places upward pressure on the exchange rate
- Through increased costs of industry inputs – for example, the increased cost of alumina due to gas price rises to the aluminium sectors; and
- Through increased competition for labour and capital with the gas sector.

In addition to these downsides, industries will, to varying degrees, benefit from the increase in demand (directly or indirectly) as a result of a larger gas industry and increased wealth in the economy, with the magnitude of this impact heavily dependent on the end users of their products.

Appendix D: CGE Modelling Assumptions

CGE Modelling Assumptions, Considerations and Case Studies

To estimate potential economic impacts of projected gas price increases, we have used a computable general equilibrium (CGE) model. Our in-house DAE-RGEM model provides a comprehensive and single framework for projecting macroeconomic aggregates such as gross domestic product (GDP), employment and investment across the national, state and industry levels. The model has been disaggregated and customised to match the manufacturing sectors selected by the project consortium.

To tailor the quantification exercise to the specifications of the manufacturing sector and prevailing gas price trends in local markets, we have made a number of modifications to our in-house model, including:

- calibrating the model to provide extra detail on the manufacturing sub-sectors of interest to the project consortium
- incorporating detail that reflects the intensity of gas usage across subsectors in manufacturing
- state-level disaggregation to take into account different price paths in respective markets.

The model has benefited from access to additional information on the gas use of those sectors. In addition, other sources of information, including ABS and BREE data, has been drawn on where required. The manufacturing subsectors assessed are listed in Table D.1.

Table D.1: Selected manufacturing industries

Modelled Industry	Description
Food and Beverages manufacturing	meat and meat products; dairy products; grain mill and cereal products; bakery products; sugar and confectionary manufacturing; other food products; and beverage manufacturing
Grocery product manufacturing	sanitary paper products; and pharmaceutical and medicinal products
Fresh food manufacturing	mushroom and vegetable growing; fruit and tree nut growing; and poultry farming
Basic Chemicals manufacturing	petroleum and coal products; basic chemical manufacturing; basic polymer manufacturing; and fertiliser manufacturing
Speciality Chemicals manufacturing	other basic chemical manufacturing; and, polymer and rubber products
Consumer Chemicals manufacturing	pesticide manufacturing; and cleaning compound and toiletry preparation manufacturing
Fabricated Metal products	copper silver lead and zinc smelting and refining; and other Basic Non-ferrous Metal manufacturing
Alumina manufacturing	
Aluminium manufacturing	
Bauxite manufacturing	
Iron and steel manufacturing	
Paper products manufacturing	excluding sanitary Paper products manufacturing

Capital expenditure assumptions

Alongside the gas price profiles, we have also included estimates of the capital expenditure associated with the Queensland LNG projects. These estimates have been based on the latest publically available information.

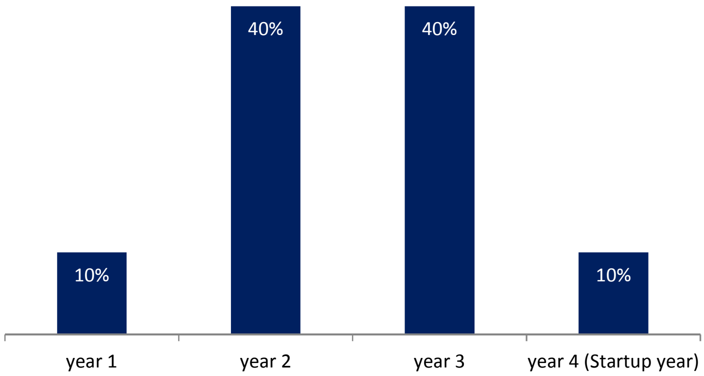
Table D.2: Capital costs associated with the Queensland LNG projects

LNG Project	Number of LNG Trains	Total Capital Cost ($B)	Start-up date
Australia Pacific LNG	2	24.7	2015
Gladstone LNG	2	18.0	2015
Queensland Curtis LNG	2	19.8	2014
Arrow LNG	2	20.0	2020

Source: BREE 2013

We have assumed that capital costs for the Australia Pacific LNG, Gladstone LNG and Queensland Curtis LNG projects are spread over the four years leading up to and including the start-up year in accordance with the profile shown in Chart D.1.

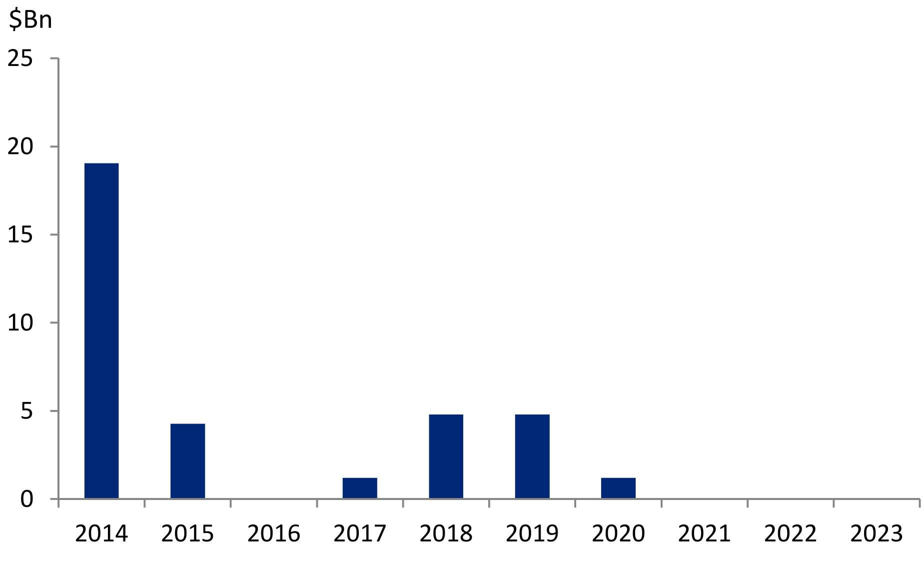
Chart D.1: Assumed capital expenditure profile for APLNG, GLNG and QCLNG projects



Source: Deloitte Access Economics estimates

Based on our assessment of the Arrow LNG project we have assumed that only 60% of the total estimated capital expenditure will be realised, as Shell/Petrochina seek to reduce costs by sharing facilities with other LNG facilities. These estimates and assumptions give rise to the following LNG capital expenditure profile over the course of the modelled period.

Chart D.2: LNG Capital Expenditure profile



Source: Deloitte Access Economics estimates
Note: The capital expenditure profile commences in financial year 2014-15

Considerations when interpreting CGE modelling results

There are four key considerations that need to be taken into account when interpreting the CGE modelling sectoral results presented in this report. Firstly, it has been assumed that gas price increases are passed through to manufacturing users regardless of individual contract price arrangements. However, as this is a simplifying assumption, it should be recognised that in the short term, the adverse impacts of gas price rises may be overstated for some sectors due to long term fixed-price contracts.

Secondly, the model assumes that input price increases, such as gas inputs, are fully passed on to final consumers. This is a simplifying assumption in the majority of CGE models used. In the context of this analysis, there may be scope in the short term for manufacturers to absorb gas price rises through reduced margins. This would lead to the model overstating the short term impacts on manufacturing production.

Thirdly, and related to the second issue raised above, the model takes limited account of fixed capital in the manufacturing sector. Capital is reasonably free to shift from one sector to other sectors based on changes in rates of return (though the model incorporates an elasticity of substitution that restricts capital mobility to some extent). This, again, can overstate any adverse output impacts of rising gas prices because industries with fixed (or lumpy) capital tend to reduce margins as input prices rise in order to continue to operate.

Finally, the model assumes that resources deployed to service the domestic market can be easily redeployed to export if necessary, for instance if demand by local manufacturers for inputs reduces along with their output. In reality a sector may be composed of many smaller businesses with physical or organisational limits to their ability to respond to such shifts. The model could thus understate adverse impacts on sectors through supply chains.

More information on the modelling framework can be found in Appendix D.

Complementary case studies

Though CGE modelling is the premier tool used to gauge effects of major developments or changes in the structure of the economy (e.g. climate change, investment pipelines, technology advancements etc.), industry outcomes are driven by smooth production functions and tend to reflect the average case. Sometimes, nuances of reality and intricacies of individual business operations cannot be practically integrated in the modelling.

For this reason, five case studies have been included to add a layer of authenticity. The case studies seek to demonstrate how changes in gas prices and contracting conditions could impact upon business profitability, risk profile and future investment decisions. These case studies are also intended to showcase the possible economic consequences under circumstances where traditional modelling assumptions may not hold true.

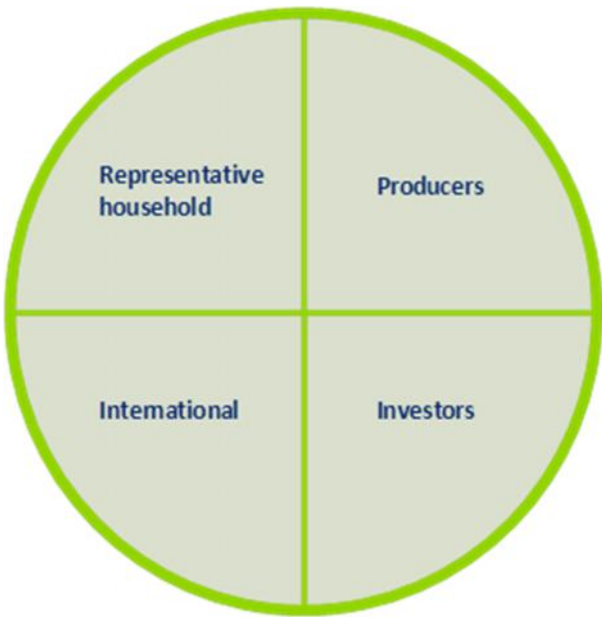
Appendix E: Regional General Equilibrium Model

The Deloitte Access Economics – Regional General Equilibrium Model (DAE-RGEM) is a large scale, dynamic, multi-region, multi-commodity computable general equilibrium model of the world economy. The model allows policy analysis in a single, robust, integrated economic framework. This model projects changes in macroeconomic aggregates such as GDP, employment, export volumes, investment and private consumption. At the sectoral level, detailed results such as output, exports, imports and employment are also produced.

The model is based upon a set of key underlying relationships between the various components of the model, each which represent a different group of agents in the economy. These relationships are solved simultaneously, and so there is no logical start or end point for describing how the model actually works.

Figure A.1 shows the key components of the model for an individual region. The components include a representative household, producers, investors and international (or linkages with the other regions in the model, including other Australian States and foreign regions). Below is a description of each component of the model and key linkages between components. Some additional, somewhat technical, detail is also provided.

Figure E.1: Key components of DAE-RGEM



DAE-RGEM is based on a substantial body of accepted microeconomic theory. Key assumptions underpinning the model are:

- The model contains a 'regional consumer' that receives income from factor payments (labour, capital, land and natural resources), taxes and net foreign income from borrowing (lending).

- Income is allocated across household consumption, government consumption and savings so as to maximise a Cobb-Douglas (C-D) utility function.
- Household consumption for composite goods is determined by minimising expenditure via a CDE (Constant Differences of Elasticities) expenditure function. For most regions, households can source consumption goods only from domestic and imported sources. In the Australian regions, households can also source goods from interstate. In all cases, the choice of commodities by source is determined by a CRESH (Constant Ratios of Elasticities Substitution, Homothetic) utility function.
- Government consumption for composite goods, and goods from different sources (domestic, imported and interstate), is determined by maximising utility via a C-D utility function.
- Savings generated in each region are used to purchase bonds whose price movements reflect movements in the price of creating capital.
- Producers supply goods by combining aggregate intermediate inputs and primary factors in fixed proportions (the Leontief assumption).Composite intermediate inputs are also combined in fixed proportions, whereas individual primary factors are combined using a CES production function.
- Producers are cost minimisers, and in doing so, choose between domestic, imported and interstate intermediate inputs via a CRESH production function.
- The model contains a more detailed treatment of the electricity sector that is based on the 'technology bundle' approach for general equilibrium modelling developed by ABARE (1996).
- The supply of labour is positively influenced by movements in the real wage rate governed by an elasticity of supply.
- Investment takes place in a global market and allows for different regions to have different rates of return that reflect different risk profiles and policy impediments to investment. A global investor ranks countries as investment destinations based on two factors: global investment and rates of return in a given region compared with global rates of return. Once the aggregate investment has been determined for Australia, aggregate investment in each Australian sub-region is determined by an Australian investor based on: Australian investment and rates of return in a given sub-region compared with the national rate of return.
- Once aggregate investment is determined in each region, the regional investor constructs capital goods by combining composite investment goods in fixed proportions, and minimises costs by choosing between domestic, imported and interstate sources for these goods via a CRESH production function.
- Prices are determined via market-clearing conditions that require sectoral output (supply) to equal the amount sold (demand) to final users (households and government), intermediate users (firms and investors), foreigners (international exports), and other Australian regions (interstate exports).
- For internationally-traded goods (imports and exports), the Armington assumption is applied whereby the same goods produced in different countries are treated as imperfect substitutes. But, in relative terms, imported goods from different regions are treated as closer substitutes than domestically-produced goods and imported composites. Goods traded interstate within the Australian regions are assumed to be closer substitutes again.

- The model accounts for greenhouse gas emissions from fossil fuel combustion. Taxes can be applied to emissions, which are converted to good-specific sales taxes that impact on demand. Emission quotas can be set by region and these can be traded, at a value equal to the carbon tax avoided, where a region's emissions fall below or exceed their quota.

Households

Each region in the model has a so-called representative household that receives and spends income. The representative household allocates income across three different expenditure areas: private household consumption; government consumption; and savings.

Going clockwise around Figure E.1, the representative household interacts with producers in two ways. First, in allocating expenditure across household and government consumption, this sustains demand for production. Second, the representative household owns and receives income from factor payments (labour, capital, land and natural resources) as well as net taxes. Factors of production are used by producers as inputs into production along with intermediate inputs. The level of production, as well as supply of factors, determines the amount of income generated in each region.

The representative household's relationship with investors is through the supply of investable funds – savings. The relationship between the representative household and the international sector is twofold. First, importers compete with domestic producers in consumption markets. Second, other regions in the model can lend (borrow) money from each other.

- The representative household allocates income across three different expenditure areas – private household consumption, government consumption and savings – to maximise a Cobb-Douglas utility function.
- Private household consumption on composite goods is determined by minimising a CDE (Constant Differences of Elasticities) expenditure function. Private household consumption on composite goods from different sources is determined is determined by a CRESH (Constant Ratios of Elasticities Substitution, Homothetic) utility function.
- Government consumption on composite goods, and composite goods from different sources, is determined by maximising a Cobb-Douglas utility function.
- Savings generated in each region are used to purchase bonds whose price movements reflect movements in the price of generating capital.

Producers

Apart from selling goods and services to households and government, producers sell products to each other (intermediate usage) and to investors. Intermediate usage is where one producer supplies inputs to another's production. For example, coal producers supply inputs to the electricity sector.

Capital is an input into production. Investors react to the conditions facing producers in a region to determine the amount of investment. Generally, increases in production are accompanied by increased investment. In addition, the production of machinery, construction of buildings and the like that forms the basis of a region's capital stock, is undertaken by producers. In other words, investment demand adds to household and government expenditure from the representative household, to determine the demand for goods and services in a region.

- Producers interact with international markets in two main ways. First, they compete with producers in overseas regions for export markets, as well as in their own region. Second, they use inputs from overseas in their production.
- Sectoral output equals the amount demanded by consumers (households and government) and intermediate users (firms and investors) as well as exports.
- Intermediate inputs are assumed to be combined in fixed proportions at the composite level. As mentioned above, the exception to this is the electricity sector that is able to substitute different technologies (brown coal, black coal, oil, gas, hydropower and other renewables) using the 'technology bundle' approach developed by ABARE (1996).
- To minimise costs, producers substitute between domestic and imported intermediate inputs is governed by the Armington assumption as well as between primary factors of production (through a CES aggregator). Substitution between skilled and unskilled labour is also allowed (again via a CES function).
- The supply of labour is positively influenced by movements in the wage rate governed by an elasticity of supply. This implies that changes influencing the demand for labour, positively or negatively, will impact both the level of employment and the wage rate. This is a typical labour market specification for a dynamic model such as DAE-RGEM. There are other labour market 'settings' that can be used. First, the labour market could take on long-run characteristics with aggregate employment being fixed and changes to labour demand changes being absorbed through movements in the wage rate. Second, the labour market could take on short-run characteristics with fixed wages and flexible employment levels.

Investors

Investment takes place in a global market and allows for different regions to have different rates of return that reflect different risk profiles and policy impediments to investment. The global investor ranks countries as investment destination based on two factors: current economic growth and rates of return in a given region compared with global rates of return.

Once aggregate investment is determined in each region, the regional investor constructs capital goods by combining composite investment goods in fixed proportions, and minimises costs by choosing between domestic, imported and interstate sources for these goods via a CRESH production function.

International

Each of the components outlined above operate, simultaneously, in each region of the model. That is, for a simulation the model forecast changes to trade and investment flows within, and between, regions subject to optimising behaviour by producers, consumers and investors. Of course, this implies some global conditions that must be met, such as global exports and global imports, are the same and that global debt repayment equals global debt receipts each year.

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